UNIVERSITY OF CALIFORNIA
UC RIVERSIDE | CE-CERT
BOURNS COLLEGE OF ENGINEERING
CENTER FOR ENVIRONMENTAL RESEARCH AND TECHNOLOGY

2017 ANNUAL REPORT

PUBLISHED
MAY 2018

WELCOME TO THE CENTER FOR ENVIRONMENTAL RESEARCH AND TECHNOLOGY

For over 25 years, the College of Engineering, Center for Environmental Research and Technology has brought together faculty and students from a variety of backgrounds and disciplines in pursuit of the knowledge needed to move us toward our goal of environmental sustainability. From working to understand how emissions impact air quality to developing the technologies needed to improve solar and other renewable energy sources, our research teams are continuing this tradition of innovation through research and development in support of one or more of these five focus areas shown in the figure on the lower right:

01 **Renewable Fuel Development and Energy Management:** Creating renewable fuels from natural waste products, exploring pathways to market for existing alternative fuels, and designing and deploying commercial microgrids that use renewable energy sources and advanced energy management.

02 **Vehicle, Technology, and Combustion Optimization:** Understanding vehicle operations, and how to modify them to maximize efficiency and minimize pollution.

03 **Transportation Systems: Vehicle and Infrastructure Interaction:** Using intelligent vehicles and infrastructure to maximize safety, health benefits, mobility, and efficiency.

04 **Pollution Formation in the Atmosphere:** Understanding how emission sources react in the atmosphere to form toxics, ozone, and particulates that impact human health.

05 **Exposure and Health Effects:** Exploring the effects of air pollution on human health and related quality of life impacts.

01 RENEWABLE FUEL DEVELOPMENT & ENERGY MANAGEMENT

02 VEHICLE, TECHNOLOGY & COMBUSTION OPTIMIZATION

03 TRANSPORTATION SYSTEMS: VEHICLE & INFRASTRUCTURE INTERACTION

04 POLLUTION FORMATION IN THE ATMOSPHERE

05 EXPOSURE & HEALTH IMPACTS

The distinctive mission of the University of California is to serve as a center of higher learning, providing long-term societal benefits through transmitting and discovering advanced knowledge and functioning as an active working repository of organized knowledge. CE-CERT's mission addresses all three aspects of UC's overarching mission: research, education, and public service in the areas of air quality, transportation, and energy.

REFLECTING ON 2017...

CE-CERT continued to make large strides in 2017, building on our many achievements over the last 25 years. This last year we had great success in bringing in several new affiliated faculty from outside of engineering. Many new air quality scientists are now working with us from the College of Natural and Agricultural Sciences, and we now have strong interaction with the School of Medicine as part of the BREATHE (Bridging Regional Ecology, Aerosolized Toxins, & Health Effects) Center. We have also seen a great increase in our policy-related research as a result of our partnership with UCR's School of Public Policy. CE-CERT has become a *de facto* "Institute" at UCR, focusing on many different aspects of sustainability.

We are also proud of our increased engagement activity, focusing on preparing our youth to think deeply and holistically so that they have the chance to become the next generation of innovators, educators, researchers and leaders who will solve the most pressing challenges facing our world. Our STEM program now crosses many of our research disciplines, with several new conferences and activities. One of our major highlights this last year is our new educational initiative aimed at preparing students and professionals of all experience levels across a variety of industries to help the State of California meet its clean air goals through the understanding and application of the latest related research and technologies. The program, called the Air Quality and Climate Research Training (ACT) Program, was made possible in part by a $1 million contribution by the South Coast Air Quality Management District.

As you flip through this annual report, you will see examples of our latest research that we publish, present, and teach. You will also see selected highlights of our 2017 accomplishments along with new graduates and faculty, illustrating how CE-CERT is playing a role in providing real-world solutions to today's challenges.

As always, I would like to thank our university and college leadership, our sponsors, and our faculty, staff and students who provide inspiration and dedication every day. Together, we are moving towards our goal of a sustainable, bright future!

Sincerely,
Dr. Matthew Barth

BOARD OF ADVISORS

2017 CE-CERT BOARD OF ADVISORS

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Sr. Principal Research Chemist, Shell Global Solutions, Inc.

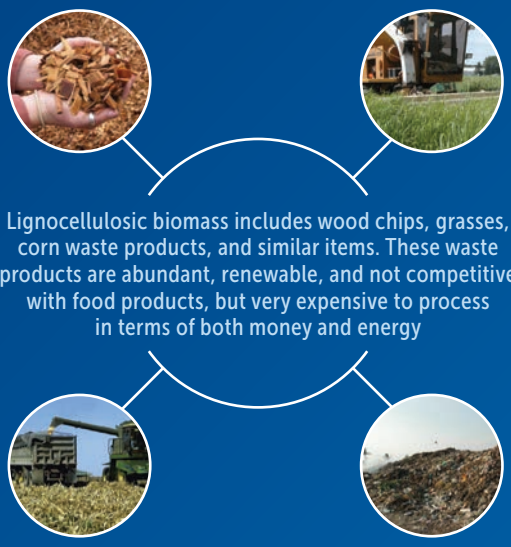
01 RENEWABLE FUEL DEVELOPMENT & ENERGY MANAGEMENT

There is much to be done if California is to realize its vision of sustainable energy that can address environmental, economic, and strategic challenges. CE-CERT is helping to make this future a reality by accelerating the transition to renewable energy through technologies that create energy from waste, capitalize on the sustainable energy sources that exist in nature, and explore methods to store, allocate, and integrate renewable energy with existing infrastructure.

AQUEOUS BIOMASS PROCESSING: CREATING BIOFUELS FROM WASTE

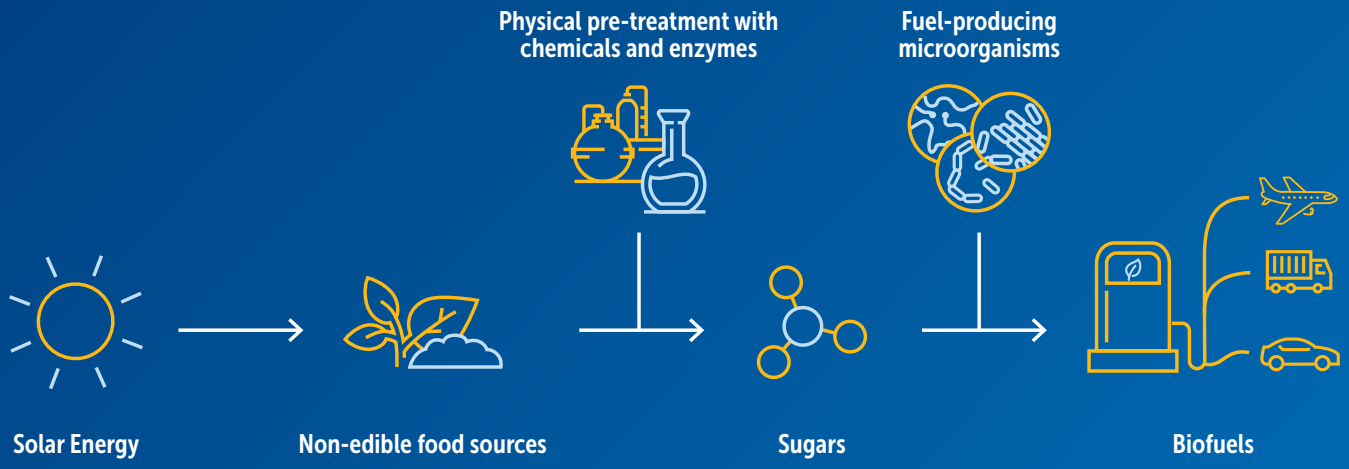
What do corn stover, switchgrass, and woody crops have in common? These materials, along with municipal solid waste and other crops, can be converted into biofuels, which are derived from living matter and its biological processes.

The CE-CERT Aqueous Biomass Processing Team is focused on understanding the fundamentals of and developing novel technologies for conversion of cellulosic biomass into sustainable fuels and chemicals at moderate temperatures in water rich environments.



Lignocellulosic biomass includes wood chips, grasses, corn waste products, and similar items. These waste products are abundant, renewable, and not competitive with food products, but very expensive to process in terms of both money and energy

Biofuel Life-Cycle



Enzymes are employed to break down the long, complex hemicellulose and cellulose chains that make up about two thirds to three quarters of cellulosic biomass into sugars that can be fermented into ethanol and other products. Thermochemical routes are also used to deconstruct cellulosic biomass into sugar dehydration products such as furfural and 5-hydroxymethyl furfural for catalytic upgrading into fuels and chemicals.

2017 RESEARCH HIGHLIGHTS

One of this year's key discoveries involved the effectiveness of coupling a novel bacterium *Clostridium thermocellum* with pretreatment to break down biomass into sugars with high yields. This process, when coupled with the Cosolvent Enhanced Lignocellulosic Fractionation (CELF) process invented at CE-CERT, achieved unprecedented sugar yields at low loadings of conventional fungal enzymes and was particularly effective in greatly accelerating sugar release from a diverse range of cellulosic materials.

2007-2017: The BioEnergy Science Center (BESC) and Beyond

This year saw the conclusion of research on the deconstruction of biomass by advanced biological systems through the support of the BioEnergy Science Center (BESC) managed by Oak Ridge National Laboratory.

Dr. Charles Wyman and his team are now looking forward to collaborating with the next generation of Bioenergy Research Centers: the Center for Bioenergy Innovation (CBI). This center, also funded by the Office of Biological and Environmental Research in the US Department of Energy (DOE) Office of Science and led by the Oak Ridge National Laboratory, will receive $25 million annually for the next 5 years, part of which will continue to fund the CE-CERT team's innovative aqueous processing research.

GRADUATE STUDENT PRIYA SENGUPTA WEIGHS BIOMASS IN PREPARATION FOR PROCESSING

THE 10-YEAR BESC INITIATIVE WAS FUNDED BY THE OFFICE OF BIOLOGICAL AND ENVIRONMENTAL RESEARCH IN THE US DEPARTMENT OF ENERGY (DOE) OFFICE OF SCIENCE IN THE AMOUNT OF $25 MILLION ANNUALLY. OVERALL THE BESC TEAM GENERATED 58 PATENT APPLICATIONS, 172 INVENTION DISCLOSURES, AND 985 JOURNAL ARTICLES WITH 21,973 CITATIONS.*

2017 Renewable Fuels Group Research Faculty and Staff

Charles Cai, Associate Research Faculty
Rajeev Kumar, Associate Research Faculty
Alfredo Martinez-Morales, Managing Director,
Southern California Research Initiative for Solar Energy
Hamed Mohsenian-Rad, Associate Professor, Electrical & Computer Engineering
Chan Seung Park, Associate Research Faculty
John Pisano, Research Staff
Arun Raju, Director, Center for Renewable Natural Gas; Assistant Research Faculty
Mike Todd, Research Staff
Sadrul Ula, Research Faculty; Interim Energy Manager, UCR
Barry Wallerstein, Research Faculty; Senior Fellow, School of Public Policy
Charles Wyman, Professor, Chemical & Environmental Engineering
Nanpeng Yu, Assistant Professor, Electrical & Computer Engineering

Selected Publications

M. Balch, E. Holwerda, M. Davis, R. Sykes, R. Happs, R. Kumar, and L. Lynd, "Lignocellulose Fermentation and Residual Solids Characterization for Senescent Switchgrass Fermentation by Clostridium Thermocellum in the Presence and Absence of Continuous In Situ Ball-Milling," *Energy & Environmental Science*, vol. 10, no. 5, pp. 1252-1261, 2017.

K. Jung, T.Lim, Y. Li, and A. Martinez-Morales, "ZnO-CuO Core-Shell Heterostructure for Improving the Efficiency Of ZnO-Based Dye-Sensitized Solar Cells," *MRS Advances*, vol. 2, no. 15, pp. 857-862, 2017.

M. Muller, L. Micheli, and A. Martinez-Morales, "A Method to Extract Soiling Loss Data From Soiling Stations with Imperfect Cleaning Schedules," in *2017 IEEE 44th Photovoltaic Specialist Conference (PVSC)*, 2017.

Z. Taylor, H. Akhavan-Hejazi, E. Cortez, L. Alvarez, S. Ula, M. Barth, and H. Mohsenian-Rad, "Customer-side SCADA-assisted Large Battery Operation Optimization for Distribution Feeder Peak Load Shaving," in *IEEE Transactions on Smart Grids*, vol. PP, no. 99, pp. 1-1, 2017.

KEY SPONSORS AND PARTNERS

- BioEnergy Science Center (BESC)
- Center for Bioenergy Innovation (CBI)
- DOE BioEnergy Technology Office (BETO) Incubator Program
- Ford Motor Company Chair in Environmental Engineering
- National Center for Sustainable Transportation (NCST)
- National Science Foundation
- USDA Biomass Research and Development Initiative Competitive Grants Program (BRDI)
- USDA National Institute for Food and Agriculture

*BIOENERGYCENTER.ORG/BESC

CENTER FOR RENEWABLE NATURAL GAS: DEVELOPING ALTERNATIVES TO FOSSIL FUELS

Renewable Natural Gas (RNG) is an important alternative fuel that can help the State of California meet several greenhouse gas (GHG) and renewable energy targets. As a transportation fuel, RNG can result in approximately 90% reduction in GHG emissions. Despite considerable potential, current RNG contribution on national and state levels is very small. CE-CERT's Center for Renewable Natural Gas (CRNG) will address this challenge by developing and validating technologies that will enable RNG production and use in substantial quantities in California and elsewhere.

RNG CAN BE PRODUCED FROM A VARIETY OF LOCAL, RENEWABLE RESOURCES INCLUDING MUNICIPAL WASTE, GREEN WASTE, BIOSOLIDS, AND DAIRY MANURE, AND CAN BE STORED AND DELIVERED USING EXISTING INFRASTRUCTURE.

CRNG Focus Areas

01 HIGH YIELD THERMOCHEMICAL RNG PRODUCTION

Develop cost-effective technologies to commercially produce fuel-grade RNG from carbonaceous waste (e.g. forest biomass, agricultural residue); address wide-scale adoption barriers such as feedstock logistics/pretreatment challenges, tar formation, gas cleanup, and high capital costs

02 POWER-TO-GAS PRODUCTION

Develop cost-effective systems to convert excess renewable electricity into hydrogen or methane as a means to increase the renewable energy content of the pipeline infrastructure while addressing grid capacity and storage issues

03 METHANATION PATHWAYS

Optimize hydrogen conversion to methane, especially in the power-to-gas context where direct hydrogen injection into pipeline or long term hydrogen storage is not viable

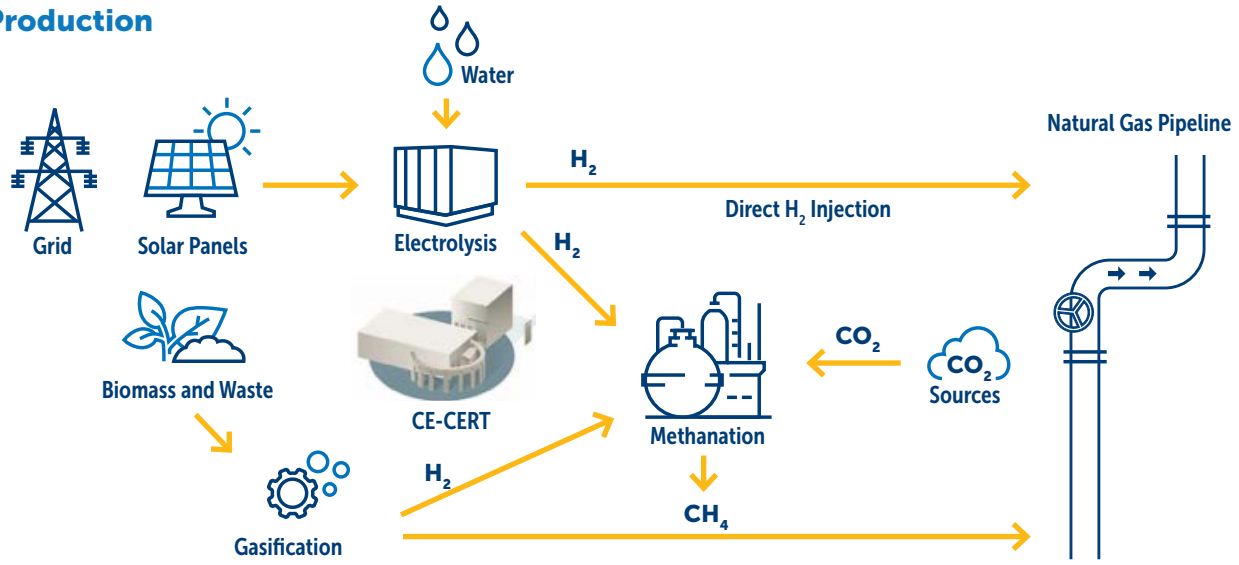
04 LIFE CYCLE AND TECHNO-ECONOMIC ANALYSIS

Conduct systems-level analyses of RNG production pathways to evaluate greenhouse gas and criteria pollutant emissions, material and energy balances (efficiencies), and commercial viability (economics)

05 ANAEROBIC DIGESTION

Optimize digestion pathways and technology options and address logistic and cost issues associated with feedstock collection and conversion

RNG Production



RIBBON CUTTING CEREMONY FOR THE CENTER FOR RENEWABLE NATURAL GAS

2017 RESEARCH HIGHLIGHTS

The Center for Renewable Natural Gas (CRNG) celebrated its inception in May 2017 as the first academic center in the U.S. dedicated to renewable natural gas research with a symposium on RNG adoption from lab to market. Of the many topics discussed at the symposium by industry, government, and academic professionals, one of the most popular was how renewable energy sources such as RNG can help California achieve climate and air pollution targets in a cost effective and timely manner.

Significant portions of fossil energy sources must be replaced with carbon neutral resources in all the major sectors in order to achieve California's greenhouse gas (GHG) reduction targets. This effort must also take into account the effects on energy security, cost effectiveness and needed criteria air toxic pollutant emission reductions. Achieving these complex and sometimes divergent goals requires the ability to understand the nature of long term demands, technology and market developments, resource and infrastructure requirements, and other factors.

Dr. Arun Raju and his team are currently evaluating greenhouse gas (GHG) emission reduction scenarios in California, including current and proposed strategies and alternate approaches incorporating renewable gas resources. The team is using advanced power systems planning models with the most current California-specific data to evaluate renewables integration into the electric grid, examine the associated benefits and challenges, and identify optimal standards and technology pathways to meet the state's goals.

The research team will also assess high renewable energy scenarios in both the electric grid and gas mix. The data will serve to inform policymakers on how best to increase renewable energy use in the near future.

"Diversification of resource and technology options and optimization of approaches and pathways is essential to ensure risk mitigation, and to develop reliable and pragmatic solutions. The CRNG is engaged in research that examines these issues and identifies optimal solutions to the most pressing challenges."

Dr. Arun Raju, Director
Center for Renewable Natural Gas

DR. RAJU PRESENTS AT THE RENEWABLE NATURAL GAS SYMPOSIUM

KEY SPONSORS AND PARTNERS

- National Center for Sustainable Transportation
- South Coast Air Quality Management District
- Southern California Gas Company

MICROGRIDS AND ADVANCED ENERGY MANAGEMENT: INTEGRATING FUTURE RENEWABLES WITH TODAY'S TECHNOLOGY

Our Sustainable Integrated Grid Initiative (SIGI) research testbed, now operational for over three years, continues to assist researchers in analyzing the operations of microgrid systems under different conditions and for different installation types using a highly reconfigurable system consisting of interchangeable technology prototypes and an open source energy management platform.

The SIGI testbed has the following key features, situated throughout Riverside:

- 4 megawatts of photovoltaic generation
- 2 megawatt-hours of battery energy storage
- 27 electric vehicle charging stations
- Monitoring of 7 building loads
- An electric-powered trolley
- Energy monitoring and smart dispatch to buildings and EVs
- Open architecture designed for expansion

What makes this testbed unique?

D Description B Benefits

Renewable Solar Generation

D Solar arrays

B Provides renewable generation to offset utility usage

Storage

D LI-ion battery or other battery storage, hydrogen, RNG or other fuel source

B Reduces electricity bill by up to 40%

Energy Management System Algorithms

D Can be configured for net zero applications, minimizing cost, or minimizing carbon

B Open source software that overlays an existing system to provide cost effective conversion

EV Charging

D Can provide level 2 or level 3 charging

B Can provide workplace charging at no cost to the employer

B Enables Vehicle-to-Grid Research

INDUSTRIES AND UTILITIES HAVE THE UNIQUE OPPORTUNITY TO PUT SIGI TO USE TO ADDRESS NEEDS IN:

01 Renewables and Distributed Energy Resources (DER) integration

02 Grid modernization, including control, optimization, and communications

03 Customer-focused products and services enablement

SIGI microgrid systems throughout California

Chemehuevi Community Center
Havasu Lake, CA 92363

Cucamonga Valley Water District
Rancho Cucamonga, CA 91730

Inland Empire Utilities Agency Regional Plant 4
Rancho Cucamonga, CA 91739

Olivenhain Municipal Water District
Rancho Santa Fe, CA 92067

Rancho Cucamonga City Hall
Rancho Cucamonga, CA 91730

UCR Main Campus
Riverside, CA 92507

Victor Valley Wastewater Reclamation Authority
Victorville, CA 92394

2017 RESEARCH HIGHLIGHTS

Chemehuevi Microgrid System Comes Online

Lake Havasu, California, is not only home to the Chemehuevi Indian Tribe, it is an extreme desert climate that is subject to intense heat, flash flooding, and other environmental conditions that contribute to frequent energy blackouts. During these incidents, the tribe depends on shelter and assistance from the Chemehuevi Community Center, which serves as the tribe's designated emergency response center. As the result of a $2.6 million grant from the California Energy Commission (CEC), CE-CERT researchers, along with a team of industry partners, have completed the installation of a microgrid system for the Community Center that combines solar panels, battery storage, and energy management features that will provide reliable power when access to the grid, which is often unreliable due to the rural location of the reservation and its single transmission line connection, is interrupted.

» SIGI group members Hao Xin, Jubair Yusuf, Research Staff Mike Todd, Miroslav Penchev, Dr. Alfredo Martinez-Morales, Dr. Sadrul Ula, Research Staff Henry Gomez, Yun Xue, A.S.M. Jahid Hasan, and Rumana Binte Faruque

CHEMEHUEVI MICROGRID KEY FEATURES:

- SunPower 90 kW solar carport PV system
- 25 kW/125 kWh Primus Power flow battery energy storage system
- EnSync Energy Systems Advanced Matrix Energy Management and DER Flex technologies coupled with OSISoft's PI software
- Optimal power management features include peak reduction, load shifting, demand response, and storage-to-grid activities

"This project has the dual benefit of providing an environmentally friendly power system for the tribe while allowing researchers to study a system that could become a model for people in California and elsewhere."

Dr. Alfredo Martinez-Morales,
Managing Director, Southern California Research Initiative for Solar Energy (SC-RISE)

Advanced Energy Management in Action at the Carbon Canyon Water Recycling Facility

A partnership between CE-CERT researchers and the Inland Empire Utilities Agency (IEUA) is projected to save the agency $30,000 annually through the reduction of monthly peak demand charges for electricity usage. Utilizing funding from the California Energy Commission, a new energy management system has been installed at the Carbon Canyon Water Recycling facility. The system provides operators with a real-time comparison of instantaneous usage data with the monthly maximum demand and allows operators to determine if pumping station operations should be delayed or suspended to avoid setting a higher maximum demand. The partnership will last three years, over which time the IEUA will determine if the system is cost-effective enough to be implemented at other facilities

KEY SPONSORS AND PARTNERS

- » California Energy Commission
- » GRID Alternatives
- » Inland Empire Utilities Agency
- » Pacific Energy

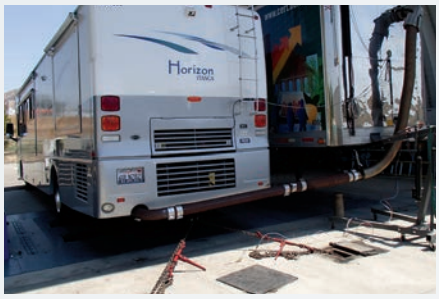
02 VEHICLE, TECHNOLOGY & COMBUSTION OPTIMIZATION

There is often a significant difference in results when engine emissions are tested in the laboratory versus when they are tested under actual driving conditions on the road. The Emissions and Fuels research team at CE-CERT is measuring the real-world impacts of all types of engine technologies – from cars and light-duty trucks to heavy duty freight trucks and construction equipment, including specialty engines such as the ones that power ocean going vessels.

THREE TESTING PROCEDURES CAN BE EMPLOYED INDEPENDENTLY OR TOGETHER TO ASSESS ENGINE PERFORMANCE

1 ENGINE DYNAMOMETER TESTING

2 CHASSIS DYNAMOMETER TESTING



3 PORTABLE EMISSIONS MEASUREMENT SYSTEM (PEMS)

2017 RESEARCH HIGHLIGHTS

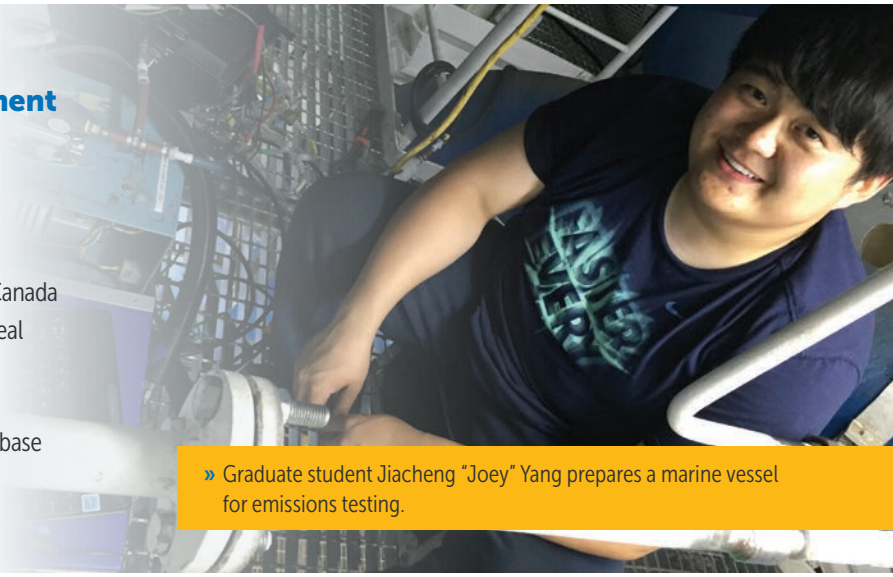
CE-CERT Researchers Join Volkswagen Testing Team

In the wake of the Volkswagen diesel scandal, the importance of onboard emissions measurement through the use of tools such as PEMS during actual on-road vehicle operation has become very apparent. UC Riverside researchers were selected to be a part of the world's largest emissions testing team, the goal of which was to provide confirmation to the public that Volkswagen's vehicle emissions are as low as reported. Eleven Volkswagen vehicles were tested in the laboratory and on the road, with results indicating that the emissions were indeed acceptable.

PORTABLE EMISSIONS MEASUREMENT SYSTEMS

UC Riverside Enters Marine Testing Agreement

During the past year, UC Riverside signed a cooperative agreement with the Maritime Administration (MARAD) of the US Department of Transportation. The first project is investigating emissions from the most modern LNG and dual-fueled ferries in maritime operation, in cooperation with the University of British Columbia (UBC) and the Canada National Research Council (NRC). The research team is measuring real time methane slippage, toxics, and PM number, and will conduct a comprehensive characterization of the physical nature of the PM. At the conclusion, the team will have the most comprehensive database for these promising LNG engines.



» Graduate student Jiacheng "Joey" Yang prepares a marine vessel for emissions testing.

Heavy Duty Diesel Engine Testing Helps Researchers Better Understand In-Use NOx Emissions

Currently, heavy-duty diesel engines (HDDEs) are certified to meet oxides of nitrogen (NOx) emission standards before the engines are integrated into vehicle chassis for commercial use. Certification standards for this laboratory testing have recently been tightened, leading to some question as to whether the NOx reductions expected from the new certification standards are fully realized for the actual in-use operations of the engines.

To investigate this possibility, two 2010 technology heavy-duty diesel trucks fitted with diesel particulate filters and selective catalytic reduction aftertreatment technologies were tested using our heavy-duty engine dynamometer, our heavy-duty chassis dynamometer, and PEMS instrumentation. The data collected from the three measurement methods were analyzed, and the differences between the measurement methods evaluated in terms of their theoretical principles, test requirements, and other related factors.

THE RESULTS SHOWED SIGNIFICANT DIFFERENCES BETWEEN VARIOUS TYPES OF DRIVING BETWEEN THE DIFFERENT TEST METHODS, AND HOW DIFFERENT FACTORS CONTRIBUTE TO NOX EMISSIONS.

2017 Emissions and Fuels Group Research Faculty and Staff

Matthew Barth, Professor, Electrical & Computer Engineering
Tom Durbin, Research Faculty
Kent Johnson, Associate Research Faculty
Heejung Jung, Associate Professor, Mechanical Engineering
Georgios Karavalakis, Associate Research Faculty
Wayne Miller, Research Faculty
Marko Princevac, Professor, Mechanical Engineering
Robert Russell, Assistant Research Faculty
Daniel Sandez, Research Staff
George Scora, Assistant Project Scientist

Selected Publications

P. Dixit, J. Miller, D. Cocker, A. Oshinuga, Y. Jiang, T. Durbin, and K. Johnson, "Differences Between Emissions Measured in Urban Driving and Certification Testing of Heavy-duty Diesel Engines," *Atmospheric Environment*, vol. 166, pp. 275-285, 2017.

T. Durbin, G. Karavalakis, and K. Johnson, "Environmental and Performance Impacts of Alternative Fuels in Transportation Application. Biomass Pretreatment and Conversion Processes," in *Biomass Pretreatment and Conversion Processes, Kumar, Singh, and Balan*, Eds., Nova Science Publishers, 2017.

G. Karavalakis, D. Short, D. Vu, V. Chen, C. Espinoza, T. Berte, T. Durbin, and A. Asa-Awuku, "Understanding Particles Emitted from Spray and Wall-Guided gasoline Direct Injection and Flex Fuel Vehicles Operating on Ethanol and Iso-butanol Gasoline Blends," *Aerosol Science and Technology*, vol. 51, pp. 330-341, 2017.

J. Yang, D. Cocker, K. Johnson, J. Miller, T. Durbin, Y. Jiang, and G. Karavalakis, "Black Carbon and NOx Measurement from Three Ocean Going Vessels," in *American Association for Aerosol Research 36th Annual Conference*, Raleigh, NC USA, 2017.

KEY SPONSORS AND PARTNERS

» Canada National Research Council
» Maritime Administration of the US Department of Transportation
» University of British Columbia
» Volvo

03 TRANSPORTATION SYSTEMS: VEHICLE & INFRASTRUCTURE INTERACTION

Our transportation systems are now in a state of rapid change, with several *revolutions* taking place that influence every aspect of how people and goods move from one place to another. There has been significant growth in shared mobility options (i.e. ride hailing, car sharing), making personal vehicle ownership less of a necessity in recent years. Simultaneously, there have been major advances in motors, controls, and batteries that are making *electric* vehicle ownership more of a practical reality.

Further, connected vehicles are now able to communicate with each other and with roadway infrastructure such as traffic signals to enable a variety of applications that improve safety, mobility, and energy efficiency. Different levels of automation can also be combined to enhance all aspects of our transportation systems.

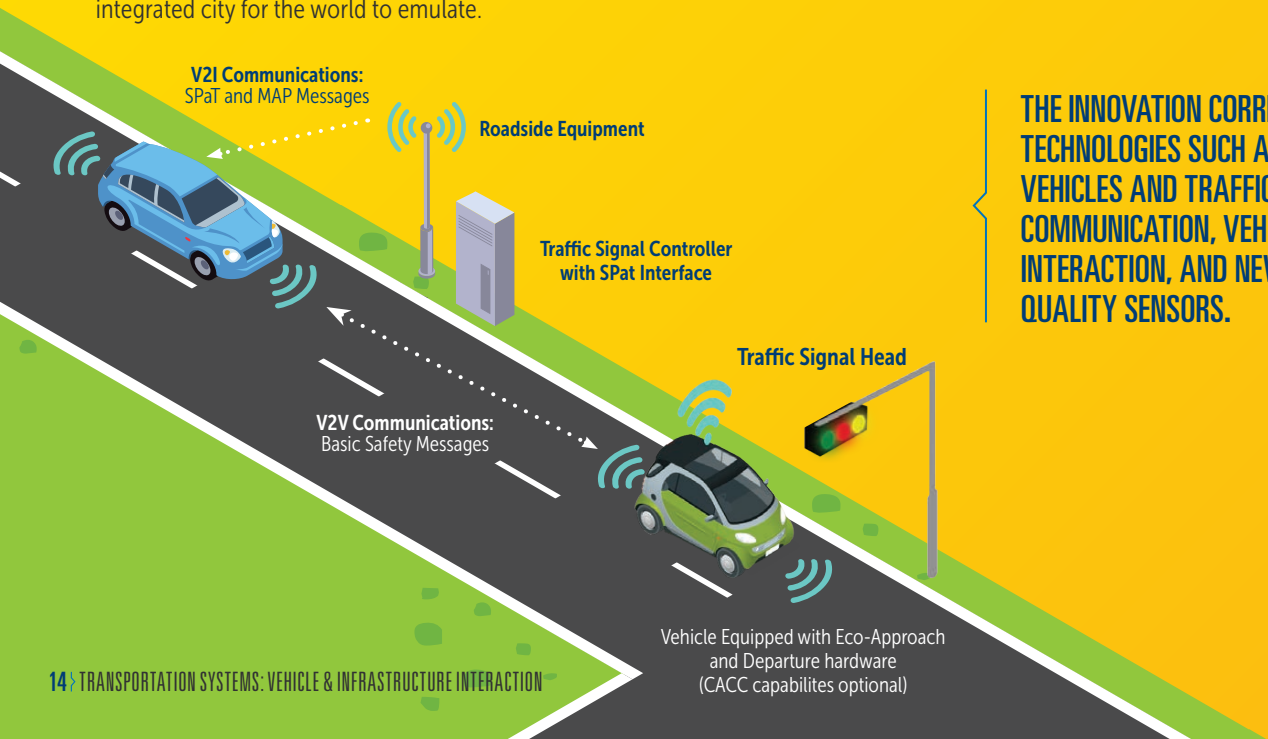
The Transportation Systems research team integrates all of these elements into its comprehensive research program that has the potential to solve many transportation problems.

TRANSPORTATION SYSTEMS RESEARCH TEAM

2017 RESEARCH HIGHLIGHTS

Riverside's Innovation Corridor to Showcase Intelligent Transportation Technologies

As a part of the City of Riverside's proposed Innovation District, CE-CERT researchers are partnering with the city to equip a six mile section of University Avenue between UC Riverside and downtown Riverside with integrated technologies such as connected vehicles and traffic signals, vehicle-to-grid interaction, and new generation air quality sensors. In addition to providing a platform for continuing research in the area of connected and automated vehicles, this "innovation corridor" represents a sustainable mobility solution that will significantly benefit California's disadvantaged communities and showcase the transformative nature of advanced transportation technologies to create a healthy, efficient, integrated city for the world to emulate.



THE INNOVATION CORRIDOR WILL FEATURE TECHNOLOGIES SUCH AS CONNECTED VEHICLES AND TRAFFIC SIGNAL COMMUNICATION, VEHICLE-TO-GRID INTERACTION, AND NEW GENERATION AIR QUALITY SENSORS.

Researchers Explore Multi-modal Low Human Exposure Routing

Traditionally, Intelligent Transportation Systems (ITS) applications have been developed to address pollutant emissions on a large regional basis, but have not focused on the local health impacts. The Transportation Systems research team has developed a new vehicle routing method that addresses this issue. Modeling results show use of this method can reduce the inhaled mass of fine particulate matter and reactive organic gas for selected susceptible populations by approximately 30% - 80% on a typical workday.* This method is particularly valuable for routing or regulating high-emitting vehicle fleets near sensitive community institutions, such as schools or hospitals.

CALIFORNIA IS HOME TO MANY DENSELY POPULATED COMMUNITIES THAT ARE ADJACENT TO ROADWAYS WITH HEAVY TRAFFIC. IN LOS ANGELES, MORE THAN 30% OF THE POPULATION IS LIVING WITHIN 50-100 METERS OF MAJOR ROADS, WHERE POLLUTANT CONCENTRATIONS ARE OFTEN 2-4 TIMES HIGHER THAN THOSE 100 METERS AWAY.*

"Dyno-in-the-Loop" Is Now an Integral Part of Vehicle Testing

In 2017, CE-CERT researchers moved their recently developed "dyno-in-the-loop" testing concept to the demonstration phase. This testing method allows for more realistic and cost effective vehicle performance and emissions testing. The concept takes advantage of vehicles being "connected" in the real world, and using data transmitted from an on-road probe vehicle to "drive" a vehicle on a dynamometer, thus eliminating the need for on-site testing in geographically distant locations. This concept also avoids limitations of "driving cycles" by linking high fidelity traffic simulation models in which the speed and associated loads of individual vehicles on a detailed roadway are translated to the test vehicle on the dynamometer. CE-CERT is currently carrying out both approaches in their ARPA-E Connected Eco-Bus project and in their Connected Vehicle Pilot Deployment project.

» Dyno-in-the-Loop in action: the traffic simulation in the bottom of this figure is "driving" the bus (upper left) on the dynamometer. The actual roadway scene is also shown in the upper right of the image.

2017 Transportation Systems Research Faculty and Staff

Richard Arnott, Distinguished Professor, Economics
Matthew Barth, Professor, Electrical & Computer Engineering
Kanok Boriboonsomsin, Associate Research Faculty
Jay Farrell, Professor, Electrical & Computer Engineering
Peng Hao, Assistant Research Faculty
Kent Johnson, Associate Research Faculty
Konstantinos Karydis, Assistant Professor, Chemical & Environmental Engineering
Zak Kassas, Assistant Professor, Electrical & Computer Engineering
Jill Luo, Assistant Research Faculty
George Scora, Assistant Project Scientist
Mike Todd, Research Staff
Guoyuan Wu, Assistant Research Faculty
Qi Zhu, Assistant Professor, Electrical & Computer Engineering

Selected Publications

O. Altan, G. Wu, M. Barth, K. Boriboonsomsin, and J. Stark, "GlidePath: Eco-Friendly Automated Approach and Departure at Signalized Intersections," *IEEE Transactions On Intelligent Transportation Systems*, vol. 2, no. 4, pp. 266-277, 2017.

P. Hao, K. Boriboonsomsin, G. Wu, and M. Barth, "Modal Activity-Based Stochastic Model for Estimating Vehicle Trajectories from Sparse Mobile Sensor Data," *IEEE Transactions On Intelligent Transportation Systems*, vol. 18, no. 3, pp. 701-711, 2017.

X. Qi, M. Barth, G. Wu, K. Boriboonsomsin, and P. Wang, "Energy Impact of Connected Eco-driving on Electric Vehicles," in *Road Vehicle Automation 4*, Meyer, Ed., Springer, 2017.

X. Qi, G. Wu, K. Boriboonsomsin, and M. Barth, "Development and Evaluation of an Evolutionary Algorithm-Based Online Energy Management System for Plug-In Hybrid Electric Vehicles," *IEEE Transactions On Intelligent Transportation Systems*, vol. 18, no. 8, pp. 2181-2191, 2017.

Z. Wang, G. Wu, P. Hao, and M. Barth, "Developing a Distributed Cooperative Eco-Approach and Departure System at Signalized Intersections Using V2X Communication," in *Proceedings of the Automated Vehicle Symposium*, San Francisco, CA USA, 2017.

KEY SPONSORS AND PARTNERS

» Advanced Research Projects Agency - Energy
» California Air Resources Board
» California Energy Commission
» Caltrans
» Federal Highway Administration
» National Center for Sustainable Transportation
» South Coast Air Quality Management District
» US Department of Energy

*SEE PUBLICATION "VEHICLE ROUTING TO MITIGATE HUMAN EXPOSURE TO TRAFFIC-RELATED AIR POLLUTANTS," J. LUO ET AL.

04 POLLUTION FORMATION IN THE ATMOSPHERE

CE-CERT's Atmospheric Processes Laboratory is the largest and most technologically advanced facility in the world for the study of chemical processes in the atmosphere. The laboratory consists of two 90 cubic meter atmospheric chambers, which are used to characterize how secondary air pollutants form from such diverse sources as transportation, wildfires, and agriculture. The chamber precisely controls variables such as temperature, pressure, humidity, and light to model a wide range of real world conditions. The laboratory also features a smaller mobile chamber that can be moved to various locations to conduct research on-site.

2017 RESEARCH HIGHLIGHTS

Surprising Discoveries About the Evaporative Properties of Fuels and Household Chemicals

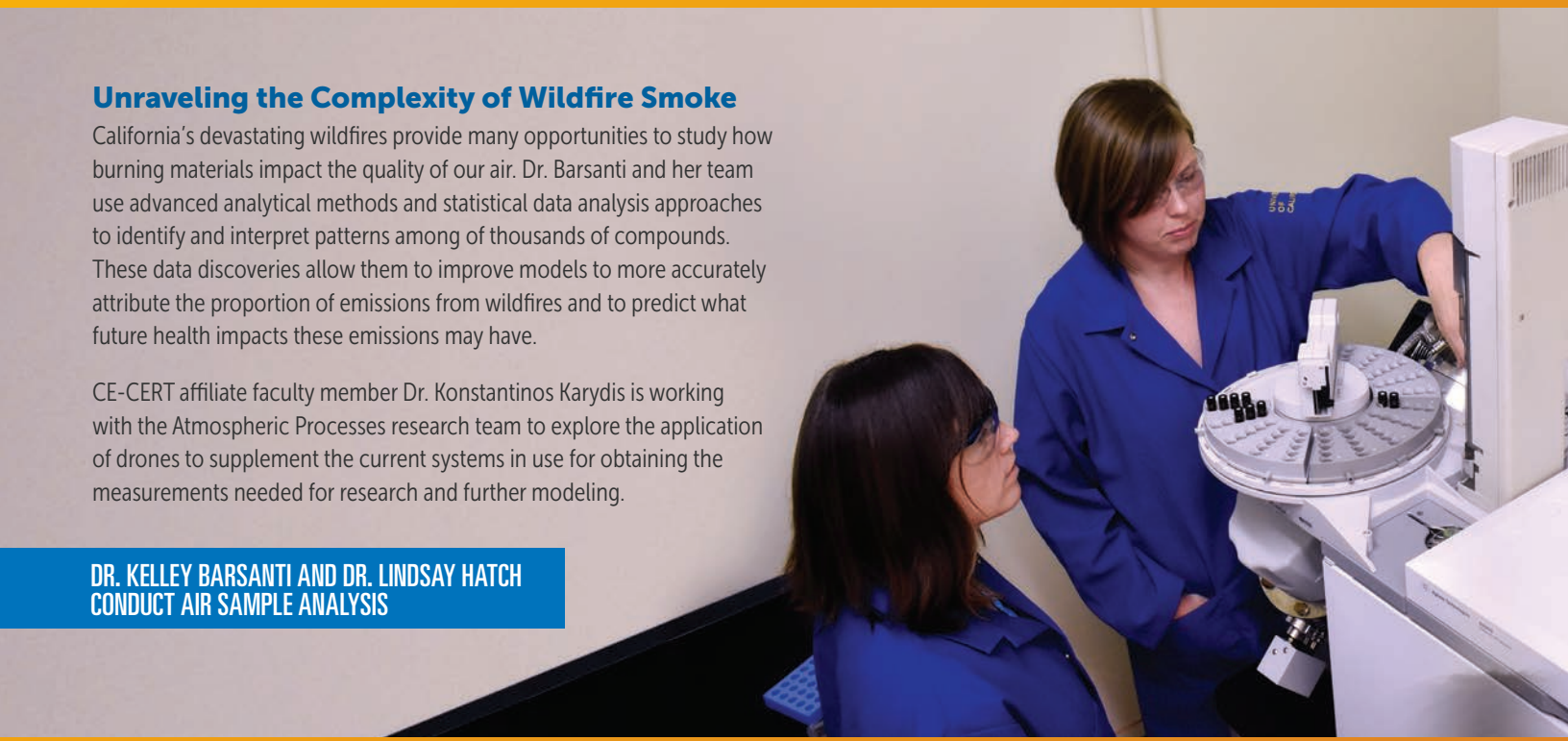
The Atmospheric Processes research team is currently studying how different varieties of fuel and blends sold in Southern California form secondary organic aerosols when allowed to evaporate. Dr. Cocker and his team discovered that there is significant particle formation from the evaporation of diesel fuel, which was unexpected as diesel is a heavier, less volatile fuel than gasoline. However, when evaporation from newly regulated consumer products such as paint thinner was measured, research demonstrated that these chemicals participate less in the formation of particulate matter (PM) than predicted. These results are currently pending publication.*

THE ATMOSPHERIC CHAMBER IN OPERATION

Unraveling the Complexity of Wildfire Smoke

California's devastating wildfires provide many opportunities to study how burning materials impact the quality of our air. Dr. Barsanti and her team use advanced analytical methods and statistical data analysis approaches to identify and interpret patterns among of thousands of compounds. These data discoveries allow them to improve models to more accurately attribute the proportion of emissions from wildfires and to predict what future health impacts these emissions may have.

CE-CERT affiliate faculty member Dr. Konstantinos Karydis is working with the Atmospheric Processes research team to explore the application of drones to supplement the current systems in use for obtaining the measurements needed for research and further modeling.

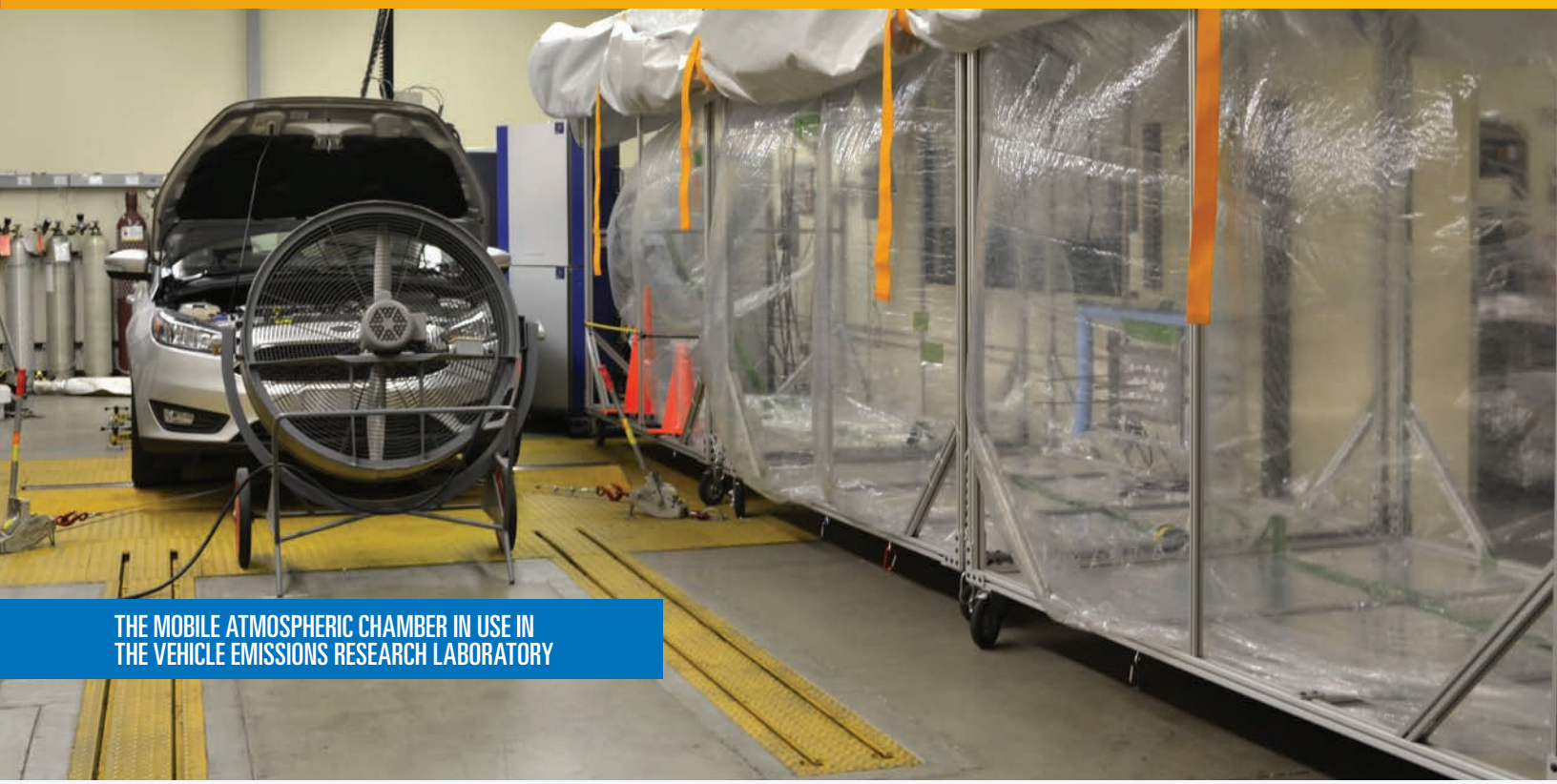


DR. KELLEY BARSANTI AND DR. LINDSAY HATCH CONDUCT AIR SAMPLE ANALYSIS

SEE PUBLICATION, "POTENTIAL OF SELECT INTERMEDIATE-VOLATILITY ORGANIC COMPOUNDS AND CONSUMER PRODUCTS FOR SECONDARY ORGANIC AEROSOL AND OZONE FORMATION UNDER RELEVANT URBAN CONDITIONS," W. LI ET AL.

The Mobile Chamber in Action

In 2017, the Atmospheric Processes research team partnered with the Emissions and Fuels research team to conduct an extensive testing campaign on current technology gasoline direct injection (GDI) vehicles to investigate the impact of ethanol and aromatics in gasoline fuels on particulate emissions and mobile source air toxic pollutants. This program included testing in CE-CERT's mobile environmental chamber, which produced first of its kind results in researching secondary aerosol formation from GDI vehicles on fuels with different compositions. The realistic conditions in the chamber provided researchers with data that could not be predicted through modeling alone.



THE MOBILE ATMOSPHERIC CHAMBER IN USE IN THE VEHICLE EMISSIONS RESEARCH LABORATORY

2017 Atmospheric Processes Research Faculty and Staff

Bill Carter, Emeritus Research Chemist

Kelley Barsanti, Assistant Professor, Chemical & Environmental Engineering

Kurt Bumiller, Research Staff

David Cocker, Professor, Chemical & Environmental Engineering

Lindsay Hatch, Assistant Project Scientist

Georgios Karavalakis, Associate Research Faculty

Konstantinos Karydis, Assistant Professor, Electrical & Computer Engineering

John Pisano, Research Staff

Akula Venkatram, Professor, Mechanical Engineering

Selected Publications

Q. Bian, S. Jathar, J. Kodros, K. Barsanti, L. Hatch, A. May, and J. Pierce, "Secondary Organic Aerosol Formation in Biomass-Burning Plumes: Theoretical Analysis of Lab Studies and Ambient Plumes," *Atmospheric Chemistry and Physics*, vol. 17, no. 8, pp. 5459-5475, 2017.

K. Barsanti, J. Kroll, and J. Thornton, "Formation of Low-Volatility Organic Compounds in the Atmosphere: Recent Advancements and Insights," *Journal Of Physical Chemistry Letters*, vol. 8, no. 7, pp. 1503-1511, 2017.

L. Hatch, R. Yokelson, C. Stockwell, P. Veres, I. Simpson, D. Blake, and K. Barsanti, "Multi-Instrument Comparison and Compilation of Non-Methane Organic Gas Emissions from Biomass Burning and Implications for Smoke-Derived Secondary Organic Aerosol Precursors," *Atmospheric Chemistry and Physics*, vol. 17, no. 2, pp. 1471-1489, 2017.

L. Li, L. Qi, and D. Cocker, "Contribution Of Methyl Group to Secondary Organic Aerosol Formation from Aromatic Hydrocarbon Photooxidation," *Atmospheric Environment*, vol. 151, pp. 133-139, 2017.

KEY SPONSORS AND PARTNERS

- California Air Resources Board
- National Science Foundation
- Manufacturers of Emission Controls Association
- South Coast Air Quality Management District
- Bureau of Land Management Joint Fire Science Program
- National Oceanic and Atmospheric Association

05 EXPOSURE & HEALTH EFFECTS

In 2017, CE-CERT became a part of an innovative partnership in which the faculty and researchers share a common goal: to determine the effects of various air pollutants on human health. The BREATHE (Bridging Regional Ecology, Aerosolized Toxins, and Health Effects) Center at the UC Riverside School of Medicine is an interdisciplinary collaborative in which a diverse group of UC Riverside faculty work together to conduct research on topics such as regional climate modeling, and the health impacts of aerosolized particles such as dust, pollens, and pollutants. The collaborative is also invested in addressing the social and policy issues surrounding air quality, with research interests in environmental justice and health disparities, and culture and policy studies on air quality and health.

2017 RESEARCH HIGHLIGHTS

Sensors Across Riverside

With the groundbreaking passage of California Assembly Bill 617, the state board will be required to develop a plan to monitor criteria air pollutants and toxic air contaminants in California's communities by October 1, 2018. A key component of this plan will be the deployment of portable, low-cost air sensors across the state.

CE-CERT is collaborating with the South Coast Air Quality Management District, the City of Riverside, Riverside County, community groups, and the Riverside Unified School District on many projects that will utilize sensor technology to help improve our health. As of December 2017, there are over a dozen operational sensors that are available for public access.

LOCAL COMMUNITY MONITORING WILL PROVIDE RESEARCHERS WITH IMPORTANT INFORMATION ABOUT THE EFFECTIVENESS OF THE SENSOR TECHNOLOGY USED, ANSWERING QUESTIONS ABOUT THE ACCURACY AND RELIABILITY OF THE SENSORS, THE QUALITY OF THE DATA THEY PRODUCE, AND HOW THAT DATA CAN BE USED TO HELP COMMUNITY MEMBERS UNDERSTAND AND REDUCE EXPOSURE TO HARMFUL AIR POLLUTION.

Do Renewable Fuels Adversely Impact Our Health?

With the goal of meeting California's aggressive new clean air standards in mind, the use of renewable fuels is increasing at an unprecedented pace. However, Dr. Kelley Barsanti and her team have discovered that these fuels emit chemical compounds that may be toxic when burned.

CONNECTING VEHICLE EMISSIONS WITH PARTICULATE SOA FORMATION

The research team is using two-dimensional gas chromatography to uncover these new compounds and determine their toxicity, after which the data is put into chemistry models for analysis so that the health impacts of these emerging technologies can be better understood.

RESEARCH QUESTIONS

- What are the key toxic emission sources?
- What are the primary formation mechanisms and how do they change with measurement/ ambient conditions?

Whole-Body Exposure Chamber Studies of Pollutants Provide New Insights

The majority of past in-vivo health studies on air pollutants such as particulate matter (PM) and gas phase pollutants utilized traditional intranasal medical treatment or nose-only exposure in a tiny chamber in which the normal activities of the subject were restricted. Dr. David Cocker, graduate student Eric Peng, and their research team decided a different approach was needed to gain a true understanding of how these pollutants impact health.

Using a large whole-body exposure chamber that simultaneously controls particle size distribution, PM mass concentration and gas concentration with uniform dispersion and exposure stability, researchers discovered that traditional health studies of air pollution on mice had significant underestimation of lung allergies.

THE TEAM DISCOVERED THAT A CONTINUOUS EXPOSURE TO PM2.5 INDUCED SIGNIFICANT ALLERGIC INFLAMMATION WITHIN FOUR DAYS, AS WELL AS BRAIN INFLAMMATION AND IMMUNE SYSTEM VULNERABILITY.

GRADUATE STUDENT ERIC PENG USING WHOLE BODY EXPOSURE CHAMBER FOR STUDYING HEALTH EFFECTS OF POLLUTION EXPOSURE

2017 Exposure and Health Effects Research Faculty and Staff (CE-CERT)

Kelley Barsanti, Assistant Professor, Chemical & Environmental Engineering
Kanok Boriboonsomsin, Associate Research Faculty
David Cocker, Professor, Chemical & Environmental Engineering
Lindsay Hatch, Assistant Project Scientist
Cesunica Ivey, Assistant Professor, Chemical & Environmental Engineering
Heejung Jung, Associate Professor, Mechanical Engineering
Georgios Karavalakis, Associate Research Faculty
Jill Luo, Research Specialist
Akula Venkatram, Professor, Mechanical Engineering

2017 BREATHE Center Affiliates

Michael F. Allen, Professor, Plant Pathology, Biology, & Microbiology
Emma L. Aronson, Assistant Professor, Plant Pathology & Microbiology
Roya Bahreini, Associate Professor, Atmospheric Science
Monica J. Carson, Professor & Chair of Biomedical Sciences
Marilyn Fogel, Director, EDGE Institute; Professor of Geoecology
Sydney I. Glassman, Assistant Professor, Plant Pathology & Microbiology
Philipp Lehmann, Assistant Professor, History
Ying-Hsuan Lin, Assistant Professor, Environmental Toxicology
David Lo, Distinguished Professor, Biomedical Sciences; Director, BREATHE Center
Keith Miyake, Assistant Professor, Ethnic Studies
Meera G. Nair, Assistant Professor, Biomedical Sciences
Tara M. Nordgren, Assistant Professor, Biomedical Sciences
William Porter, Assistant Professor, Atmospheric Dynamics and Modeling
Dana Simmons, Assistant Professor, History

KEY SPONSORS AND PARTNERS

- Coalition for Clean Air
- Riverside Unified School District
- South Coast Air Quality Management District

HIGH-IMPACT ENGAGEMENT

In 2017, CE-CERT continued to honor its long-standing commitment to the development of future innovators, educators, researchers, and leaders through a variety of activities, events, and initiatives. We have found that just a one-day STEM experience can inspire an interest that could last a lifetime. CE-CERT's 2017 highlights are listed below.

COMMUNITY OUTREACH: CONTINUING THE TRADITION OF INSPIRING OUR YOUTH TO PURSUE SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM)

Inspire Her Mind Program

CE-CERT was proud to host the 2nd Annual *Inspire Her Mind* Program in partnership with the Riverside Unified School District (RUSD). Over 180 female high school students engaged in hands-on activities in a working laboratory, during which they were mentored by CE-CERT graduate students. This event is part of the larger *Inspire Her Mind* campaign, which encourages female students to pursue and stay engaged in STEM subjects in high school, a time when girls often lose interest in those fields.

WOMEN CONTINUE TO BE UNDERREPRESENTED IN THE STEM WORKFORCE, WITH LESS THAN 25% OF FEMALES PURSUING CAREERS IN ENGINEERING FIELDS SUCH AS INDUSTRIAL, COMPUTER, CHEMICAL, CIVIL, ELECTRICAL, AND AEROSPACE.*

Science and Technology Education Partnership (STEP) Conference

2017 marked the 7th year of the *STEP Conference*, an innovative alternative to the standard science fair that provides Riverside high school students with the opportunity to participate in hands-on activities in a working engineering research facility. The 2017 conference, co-hosted by Bourns, Inc. and CE-CERT, presented 250 students with the opportunity to complete a research activity in each of CE-CERT's six laboratories under the guidance of experienced graduate students.

This year's conference program was expanded to include a professional development session for 240 K-12 educators that presented ideas on how instruction in STEM fields can be improved, and a small group activity session specifically for female students called GEMS (Girls Excelling in Mathematics with Success).

*WWW.BLS.GOV/OPUB/TED/2017/WOMEN-IN-ARCHITECTURE-AND-ENGINEERING-OCCUPATIONS-IN-2016.HTM

PROFESSIONAL DEVELOPMENT: PREPARING INDUSTRY PROFESSIONALS AND EDUCATORS TO ADDRESS THE LATEST ENVIRONMENTAL CHALLENGES IN OUR NATION AND AROUND THE WORLD

Riverside Air Monitoring Project (RAMP) Will Provide Scientific Education for Students and Teachers

CE-CERT and Riverside Unified School District are developing a partnership that will provide both engagement opportunities for students and professional development for educators through the emerging STEM field of air quality.

This proposed multi-project effort will create an inventive science curriculum focused on air quality and its health impacts on the local community that will motivate students to actively participate in learning activities that connect their course materials to their everyday lives.

IDEALLY, EXPOSURE TO THIS CURRICULUM WILL ENCOURAGE STUDENTS TO PURSUE A STEM CAREER, AND WILL EDUCATE THEM ABOUT THE GROWING NUMBER OF AIR QUALITY CAREER OPPORTUNITIES, BOTH REGIONALLY AND NATIONALLY

Development Begins on the Air Quality and Climate Research Training (ACT) Program

CE-CERT has launched a new educational initiative called the Air Quality and Climate Research Training (ACT) Program. This program was made possible in part by a $1 million contribution by the South Coast Air Quality Management District.

CE-CERT seeks to improve air quality and mitigate climate impacts through developing, vetting, and implementing technological solutions in the areas of energy and transportation. The first course in the program is titled, "Collecting Real World Emissions Using Portable Emission (and Activity) Measurement Systems," and is scheduled for July of 2018. Future courses will address topics such as air pollution health impacts, maximizing co-benefits of clean air and climate change activities, sustainable mobility and goods movement, clean air and climate change policies, and renewable energy generation and integration. For more information, visit www.cert.ucr.edu/ACT.

GRADUATE STUDENT ANTHONY GERIGK WEIGHS THE FINAL MASS OF EMISSIONS ON A TEFLON FILTER

The South Coast Air Quality Management District is honored to support the hopes, dreams, and passion of future scientists who want to be part of the effort to clean our air. Our partnerships with UCR and CARB have been fruitful, and we are excited to see the innovations that come out of this collaboration.

Wayne Nastri, Executive Officer
South Coast Air Quality Management District

KEY SPONSORS AND PARTNERS

- Center for Advancing Research in Transportation Emissions, Energy, and Health
- National Center for Sustainable Transportation
- National Science Foundation
- Riverside Unified School District
- South Coast Air Quality Management District
- University of California Center on Economic Competitiveness in Transportation

OUR STUDENTS: REALIZING THEIR POTENTIAL

2017 HIGHLIGHTS

DANYANG TIAN AND FEI YE
Electrical and Computer Engineering

Awarded a total of $8,000 through the Women in Transportation 2017 Helene M. Overly Memorial Scholarship for their work in Intelligent Transportation Systems.

JOSHUA MORALES
Electrical and Computer Engineering

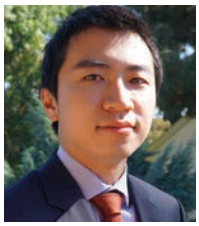
Named the National Center for Sustainable Transportation Student of the Year for 2017. This competitive award included a $1,000 prize and special recognition by the US Department of Transportation at the 2018 Transportation Research Board meeting and awards ceremony.

YU "JADE" JIANG
Chemical and Environmental Engineering

Selected for a Co-op Internship at Cummins Technical Center, Indiana in November of 2017. Cummins, Inc. is a global leader in the design and manufacturing of diesel and alternative fuel engines.

ERIC PENG
Chemical and Environmental Engineering

Awarded an internship with Ramboll, a top 10 international environmental consulting company. The screening process was highly competitive, resulting in one internship offer for over 300 applicants. Eric was also instrumental in coordinating an Air Quality and Waste Management Association chapter meeting that brought together leaders, policy makers, and the public here at CE-CERT.

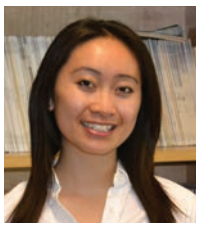


ZIRAN WANG
Mechanical Engineering

Awarded Best Student Poster from the 2017 Los Angeles Environmental Forum in August of 2017 for his poster, "Developing a Platoon-Wide Eco-Cooperative Adaptive Cruise Control (CACC) System."

JIACHENG "JOEY" YANG
Chemical and Environmental Engineering

Recognized with the Best Student Poster Award from 27th CRC Real World Emissions Workshop in March of 2017. He also won the Best Student Research Award at the 2017 Los Angeles Environmental Forum (LAEF) for his poster, "Emission Control Challenges from Large Ocean Going Vessels." Joey was an invited speaker at the U.S. China Green Ports and Vessels Initiative Workshop in May of 2017, and received one of the 2018 Co-op Internships at Cummins Technical Center, Indiana.



MICHELLE LE
Mechanical Engineering

Elected as the UCR's Society of Women Engineers Board Member - Public Relations Chair for 2017-2018. She is the recipient of a University Honors Program Scholarship, as well as the 2017 Community Scholarship Award by the Law Offices of Larry H. Parker. She also serves as a Student Ambassador for UCR's University Honors Program.

YUN XUE
Electrical and Computer Engineering

Received 3rd place in the student poster competition at the 3rd Annual Solar Conference for her poster titled, "Demonstration of Community Scale Low Cost Highly Efficient PV and Energy Management System at the Chemehuevi Community Center (CCC)." The poster was authored by Yun Xue, Michael Todd, Dr. Sadrul Ula, and Dr. Alfredo A. Martinez-Morales.

2017 GRADUATE STUDENTS

Afreh, Isaac
Alcaraz, Christian
Dhir, Rachna
Faruque, Rumana
Feenstra, Brandon
Fofie, Emmanuel
Gerigk, Anthony
Gu, Fei
Gu, Yuehua
Hasan, ASM Jahid
Huntamer, Ryo
Jiang, Jia
Jiang, Yu
Jung, Kichang
Kim, Jiyong
Kothari, Ninad
Le, Chen
Lee, Seungjin
Li, Qi
Li, Weihua
Li, Yaqiong
Lin, Yue
Lichtenberg, William
Lu, Mayling
McCaffery, Cavan
Morales, Joshua
Moretti, Ayla
Oswald, Roland David
Patri, Abhishek
Patrikh, Aakash
Peng, Eric
Peng, Weihan
Pham, Liem
Poojary, Sushmit
Roth, Patrick
Roy, Partho
Sanpakit, Chirawat
Sengupta, Priya
Simkins, Michele
Singh, Priyanka
Stamatis, Christos
Svenningsen, Glen
Tian, Danyang
Uribe-Robles, Minerva
Van Rooy, Paul
Vizenor, Ashley
Wang, Chao
Wang, Ziran
Williams, Nigel
Xin, Hao
Xinyue, Kan
Xue, Yun
Yang, Jiacheng
Ye, Fei
Yusuf, Jubair
Zhang, Jinwei
Zhao, Yuchen

2017 UNDERGRADUATE STUDENTS

Barajas, Hector
Basa, Ion
Chan, Aaron
Chan, Jackie
Chao, Daniel
Chiang, Terry
Contreras-Enriquez, Luis
Corrales, Tyler
Ealy, Matthew
Eckel, Thomas
Esaid, Daniel
Espinosa, Robert
Estrada, Brian
Geiger, Jeffrey
Gomez, Sebastian
Gozum, Daniel
Han, Michael
Hanson, Samantha
Hazameh, Ahmad
Hernandez, Leonardo
Kang, Ho-Ren
Kwee, Darren
Le, Michelle
Macaluso, Sammy
Mohammed, Taymour
Mostafa, Hoda
Musid, Saleh
Nguyen, Amanda
Ortega, Kevin
Perdomo, Brian
Rahman, Merrick
Reliford, Kaitlin
Rubio, Marco
Ruelas, Juan
Sarwar, Husnain
Scudder, Matthew
Semelka, Kyle
Shah, Vrunda
Shalabi, Jihad
Sharma, Shiva
Shuba, Molovi
Soriano, Albert
Tith, Rany
Tran, Alan
Tran, Kenny
Trang, Ryan
Watanabe, Reid
Wu, Jianqing
You, Yue
Zaher, Maher

2017 DISSERTATIONS AND THESES

Fofie, Emmanuel. "The Effects of Anthropogenic Emissions on Cloud Condensation Nuclei and Droplet Formation." Ph.D. Dissertation.

Liem, Pham. "Development of Particulate Matter Mass Measurement Methods for Atmospheric Air Quality Monitoring and Very Low Vehicle Emissions." Ph.D. Dissertation.

Patrikh, Aakash. "Methods of Lignin Extraction to Enable its Integration as a High Value Feedstock in a Biorefinery." MS Thesis.

Poojary, Sushmit. Ph.D. awarded in Chemical and Environmental Engineering.

Vizenor, Ashley. "Advanced Applications of Cloud Condensation Nuclei Activity." Ph.D. Dissertation.

Zhao, Yuchen. "Vehicle to Grid Implementation and Battery Management Optimization." MS Thesis.

OUR DONORS: INVESTING IN INFINITE POSSIBILITIES

GRADUATE AWARD WINNERS

WILLIAM R. PIERSON/FORD GRADUATE AWARD: NINAD KOTHARI

Major: Chemical and Environmental Engineering
Focus: Biofuels

"I believe that integration of chemical engineering with biology is the future of the manufacturing industry."

ESTHER F. HAYS GRADUATE FELLOWSHIP AWARD: PATRICK ROTH

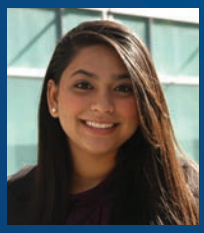
Major: Chemical and Environmental Engineering
Focus: Atmospheric Processes

"One of my goals is to aid regulators to better understand what tailpipe precursors contribute the most to secondary aerosol formation."

COLIN E. HACKETT ENDOWED ENGINEERING RESEARCH AWARD: FEI YE

Major: Electrical and Computer Engineering
Focus: Intelligent and Autonomous Vehicles

"I chose electrical and computer engineering as my major because I think it is a major that can make the world different."



ESTHER F. HAYS GRADUATE FELLOWSHIP AWARD: PRIYANKA SINGH

Major: Chemical Engineering
Focus: Biofuels

"What we do matters, so we must do our part to make this world a better place for future generations."

ESTHER F. HAYS GRADUATE FELLOWSHIP AWARD: RACHNA DHIR

Major: Chemical and Environmental Engineering
Focus: Biofuels

"A desire to address various environmental issues in my country, such as increasing CO2 emissions, led me to choose this career path."

ESTHER F. HAYS GRADUATE FELLOWSHIP AWARD: JIACHENG "JOEY" YANG

Major: Chemical and Environmental Engineering
Focus: Emissions

"Air pollution may not visible all the time, but it is always a worldwide public health issue."

$38,000 IN AWARDS MADE POSSIBLE BY OUR DONORS

WHEN PASSION AND COMMITMENT MEET SOUND SCIENCE, ANYTHING CAN HAPPEN. THE GENEROUS SUPPORT OF OUR DONORS ALLOWS OUR STUDENTS TO PURSUE THE RESEARCH AND PROFESSIONAL DEVELOPMENT OPPORTUNITIES THAT WILL CREATE AGENTS OF CHANGE FOR A BETTER WORLD.

UNDERGRADUATE AWARD WINNERS

FORD UNDERGRADUATE AWARD: MATTHEW EALY

Major: Chemical Engineering
Focus: Biofuels

"The work I will be conducting in the lab will hopefully be used to produce the needed biofuels and plastics of the future."

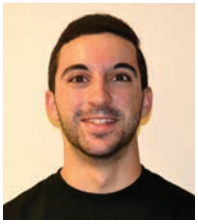
JIM GUTHRIE RESEARCH AWARD: BRIAN ESTRADA

Major: Mechanical Engineering
Focus: Emissions and Fuels

"I see myself as a problem solver."

JIM GUTHRIE RESEARCH AWARD: TAYMOUR MOHAMMED

Major: Mechanical Engineering
Focus: Transportation Systems Research



JIM GUTHRIE RESEARCH AWARD: MAHER ZAHER

Major: Environmental Engineering
Focus: Biofuels

"I see myself employed either at a government agency to help serve the public or as an environmental consultant. Helping others is a way of helping yourself."

LIST OF DONORS AND AWARDS

- Advanced Engine Technology (AET) Endowment
- CE-CERT Regional Properties, Inc. Endowment
- Colin E. Hackett Endowed Engineering Research Award
- Esther F. Hays Graduate Fellowship Award
- G. Neal Richter Student Support Fund in Energy Innovation
- Jacques and Eugene Yeager Families Endowed Chair
- Jim Guthrie Research Award
- Johnson Ruel
- Joseph Norbeck Memorial Fund for Student Success
- Packard Foundation Fellowship in Environmental Engineering
- Roberta Nichols
- Salim Khan Award
- Tanfeng Cao Award
- USA Waste of California and the County of Riverside
- William Pierson & The Ford Foundation

ONE DONATION. INFINITE POSSIBILITIES.

LOOKING BACK ON 2017...

$18 MILLION
IN ACTIVE AWARDS AND PROJECTS

COLLABORATIVE DISCIPLINES

- Bioengineering
- Business
- Chemical and Environmental Engineering
- Chemistry
- Computer Engineering
- Computer Science and Engineering
- Electrical and Computer Engineering
- Environmental Science
- Materials Science and Engineering
- Mechanical Engineering
- Medicine
- Public Policy

"UCR's Center for Environmental Research and Technology (CE-CERT) has worked with CARB and San Pedro Bay businesses for over ten years on all aspects of freight movement. They are recognized as a global leader in approaches to achieving sustainable freight mobility and pathways to cleaner air for disadvantaged and inland county communities."

Abas Goodarzi, Ph.D., P.E.
President and CEO, US Hybrid Corporation

27 INTERDISCIPLINARY FACULTY

53 GRADUATE STUDENTS

30 FULL TIME STAFF

50 UNDERGRADUATE STUDENTS

"CE-CERT is certainly a center of excellence on vehicular emissions and air quality."

Timothy V. Johnson, Sc.D.
Corning Incorporated

2,500
VISITORS HOSTED AT OVER 40 EVENTS, TOURS, AND CONFERENCES

152 PARTNERSHIPS WITH INDUSTRY AND ACADEMIA

"As well as being a national leader in understanding atmospheric processes, alternative fuels and emissions, smart transportation and connected vehicles, CE-CERT is also partnering with UCR's budding School of Medicine to focus on the health of our community, and with UCR's School of Public Policy to offer ample education and joint research opportunities that align closely with CARB's mission."

Gordon Bourns
Chairman and CEO, Bourns, Inc.
(On CE-CERT's collaboration with the California Air Resources Board and CARB's move to Riverside)

. . .AND LOOKING AHEAD TO 2018

The California Air Resources Board (CARB) is slated to begin construction in February 2018 on its new $419 million facility, which will be located on a 19-acre site at UC Riverside on Iowa Avenue near Martin Luther King Boulevard. This facility will serve as the board's Southern California headquarters as well its principal motor vehicle and engine emissions testing and research center.

This partnership will provide many opportunities for collaboration between CE-CERT and CARB, such as internship opportunities for UC Riverside students, continuing education for CARB staff, joint appointment opportunities for CARB scientists, and the development of a synergistic Sustainable Mobility Evaluation Center. This partnership will also benefit the city of Riverside economically by bringing over 400 new jobs to the area.

ARTIST'S RENDITION OF THE FUTURE CARB FACILITY IN RIVERSIDE, CA

"This facility will bring together two world-class institutions working in air quality and emissions science and promises to create a whole range of synergies that simply wouldn't be possible otherwise. Building this new facility in Riverside now positions our region to become the global capital for air quality research."

Dr. Kim A. Wilcox
Chancellor, UC Riverside

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