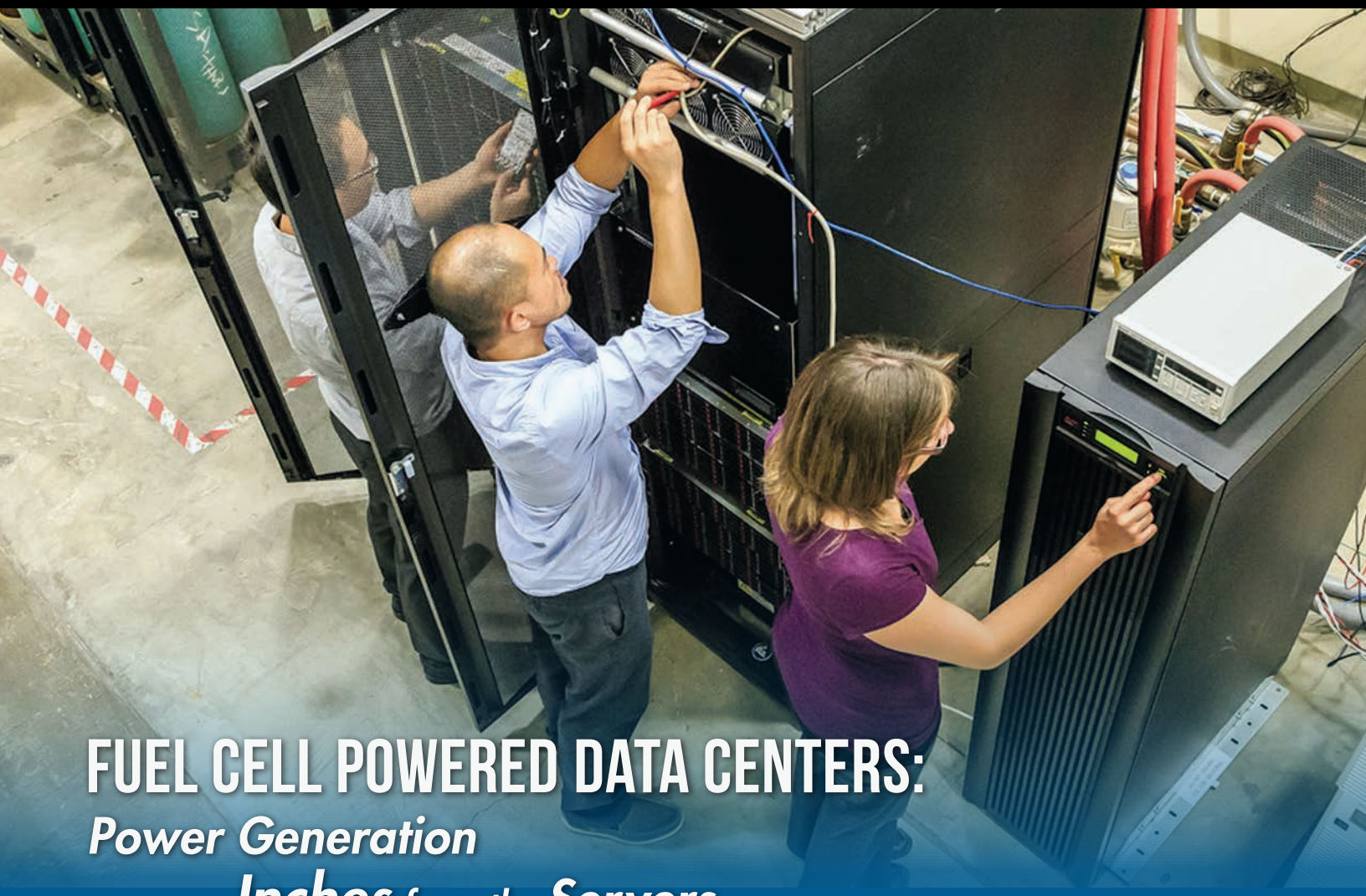
ADVANCED POWER & ENERGY PROGRAM

BRIDGING

Transforming Clean Energy
Developments into Practical Application

Annual Report

Vol. 2 | 2014



FUEL CELL POWERED DATA CENTERS:

Power Generation Inches from the Servers

University of California, Irvine

DIRECTOR'S MESSAGE

Professor Scott Samuelsen
Director, Advanced Power and Energy Program

In the year since the launch of the inaugural edition of our annual Bridging Magazine, the Advanced Power and Energy Program (APEP) has continued to focus on research, our students, and the area that sets APEP apart from other research organizations, deployment. The name of our magazine was specifically chosen to highlight APEP's continual and successful efforts to "Bridge the Gap" between research and application in the everyday lives of Americans and all global citizens. The connection to practical application is supported by our close collaboration with industry, national and international agencies and laboratories, and by APEP's presentation this year of three very significant clean energy events. Each of these events had a global reach and was a synergistic blend of industry, academia, and government agencies targeting specific areas of the global clean energy revolution, yet each focused on a specific area of activity.

The **National Fuel Cell Symposium (NFCS)** brought together leaders from industry, research, and the government to discuss the impact of fuel cell technology on the U.S. and the global community, and the acceleration of this technology to address the nation's most pressing energy, environmental, and economic challenges. Speakers and panel members represented some of those at the forefront of both mobile and stationary fuel cell technology and included: **Toyota, Hyundai, Honda, Mercedes Benz, General Motors, FuelCell Energy, Bloom Energy,** the **California Air Resources Board (CARB),** the **California Energy Commission (CEC),** the **California Fuel Cell Partnership (CaFCP),** the **South Coast Air Quality Management District,** the **California Natural Resources Agency,** the **California Stationary Fuel Cell Collaborative (CaSFCC),** and the **National Fuel Cell Research Center (NFCRC).**

The **International Colloquium on Environmentally Preferred Advanced Power Generation (ICEPAG)**, our annual Colloquium specifically constructed to facilitate a shared understanding of advanced energy technologies, promote strategic alliances between the world's energy communities, and inspire students to embrace the challenges and opportunities associated with advanced power generation, was again a resounding success. Speakers representing leaders in the area of clean power generation and utilization included: the **U.S. Department of Energy (DOE),** the **U.S Trade and Development Agency, Southern California Gas Company (SoCalGas) Southern California Edison (SCE), ETAP, MelRok, FuelCell Energy, Polytechnic University of Torino, Inha University,** and the **University of California, Irvine (UCI).**

The **Microgrid Global Summit** brought together key representatives from industry, utilities, government agencies, and academia from around the world, to examine issues and learn about real-world on the ground Microgrid deployments that are pushing the envelope of energy reliability, quality, and accessibility. Speakers and panelists from across the spectrum of the Microgrid Community included: the **U.S. Department of Energy (DOE), Sandia National Laboratories, MIT Lincoln Labs, Lawrence Berkeley National Labs, Oakridge National Laboratory,** the **U.S. Army Corps of Engineers, MelRok, Siemens, ETAP, Schneider Electric, Bloom Energy, Southern California Edison (SCE), San Diego Gas and Electric (SDG&E), Pareto Energy, GE Energy Storage,** and **Bechtel Power Corporation.**

In summary, we are indebted to our long standing relationships that contribute in so many ways to our research, our real world demonstration projects, our students, and our "Bridging the Gap" between research, industry, and government agencies.

We thank you for your support, partnership, and participation in our efforts.

Scott Samuelsen

OUR APEP MEMBERS

TOYOTA

Southern California Gas Company
A Sempra Energy utility

HORIBA
Explore the future

U.S. DEPARTMENT OF ENERGY

FuelCell Energy

Capstone

California Environmental Protection Agency
Air Resources Board

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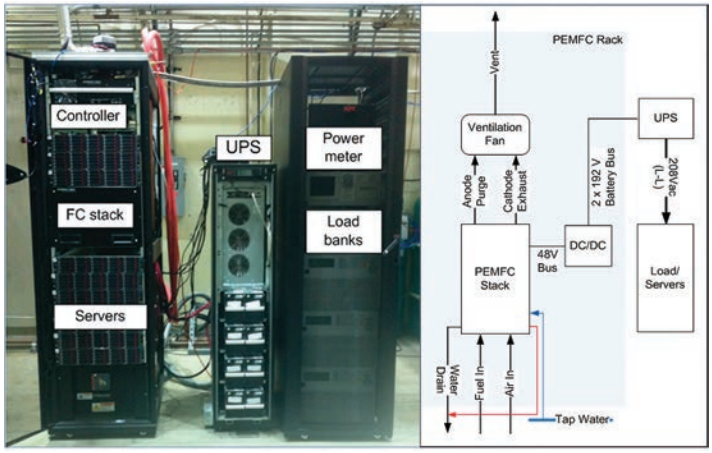
DATA CENTERS AND FUEL CELLS

Data center energy consumption in the United States doubled from 2000 to 2006, and more than 92 billion kWh were consumed in 2013. With fast growing cloud and online services, energy consumption in data centers is expected to double every 5 years. Widespread implementation of fuel cell technology in data centers could significantly lower emissions and overall energy consumption, however only a fraction of data center power is provided by fuel cells today. In the future, fuel cell installations will benefit from the unique features of fuel cells that can be synergistically integrated into data center installations.

A NEW CONCEPT: IN-RACK GENERATION INCHES FROM THE SERVERS

The **National Fuel Cell Research Center** is working with Microsoft to test and demonstrate a direct generation method that places fuel cells in the server rack – inches from the servers, a design that could potentially introduce significant emissions reductions and energy savings, while further enhancing data center reliability. This close proximity allows direct use of DC power without the capital cost, potential failure, and efficiency penalties of AC-DC inversion and conversion equipment. As a result of this concept, power distribution units, high voltage transformers, expensive switchgear, and AC-DC power supplies can be eliminated in data center applications.

The high efficiency potential of fuel cell systems even in small sizes, allows a design that provides for multiple fuel cells installed in a Distributed Fuel Cell (DFC) architecture. DFC limits the power failure domain to a few dozen servers, rather than to a larger portion of or even the entire data center. Utilizing replication and load balancing, modern software technologies can better tolerate such limited failures.



In-Rack Test Unit and System Schematic

DEMONSTRATING THE IN-RACK GENERATION CONCEPT

In close collaboration with Microsoft, the NFCRC has successfully demonstrated the In-rack Generation concept utilizing a rack of servers powered from the direct current (DC) output of a 10kW Proton Exchange Membrane Fuel Cell (PEMFC) stack and system. As the distributed power source is used to power a server rack, it eliminates the need for a power distribution system in the data center, and the grid outside of the data center. Utilizing

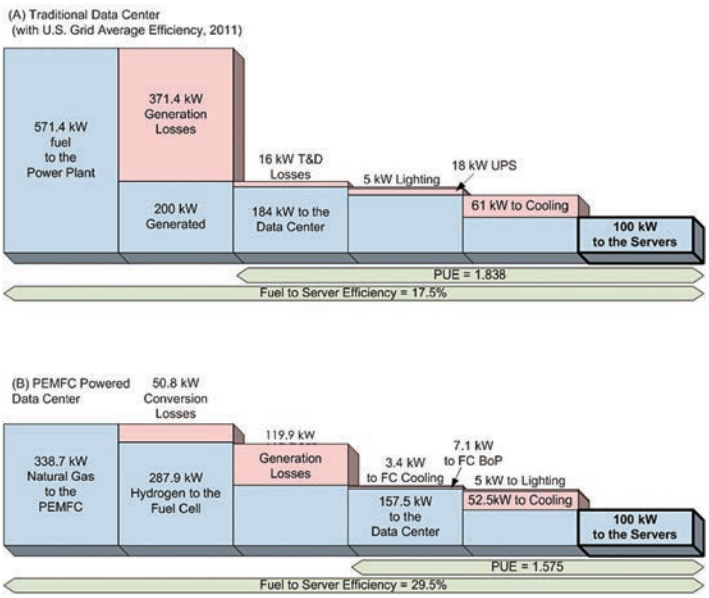
the fuel cell DC output, 53% energy efficiency in a single server rack was achieved.

Dynamic operation of the fuel cell system is also important to the success of In-Rack Generation. Both the steady state performance and the dynamic load following capability of the fuel cell system were evaluated and results showed that the PEMFC is able to respond quickly to both AC and DC load changes directly from the rack. In addition, direct DC power from the fuel cell system can eliminate the capital cost and operating conversion losses from systems that use energy storage and AC/DC conversion equipment. Reducing components in the energy supply chain not only cuts cost but reduces points of maintenance and failure in order to improve availability in data centers.

In the current collaboration, the NFCRC has experimentally and theoretically evaluated In-Rack Generation to determine that it is up to 30% more economical than traditional designs to build and operate. With the improving energy efficiency of small sized fuel cells, we can also predict that the DFC architecture will be cheaper to operate than centralized fuel cells.

EXPECT MORE FROM THE MICROSOFT-NFCRC TEAM!

In future collaborations with Microsoft, the implementation of Solid Oxide Fuel Cells (SOFC) in data center server racks will be evaluated. SOFC advantages include fuel flexibility, non-precious metal catalyst, completely solid-state cell components, and the production of high quality waste heat for co-generation applications. These advantages will enable the direct utilization of natural gas as fuel, and synergistic integration of power and cooling to benefit the data center.



(A) Traditional Data Center System Losses
(B) Fuel Cell Powered Data Center System Losses

UC IRVINE SOLAR SHADE KEEPS THE GRID "COOL"

UC Irvine's plug-in electric vehicle (PEV) drivers now have the ability to charge while attending class or work.

The PEV charging stations, installed at UC Irvine as part of the **Irvine Smart Grid Demonstration** project in collaboration with Southern California Edison, consists of a 48 kW array of solar photovoltaic (PV) panels located on top of an on-campus parking garage, a battery energy storage system (BESS), electric vehicle supply equipment (EVSE), and smart PEV charging capabilities.

The project is designed to study how PEV charging can be implemented with the capability to (1) minimize the impact on the grid during on-peak periods, and (2) charge vehicles with renewable energy around the clock.

The 100 kWh BESS displaces demand on the grid during on-peak demand periods and cloudy days should PEV charging exceed the solar PV generation, and provides a source of renewable power for night charging. Twenty (20) parking spaces, each equipped with a 6.6 kW EVSE, are available for PEV's with a UC Irvine parking permit.

Vehicle Charging Stations in UCI's Anteater Parking Structure

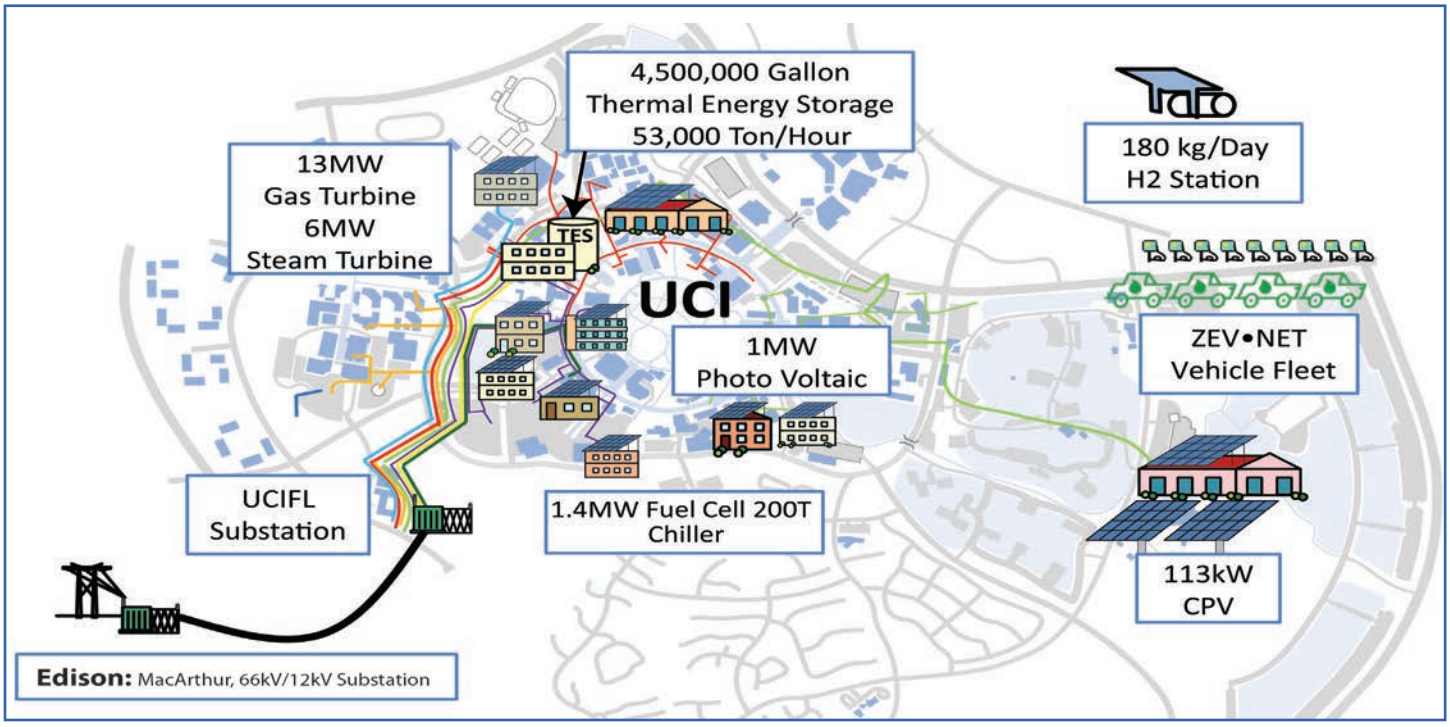
UCI Field Laboratory Wins APPA award

The UC Irvine Field Laboratory, a research-driven partnership led by the Advanced Power and Energy Program (APEP), in collaboration with UC Irvine's Facilities Management and Environmental Planning and Sustainability, has received international recognition for being "extremely innovative" in its use of utility infrastructure as a model for communities and colleges worldwide.

UC Irvine's Campus Energy Manager, Matt Gudorf, accepted APPA's 2013 Effective and Innovative Practices Award for "programs and processes that enhance service delivery, lower costs, increase productivity, improve customer service, generate revenue, or otherwise benefit the educational institution." Other participants include Siemens, MelRoK, Toyota, ETAP, UC Irvine's Transportation and Distribution Services, Southern California Edison, and Southern California Gas Company.

The Field Laboratory acts as a "microgrid" wherein campus power needs are addressed primarily through on-site generation and novel energy efficiency and management strategies. With the use of advanced technologies like concentrated solar power, electric vehicles and charging stations, and high-resolution power metering, APEP is able to collect data and monitor energy usage and savings. With the collaboration of APEP and Facilities Management, UC Irvine acts as a recognizable model for universities and institutes around the world to practice reliable and sustainable energy use strategies.

UCI Field Laboratory



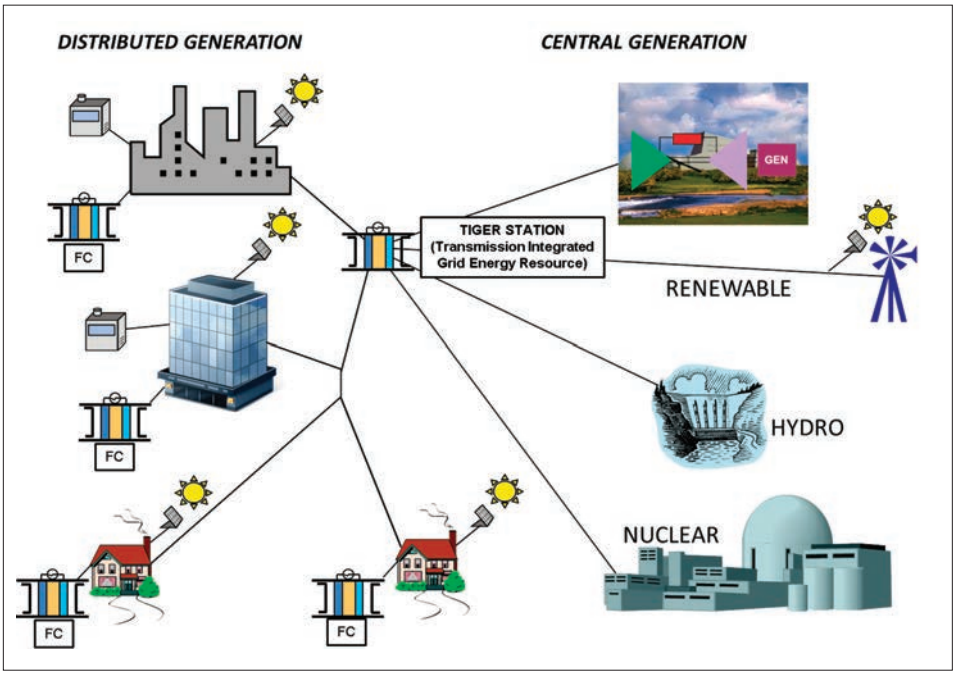
TIGER STATIONS

Transmission Integrated Grid Energy Resource

Dominion Bridgeport Fuel Cell, Bridgeport, CT

The stationary fuel cell market has been experiencing sustained growth over the past five years with a nearly 35% increase in the number of systems shipped from 2011 to 2012 (US DOE). In particular, there has been growing interest in larger, multi-MW stationary fuel cell installations whether at data centers or at utility substations. The **TIGER Station** is a multi-MW class deployment of stationary fuel cell technology at a distribution substation of an electric utility. This concept originated at the National Fuel Cell Research Center as an application of stationary fuel cells that provides desired grid support benefits at the distribution level.

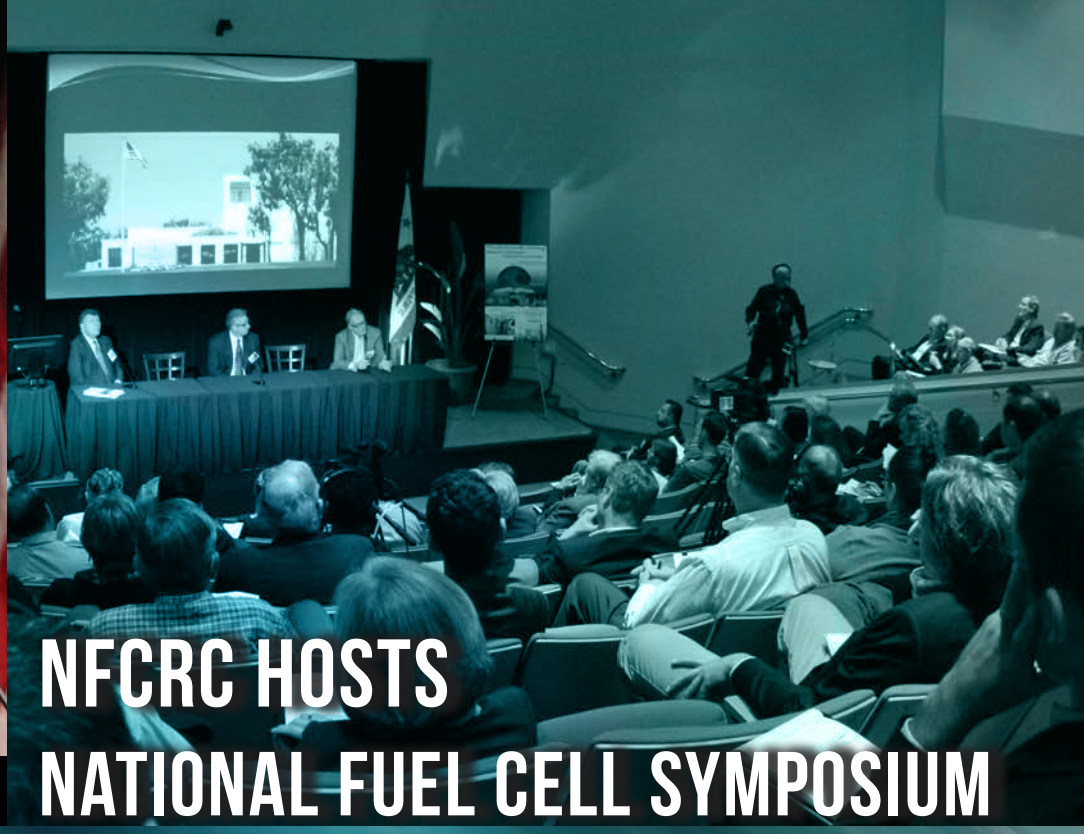
Distribution substations are typically located in or near populated areas, which means locating traditional power generation technologies at substations results in permitting issues given the acoustic and pollutant emissions. Stationary fuel cells have virtually zero pollutant emissions and are acoustically benign, making them much easier to permit in these areas. The substation also provides access to utility communication infrastructure enabling these systems to support the evolving electric grid via ancillary services, flexible operation to buffer intermittent renewables, and emergency support of critical loads served by the substation. TIGER Stations also reduce the need for additional transmission lines and provide congestion relief.



A Schematic Depicting a TIGER Station in the Context of Distributed and Central Generation

NFCRC studies using the Holistic Grid Resource Integration and Deployment (HiGRID) tool have shown that, even at increased levels of renewable penetration, TIGER Stations reduce both carbon and pollutant emissions even with baseload operation. A 5 GW deployment of TIGER Stations was also investigated as illustrative of the estimated capacity required to replace retiring power plants in California. The results show that, at 43% renewable penetration with baseload TIGER Stations, carbon and NOx emissions reductions of 6% and 30% can be achieved, respectively. With added TIGER Station flexibility, carbon emissions could be reduced by 8% and thereby avoid excessive curtailment of renewables.

Professor Scott Samuelsen
Director, National Fuel Cell Research Center



NFCRC HOSTS NATIONAL FUEL CELL SYMPOSIUM

On February 27, 2014, the National Fuel Cell Research Center (NFCRC) hosted the National Fuel Cell Symposium. The Symposium brought together leaders in industry, research, and government to discuss how fuel cell technology is impacting the U.S. today, and how further adoption of both mobile and stationary fuel cell technology can be accelerated to address the nation's most pressing energy, environment, and economic challenges.

UCI's Chancellor Michael Drake welcomed over 200 attendees to this premier event and Mary Nichols, Chair of the California Air Resources Board, provided the opening keynote address. Other keynote addresses were presented by, John Laird, California Natural Resources Agency, and Bert Valdman, Senior Vice President of Strategic Planning, Edison International. Scott Samuelsen, Director of the National Fuel Cell Research Center, provided an introductory message and was the Symposium moderator.

Mary Nichols, Chair of the California Air Resources Board

The afternoon of the event was highlighted by two panel sessions, the first focusing on Hydrogen Fuel Cell Vehicles with panel representatives from major vehicle manufactures. The second focused on the current state and future needs of hydrogen vehicle fueling infrastructure. The number of attendees and the high level of interest expressed by those attending the event is a reflection of the global importance of Fuel Cell Technology in meeting the significant challenges related to clean energy, climate change, and energy independence.

Beyond Computational Fluid Dynamics

As combustion system technology advancements continue, strategies to further reduce pollutant emissions require more detailed understanding of the combustion process. In addition, because these advanced systems are operated near stability limits, they are prone to upsets associated with changes in fuel composition, ambient conditions, and system wear.

Computational fluid dynamics (CFD) can be used to elucidate the details about the combustion system flowfield and temperature field. However, the challenge of coupling the flowfield and temperature to the complex chemistry associated with pollutant formation, limits the ability of CFD to provide the detailed understanding required to further improve combustion technology. As a result, a strategy to combine the overall flow and temperature structure with the complex chemistry has been established in which a series of individual idealized "reactors" are networked together in a manner that mimics the structure of the reaction.

This "reactor network" concept has been used previously to help understand pollutant emissions. In recent years, developments in kinetic mechanisms for various types of fuels combined with ever evolving computational power makes the reactor network a powerful tool for unraveling the dependence of pollutant emissions on fuel composition and burner configurations.

To illustrate its application, the figure presents schematics and NOx results for three different burners. Each were studied as part of a recently completed California Energy Commission project directed at the study of how fuel composition and type impacts operability and emissions of combustion systems (Contract 500-08-034). What is shown and confirmed by measurements for all three burners is that, as hydrogen is added to natural gas, NOx can either increase or decrease depending upon the configuration.

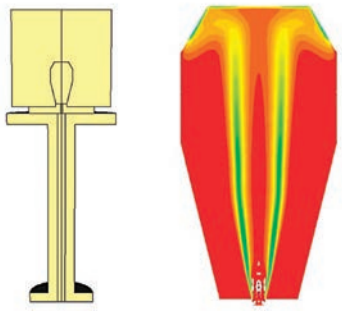
The figure also presents the relative contribution to NOx from different known NOx formation pathways (e.g., thermal or Zeldovich, Prompt, N_2O intermediate, or NNH) and illustrates that:

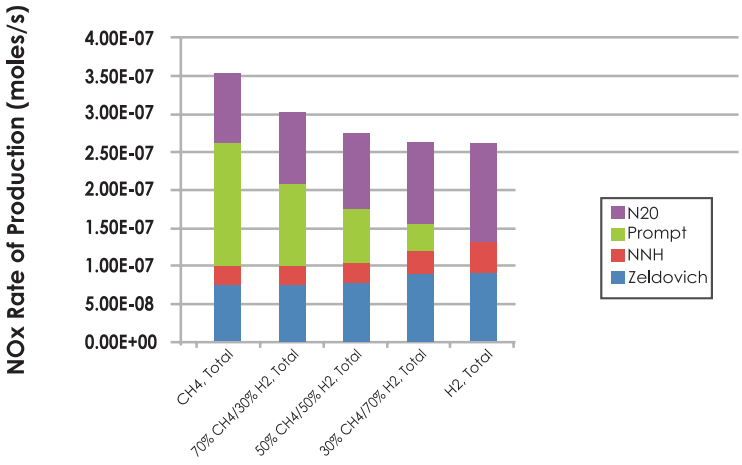
- The Jet Stirred Reactor forms NOx mainly through the Prompt mechanism which requires the presence of CH. Hence as hydrogen is added, CH reduces and the overall NOx is reduced.
- For the swirl burner, NOx changes only modestly as hydrogen is added. In this case as hydrogen is increased, NOx formed via the NNH mechanism dominates and, as hydrogen increases, the relative contributions of the other mechanisms cancel each other out.
- For the microturbine generator, NOx increases with added hydrogen and NOx is formed mainly via the N_2O mechanism. Hence the figure illustrates that the impact of fuel composition on NOx emission is not a general result. With the methodology used to predict how fuel composition impacts emissions, details become available that can be used to explain how the burner geometry also affects the behavior. It can also be used to explore how modifying the burner configuration might help reduce NOx.

In this example, all three burners are low NOx configurations, relying on lean premixed approaches to achieve low emissions. It is expected that all combustion systems will need to move towards lower emission levels and, as a result, many will likely adopt lean strategies with premixed fuel and air. This is certainly the case for gas turbines, low emission boilers, and furnaces which are responsible for much of fuel based power generation. With tools such as the reactor network, we can ascertain a better understanding of how adoption of alternative fuels in these systems impact emissions.

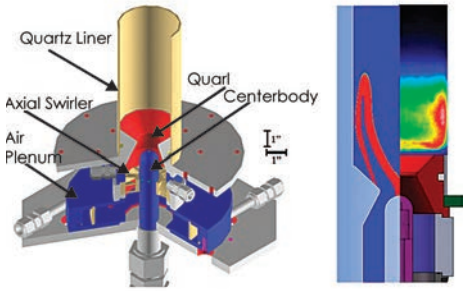
to Reactor Networks

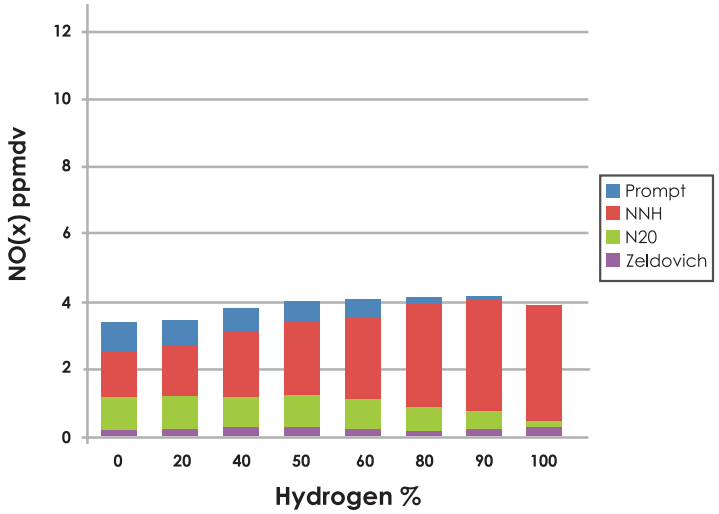
Jet Stirred Reactor
1 atm, 1800 K



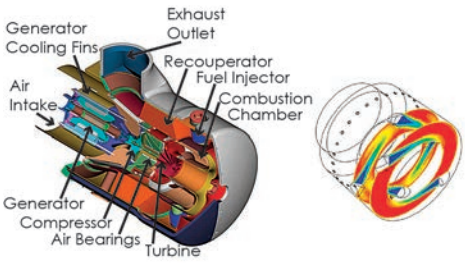


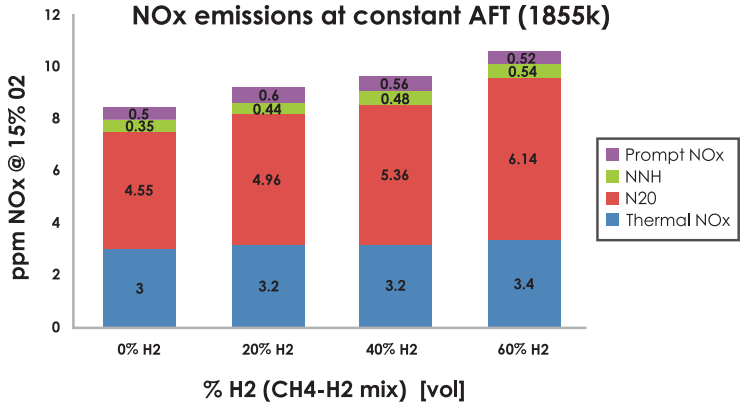
Axisymmetric Swirl Burner
1 atm, 1800 K





Microturbine Generator
4 atm, 1855 K





Summary of Burner Geometry, CFD of Flowfield, and NOx results.

Student Exchange Program Leads to Publication

UC Irvine and the Technical University of Munich have been collaborating on research directed at investigating the mechanisms of flashback in combustion systems. The impetus for collaboration is associated with achieving very low emissions levels through lean premixed combustion strategies. These strategies require very well mixed reactants to be successful. To introduce well mixed reactants to the combustion zone, premixing ducts are used which lead to the possibility of the reaction propagating into the mixing zone causing possible damage and elevated emissions. The collaboration led to identification of additional factors influencing flashback and resulted in a joint publication. The collaboration was made possible through the Bavarian-California Technology Center (BaCaTec) which sponsors high tech research between Bavarian and California institutions. With the success of the initial collaboration a follow-on proposal has been submitted to extend the work to study additional burner materials and to study how combustion acoustics influence the flashback process.

Technische Universität München

BaCaTeC

UCIrvine

RECENT GRADUATES

Doctor of Philosophy (Ph.D.) in Mechanical and Aerospace Engineering

Howard Lee
"NOx Emissions Characteristic in the Wake of a Reacting Air Jet in Rich Crossflow"

Li Zhang
"Charging Infrastructure Optimization for Plug-In Electric Vehicles"

Brian Tarroja
"Advising and Optimizing the Deployment of Sustainability-Oriented Technologies in the Integrated Electricity, Light-Duty Transportation, and Water Supply System"

Zhixuan Duan
"Flashback Propensity of Premixed Jet Flames Operated on Synthetic Gaseous Fuel with Alternative Burner Configurations and Materials"

Master of Science (M.S.) in Mechanical and Aerospace Engineering

Roxana Bekemohammadi
"Development and Verification of a Steady-State Internal Reforming Molten Carbonate Fuel Cell Model for Tri-generation of Hydrogen, Electricity, and Heat"

Justin Chow
"Hydrogen Fueled Hybrid Solid Oxide Fuel Cell-Gas Turbine (SOFC-GT) System for Long-Haul Rail Application"

Renee Cinar
"Applying Smart Grid Technology to the Secondary Distribution System"

Chris Cogan
"Investigating the Integration of Solar Heat Recovery with Natural Gas Absorption Chilling"

Robert Flores
"Control of Dispatch Dynamics for Lowering the Cost of Distributed Generation in the Built Environment"

Guillermo A. Gomez
"Emulsion Jet-in-Crossflow Penetration in High Pressure Conditions"

Fei Gu
"Analysis and Design of a High Efficiency Energy Regenerative Snubber Applied to a Tapped Inductor Boost Converter"

Gevorg Hovakimyan
"Dynamic Modeling and Analysis of Fuel Cell Performance on Aircraft"

Kyle Hosford
"Design and Economic Potential of an Integrated High-Temperature Fuel Cell and Absorption Chiller Combined Cooling, Heat, and Power System"

Anthony Jordan
"The Use of Optimization Search Algorithms on a Scaled Industrial Boiler Under Fluctuating Fuel Composition to Maximize Performance"

James Kast
"Dynamic Modeling, Design, and Performance Evaluation of Large Scale High Temperature Fuel Cell Tri-Generation Systems"

Kersey Manliclic
"Advanced Methodologies for Fuel Cell Vehicle Infrastructure Deployment using Geographic Information Systems (GIS) and Vehicle Sales Data"

Michael McKinnon
"Air Quality Impacts of Greenhouse Gas Mitigation Technologies in the Power Generation and Transportation Sectors"

Gia Nguyen
"Dynamic Modeling and Experimental Evaluation of a High Temperature Polymer Electrolyte Membrane Fuel Cell System"

Karina Reyes
"Development and Simulation of Increased Distributed Generation on a Secondary Circuit of a Microgrid"

Ryan Sullivan
"Dispatch Strategies of Stationary Fuel Cells and Complementary Technologies for Lowering Cost and Reducing Emissions"

Meagan Sung
"Influence of Steam Injection and Water-in-Oil Emulsions on Diesel Fuel Combustion Performance"

Alicia Tan
"Spatially and Temporally Resolved Emissions Impacts of Renewable Energy Integration into the Electric Grid"

Peter Willette
"A Holistic Analysis of the Energy and Environmental Impacts of Hydrogen as an Alternative Fuel in 2050"

Awards

Analy Castillo-Munoz
3-year fellowship from the National Science Foundation to research hydrogen infrastructure for sustainable mass transportation

Dustin McLarty
Fulbright Scholarship supporting four months of energy research at the University of Genoa in Italy

Brian Tarroja
Association of Energy Engineers Dennis Acton Memorial Scholarship and UCI Distinguished Public Impact Fellowship

PUBLICATIONS

BUFFERING INTERMITTENT RENEWABLE POWER WITH HYDROELECTRIC GENERATION: A CASE STUDY IN CALIFORNIA (2013). Applied Energy, Vol. 112, pp. 1–11 (Martin K. Chang, Joshua D. Eichman, Fabian Mueller, Scott Samuelsen)

COORDINATING PLUG-IN ELECTRIC VEHICLE CHARGING WITH ELECTRIC GRID: VALLEY FILLING AND TARGET LOAD FOLLOWING (2014). Journal of Power Sources, Vol. 257, pp. 412-420 (Li Zhang, Faryar Jabbari, Tim Brown, and Scott Samuelsen)

DYNAMIC DISTRIBUTED GENERATION DISPATCH STRATEGY FOR LOWERING THE COST OF BUILDING ENERGY (2014). Applied Energy, Vol. 123, pp. 196-208 (Robert J. Flores, Brendan P. Shaffer, and Jacob Brouwer)

EVALUATION OF THE EFFECTS OF CARBON TO HYDROGEN RATIO AND SULFUR LEVEL IN FUEL ON PARTICULATE MATTERS FROM MICRO GAS TURBINE ENGINE (2014). Journal of Engineering for Gas Turbines and Power, Vol. 136, Issue 2, pp. 024501-1 to 024501-4 (Takeshi Akamatsu, Richard Hack, Vince McDonell, and Scott Samuelsen)

FEASIBILITY OF SOLID OXIDE FUEL CELL DYNAMIC HYDROGEN COPRODUCTION TO MEET BUILDING DEMAND (2014). Journal of Power Sources, Vol. 248, pp. 58-69 (Brendan Shaffer and Jacob Brouwer)

FLASHBACK AND TURBULENT FLAME SPEED MEASUREMENTS IN HYDROGEN/METHANE REACTIONS STABILIZED BY A LOW-SWIRL INJECTOR AT ELEVATED PRESSURES AND TEMPERATURES (2014). ASME Journal of Engineering for Gas Turbines and Power, Vol. 136, No. 3, pp. 031502-1 -- 031502-9 (D.J. Beerer, V.G. McDonell, P. Therkelsen, and R.K. Cheng)

FUEL CELL-GAS TURBINE HYBRID SYSTEM DESIGN PART I: STEADY STATE PERFORMANCE (2014). Journal of Power Sources, Vol. 257, pp. 412-420 (Dustin F. McLarty, Jacob Brouwer, and Scott Samuelsen)

FUEL CELL-GAS TURBINE HYBRID SYSTEM DESIGN PART II: DYNAMICS AND CONTROL (2014). Journal of Power Sources, Vol. 254, pp. 126-136 (Dustin F McLarty, Jacob Brouwer, and Scott Samuelsen)

H2 COPRODUCTION IN IGCC WITH CCS VIA COAL AND BIOMASS MIXTURE USING ADVANCED TECHNOLOGIES (2014). Applied Energy, Vol. 118, pp. 258-270 (Ashok Rao, Qin Chen, and Scott Samuelsen)

HYBRID FUEL CELL GAS TURBINE SYSTEM DESIGN AND OPTIMIZATION (2013). Journal of Fuel Cell Science and Technology, Vol. 10, No. 4, pp. 041005-0410016 (Dustin McLarty, Jack Brouwer, and Scott Samuelsen)

IMPACTS OF PLUG-IN HYBRID ELECTRIC VEHICLES ON A RESIDENTIAL TRANSFORMER USING STOCHASTIC AND EMPIRICAL ANALYSIS (2014). Journal of Power Sources, Vol. 252, pp. 277-285 (Ghazal Razeghi, Li Zhang, Tim Brown, and Scott Samuelsen)

INFLUENCE OF BURNER MATERIAL, TIP TEMPERATURE, AND GEOMETRICAL FLAME CONFIGURATION ON FLASHBACK PROPENSITY OF H2-AIR JET FLAMES (2014). ASME Journal of Engineering for Gas Turbines and Power, Vol 136(2), pp. 021502-1 to 021502-10 (Z. Duan, B. Shaffer, V. McDonell, G. Baumgartner, and T. Sattelmayer)

INJECTION OF WATER-IN-OIL EMULSION JETS INTO A SUBSONIC CROSSFLOW: AN EXPERIMENTAL STUDY (2014). Atomization and Sprays, July (C.D. Bolszo, V.G. McDonell, G.A. Gomez, and Scott Samuelsen)

SOLAR POWER VARIABILITY AND SPATIAL DIVERSIFICATION: IMPLICATIONS FROM AN ELECTRIC-GRID LOAD BALANCING PERSPECTIVE (2013). International Journal of Energy Research, pp. Vol. 37, No. 9, pp. 1002–1016 (Brian Tarroja, Fabian Mueller, and Scott Samuelsen)

SUGGESTION OF A MODEL FOR WELL-TO-WHEEL ASSESSMENT CONSIDERING THE REGIONAL CHARACTERISTICS OF FUTURE HYDROGEN AUTOMOBILE SOCIETY (2013). JSAE (Society of Automotive Engineers of Japan), pp. 171-176, Vol. 44, No. 1, January (Kazuhiro Akihisa, Hidemasa Baki, Yuichi Mori, Shane Stephens-Romero, Scott Samuelsen, Masayuki Adachi, and Jiro Senda)

THE EFFECTIVENESS OF PLUG-IN HYBRID ELECTRIC VEHICLES AND RENEWABLE POWER IN SUPPORT OF HOLISTIC ENVIRONMENTAL GOALS: PART 1 - EVALUATION OF AGGREGATE ENERGY AND GREENHOUSE GAS PERFORMANCE CORRESPONDING (2014). Journal of Power Sources, Vol. 257, pp. 461-470 (Brian Tarroja, Josh Eichman, Li Zhang, Tim Brown, and Scott Samuelsen)

HIGHLIGHTS

SPRING 2014

Applied Energy Publication for Hydrogen Co-Production and Biomass

APEP researcher, Qin Chen, along with Dr. Ashok Rao and Professor Scott Samuelsen published a paper in Applied Energy [Vol 118 (2014), pp. 258-270] that identifies suitable advanced technologies for hydrogen co-production in Integrated Gasification Combined Cycle (IGCC) with carbon capture and sequestration (CCS) using coal and biomass mixtures.

UCICL Hosts Annual Gas Turbine Combustion Short Course

Attendees from across the U.S. received comprehensive instruction on the emissions, design, performance, theory, and regulations associated with gas turbine combustion systems.

APEP Students Present Research at CalTech

Three APEP students, Meagan Sung, Elliot Sullivan-Lewis, and Howard Lee, presented papers at the 2014 Spring Meeting of the Western States Section of the Combustion Institute held on the campus of the California Institute of Technology in Pasadena, CA.

ICEPAG Clean Energy Conference 14th Year of Success

APEP hosted its 14th annual International Colloquium on Environmentally Preferred Advanced Power Generation (ICEPAG).

Microgrid Global Summit 2014

APEP brought together global technology and business leaders for a four-day summit to discuss the very latest market opportunities, strategies, and technology developments powering the microgrid industry .

WINTER 2014

Bloom Energy Installs First Fuel Cell Overseas with Investment From Japan's Softbank

SoftBank, a Japanese technology investment company, has entered into a joint venture with Bloom Energy, a fuel cell manufacturer from Silicon Valley, to bring its fuel cell products to Japan. As a result of their venture, a 200–kilowatt system was installed to power 75% of the energy needs for a 21-story high-rise building in Fukuoka, the first Bloom Energy fuel cell to be installed outside the U.S.

UK Delegation Explores U.S. Alternative Vehicle Advancements

In January, the United Kingdom's Minister of State for Transport, the Baroness Susan Kramer, lead a delegation to California with the goal of better understanding the current state of alternative vehicles in the U.S. This fact finding mission included the topics of regulation, legislation, and infrastructure, with visits to industry, government, and important research centers including the National Fuel Cell Research Center at the University of California, Irvine.

DOE, Deputy Secretary Poneman Visits UC Irvine

UCI was pleased to host Deputy Secretary Daniel Poneman from the U.S. Department of Energy as he officially revealed that the location for the 2015 Solar Decathlon will be Orange County's Great Park for the second consecutive time.

FALL 2013

Austrian Delegation Tours Irvine Smart Grid Demonstration (ISGD)

APEP hosted the Austrian Ambassador Hans Peter Manz and a delegation of 20 researchers, officials, and journalists during the 2013 Solar Decathlon. APEP conducted a tour of its laboratories and the Irvine Smart Grid Demonstration (ISGD) project.

NFCRC Presents Vision for the Future of Energy at Hydrogen Summit

Professor Scott Samuelsen, Director of the NFCRC, presented at the California Hydrogen Business Council (CHBC) Summit as part of the Executive Panel. During his presentation, he outlined the use of stationary fuel cells for Tri-Generation of hydrogen, electricity and high quality heat, and outlined a vision for how the use of both stationary and mobile fuel cell technology will become prevalent in our energy infrastructure.

CleanTech OC Conference and Expo

APEP participated in CleanTech OC's fourth annual conference as both an exhibitor and a presenter. The conference attracted leaders from the field of clean energy and covered topics that included: cleantech issues unique to Orange County, expansion in the use of natural gas, military adoption of cleantech, building intelligence, and energy efficient technologies.

Fuel Cell Cars Displayed at LA and Tokyo Auto Shows

As fuel cell vehicles near their 2015 retail introduction, major car manufacturers such as Toyota, Honda, and Hyundai, that have been working in partnership with the NFCRC on hydrogen infrastructure, unveiled their models at the Los Angeles, Tokyo, and other key global auto shows.

U.S. Department of Energy Solar Decathlon 2013

The U.S. Department of Energy's Solar Decathlon was held in Irvine, CA, the first time it has been held outside the National Mall in Washington DC. UC Irvine was the hosting University for the event, and APEP presented its current fuel cell and advanced power technology research initiatives.

Advanced Power and Energy Program
University of California, Irvine
Irvine, California 92697-3550

www.apep.uci.edu

The Advanced Power and Energy Program (APEP) encompasses three organizational elements: the National Fuel Cell Research Center, the UCI Combustion Laboratory, and the Pacific Rim Consortium on Combustion, Energy, and the Environment.

Major goals include Education, Research and Development, Beta Testing, Demonstration, and Deployment of new technology into the marketplace.

APEP is affiliated with The Henry Samueli School of Engineering at the University of California, Irvine and is located in the Engineering Laboratory Facility (Building 323) near East Peltason Drive and the Engineering Service Road.

For additional information, please contact:

Will Decker
Director of Outreach
Advanced Power and Energy Program
Tel: +1 (949) 824-7302 x11130
Fax: +1 (949) 824-7423
wd@apep.uci.edu