

BOARD MEETING DATE: October 7, 2018

AGENDA NO. 8

**PROPOSAL:** Approve Endowment to University of California Irvine to Support Graduate Student Scholarship Fund and Execute Contract to Develop Fuel Cell-Gas Turbine Hybrid Technology

**SYNOPSIS:** The University of California Irvine (UCI) is seeking endowment funding that will support the research and education of one graduate student to be designated a Samuelsen Energy Visionary Scholar. The graduate student will lead and promote important and impactful research for air quality and emissions reductions. Additionally, UCI through its Advanced Power and Energy Program is working on developing solid oxide fuel cell-gas turbine (SOFC-GT) hybrid technology. This project will focus on the modeling of a SOFC-GT integrated system using biogas, natural gas and renewable hydrogen fuels for applications in the 1-10 megawatt range. These actions are to approve a one-time \$1 million endowment to UCI from interest accrued in the BP ARCO Settlement Projects Fund (46) for the scholarship fund and to execute a contract with UCI in an amount not to exceed \$200,000 from the Clean Fuels Fund Program (31) for the SOFC-GT hybrid technology.

**COMMITTEE:** Technology, September 21, 2018; Recommended for Approval

**RECOMMENDED ACTIONS:**

1. Authorize the Chairman to execute an agreement with the University of California Irvine to contribute \$1 million from interest accrued in the BP ARCO Settlement Projects Fund (46) for an endowment to support a graduate student scholarship fund for a Samuelsen Energy Visionary Scholar.
2. Authorize the Chairman to execute a contract with the University of California Irvine in an amount not to exceed \$200,000 from the Clean Fuels Fund Program (31) for development of SOFC-GT hybrid technology.

Wayne Natri  
Executive Officer

## **Background**

### Endowment to Support Scholarship Fund

The University of California Irvine (UCI) has a long history of excellence in clean energy, emissions reductions and air quality research, beginning with the establishment of the UCI Combustion Laboratory by Dr. Scott Samuelson in 1970. Dr. Samuelson pioneered the development and implementation of low nitrogen oxide combustion technology for power plants with Southern California Edison. He also worked with CARB to investigate and recommend gasoline octane rating standards, researched pathways to reduce pollutant emissions from gas turbine combustion, envisioned a renewable solar and wind powered world that was complemented by a zero emissions dispatchable technology, and coordinated with DOE and CEC to establish the National Fuel Cell Research Center at UCI. Dr. Samuelson also established the Advanced Power and Energy Program (APEP) at UCI, with a mission to advance the development and deployment of efficient, environmentally sensitive and sustainable power generation and energy conversion worldwide.

Dr. Samuelson's vision of research and education in the fields of clean energy, emissions reductions and air quality research has significantly enhanced the field of energy generation and management. UCI is seeking endowment funding to establish a permanent Samuelson Energy Visionary Scholarship for graduate students dedicated specifically to important air and climate issues being addressed by the SCAQMD.

### Development of Fuel Cell-Gas Turbine Hybrid Technology

Additionally, UCI APEP is conducting a DOE-funded study for the development of solid oxide fuel cell-gas turbine (SOFC-GT) hybrid technology with the goal to dramatically reduce the water requirement for operating on natural gas distributed generation (~10 MW) and gasified coal and biomass central power generation (~100MW). A suitable fuel cell for these applications is the SOFC which may be fueled by natural gas, biogas and hydrogen. The SOFC-GT hybrid technology may achieve a high efficiency generation of electricity up to 75 percent. Due to the ultra-high efficiency of the SOFC-GT hybrid system, CO<sub>2</sub> emissions are reduced significantly. UCI is interested in leveraging the DOE-funded study to expand the scope to include natural gas, biogas, mixtures of natural gas and biogas, and eventually renewable hydrogen applications in the 1-10 MW range for potential uses for off-road vehicles.

## **Proposal**

### Endowment to Support Scholarship Fund

The proposed endowment, in conjunction with matching support by APEP, will provide a one-year graduate student scholarship that will be supported annually in perpetuity. This program will be overseen by an advisory board consisting of representatives from UCI, APEP, SCAQMD and CARB, providing guidance for the selection of the Samuelson Energy Visionary Fellow, relevant topics for research and coursework, and recommendations for program management and effectiveness. The attached summary

outlines the proposed endowment approach, with anticipated refinements to be further discussed with UCI, including specific use of SCAQMD funding and guidance by the advisory board. This action is to approve a one-time \$1 million endowment to UCI from interest accrued in the BP ARCO Settlement Projects Fund (46).

#### Development of Fuel Cell-Gas Turbine Hybrid Technology

The proposed project will develop an integration model to fully realize the potential of hybrid SOFC-GT systems in the 1-10 MW range fueled by natural gas, biogas and renewable hydrogen. The model will quantify thermal and environmental performances and economics of various alternate schemes. The 1-10 MW range is applicable for repowering locomotives with SOFC/GT power blocks, from switchers (~1MW) to long-haul locomotives (~5 MW). Similarly, ocean going vessel (OGV) power also falls into this power range. The potential for powering locomotives and OGVs powered by SOFC-GT technology will be addressed along with the applications to the distributed generation market. This action is to execute a contract with UCI in an amount not to exceed \$200,000 from the Clean Fuels Program Fund (31).

#### **Sole Source Justification**

Section VIII.B.2 of the Procurement Policy and Procedure identifies four major provisions under which a sole source award may be justified. This request for sole source award is made under provision B.2.d.(8): Research and development efforts with educational institutions or nonprofit organizations. UCI is an educational institution and the APEP is an umbrella organization that addresses the broad utilization of energy resources and the emerging nexus of electric power generation, infrastructure, transportation, water resources and the environment. Built on a foundation established in 1970 with the creation of the UCI Combustion Laboratory and the 1998 dedication of the National Fuel Cell Research Center, APEP focuses on education and research on clean and efficient distributed power generation and integration.

#### **Benefits to SCAQMD**

An opportunity has arisen to support the UCI proposal in a manner that could result in significant benefits for SCAQMD. Specifically, the endowment will enhance the SCAQMD's long-standing relationship with UCI in a manner that could provide additional training of SCAQMD staff and provide opportunities for enhanced candidate pools for mobile source related positions at SCAQMD as well as opportunities to partner on issues related to energy production and management, mobile source emissions characterization and control, related health impacts, and planning and control strategy implementation.

Additionally, the modeling study on the SOFC-GT power capability for locomotives and OGVs has the potential to significantly reduce criteria pollutant emissions from mobile sources, and the technology could be subsequently developed and implemented in some on-road vehicles.

**Resource Impacts**

Endowment to Support Scholarship Fund

Sufficient funds are available for a contribution of \$1 million from the interest accrued in the BP ARCO Settlement Projects Fund (46).

Development of Fuel Cell-Gas Turbine Technology

The total cost for the proposed project to develop SOFC-GT hybrid technology is \$900,000, of which SCAQMD’s proposed cost-share will not exceed \$200,000 from the Clean Fuels Program Fund (31), as summarized below.

<b>Proposed Project</b>	<b>Funding Amount</b>	<b>% of Project</b>
UCI/DOE (match funding)	\$700,000	78
SCAQMD ( <i>requested</i> )	\$200,000	22
<b>Total</b>	<b>\$900,000</b>	<b>100</b>

Sufficient funds are available from the Clean Fuels Program Fund, established as a special revenue fund resulting from the state-mandated Clean Fuels Program. The Clean Fuels Program, under Health and Safety Code Sections 40448.5 and 40512 and Vehicle Code Section 9250.11, establishes mechanisms to collect revenues from mobile sources to support projects to increase the utilization of clean fuels, including the development of the necessary advanced enabling technologies. Funds collected from motor vehicles are restricted, by statute, to be used for projects and program activities related to mobile sources that support the objectives of the Clean Fuels Program.

**Attachment**

“Endowing the Samuelson Energy Visionary Scholarship Program at the University of California Irvine”

## ATTACHMENT

### Endowing the **Samuelsen Energy Visionary Scholarship Program** at the University of California, Irvine

UC Irvine has a long history of excellence in clean energy, emissions reduction, and air quality research, beginning with the establishment of the UCI Combustion Laboratory by Professor Scott Samuelsen in 1970. Prof. Samuelsen pioneered the development and implementation of low nitrogen oxide combustion technology for power plants with Southern California Edison. He also worked with the California Air Resources Board to investigate and recommend gasoline octane rating standards that led to the widely adopted (R+M)/2 method. He tirelessly worked to reduce pollutant emissions from gas turbine combustion as applied to jet propulsion and power plant applications. In the early 1990s Prof. Samuelsen envisioned a renewable solar and wind powered world that was complemented by a zero-emissions dispatchable technology. He determined that fuel cell technology would best meet the need and worked with the U.S. Department of Energy and the California Energy Commission and more than 15 companies to establish the National Fuel Cell Research Center at UC Irvine in 1998. He has since established the Advanced Power and Energy Program (APEP) at UC Irvine, with a mission to advance the development and deployment of efficient, environmentally sensitive, and sustainable power generation and energy conversion worldwide.

Prof. Samuelsen is one of the most widely recognized scholars, researchers, mentors and policy leaders in the worldwide fuel cell community. He is the most recognized leader in the state of California and one of the most recognized in the world for developing the technology and policy framework for introducing stationary fuel cell systems, hydrogen infrastructure for fuel cell vehicles, and the initial market for fuel cell electric vehicles.

Prof. Samuelsen's work in power plant emissions reductions has been widely implemented in California and adopted world-wide to meet strict emissions standards leading to better air quality. His gas turbine combustion nitrogen oxide reduction research has influenced the design of all modern jet aircraft engines in use today. More than 500 MW of stationary fuel cell systems have been installed in markets in California, the northeastern U.S., Korea, and Japan, in large-part due to his research and policy work. He mentored students who have become entrepreneurs in zero emissions vehicles, zero-emissions stationary fuel cell power generation, hydrogen infrastructure development, and green buildings who all lead successful and profitable companies. The National Fuel Cell Research Center that he has led for the last 20 years has invented tri-generation technology that has become commercially developed by a partner company (FuelCell Energy) and implemented by Toyota and other partners to most efficiently produce electricity, heat and hydrogen in the LA/Long Beach Port.

To continue Prof. Samuelsen's vision of research and education in the fields of clean energy, emissions reduction, and air quality research that will change the world, APEP is seeking \$1 million in endowment funding to establish a permanent **Samuelsen Energy Visionary Scholarship** dedicated specifically to the important air and climate issues being addressed by the South Coast Air Quality Management District, the California Air Resources Board, the Bay Area Air Quality Management District, and others. APEP is committed to garner matching support for this new program, which will provide a 1-year graduate student scholarship that will be supported annually in perpetuity. Each year, the graduate student that is designated a "Samuelsen Energy Visionary Scholar" will be required to be an outstanding scholar (mainly determined by grades in classes, research accomplishments (e.g., publications), and letters of recommendation), AND, must be an "energy visionary" or potential

“energy visionary” that is leading and promoting important and impactful research in a sustainable energy and environment field. This is all in the mold of Professor Scott Samuelsen.

This proposed program will be overseen by an Advisory Board consisting of representatives from UC Irvine, APEP, the South Coast Air Quality Management District, and the California Air Resources Board. The Advisory Board will provide guidance for the selection of the Samuelsen Energy Visionary Fellow, relevant topics for research and coursework, and recommendations for program management and effectiveness. The program will be sustained with investment interest proceeds from the endowment, as well as from support from other individuals and organizations interested in supporting the endowment. Example initial topic areas and coursework areas that are suggested for the program are outlined below:

**Topic 1: Sustainable Energy Conversion Technology**

- *Fuel cell technology for stationary power*
- *Fuel cell technology for vehicles (especially heavy duty)*
- *Zero emissions and renewable hydrogen production technologies*
- *Zero emissions and renewable hydrogen end-use technologies*
- *Novel high efficiency electrolysis technology*
- *Hybrid fuel cell gas turbine and fuel cell battery systems*

**Topic 2: Criteria Pollutant Emissions & Air Quality**

- *Pollutant emissions impacts of alternative fuels and conversion technologies*
- *Measurement of pollutant emissions from multiple sources*
- *System dynamic impacts of alternative fuels and conversion technologies*
- *Spatial and temporal characterization of future emissions*
- *Developing future pollutant emissions scenarios*
- *Regional air quality modeling*

**Topic 3: Energy Sustainability & Climate Change**

- *Primary energy resource availability and dynamics*
- *Climate change and sustainability*
- *Integrated food, energy, and water sustainability*
- *Climate modeling*
- *Atmospheric chemistry of PM formation, toxics, and ozone*
- *Atmospheric chemistry of greenhouse gases*

**Topic 4: Sustainable Transportation Systems**

- *Shared-use vehicles and mass transit facilitation*
- *Autonomous vehicle emissions and sustainability dynamics*
- *Low carbon infrastructure and efficient transportation system operations*
- *Low impact and sustainable land use transportation systems*
- *Zero emission vehicles and fuels*
- *Intelligent transportation systems and automation*

**Topic 5: Sustainable Stationary Power and Energy Systems**

- *Renewable solar and wind power generation*
- *Renewable gas production and use*
- *Energy storage technologies*

- *Smart grid technologies*
- *Sustainable Micro- and Nano-grid technologies*

**Topic 6: Sustainable Energy and Transportation Policy**

- *Sustainable energy law and policy development and support*
- *California region, state, and international air quality policies and regulations*
- *California region, state, and international sustainable energy and climate change policies and regulations*
- *Integrated analysis and support of climate change, toxic and air quality policies and regulations*
- *Impacts in disadvantaged communities*