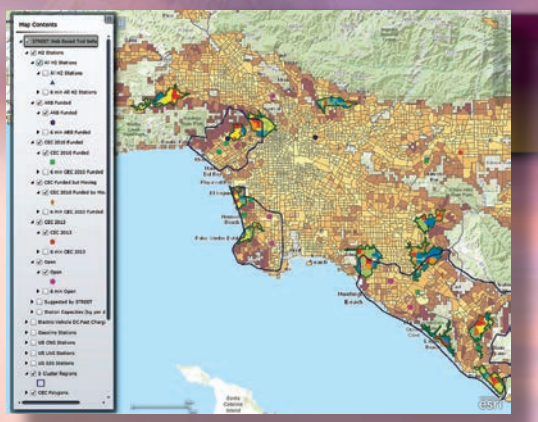
BRIDGING

ADVANCED POWER AND ENERGY PROGRAM

Transforming clean energy developments into practical application

Vol. 1 | JUNE 2013

UNIVERSITY OF CALIFORNIA IRVINE



STREET

Spatially and Temporally Resolved Energy and Environment Tool

Director's Message

Professor Scott Samuelsen
Director
Advanced Power and Energy Program

The Advanced Power and Energy Program (APEP) continues to grow with exciting programs at the frontier of advanced energy devices and systems. The connection of our research to practical application has reached new heights through our close collaborations with industry and national and international agencies and laboratories. Particularly rewarding is the role that the APEP-developed energy and transportation infrastructure planning and analyses tools are playing in (1) the deployment of alternative fueling infrastructure throughout California, and (2) the development for smart grid technology in the context of both high-penetration of renewable solar and wind, and plug-in electric vehicles.

The UCI Combustion Laboratory (UCICL) is having remarkable success in understanding the impact of alternative fuels in gas turbine and industrial combustion applications. Key partners are the ***U.S. Department of Energy*** (DOE), the ***U.S. Department of Defense*** (DoD) the ***California Energy Commission*** (CEC), the ***South Coast Air Quality Management District*** (AQMD), ***General Electric*** (GE), ***Siemens Energy***, ***Solar Turbines Incorporated***, ***Lawrence Berkeley National Laboratory***, and ***Capstone Turbine Corporation.***

The National Fuel Cell Research Center (NFCRC) is witnessing unprecedented international attention associated with the first-of-a-kind demonstration of tri-generation of bio-hydrogen from a stationary fuel cell at the ***Orange County Sanitation District***. Key partners are ***Air Products, FuelCell Energy***, the ***DOE***, the ***California Air Resources Board***, the ***AQMD***, and ***Southern California Gas*** (SoCalGas).

Concerning smart grid technology, two program examples are noteworthy. First, APEP is working with ***Southern California Edison*** (SCE) to lead the Irvine Smart Grid Demonstration Project as it transitions from the preparation stage to the full implementation of research, development and demonstration. In this major ***DOE*** initiative, ***SCE*** and APEP are working with a host of entities that include contributions from ***Toyota***, ***GE, A123 Systems***, ***EPRI***, and ***SunPower***.

Second, APEP is working with UCI Facilities Management to evolve the UCI Microgrid into a major field laboratory. The UCI Microgrid includes one of the most stellar energy efficiency initiatives in the country, the broadest array of advanced energy and transportation technologies, and the latest in diagnostics and computer simulation resources. Key partners are ***ETAP***, ***MelRoK***, ***SCE***, ***PG&E***, ***SoCalGas***, the ***California Solar Initiative*** under the ***California Public Utilities Commission***, ***Amonix***, the ***CEC***, the ***DOE***, and ***Siemens Corporate Research***.

We are indebted to our long-standing relationship with ***Horiba Ltd***. and the outstanding Horiba scholars who contribute in so many ways during their one-year appointments.

In summary (as perhaps you can sense), I am excited to share that the **new era** of APEP, launched in 2010, has been a major success. While demanding, the construct is as effective as it is rewarding.

We thank you for your continuing interest and support.

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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STREET

Spatially and Temporally Resolved Energy and Environment Tool

A New Paradigm in Energy

Over the next decade a transition will occur to a new paradigm in how we use energy, both in electric power generation and in transportation. For electricity, the central plant model of combustion and nuclear based power generation is transitioning to include more local power generation with stationary fuel cells, microgrids, smart grid systems, and more renewable electricity production. For transportation, combustion automobiles fueled with gasoline and liquid fuels are transitioning to a more electrified drive train that will more frequently be fueled by electricity and hydrogen. As a result of these transitions, the electric power and transportation sectors will begin to see more interplay and eventually merge into one integrated system. This paradigm shift in our energy infrastructure will require large investments on the part of government, business, and society as a whole.

But how do we know that investments we make today will lead to benefits we hope to achieve in the future, or that we are making those investments in the most efficient way? The **STREET** model (Spatially and Temporally Resolved Energy and Environment Tool), developed by the Advanced Power and Energy Program (APEP), is playing an ever-more prominent role in providing the insight that decision-makers need to help make those investments. With its roots in a U.S. Department of Energy program focused on hydrogen fueling infrastructure, **STREET** is now being relied upon to inform decisions made by industry and government on a wide breadth of alternative transportation fuels including hydrogen, electricity, and natural gas.

UC Irvine Hydrogen Station

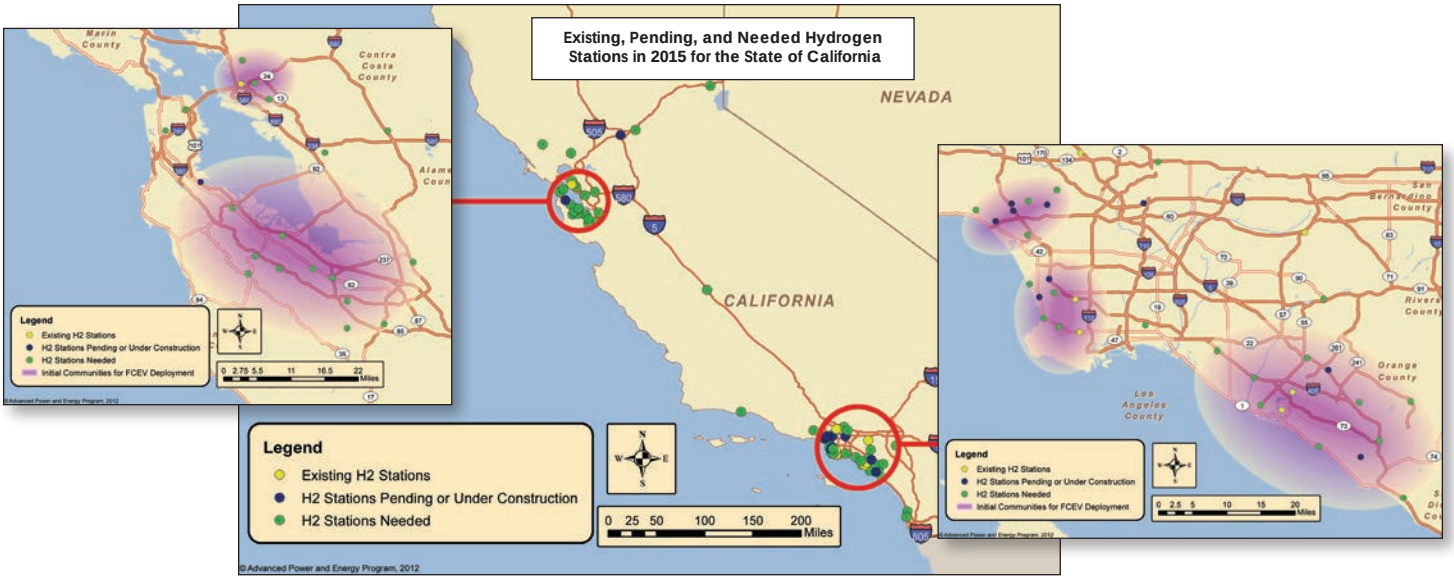
Development and Early Findings

From early on to its current state of maturity, **STREET** has been developed in collaboration with both government and industry. The initial program was funded by the DOE with the goal of optimizing hydrogen infrastructure in California. The program produced hydrogen supply chain models with the capability to assess the ***energy, emissions, and water impacts of future scenarios*** for hydrogen infrastructure deployment. Industry partners who were engaged to critique, provide feedback, and incorporate data into the model development, included automakers, energy companies, and hydrogen providers.

STREET was further developed with the capability to simulate ***air quality impacts*** associated with future scenarios for hydrogen infrastructure deployment. In parallel to the DOE program, APEP had been developing the capability to model urban air quality impacts associated with future energy and emissions scenarios in collaboration with the UC Irvine's Computational Environmental Sciences Laboratory, and with support from the California Energy Commission, California Air Resources Board, South Coast Air Quality Management District, and the San Joaquin Air Pollution Control District.

The integration of hydrogen infrastructure modeling with air quality simulations required spatially and temporally resolved data, which led to adopting geographic information systems (GIS) data as part of the modeling effort. Early results of this capability produced highly geographically detailed planning for hydrogen infrastructure, and demonstrated that hydrogen infrastructure and fuel cell vehicles can reduce GHGs by more than 60% and reduce ozone and particulate concentrations in southern California by 10% and 15% respectively.

Through the use of GIS data, **STREET** further evolved to include the capability to determine the optimal number and location of hydrogen stations needed to serve a community. Demographic data, market data provided by automakers, and traffic flow data, are combined with optimization routine algorithms to identify key communities for early fuel cell vehicle deployment, and the number and location of hydrogen stations needed to serve those communities. A key early result of this modeling effort was that the number of hydrogen stations required to provide a community with the same fuel accessibility as is currently available is only 15% of the number of gas stations, if the locations are optimized.



Spatially and Temporally Resolved Energy and Environment Tool

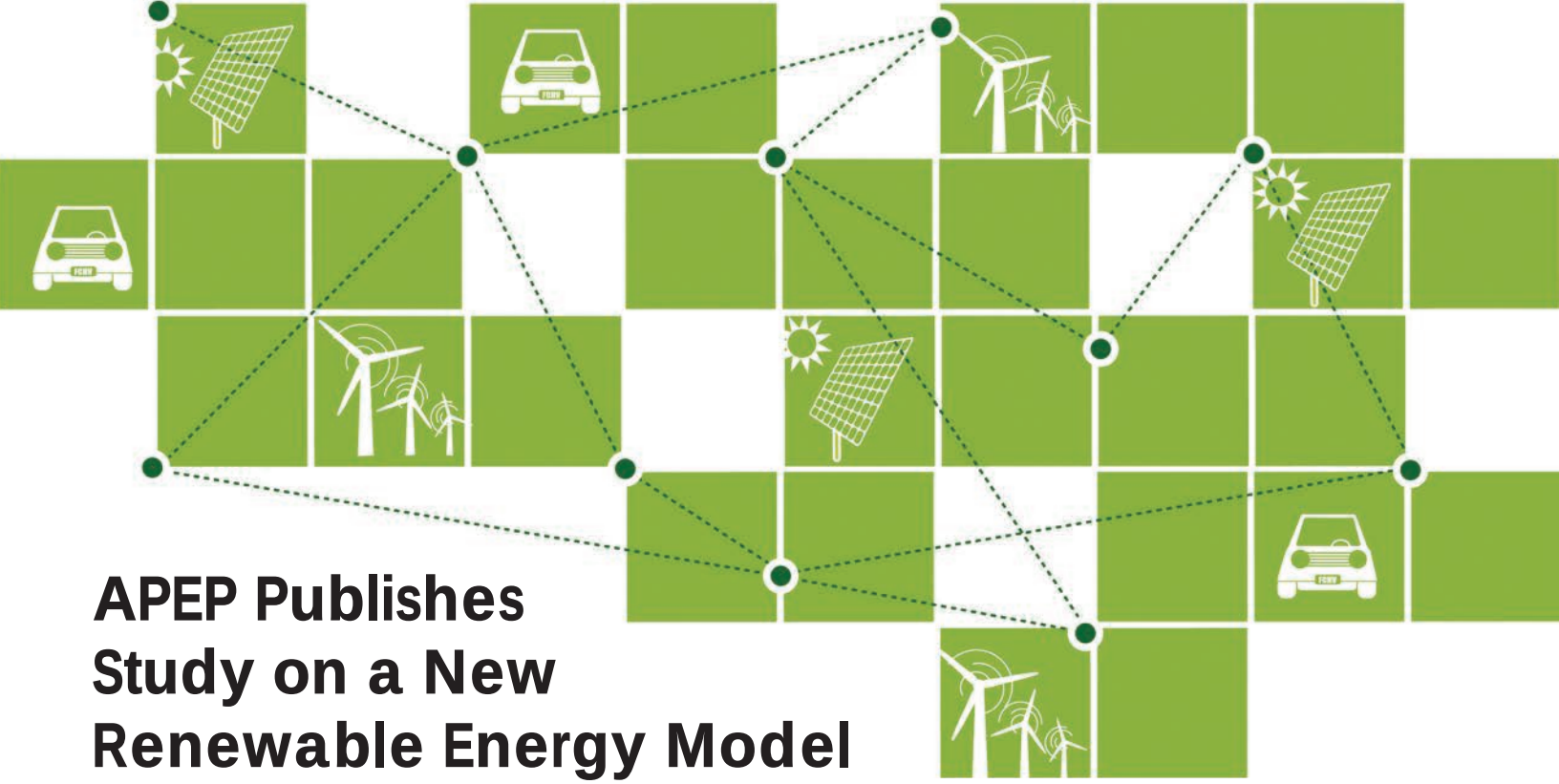
Bridging to Practical Application

As **STREET** matured to encompass the principal capabilities described above, government and business leaders came to recognize its value in assessing how today's investments will impact future energy use, and how those investments can be optimized to reach desired outcomes. For the past few years leaders in business and government have been relying on **STREET** for real world investments and business decisions.

For example, the California Energy Commission, which is charged through California's AB 118 program to make approximately $100 M per year investments in alternative fuels that reduce greenhouse gases, selected **STREET** as the planning tool to help guide their investment decisions. As part of their adoption of **STREET**, they directed APEP to expand the model to include other alternative fuels. Today **STREET** encompasses the ability to model future scenarios for electricity and natural gas as well as hydrogen, and continues to help the Energy Commission make investment decisions for those fuels as well.

In another major example, a stakeholder group of six major automobile companies – Toyota, Honda, Hyundai, Mercedes, General Motors, and Nissan – worked in collaboration with APEP engineers to use **STREET** to estimate the number and location of hydrogen stations needed to launch the fuel cell vehicle market in California. The stakeholder group decided collectively, based on the results of **STREET**, that 68 hydrogen stations strategically located in key market areas of California was the optimal number of stations needed to support the initial retail sales of fuel cell vehicles in the state.

The plan for 68 stations has now been adopted by the Governor's office in the ZEV Action Plan, in the California Energy Commission Solicitation and, by the Air Resources Board. In addition, the plan served as the foundation for the California Fuel Cell Partnership Roadmap for Fuel Cell Vehicles.



APEP Publishes Study on a New Renewable Energy Model

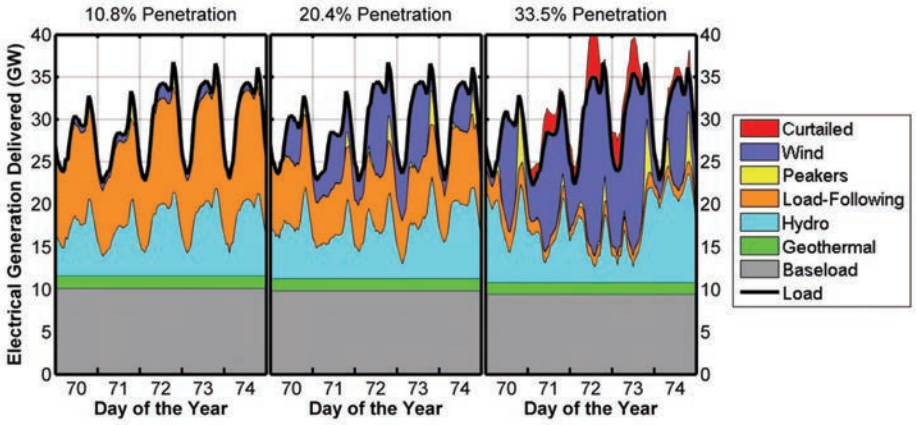
HiGRID models the projected electricity production by resource type as wind and solar penetration increases.

The Advanced Power and Energy Program has developed a high-resolution computer model of the California electric grid that is capable of exploring the impact of renewable generation, electric vehicles, demand response programs, large-scale energy storage, and other types of complementary technologies. A paper describing the model and applying it to scenarios for renewable energy deployment was released in January in the peer-reviewed scientific journal *Energy* (Eichman, et. al).

The model, referred to as the Holistic Grid Resource Integration and Deployment (HiGRID) tool, provides a critical capability at a time when California and a few other parts of the country are beginning to face challenges associated with an increasing penetration of intermittent renewables and plug-in vehicles on the electrical grid.

HiGRID can resolve the hourly operating behavior for each type of power generating facility in California for broad, diverse deployments of new technologies. Understanding the detailed dispatch of generators is the key to accurately assessing greenhouse gas emissions, criteria pollutant emissions, fossil energy consumption, and ultimately future electricity cost. Initial model results show the importance of diversifying renewable power to include both solar and wind resources in order to reduce electric rates.

The Advanced Power and Energy Program has developed a high-resolution computer model of the California electric grid



UC Irvine's Car-Sharing Program

charges ahead

Scion IQ electric vehicles were added to APEP's Zero Emission Vehicle•Network Enabled Transport (ZEV•NET) fleet, thanks to our long history of partnership with Toyota. ZEV•NET provides battery-powered vehicles to commuters who are making that last segment from the Irvine Transportation Center to their place of work. Of only 100 vehicles being manufactured, 90 will be used in U.S. car-sharing demonstration projects. APEP was the first to receive these vehicles in the U.S. With the additional electric vehicles, APEP and the city of Irvine agreed to expand support for the ZEV•NET fleet with additional parking spaces and installation of next-generation battery chargers at the Irvine Transportation Center.

Since 2002, ZEV•NET has been providing vehicles that reduce road congestion and harmful "start-up" emissions through its car-sharing concept. With 10 first-generation RAV4 electric vehicles still in the ZEV•NET fleet, APEP is pleased to now have additional vehicles to proudly serve customers like Oakley, Thales, and Kofax in the Irvine district.

The Tri-Generation Installation at the Orange County Sanitation District

Tri-Generation

Second Year Anniversary

The world's first Tri-Generation fuel cell and hydrogen energy station celebrated its second year anniversary after being commissioned at the Orange County Sanitation District (OCSD) on August 5, 2011. The National Fuel Cell Research Center (NFCRC), one of the main partners on the project, has hosted visits and tours of the demonstration project for over six hundred visitors from all over the world. Like the many hydrogen fueling stations in California, the OCSD station is seeing an increase in use and popularity. The use of Tri-Generation to produce renewable hydrogen has captured the attention of the world.

Tri-Generation technology was first conceived at the National Fuel Cell Research Center in 2002 and then developed further through research and collaboration with Air Products & Chemicals, Inc. and FuelCell Energy, Inc., eventually leading to the demonstration at the OCSD. The project was also developed in collaboration with U.S. Department of Energy, the California Air Resources Board, the South Coast Air Quality Management District, and Southern California Gas.

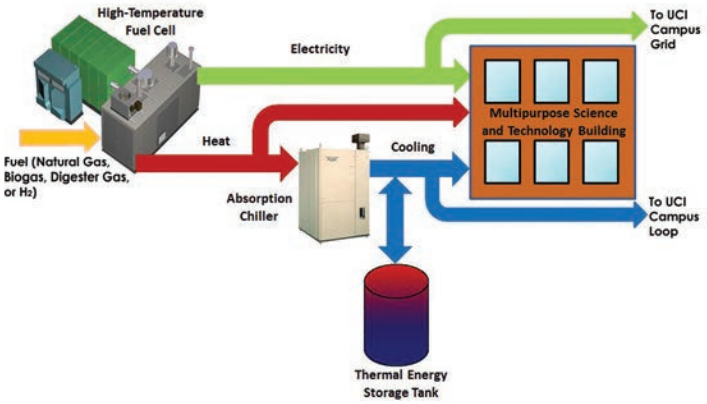
From the collection of waste that is treated at the OCSD this fuel cell is able to produce renewable electricity and heat, while simultaneously producing over 120 kilograms of renewable hydrogen gas to fill on average 30 fuel cell vehicles per day. As more people see how waste can be converted to everyday electricity and fuel, the enthusiasm for fuel cell technology is encouraging car manufacturers such as Toyota, Hyundai, and Honda to commercially deploy fuel cell vehicles by 2015.

Tri-Generation technology was first conceived at the National Fuel Cell Research Center

High Temperature Fuel Cell (HTFC) Chiller

Researchers at the National Fuel Cell Research Center will soon showcase on the UC Irvine campus, the world's first demonstration of a high-temperature fuel cell integrated with an absorption chiller. The system will be installed for a campus building along with an educational display, as part of the NFCRC's efforts to develop and showcase an integrated HTFC with an absorption chiller that provides clean and efficient combined cooling, heat, and power (CCHP) for commercial and institutional buildings. High-temperature fuel cells are highly-efficient, quiet, scalable, and fuel flexible power generators that produce virtually zero criteria pollutants. An exhaust-fired absorption chiller can utilize the high-quality exhaust heat from the fuel cell to generate cooling, replacing the need for electric-driven chillers and increasing overall system efficiency. The integrated HTFC-Chiller system also represents a distributed generation strategy for decreasing grid congestion and avoiding power transportation losses by locating the system near the target loads.

The NFCRC has pioneered research of this system to determine optimal system configurations and operation, scalability, and economic viability. With the help of a third-party provider, the NFCRC is working to design and install an extensively-metered demonstration of this system with a 300 kW molten carbonate fuel cell and a 40 ton exhaust-fired absorption chiller at the Multipurpose Science and Technology Building (MSTB) on the UCI campus. This installation will also feature a heat recovery unit to provide space heating from the fuel cell exhaust, and a thermal energy storage tank to provide cold water storage for buffering periods of extreme cooling demand. The installation, slated for 2014, will operate in island mode by serving only the MSTB building or demonstrate institutional operation by also supplementing the UCI campus grid and chilled water loop.

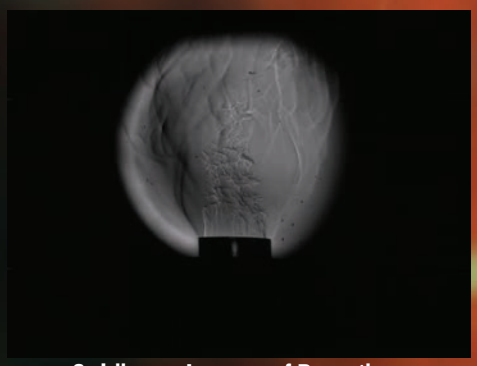


Proposed HTFC/Chiller Installation at UC Irvine

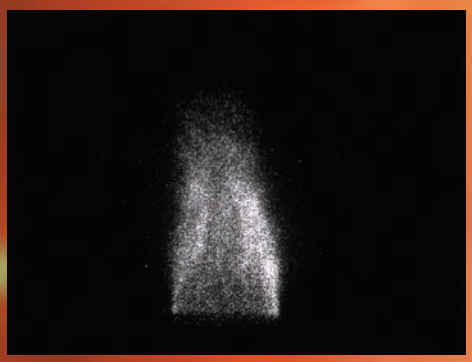
UCICL Research

UNRAVELING the mechanisms of "FLASHBACK"

To attain state-of-the-art criteria emission levels many combustion systems utilize lean premixed strategies. These strategies can avoid formation of high temperature reaction zones that are responsible for high NOx emissions. A challenge with this strategy is that the fuel and air are mixed upstream of the reaction zone. Upsets in the system (e.g., load change, changes in ambient conditions, fuel compositional changes) can lead to propagation of the reaction from the reaction zone into the premixer causing damage and leading to high emissions. An understanding of the mechanisms behind flashback is needed to help designers develop premixing systems that are less prone to flashback. A key mechanism is "boundary layer" flashback. Due to the low velocity region along walls in the premixer, propagation of a reaction from downstream is likely to occur in these regions. The ability to propagate is a complex function of, among other things, the fuel composition, the local conditions within the premixer, the wall material, and the turbulence levels in the system. At the University of California Irvine Combustion Laboratory (UCICL), extensive data have been obtained for various factors and work is underway to develop design rules that predict when flashback will occur. With funding from the California Energy Commission and the U.S. Department of Energy, initial design rules have been developed that can be used to estimate boundary layer flashback in practical premixer tubes.



Schlieren Image of Reaction Just Prior to Flashback



OH* Chemiluminensence Just Prior to Flashback

Novel Diagnostic Methods for Emulsions

The UCICL has developed a novel laser based diagnostic approach which makes it possible, for the first time, to study how water and fuel disperse and mix with air when injected into a combustion chamber. It has been observed that introduction of water into the combustion chamber during combustion can decrease the emissions of pollutants. One concept which appears promising is the introduction of water into the fuel (i.e., as an emulsion) prior to injection into the system which (1) greatly simplifies the injection infrastructure, (2) can enhance atomization, and (3) can improve the range of loads over which the system operates.

However, like an oil and vinegar dressing, the water and fuel resist remaining mixed. As a result, it is very difficult to study the behavior of the spray plume resulting from the injection of the emulsion. One primary question is where does the water and fuel go once injected? By using different wavelength lasers and color filters, it is possible to isolate the spatial distribution of fuel and water from each other, and understand more about how the water and fuel disperse and mix with the air once injected. One key finding is that, despite the highly turbulent nature of the emulsion spray, the density differences and separation time scales of the emulsions can lead to segregation of the two liquids within the spray plume. This has important implications relative to designing combustion systems for optimal performance if operated using an emulsion.

By using different wavelength lasers and color filters, it is possible to isolate the spatial distribution of fuel and water from each other

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PRESSURE-SWIRL ATOMIZATION OF WATER-IN-OIL EMULSIONS (2011).
Atomization and Sprays, Vol 201(12), pp 1077-1099
(C.D. Bolszo, A.A. Narvaez, V.G. McDonell, D.Dunn-Rankin, and W.A. Sirignano).

EXPERIMENTAL STUDY OF OIL-WATER EMULSIONS INJECTED INTO A SUB-SONIC CROSSFLOW (2012).
International Conference on Liquid Atomization and Spray Systems (ICLASS-2012), Heidelberg, September
(C.D. Bolszo, G.A. Gomez, and V.G. McDonell)

Recent Graduates

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

Amin Akbari Monfared, Ph.D.

Dissertation: *Combustion Behavior Associated with Alternative Fuels in Lean Premixed, High-Swirl Stabilized Distributed Reactions*

Anh-Tuan Do, Ph.D.

Dissertation: *Performance and Controls of Gas Turbine-Driven Combined Cooling Heating and Power Systems for Economic* Dispatch

David Beerer, Ph.D.

Dissertation: *Combustion Characteristics and Performance of Low-Swirl Injectors with Natural Gas and Alternative Fuels at Elevated Pressures and Temperatures*

Dustin McLarty, Ph.D.

Dissertation: *Thermodynamic Modeling and Dispatch of Distributed Energy Technologies Including Fuel Cell – Gas Turbine Hybrids*

Josh Eichmann, Ph.D.

Dissertation: *Energy Management Challenges and Opportunities with Increased Intermittent Renewable Generation on the California Electrical Grid*

Ghazal Razeghi, Ph.D.

Dissertation: *The Deveopment and Evaluation of a Highly-Resolved California Electricity Market Model to Characterize the Temporal and Spatial Grid, Environmental, and Economic Impacts of Electric Vehicles*

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

Hong Hoa Do, M.S.

Thesis: *Model Characterization of the Dispatch Potential of Building HVAC Loads and Resulting Impact on Occupant Comfort*

Josh Payne, M.S.

Thesis: *Analysis of Distribution Circuits with High Penetrations of Photo-Voltaic Generation and Progressive Steps to Enable Higher Penetrations*

Incoming Students

Analy Castillo-Munoz

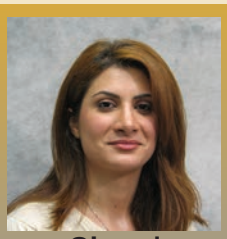
Nathan Kirksey

Adam Silver

Ashley Serbus

Student Awards

Guillermo Gomez



Ghazal Razeghi

Graduate Student Scholarship: $1500 SoCal AEE award recipients

Dimas Avila

Hugo Valverde

Summer Undergraduate Research Fellowship (SURF) recipients

Amin Akbari Monfared

David Beerer

International Gas Turbine Institute (IGTI) Student Scholarship recipients for 2012

Daniel Howard

3 year fellowship from the National Science Foundation to research sustainable energy in California and developing countries. The focus is on bioenergy and renewable energy integration optimization.

Brian Tarroja

"Dennis Acton Memorial Scholarship"- Outstanding Energy Engineering Student Scholarship: $2500

Won the Association of Energy Engineers Scholarship

Authored a report for the California Air Resources Board that will be used to influence the AB32 Scoping Plan Update

Publications

A SPATIALLY RESOLVED PHYSICAL MODEL FOR TRANSIENT SYSTEM ANALYSIS OF HIGH TEMPERATURE FUEL CELLS (2013). International Journal of Hydrogen Energy, Vol. 38, pp. 7935-7946 (D. McLarty, J. Brouwer, and G.S. Samuelsen)

BUFFERING INTERMITTENT RENEWABLE POWER WITH HYDROELECTRIC GENERATION: A CASE STUDY IN CALIFORNIA (2013). Applied Energy, in press (J. Eichman, Chang, Mueller, and G.S. Samuelsen)

DYNAMIC MODELING OF COMPRESSED GAS ENERGY STORAGE TO COMPLEMENT RENEWABLE WIND POWER INTERMITTENCY (2013). International Journal of Hydrogen Energy, Vol. 38, pp. 7867-7880 (J.P. Maton, L. Zhao, and J. Brouwer)

ECONOMIC ANALYSIS OF NEAR-TERM CALIFORNIA HYDROGEN INFRASTRUCTURE (2013). International Journal of Hydrogen Energy, Vol. 38, Issue 10, pp. 3846-3857 (T. Brown, L. Smith Schell, S. Stephens-Romero, and G.S. Samuelsen)

EFFICIENCY COMPARISON OF TRI-GENERATING HTFC TO CONVENTIONAL HYDROGEN PRODUCTION TECHNOLOGIES (2012). International Journal of Hydrogen Energy, Vol. 37, Issue 12, pp. 9853-9862 (P. Margalef, T. Brown, J. Brouwer, and G.S. Samuelsen)

EVALUATION OF CHARGING INFRASTRUCTURE REQUIREMENTS AND OPERATING COSTS FOR PLUG-IN ELECTRIC VEHICLES (2013). Journal of Power Sources, Vol. 240, pp. 515-524 (L. Zhang, T. Brown, and G.S. Samuelsen)

EVALUATION OF THE LEVEL OF GASEOUS FUEL-BOUND SULFUR ON FINE PARTICULATE EMISSION FROM A LOW EMISSION GAS TURBINE ENGINE (2013). ASME J. Engr Gas Turbines and Power, Vol. 135, pp. 031501-1: 8. (B. Spang, S. Yoshimura, R. Hack, V.G. McDonell, and G.S. Samuelsen)

EXPLORATION OF THE INTEGRATION OF RENEWABLE RESOURCES INTO CALIFORNIA'S ELECTRIC SYSTEM USING THE HOLISTIC GRID RESOURCE INTEGRATION AND DEPLOYMENT (HIGRID) TOOL (2013). Energy, Vol. 50, pp. 353 - 363 (J. Eichman, Mueller, B. Tarroja, L. Smith Schell, and G.S. Samuelsen)

QUANTITATIVE ANALYSIS OF A SUCCESSFUL PUBLIC HYDROGEN STATION (2012). International Journal of Hydrogen Energy, Vol. 37, Issue 17, pp. 12731-12740 (T. Brown, S. Stephens-Romero, and G.S. Samuelsen)

STATISTICAL EVALUATION OF RANS SIMULATIONS COMPARED TO EXPERIMENTS FOR A MODEL PREMIXER (2013). Engineering Applications of Computational Fluid Mechanics, Vol. 7(1), pp. 103 -115. (A. Akbari, V.G. McDonell, and G.S. Samuelsen)

STUDY OF FUEL COMPOSITION EFFECTS ON FLASHBACK USING A CONFINED JET FLAME BURNER (2013). ASME J. Engr Gas Turbines and Power, Vol. 135, pp. 011502-1:9 (B. Shaffer, Z. Duan, and V.G. McDonell)

Highlights

Summer 2013

Connectivity Lab

A Connectivity Lab at APEP is being established as a platform that allows for experimentation of real world distributed power generation.

NFCRC briefed CAISO on Fuel Cells.

Professor Scott Samuelsen provided a briefing to 100 CAISO employees outlining a vision for the role that fuel cells can play in the future electrical grid.

CleanTech OC's Smart Grid Symposium held at UC Irvine

CleanTech OC hosted the first-ever Smart Grid Symposium "The Smart Grid – A Revolution in Progress" in collaboration with APEP at UC Irvine.

8th U.S. National Combustion Meeting

UCICL graduate students, Anthony Jordan, Zhixuan Duan, Andrés Colorado, and Dr. Amin Akbari, presented on their research at the 8th US National Combustion Meeting, held in Park City, UT.

ASME International Gas Turbine Institute's Turbo Expo

Zhixuan Duan and Dr. Amin Akbari, UCICL graduate students, participated in the annual ASME International Gas Turbine Institute's Turbo Expo conference in San Antonio, TX.

Spring 2013

Elementary and middle school students learn about clean energy while visiting APEP

Students from Our Lady of Peace School in North Hills and Tarbut V'Torah Middle School in Irvine visited APEP to learn about sustainable energy and the real life application of alternative energy systems.

ICEPAG clean energy conference is a success for thirteen years in a row

APEP hosted its 13th annual International Colloquium on Environmentally Preferred Advanced Power Generation (ICEPAG).

APEP scientist publishes book on combined cycle systems for electric power generation

APEP's Dr. Ashok Rao, along with an international team of contributors, released the book "Combined Cycle Systems for Near-Zero Emission Power Generation" through Woodhead Publishing.

Two Major Customers to use Fuel Cells for Clean Energy

May 3rd, 2013 marked the groundbreaking for the largest North American fuel cell power project in Bridgeport, Connecticut. Dominion electric utility will own and operate the 14.9 MW fuel cell system provided by FuelCell Energy, Inc.

A deal announced between ClearEdge Power and Verizon to install ClearEdge Power's PureCell Model 400 stationary fuel cell, at 10 of Verizon's corporate offices, call centers, data centers, and central offices as part of a $100 million investment by Verizon in clean energy projects.

Microgrid World Forum

The Advanced Power and Energy Program co-hosted the first-ever Microgrid World Forum in Irvine, CA, underscoring the leadership role that UC Irvine is playing in shaping microgrid and smart grid strategies.

Tri-Generation Encyclopedia

The definitive book chapter on Tri-Generation of power, heat and hydrogen from a high temperature fuel cell was published by NFCRC researchers in the Encyclopedia of Sustainability Science and Technology.

Winter 2013

White House staffer Cyrus Wadia visits the NFCRC

Dr. Cyrus Wadia, Assistant Director for Clean Energy R&D at the White House Office of Science and Technology Policy, visited the NFCRC to discuss the current status of fuel cell technology as well as the evolution of the market.

Fuel cells maintain power during Hurricane Sandy outages

During Hurricane Sandy power outages, two dozen businesses were able to keep their lights on thanks to their ability to produce power onsite with a stationary fuel cell.

NFCRC hosted the first-ever Tri-Gen Workshop

Representatives from industry, government, and academia visited the NFCRC to attend the first-ever workshop on Tri-Generation of electricity, heat, and hydrogen with a high temperature fuel cell.

UCICL students receive IGTI scholarship

UCICL Ph.D. students, Amin Akbari and David Beerer, were awarded the International Gas Turbine Institute (IGTI) Student Scholarship for 2012.

University Turbine Systems Research Workshop

UC Irvine hosted the three-day annual UTSR Workshop, which was also co-organized by the U.S. Department of Energy, National Energy Technology Laboratory.

Fall 2012

Top DOE officials visit the National Fuel Cell Research Center

Dr. David Danielson, Assistant Secretary for DOE's office of EERE, and Richard Kauffman, Senior Advisor to the Secretary of Energy each were briefed by Professor Samuelsen on recent progress in fuel cell power plants and fuel cell vehicles.

Fuel Cell Briefing at the California Public Utilities Commission

Representatives of the California Stationary Fuel Cell Collaborative and the NFCRC convened at the California Public Utilities Commission (CPUC) in San Francisco to provide a half-day briefing on stationary fuel cell deployment in California.

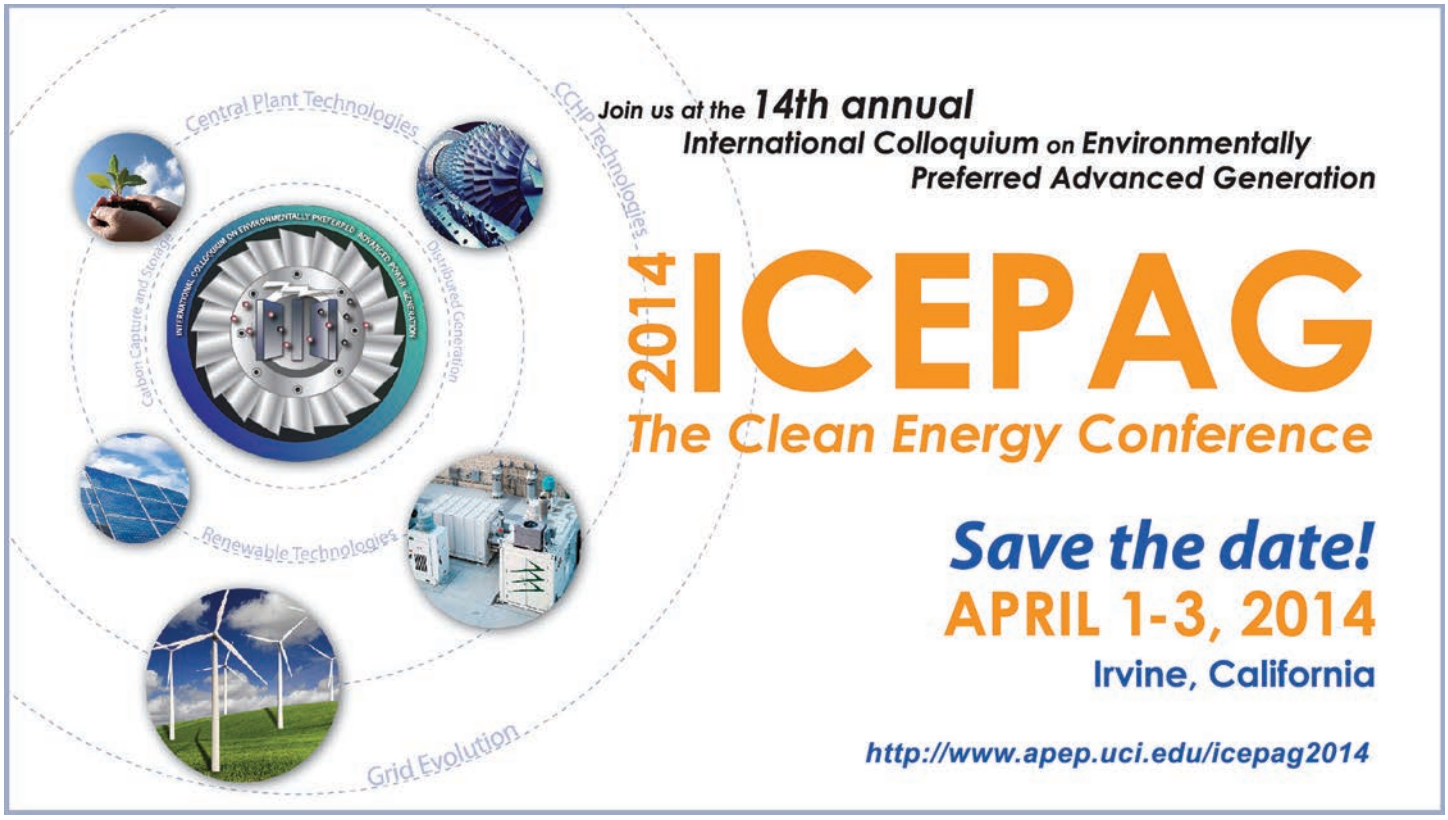
FCHV deployment to Irvine Company

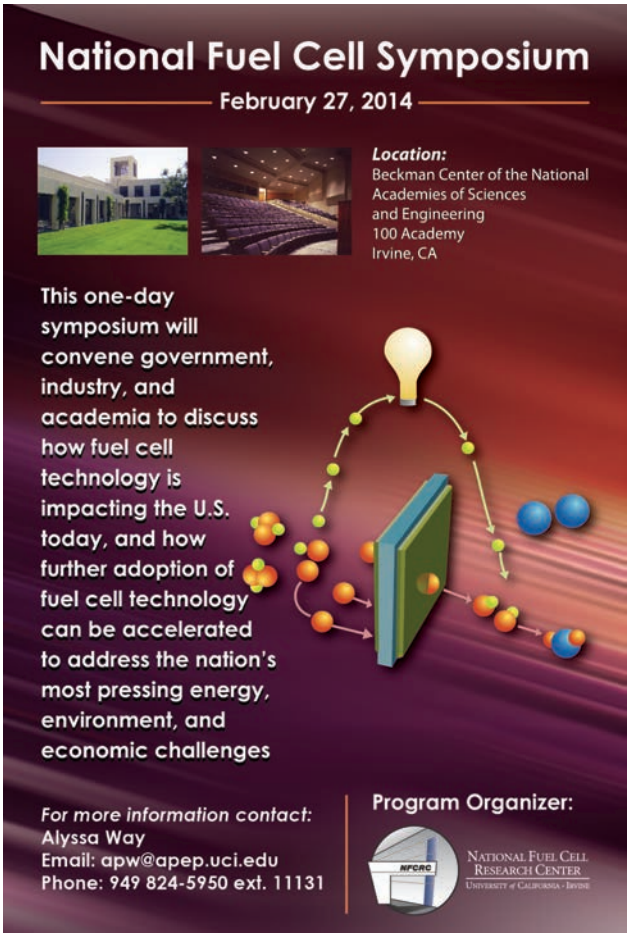
APEP deployed two Toyota Fuel Cell Vehicles to the Irvine Company in November as part of the ongoing vehicle deployment program. APEP is currently managing 17 fuel cell vehicles and two hydrogen stations as part of the deployment program.

Elementary school students learn about clean energy during a visit to APEP

Fifth graders from Viejo Elementary, a local Orange County elementary school in Mission Viejo, visited APEP to learn about clean energy, engineering, college life, and participate in a hands-on activity.

Coming Events - 2014





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

www.apep.uci.edu

The Advanced Power and Energy Program (APEP) consists of 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, Demonstrations, and Facilitation of New Technologies into the Market.

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

For additional information, please contact:

Dr. Shane Stephens-Romero
Manager, Program Development
and External Relations
Advanced Power and Energy Program
Tel: +1 (949) 824-1999 x11118
Fax: +1 (949) 824-7423
ssr@apep.uci.edu