



Bourns College of Engineering  
Center for Environmental Research and Technology

# CE-CERT

## 2022 ANNUAL REPORT



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# DIRECTOR'S MESSAGE



This past year has been a remarkable one for all of us at CE-CERT. We emerged from the pandemic more resilient than ever before. I started as director in July 2022 as Dr. Matt Barth took on his new role as Associate Dean for Research and Graduate Education at the UCR Bourns College of Engineering. I am humbled by the progress CE-CERT has made over the 18 years Matt served as director and am thankful that, because of his hard work and strong leadership, I step into this role in a CE-CERT that is stronger than it has ever been. I am equally thankful to all of the staff, researchers, and students that make CE-CERT so special and productive. The year 2022 has been a new and promising chapter as we continue to develop innovative and transformative technologies that will enhance the quality of life of our local and nationwide communities.

In April, we celebrated our 30<sup>th</sup> anniversary with an alumni research symposium, an awards recognition lunch, and a dinner reception. We enjoyed welcoming back so many researchers who began their careers here and have since gone on to be leaders in industry, government, and academic institutions. Among our distinguished guests at the celebration dinner and reception were UCR Chancellor Kim Wilcox, Riverside Mayor Patricia Lock Dawson, California State Senator Richard D. Roth, and Pete Hardigan of Ford Motor Company, which is CE-CERT's founding donor.

With the worst of the pandemic now behind us, activity in the offices and labs at CE-CERT today is much like that at the start of 2020. Though we always worked as a team even when we weren't occupying the same physical space, we appreciate now more than ever how important our in-person interactions are for fostering the sort of collaborative and out-of-the-box approaches we excel at. The continued path towards normalcy also meant we could take part in more outreach events that are so important for showing the community some of the exciting things happening in our labs.

As just one measure of the impressive level of research activity at CE-CERT, we ended 2022 with over \$37.7M in active research projects, which is 39.5% higher

than during any prior year! That research funding supports the 30 research faculty members, 40 technical and administrative staff, and more than 81 graduate and undergraduate student researchers here. We are grateful for the many industry, state and federal government partners that have supported our research and challenged us to find solutions to the most pressing environmental problems.

Looking forward, CE-CERT is poised to build on its core strengths and expand into new research areas. As leaders in air quality, climate change, energy, and transportation research, we are well-positioned to play a leading role in a range of federal and state initiatives, which ensures we will have another exciting annual report to share with you next year!

This annual report highlights the work of CE-CERT from the last year and acknowledges our many partners, supporters, and personnel. As always, you can find more detailed information on our website, <https://www.cert.ucr.edu/>. Feel free to reach out and let us know how we are doing!

Sincerely,  
**Dr. Don Collins**

# CE-CERT MAJOR



## CE-CERT FACULTY MEMBERS ACHIEVE GLOBAL RECOGNITION AS TOP SCIENTISTS

Five distinguished members of CE-CERT faculty, Charles Wyman, William (Bill) Carter, Matthew Barth, Georgios Karavalakis, and Thomas Durbin, have achieved recognition as top scientists in the world. This esteemed acknowledgment comes from Stanford University's highly regarded database of highly cited scientists, which evaluates experts based on standardized metrics such as citations, h-index, co-authorship adjusted hm-index, citations to papers in different authorship positions, and a composite indicator (c-score). With scientists classified into 22 scientific fields and 176 sub-fields, this recognition is based on being among the top 100,000 scientists with or without self-citations or having a percentile rank of 2% or above in their respective sub-field.



## UC RIVERSIDE SELECTED TO COMPETE IN PRESTIGIOUS ECOCAR EV CHALLENGE, PROVIDING STUDENTS WITH INDUSTRY-LEVEL EXPERIENCE IN ADVANCED AUTOMOTIVE RESEARCH AND DEVELOPMENT

UC Riverside has been chosen as one of only 15 North American universities to participate in the prestigious EcoCAR EV Challenge (2022-2026), the latest Advanced Vehicle Technology Competition (AVTC). The competition, managed by Argonne National Laboratory, allows students to engineer a cutting-edge battery electric vehicle (BEV) that integrates connected and autonomous vehicle (CAV) features while meeting decarbonization goals. This four-year challenge is allowing UCR students to gain valuable industry-level experience in advanced automotive research and development and become leaders and innovators in the field. Students are being exposed to career opportunities with various sponsors and mentors, and are even incorporating EcoCAR EV Challenge tasks into their curriculum.



# HIGHLIGHTS



## CE-CERT RELEASES REPORT ON HYDROGEN BLENDING INTO CALIFORNIA'S NATURAL GAS INFRASTRUCTURE

CE-CERT researchers released the final report for a two-year study sponsored by California Public Utilities Commission (CPUC) on the impacts of injecting hydrogen into California's natural gas infrastructure. The research team, led by Arun S.K. Raju, evaluated the potential effects of hydrogen on the safety, performance, and integrity of the natural gas infrastructure using experimental and modeling techniques. Focus areas included the impacts of hydrogen blending on leakage rates, durability, and embrittlement of pipeline materials at various hydrogen blends. An important first step in potentially utilizing the natural gas infrastructure to store, transport, and distribute hydrogen, the study recommends real-world demonstration projects at select blending percentages, complemented by continuing R&D at higher blends, policy support, and community engagement as the next steps.

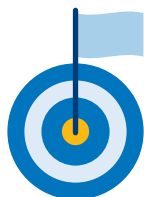


## CE-CERT EMBARKS ON A GROUNDBREAKING PROJECT TO BRIDGE THE GAP BETWEEN SCIENCE AND PUBLIC POLICY

UCR's five-year project, supported by a \$3 million grant from the National Science Foundation, is equipping graduate students with the skills to bridge the gap between science and policymaking. Led by Matthew J. Barth, the associate dean of research at the Marlan and Rosemary Bourns College of Engineering and former director of CE-CERT, the project aims to train around 80 doctoral students to engage stakeholder groups, understand and incorporate their needs into research programs, and effectively communicate the science. Through hands-on internships in legislative offices, government agencies, non-profits, and industry, the students will gain a deeper understanding of the public policy arena. Ultimately, the project is providing a platform to reduce energy costs and greenhouse gas emissions while promoting the integration of renewable energy sources into the electric grid in a manner that meets environmental justice and equity goals.

# ATMOSPHERIC PROCESSES LABORATORY

## MISSION



The Atmospheric Processes Laboratory (APL) Research Group's mission is to gain an improved understanding of the sources and impacts of particles, toxins, ozone, and greenhouse gases and apply advanced air quality measurement, modeling, and data fusion approaches to characterize air pollution throughout the United States. These advanced approaches are used to understand secondary organic aerosol formation in the atmosphere and answer exposure and source characterization questions. Researchers use our many various chambers to recreate atmospheric conditions to study the impacts of emissions from diverse sources such as vehicles, wildfires, agricultural operations, and consumer products.

## HIGHLIGHTS

1

**Riverside air quality study:** Don Collins, Roya Bahreini, and former CE-CERT researcher Sunni Ivey launched a new CARB-funded study aimed at understanding the emissions and chemistry responsible for fine particulate matter in three California cities. Ph.D. students Xuanlin Du and Ying Zhou and post-doc Alex MacDonald led the first two measurement campaigns in the winter and late summer of 2022 in Riverside. Future studies will be conducted in Wilmington in 2023 and Bakersfield in 2024.

2

**Department of Energy TRACER study:** Don Collins' research group participated in a major DOE study in the Houston, TX region in the summer of 2022. Ph.D. student Xuanlin Du studied the formation and growth of atmospheric particles inside a portable environmental chamber, while Ph.D. student Zihan Zhu measured particles from within a mobile lab that moved between several locations around Houston.

3

**California Air Resources Board Study:** David Cockers' group worked with the Seinfeld group (Caltech) and Cappa group (UC Davis) and completed a study evaluating and improving secondary organic aerosol formation (SOA) mechanisms used for scientific and regulatory modeling applications. Ph.D. students Qi Li and Huawei Li evaluated SOA precursors released from a variety of consumer products. The work included matched experiments between CE-CERT and Caltech leading to the development of a standard SOA chamber protocol.

4

**Coordinated Research Council Study:** David Cockers' group completed a program evaluating the influence of NO<sub>x</sub> on SOA and ozone formation. Ph.D. student Sahar Ghadimi utilized a novel approach first utilized by former Ph.D. student Weihang Peng to control the reaction mechanism associated with the first-generation oxidation products from aromatic, biogenic, and PAH precursors.

Graduate students working with faculty operating the environmental chamber facility.



## KEY PUBLICATIONS

Peng, W., Le, C., Porter, W., and Cocker, D. "Variability in Aromatic Aerosol Yields under Very Low  $\text{NO}_x$  Conditions at Different  $\text{HO}_2/\text{RO}_2$  Regimes." *Environmental Science and Technology*, 2022, p. 750-760.

Li, Q., Jiang, J., Afreh, I., Barsanti, K., and Cocker, D. "Secondary organic aerosol formation from camphene oxidation: measurements and modeling," *Atmospheric Chemistry and Physics*, 2022, p. 3131-3147.

Chen, L., Zhang, F., Collins, D., Ren, J., Liu, J., Jiang, S., and Li, Z. "Characterizing the volatility and mixing state of ambient fine particles in the summer and winter of urban Beijing," *Atmospheric Chemistry and Physics*, 2022, p. 2293-2307.

Perkins, R. J., Marinescu, P. J., Levin, E. J. T., Collins, D. R., and Kreidenweis, S. M. "Long- and Short-Term Temporal Variability in Cloud Condensation Nuclei Spectra in the Southern Great Plains," *Atmospheric Chemistry and Physics*, 2022, p. 6197-6215.

## KEY SPONSORS & PARTNERS

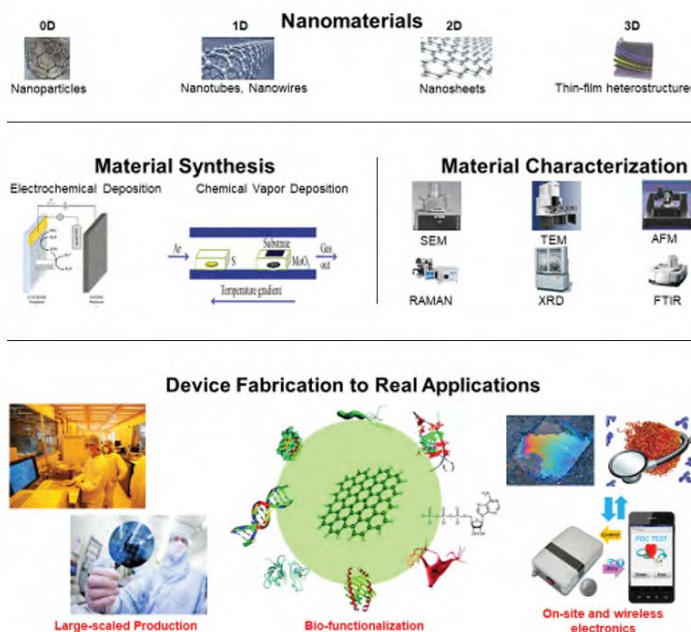
- Department of Energy Atmospheric System Research Program
- California Air Resources Board
- National Science Foundation Atmospheric Chemistry Program
- Coordinating Research Council
- Environmental Protection Agency
- National Oceanic and Atmospheric Administration

# BIONANOTECHNOLOGY

## MISSION



Our research efforts are primarily aimed at developing innovative technologies for improving human health and the quality of life, which may be summarized by "Better Science, Better Health, Better Life." The focus of our research is in the emerging area of BioNanotechnology creating bio/chemical sensors for applications in healthcare, environmental monitoring, personal/homeland security, food safety/quality, and energy generation and storage devices.



## KEY SPONSORS & PARTNERS

- National Institute of Justice/Department of Justice
- U.S. Department of Agriculture
- W. Ruel Johnson Chair



# EMISSIONS AND FUELS RESEARCH GROUP

## MISSION



The Emissions and Fuels Research (EFR) Group applies advanced technologies and methods to measure emissions and activity from various sources, such as passenger vehicles, heavy-duty vehicles, off-road equipment, and large engines that power marine vessels and locomotives. This information is critical to understand the impacts of mobile sources on emission inventories, human health, and the environment. For many years, the EFR group has expanded its research activities beyond traditional laboratory measurements to focus more on measurements under real-world conditions using emerging portable emissions/activity monitoring systems (PEMS/PAMS) and On-board Sensing and Reporting (OSAR) tools. Recent projects have evaluated the performance of zero-emission vehicles with either batteries or hydrogen for power.

## HIGHLIGHTS

1

The EFR group initiated a number of programs in our On-board Sensing And Reporting (OSAR) research area. Under these programs, EFR will be implementing a sensor-based, micro-portable emissions measurement system, called OSAR, on over 200 heavy-duty vehicles and equipment to monitor emissions.

2

The EFR group is conducting extensive research in characterizing emissions from marine vessels. This research includes testing of commercial harbor craft and ocean-going vessels with the latest emission control technology over standard and real-sailing operating modes.

3

The EFR group is initiating a major program to run the referee program under California's heavy-duty Inspection and Maintenance (HD I/M). Under this program, EFR will play a major role in the implementation of California's HD I/M by performing referee inspections of HD vehicles that require additional inspections on vehicles that are otherwise outside of the typical testing requirements.

4

The EFR group has a number of ongoing studies to characterize the performance of zero-emissions heavy-duty vehicles including battery electric and hydrogen-powered fuel cell electric trucks with several OEMs. Recently, UCR partnered with Cummins Inc for the performance and evaluation of their heavy-duty class 8 fuel cell truck including hydrogen refueling at a refueling station located at CE-CERT, as shown to the right.

Testing a Fuel Cell Vehicle on the CE-CERT Heavy Duty Chassis Dynamometer



Refueling a Fuel Cell Vehicle at the CE-CERT hydrogen refueling station (rated to 700 bar, 500 kg of fuel)







Emissions research being conducted in the light-duty vehicle laboratory by graduate students.

## KEY PUBLICATIONS

Li, C., Ma, T., Karavalakis, G., Johnson, K. C., Durbin, T. D. (2022). Evaluation of on-board sensor-based NO<sub>x</sub> emissions from the heavy-duty vehicles in an inspection and maintenance program. *Emission Control Science and Technology*, 9(1), 12–24.

McCaffery, C., Yang, J., Karavalakis, G., Yoon, S., Johnson, K. C., Miller, J. W., Durbin, T. D. (2022). Evaluation of small off-road diesel engine emissions and Aftertreatment Systems. *Energy*, 251, 123903.

Ghadimi, S., Zhu, H., Durbin, T. D., Cocker, D. R., Karavalakis, G. (2022). The impact of hydrogenated vegetable oil (HVO) on the formation of Secondary Organic Aerosol (SOA) from in-use heavy-duty diesel vehicles. *Science of The Total Environment*, 822, 153583.

McCaffery, C., Zhu, H., Sabbir Ahmed, C. M., Canchola, A., Chen, J. Y., Li, C., Johnson, K. C., Durbin, T. D., Lin, Y.-H., Karavalakis, G. (2022). Effects of hydrogenated vegetable oil (HVO) and HVO/biodiesel blends on the physicochemical and toxicological properties of emissions from an off-road heavy-duty diesel engine. *Fuel*, 323, 124283.

## AWARDS & HONORS

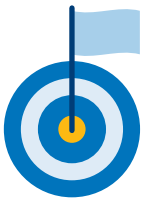
- Georgios Karavalakis and Thomas Durbin are named on Stanford's list of the top 2% of scientists in the world.
- Kent Johnson made an invited presentation at the Cummins Board of Advisors meeting.

## KEY SPONSORS & PARTNERS

- 3DATX
- South Coast Air Quality Management District
- AKKA
- AVL
- California Air Resources Board
- California Energy Commission
- CALSTART
- Caltrans
- Cummins Inc.
- Department of Defense
- Department of Energy
- Department of Transportation Maritime Administration
- United States Environmental Protection Agency
- Eastern Research Group, Inc.
- Hager Environmental & Atmospheric Technologies (HEAT)
- HEM Data
- Horiba
- National Center for Sustainable Transportation
- NGK Sparkplugs
- RA Automotive
- Sensors Inc.
- Southern California Gas Company
- Tetra Tech, Inc.
- The Texas A&M University System
- TSI Incorporated
- U.S. Environmental Protection Agency
- Volvo Truck Corporation

# SOUTHERN CALIFORNIA RESEARCH INITIATIVE FOR SOLAR ENERGY (SC-RISE)

## MISSION



The Southern California Research Initiative for Solar Energy (SC-RISE) Group focuses on multiple aspects of research, demonstration, and engagement related to Solar Energy. The Advanced Materials and Energy Devices Laboratory (AMEDL) focuses on basic research and technology development, while the Distributed Energy Resources Laboratory (DERL) works on applied research related to the design, integration, deployment, demonstration, and validation of renewable energy, green infrastructure, and new clean technologies. The Solar Valley Consortium (SVC) works with key stakeholders in public policy matters of high importance for transforming the counties of Riverside and San Bernardino into the Solar Valley of California.

## HIGHLIGHTS

1

The 7th annual Solar Valley Conference took place on May 5th, 2022, with a focus on four themes: 1) The State of Solar in Inland Southern California; 2) Impacts of New NEM 3 Policies on jobs and the local economy; 3) What the 2035 Grid should look like (key attributes); and 4) Key Regulatory Actions affecting solar and storage in Riverside and San Bernardino Counties.

2

On November 10, 2022, and December 8, 2022, the SVC presented two webinars on land availability and the availability of transmission in the counties of San Bernardino County and Riverside. Recognizing that there is an urgent need for California to increase solar deployment and interconnection capability if the state is to meet its renewable energy goals, SVC welcomed a distinguished panel of experts to discuss this pressing issue.

3

A research report was authored by the Science to Policy (S2P) program and the Bourns College of Engineering, Center for Research & Technology (CE-CERT) to inform the public and decision-makers on the background, context, environmental, social, and management issues surrounding Net Energy Metering (NEM) policies and how current proposals might affect ratepayers, the solar industry, the state of California and its goals.

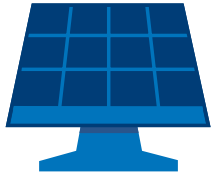
4

Mplus Solar Inc., a spin-off from UC Riverside was awarded a CalSEED Concept Award to advance a solar cell technology that seamlessly and simultaneously integrates the generation and storage of solar energy in a single device architecture.



## PROFESSIONAL ACTIVITY

- IEEE Global Energy Conference 2022, Technical Co-Chair, Alfredo A. Martinez-Morales
- Solar Valley Consortium, Co-chair, Alfredo A. Martinez-Morales
- Energy Journal, Elsevier, Vice Editor, Tahir Cetin Akinci
- Reviewer, Maryland, Industrial Partnerships Program, Alfredo A. Martinez-Morales



## SOLAR VALLEY CONSORTIUM MEMBERS

- EDF Renewables
- Inland Economic Growth and Opportunity
- Intersect Power
- Riverside County
- Riverside Public Utilities
- San Bernardino County
- Southern California Edison
- Sunrun
- Western Riverside Council of Governments

## KEY PUBLICATIONS

Akinci, T. Çetin, and Alfredo A. Martinez-Morales. "Cognitive Based Electric Power Management System." *Balkan Journal of Electrical and Computer Engineering* 10.1, p. 85-90.

Akinci, T. Çetin, and Alfredo A. Martinez-Morales. "Post-Humanism, Artificial Intelligence, and Cognitive Robots." *Posthumanism in Multidisciplinary Studies*, 2022.

Akinci, T. C., Martinez-Morales, A., Yilmaz, M., and Demir, I. "Advanced Measurement Systems with Smart Grid in Turkey: Roadmap 2032." *Global Energy Conference (GEC)*, 2022, p. 1-6.

Nogay, H. S., Akinci, T. C., & Yilmaz, M. "Detection of invisible cracks in ceramic materials using by pre-trained deep convolutional neural network." *Neural Computing and Applications*, 2022, p. 1423-1432.

## AWARDS & HONORS

- First Place Poster Competition, Annual National Institute of Neurology and Neurosurgery Research Meeting, Alfredo A. Martinez-Morales
- Scientific and Technological Research Council of Turkey (TUBITAK) Fellowship, Tahir Cetin Akinci
- 2022-23 Bonnie Reiss Climate Action Student Fellowship Program, Chanisa Tangtananusak
- "West & Rest" Regional Competition Runner-Up, Mlplus Solar, Inc.

## KEY SPONSORS & PARTNERS

- California Energy Commission
- California Resiliency Challenge
- Eurosemillas Technology Acceleration Program
- New Energy Nexus
- UC MEXUS
- Blue Lake Rancheria
- Climate Resolve
- Council for Watershed Health
- Enzinc, Inc.
- Fernando Tataviam Band of Mission Indians
- GRID Alternatives
- Invinity Energy Systems
- La Jolla Band of Luiseño Indians
- Linc Housing
- National Autonomous University of Mexico
- National Institute of Neurology and Neurosurgery (Mexico)
- Oklahoma State University
- ONYX Power Inc.
- Powersmiths International
- Soboba Band of Luiseño Indians
- Socomec



# TRANSPORTATION SYSTEMS RESEARCH

## MISSION



CE-CERT's Transportation Systems Research (TSR) Group applies the latest advances in the field of shared electric, connected, and automated vehicles to mitigate the environmental and energy issues associated with moving goods and people. The group focuses on developing and implementing advanced computing, control, communication, and sensing technologies to transform today's vehicles and associated roadway infrastructure into sustainable transportation system solutions that take into consideration safety, the environment, health, mobility, and economics.

In 2022, the TSR group made significant progress in further developing their real-world smart intersection, conducting several experiments and producing several papers. The group has also been busy in the area of vehicle electrification, developing a zero-emission vehicle planning tool for Caltrans, and joining the National EcoCAR EV challenge. Details of these programs are provided below.

## HIGHLIGHTS

1

**Smart Intersection Program:** TSR researchers have been working closely with the City of Riverside to further develop their Smart Intersection (University Ave. & Iowa Ave.) testbed to enable Shared, Electric, Connected, and Automated (SECA) transportation system research. Currently, it is equipped with a variety of sensors (e.g., LiDAR, fisheye camera, and fixed bullet camera) and wireless communication devices (such as 4G/LTE modem, UniFi, and Dedicated Short-Range Communications). Several key experiments have been carried out; highlights are provided here: Youtube Link: [Roadside LiDAR-based 3D Object Perception and Reconstruction in Real World](#)



Riverside's Innovation Corridor with UCR's smart intersection testbed to evaluate connected vehicle scenarios.

2

**Zero-Emission Vehicle (ZEV) Planning Tool:** TSR researchers have developed a spreadsheet-based planning tool to enable the evaluation and use of zero-emission vehicles (ZEVs) within the Caltrans fleet. The tool assists with determining both the deployment of ZEVs and the placement of new charging/fueling stations to obtain the maximum benefits. The ZEV tool allows Caltrans to maximize the usage of ZEVs that will be coming into the Caltrans fleet, both for environmental reasons as well as to take advantage of fuel credits that accompany these vehicles. Caltrans staff will be able to utilize the ZEV tool to strategically select existing vehicles to be turned over to ZEVs based on vehicle specifications, refueling infrastructure, and prior vehicle activity. The ZEV tool provides evaluation by vehicle classification, region, activity, and refueling/charging capabilities. Utilization of the tool will assist the state in the transition to ZEV platforms that are either battery electric or hydrogen fuel cell.



ZEV Tool compatibility GUI which depicts vehicle travel suitable for ZEV transitioning.

TSR announced a collaboration with AVL on a connected and automated vehicle research project. The team is using the AVL Dynamic Ground Truth System™ to collect roadway data on test drives through the City of Riverside Innovation Corridor, and other locations. The vehicle data are then fused with infrastructure to optimize the dataset from V2X communication.

[www.cert.ucr.edu/news/2022/08/03/ce-cert-collaborates-avl-dynamic-ground-truth-systemtm](http://www.cert.ucr.edu/news/2022/08/03/ce-cert-collaborates-avl-dynamic-ground-truth-systemtm)

3

**OMEGA Research Program (Objective Measurement/Monitoring/Mitigation of Emissions from Goods Movement and Impacts on Air Quality):** CE-CERT researchers, including several from the TSR group, launched a \$2 million project to study the air quality impacts of goods movement in Inland Southern California communities most affected by air pollution. In this program, CE-CERT and partners are monitoring emissions from diesel truck fleets around various cargo hubs and monitoring air quality in the surrounding communities, modeling air quality impacts of truck activities, and developing strategies such as innovative truck routing to mitigate the emissions and air quality impacts.

The project brings together key researchers working on novel onboard emissions monitoring technology, innovative freight management strategies, and community air quality monitoring. To date, CE-CERT has been addressing these research areas somewhat separately; this project will integrate these research elements for an even greater impact. For further details, see [www.cert.ucr.edu/news/2021/09/24/ce-cert-lead-new-2-million-initiative-monitor-air-quality-impacts-goods-movement](http://www.cert.ucr.edu/news/2021/09/24/ce-cert-lead-new-2-million-initiative-monitor-air-quality-impacts-goods-movement)

4

**EcoCAR EV National Challenge:** The U.S. Department of Energy (DOE), General Motors, and MathWorks announced the 15 North American universities and the 2023 Cadillac LYRIQ as the vehicle selected for the EcoCAR EV Challenge, the next DOE-sponsored Advanced Vehicle Technology Competition (AVTC) which launched in the Fall of 2022. The University of California, Riverside has earned a spot as one of the 15 universities to participate in this prestigious series. The goal of this four-year program (2022-2026) is to engineer a battery electric vehicle (BEV) that utilizes automation and vehicle-to-everything (V2X) connectivity to implement energy-efficient and customer-pleasing features, to meet the decarbonization needs of the automotive industry. The UCR EcoCAR team is off to a good start, see <https://ecocar.engr.ucr.edu/>



(From left to right) Matt Barth, Christopher Stubbs (General Motors) & the UC Riverside's EcoCAR Team at CE-CERT

## KEY PUBLICATIONS

Bai, Z., Wu, G., Qi, X., Liu, Y., Oguchi, K., and Barth, M. "IEEE Cyber Mobility Mirror for Enabling Cooperative Driving Automation in Mixed Traffic: A Co-Simulation Platform." *IEEE Intelligent Transportation Systems Magazine*, 2022, p. 2-15.

Bai, Z., Hao, P., Wei, S., Cai, B., and Barth, M. "Hybrid reinforcement learning-based eco-driving strategy for connected and automated vehicles at signalized intersections." *IEEE Transactions on Intelligent Transportation Systems*, 2022, p. 15850-15863.

Luo, J., Wang, C., Wallerstein, B., Barth, M., and Boriboonsomsin, K. "Heavy-duty truck routing strategy for reducing community-wide exposure to associated tailpipe emissions." *Transportation Research Part D*, 2022.

Un-Noor, F., Vu, A., Tanvir, S., Gao, Z., Barth, M., and Boriboonsomsin, K. "Range extension of battery electric trucks in drayage operations with wireless opportunity charging at port terminals." *2022 IEEE Vehicle Power and Propulsion Conference*, 2022.

## KEY SPONSORS & PARTNERS

### FEDERAL

- USDOT
- USDOE
- NSF
- NCST
- CARTEEH

### STATE

- Caltrans
- CARB
- California Attorney General's office

### LOCAL

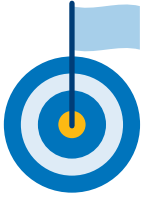
- City of Riverside
- WRCOG
- SCAG

### INDUSTRY

- AVL
- Toyota InfoTech
- Honda

# SUSTAINABLE FUELS INITIATIVE

## MISSION



The Sustainable Fuels Initiative (SFI)'s mission is to advance and demonstrate sustainable energy solutions, including advanced technologies for the production and use of sustainable fuels such as green hydrogen and renewable natural gas. Focus areas include energy systems analysis, waste/biomass to energy, transportation electrification, high renewables grid management, techno-economic, and life cycle assessment.

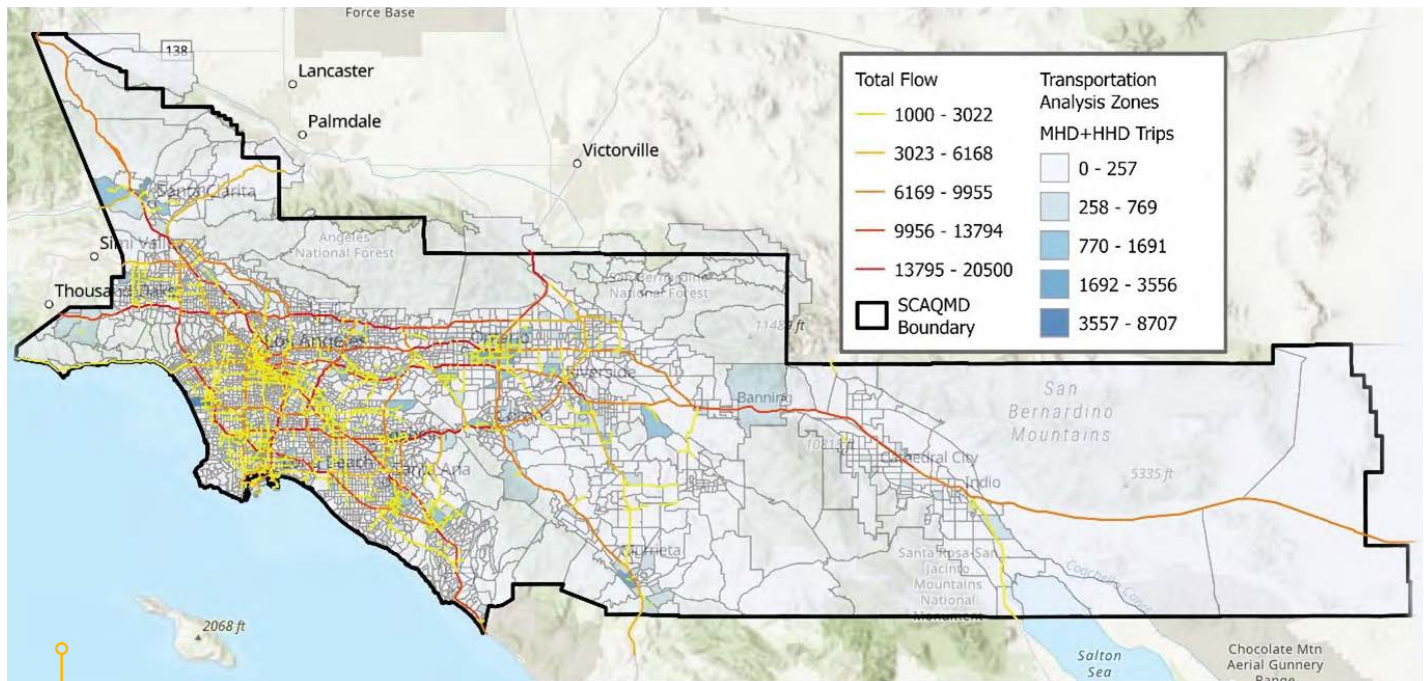
CE-CERT's hydrogen exposure laboratory configuration to evaluate impacts of blending hydrogen within the natural gas pipeline infrastructure as part of the CPUC funded Hydrogen Blending Impacts Study.



## KEY PUBLICATIONS

Penchev, M., Lim T., Todd, M., Lever, O., Lever, E., Mathaudhu, S., Martinez-Morales, A., & Raju, A.S. K.; Hydrogen Blending Impacts Study - CPUC Final Report (2022).





Results from the CEC Medium and Heavy-Duty Blueprint study to identify infrastructure needs for transitioning commercial fleets to Zero Emission Vehicle platforms.

## HIGHLIGHTS

1

The SFI group completed Hydrogen Blending Impacts Study, commissioned by the California Utilities Commission (CPUC) in compliance with Senate Bill 1369 and CPUC Rulemaking 13-02-008. The study evaluates the operational and safety concerns associated with injecting hydrogen into the existing natural gas pipeline system. The findings of the study are presented in the report Hydrogen Blending Impacts Study, published by the CPUC. <https://www.cpuc.ca.gov/news-and-updates/all-news/cpuc-issues-independent-study-on-injecting-hydrogen-into-natural-gas-systems>.

2

The SFI group is creating a blueprint for the California Energy Commission (CEC), for future deployment of zero emission medium and heavy duty vehicles and related infrastructure in the South Coast Air Quality Management District (SCAQMD) territory. The study is evaluating fuel, energy resources and essential infrastructure requirements for various stages of future vehicle deployment.

## KEY SPONSORS & PARTNERS

- California Public Utilities Commission
- California Energy Commission
- Pacific Gas & Electric
- Gas Technology Institute
- Taylor Energy
- SoCalGas
- Strategic Growth Council
- Berkshire Hathaway Energy Renewables

# B<sup>3</sup>: BIOENERGY, BIOREFINING, AND BIOMATERIALS TEAM (SUSTAINABLE FUELS)

## MISSION



B<sup>3</sup>'s goal is to transform earth-abundant agricultural and forestry plant waste residues, otherwise known as lignocellulosic biomass, into sustainable alternatives to petroleum-derived fuels and products. Uniquely, the group has specialized in developing low-cost technologies to allow a more efficient breakdown of biomass so that its valuable components may serve as building blocks for biofuels, bioplastics, bio resins, and biocomposites of the future. They specialize in Co-solvent Enhanced Lignocellulosic Fractionation (also known as CELF): a next-gen biomass pretreatment technology that promises to reduce the cost of biorefining and improve the performance of biomass products.

Associate Research Professor, Charles M. Cai, leads the B<sup>3</sup> team at CE-CERT to advance biomass conversion technologies that produce high-performance composites, liquid transportation fuels, and lignin-based adhesives and bioplastics.



## HIGHLIGHTS

1

Through project funding from the US Environmental Protection Agency, B<sup>3</sup> has developed new techniques for transforming newly legalized industrial hemp into high-performance hempcrete 2.0, hemp board, and ethanol. With their team of graduate and undergraduate students, they developed a new stronger hempcrete 2.0 that could prove to be a far better structural material than previous hempcrete products. This more advanced hempcrete does not require mechanical decortication; instead, this group uses novel CELF (co-solvent enhanced lignocellulosic fractionation) pulping of raw hemp to directly achieve the material properties they desire.

Hempcrete made from raw decorticated hemp hurd (left) and CELF pulped hemp stalk (right). CELF-pulped hempcrete was noticeably denser, less porous, less brittle, harder, and conformed better as it cured inside our briquette mold as compared to the traditional hempcrete. We anticipate that CELF-pulped hempcrete to have better insulating properties, higher compressive strength, improved durability, and less friable than traditional hempcrete. These samples were produced using identical 1:1:3 (biomass:binder:water) ratios in formulation.



Traditional Hempcrete



Hempcrete 2.0

## KEY PUBLICATIONS

Sengupta, P., Mohan, R., Wheeldon, I. "Prospects of thermotolerant *Kluyveromyces marxianus* for high solids ethanol fermentation of lignocellulosic biomass." *Biotechnol Biofuels*, 2022.

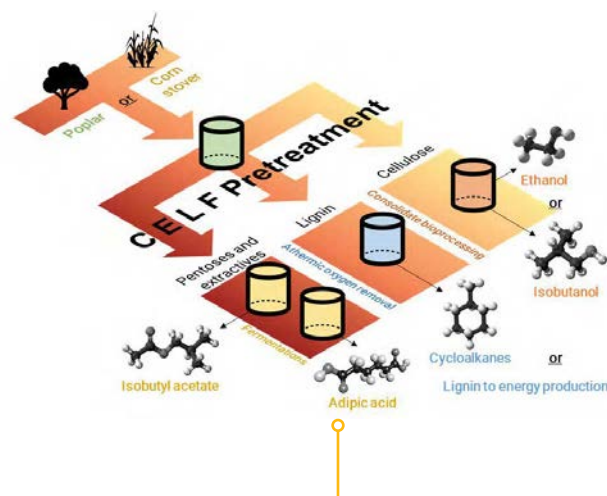
Meng X, et al. "Preparation and characterization of aminated co-solvent enhanced lignocellulosic fractionation lignin as a renewable building block for the synthesis of non-isocyanate polyurethanes." *Industrial Crops and Products*, 2022.

Zhao Z-M, et al. "Cosolvent enhanced lignocellulosic fractionation tailoring lignin chemistry and enhancing lignin bioconversion." *Bioresource Technology*, 2022.

2

Through project funding from the US Department of Energy, B3-SFI has partnered with researchers at Oak Ridge National Laboratories (ORNL), National Renewable Energy Laboratories (NREL), and University of Tennessee Knoxville (UTK) to develop a high-fidelity computer model that calculates the economics and environmental impacts of a full-scale CELF biorefinery that transforms poplar wood and corn stover into sustainable aviation fuels (SAFs), green chemicals, and fuel alcohols. The analysis also showed the possibility of supplying alcohol-derived SAF to the market at competitive prices – as low as \$3.15/GGE (gallon of gasoline-equivalent) – as well as carboxylic acids and esters.

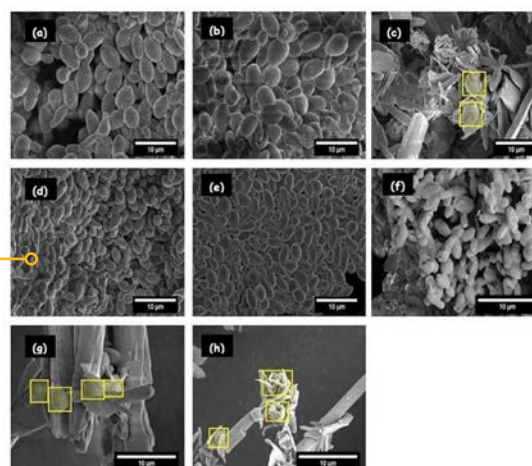
CELF (Co-solvent Enhanced Lignocellulosic Fractionation) is a leading biomass pretreatment and fractionation technology that promises to lower the cost of 2nd generation biofuels and improve the manufacturing advanced materials from biomass. CELF was invented by Prof. Cai in 2012 to efficiently overcome the natural recalcitrance of plant biomass and deliver high quality sugar and lignin intermediates to downstream biological and catalytic processes. Simplified diagram for the proposed CELF-based biorefineries outlining the mass integration strategy. CELF: Co-solvent Enhanced Lignocellulosic Fractionation.



3

Through project funding from the US Department of Agriculture, we have investigated the potential for employing thermotolerant yeast to produce ethanol from corn stover and poplar wood biomass at high yields. This is because most conventional yeast strains could only thrive at temperatures below 98F, however, the enzymes that help to release sugars from biomass perform better at a higher 125F. To better pair enzyme function with yeast fermentation, we tested *Kluyveromyces marxianus*, a thermotolerant yeast, and demonstrated its exciting potential as a new host for genetics research for improving ethanol yields from biomass.

Scanning electron micrographs (SEM) for anaerobic growth of standard yeast *S. cerevisiae* (a-c) and thermotolerant yeast *K. marx* (d-h) during fermentation of CELF-pretreated poplar wood to ethanol.





# SUSTAINABLE INTEGRATED GRID INITIATIVE

## MISSION



The Sustainable Integrated Grid Initiative (SIGI) was developed specifically to research and implement systems that demonstrate the successful integration of intermittent renewable energy, energy storage, and all types of electric and hybrid electric vehicles and motors. Now in its eighth year of operation, the research testbed 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. Focus areas include:

- ✓ Effectively and efficiently integrating utility-scale renewable energy and transportation electrification with unique microgrid solutions;
- ✓ Characterizing and quantifying solar photovoltaic power production, and matching with energy storage and peak load reduction strategies including behind-the-meter building management;
- ✓ Demonstrating and validating pre-commercial technologies in microgrid technology and energy management algorithms;
- ✓ Training and educating at all levels in deploying and using renewable systems;
- ✓ The design, development, and evaluation of unique energy storage solutions, including power-to-gas, hydrogen production, thermal energy storage, and second-life batteries;
- ✓ Evaluating electric motor efficiency and designing associated control systems.
- ✓ Understanding the energy-water agricultural nexus

## HIGHLIGHTS

1

**EV Penetration Impact Analysis:** Analysis utilizes the Transmission and Distribution (T&D) co-simulation approach to analyze the EV integration impacts on the transmission system. The analysis is carried out for uncoordinated EV charging activities and different levels of EV penetration in the distribution feeder. Later on, distributed solar photovoltaic (PV) resources are also integrated to investigate their combined impacts.

2

**Bad Cell Identification of Utility-Scale Battery Energy Storage System:** A detailed formulation of the analysis process was carried out and applied to data from SIGI's BESS Trailer. Results demonstrated that the method can successfully identify bad cells in a BESS containing a large number of cells.

## KEY PUBLICATIONS

Jahid Hasan, A.S.M., Yusuf, J., Enriquez-Contreras, L., Ula, S. "Bad Cell Identification of Utility-Scale Battery Energy Storage System through Statistical Analysis of Electrical and Thermal Properties." *IEEE PES Innovative Smart Grid Technologies Europe (ISGT Europe)*, 2021, p. 1-5.

Jahid Hasan, A.S.M., Yusuf, J., Enriquez-Contreras, L., Ula, S. "A Comprehensive Building Load Optimization Method from Utility Rate Structure Perspective with Renewables and Energy Storage." *International Conference on Smart Energy Systems and Technologies (SEST)*, 2021, p. 1-6.

Garrido, J., et al. "Dynamic Data-Driven Carbon-Based Electric Vehicle Charging Pricing Strategy Using Machine Learning." *IEEE International Intelligent Transportation Systems Conference (ITSC)*, 2021, p. 1670-1675.

Jahid Hasan, A.S.M., Yusuf, J., Enriquez-Contreras, L., Ula, S. "Demonstration of Microgrid Resiliency with V2G Operation." *IEEE Transportation Electrification Conference and Exp*, 2021, p. 243-248.

## KEY SPONSORS & PARTNERS

- Western Municipal Water District (WMWD)
- CalTestBed Program:
  - a. Cylonetix
  - b. Future Motors
  - c. Rejoule
  - d. Umida AG
  - e. Alpine Hydromet
- Glendale Water and Power
- Western Riverside Council of Government's (WRCOG)



SIGI researchers at the CE-CERT microgrid capable of islanding, V2X, load management, and energy pricing evaluations.

# 3

**Microgrid Demand Response:** CE-CERT's research explores a real-world microgrid implementation done at the University of California, Riverside. The intended purpose is to see the feasibility of demand response and islanding in a real microgrid. An algorithm is used to generate "target data" for the Battery Energy Storage (BES) Inverter to follow. The other purpose is to show it is feasible to respond to demand response scenarios with the current setup.

# 4

**CalTestBed:** The SIGI testing facility, developed with California Energy Commission (CEC) and CalTestBed, has completed projects with several companies such as Future Motors, Greentech Motors, Cylonatix, Umida AG, Alpine Hydromet, and Rejoule.

# GREENHOUSE GAS LAB

## MISSION



The Greenhouse Gas Emissions Lab studies emissions that affect the climate and air quality to develop the science of reducing these emissions. We focus primarily on emissions of methane from anthropogenic sources, but also of carbon dioxide, nitrous oxide, carbon monoxide, and ammonia. We use field studies with a mobile laboratory, isotope measurements in the environment, spatial mapping, and other atmospheric and soil science techniques to better understand emission sources.

## HIGHLIGHTS

1

**Dairy Digester Emission Reductions:** The Greenhouse Gas Emissions Lab group has conducted four field sampling campaigns to study methane emissions at a dairy farm in the San Joaquin Valley after the installation of a digester. The digester captures methane produced from manure for use as biofuel. Digesters are one of the primary ways California is working to reduce methane emissions, and their work will contribute to verifying the effectiveness of this strategy. (The photo below shows the mobile lab set up with a mast for sampling around the dairy digester-lagoon complex at the field site).

2

**COVID-19 Changes in CO<sub>2</sub> Emissions:** Using mobile surveys before, during, and after the shutdowns of the COVID-19 pandemic, they found a 60% reduction in on-road levels of CO<sub>2</sub> in the greater Los Angeles region during 2020 compared to 2019. CO<sub>2</sub> levels in 2021 rebounded to 2019 levels.

3

**New Tools for Measuring Fossil Fuel CO<sub>2</sub>:** The Greenhouse Gas Emissions Lab group collaborated with UC Irvine on the acquisition of a new accelerator mass spectrometer to measure radiocarbon, a tracer of fossil fuel CO<sub>2</sub>. Measuring the radiocarbon of plant samples collected in 2020 and 2021, they documented an uneven recovery of fossil fuel-derived CO<sub>2</sub> across California, where CO<sub>2</sub> levels rebounded more quickly in inland areas than along the coast, and in Los Angeles faster than in the Bay Area.

4

**Congratulations to 3 new Ph.D.s!** Three students from the group were awarded Ph.D.s in 2022! Congratulations to Dr. Talha Rafiq, Dr. Isis Frausto Vicencio, and Dr. Valerie Carranza. Dr. Rafiq is now working for Apple Maps, Dr. Frausto Vicencio is working in the Research Division at the California Air Resources Board (CARB), and Dr. Carranza is now at the Sustainable Transportation and Communities Division at CARB.



Mobile lab set up with an 8 meter mast for sampling around the dairy digester-lagoon complex.

## KEY PUBLICATIONS

Marklein, A.R., Meyer, D., Fischer, M.L., Jeong, S., Rafiq, T., Carr, M., Hopkins, F.M.A.R. Marklein, D. Meyer, M.L. Fischer, S. Jeong, T. Rafiq, M. Carr, and F.M. Hopkins. "Facility scale inventory of dairy methane emissions in California: Implications for mitigation." *Earth Syst. Sci. Data*, 2021, p. 1151–1166.

Carranza, V., Biggs, B., Meyer, D., Townsend-Small, A., Thiruvengkatachari, R.R., Venkatram, A., Fischer, M.L., and Hopkins, F.M. "Isotopic signatures of methane emissions from dairy farms in California's San Joaquin Valley." *Journal of Geophysical Research: Biogeosciences*, 2022, p. 127.

Frausto-Vicencio, Moreno, A., Goldsmith, H., Hsu, Y.-K., and Hopkins, F.M. "Characterizing the Performance of a Compact BTEX GC-PID for Near-Real Time Analysis and Field Deployment." *Sensors*, 2022, p. 21.

Yañez, C.C., Hopkins, F.M., Xu, X., Tavares, J.F., Welch, A., Czimczik, C.I. "Reductions in California's Urban Fossil Fuel CO<sub>2</sub> Emissions During the COVID-19 Pandemic." *AGU Advances*, 2022.

## KEY SPONSORS & PARTNERS

- California Energy Commission
- California Air Resources Board
- National Science Foundation



# FACILITIES

## CE-CERT



Established in 1992 and operating as the largest research center at UCR, CE-CERT offers many state-of-the-art laboratories and services. These facilities support our ability to address society's most pressing environmental challenges in air quality, climate change, energy, and transportation. CE-CERT remains committed to strengthening our research capabilities and expanding our laboratories.



## THE OUTDOOR ROBOTICS TESTING ARENA

CE-CERT is committed to advancing research and innovation across a range of fields, including robotics. As part of this effort, CE-CERT has recently made improvements to several labs, including the outdoor robotics testing arena. This impressive facility measures 80 ft L x 40 ft W x 30 ft H and features a high-impact netting securely attached to a weatherized metallic truss structure. The arena provides a safe and contained environment for testing mobile robot navigation in near-real-world settings, allowing for the exploration of aerial robot flight, wheeled robot localization and mapping, and other cutting-edge robotics technologies. With these improvements, CE-CERT continues to push the boundaries of innovation in robotics research.

# ENGAGEMENT &

CE-CERT continues to engage with the community through conferences and unique collaborations. This year, we have had the opportunity to interact with and educate large groups of young students on the work we do at CE-CERT and how they too can contribute to the effort to solve environmental issues.

## HIGH SCHOOL COLLABORATIONS

### SUSTAINABLE TRANSPORTATION & COMMUNITY IMPACTS WORKSHOP

OASIS Accelerator launched a two-workshop series designed for high school students and community members to be inspired to pursue careers in the field of sustainability. These workshops were created for anyone with an interest in learning about career and entrepreneurship opportunities in the fields of modern agriculture or sustainable transportation. CE-CERT proudly collaborated in two workshops of the series, where students were able to tour CE-CERT labs and interact with graduate students currently working on their education and careers related to sustainability. The high school students were then guided through entrepreneurship exercises to prepare them for future public speaking and collaboration opportunities.



### STEM SUMMER LEARNING LABS

The Science and Technology Education Partnership (STEP) held its first in-person STEM Summer Learning Labs, a 3 week-long program where 50 junior high and high school students worked in teams of 4-5 to develop and present solutions to proposed problems to a panel of judges for scholarship rewards. Students had the opportunity to tour CE-CERT's various laboratories including the Electric Grid Computer Simulation (SIGI), Transportation Systems Research (TSR), the Atmospheric Processes Lab (APL), and the Heavy-Duty Chassis Dynamometer (HDCD). Throughout the interactive morning, students were able to experience first hand the state of the art systems and simulations used to conduct research. The students then used this knowledge to propose their own solutions to today's environmental and climate issues.



# PARTNERSHIPS

## CE-CERT COLLABORATION WITH ANNUAL STEP CON

In another successful partnership with the Science and Technology Education Partnership (STEP), CE-CERT provided tours to 80 high school students from across the Inland Empire for their annual STEPCon conference. The event was established to bridge the gap between our K-12 students and high-technology industry needs, and students had the opportunity to tour through CE-CERT's labs in sustainable transportation, microgrids, and atmospheric processes.



## CE-CERT IN THE MEDIA

CE-CERT has been featured in media interviews highlighting areas of interest and providing further insight into the future of environmental research. We take great pride in sharing our laboratory research with the greater public and hope to continue doing so in the future.

## VIEWPOINT DOCUMENTARY WITH KENT JOHNSON

Dr. Kent Johnson, CE-CERT research faculty was briefly interviewed for the Viewpoint with Dennis Quaid about the benefits of zero emissions. This educational documentary series focuses on ground-breaking technologies and concepts.

## KBS NEWS INTERVIEW WITH DAVID COCKER

Korean Broadcasting System (KBS) visited CE-CERT to interview Dr. David Cocker on the research being conducted at the Atmospheric Processes Chamber and what could be done in Korea to address pollution issues. There is growing interest in CE-CERT's research on this topic and the solutions that have been developed.





# STUDENT SCHOLARSHIPS & AWARDS

## CE-CERT



is an interdisciplinary research center that fosters collaboration and innovation among students from diverse academic backgrounds. In 2022, we had 34 undergraduate students employed who were provided with hands-on research experience for students majoring in engineering, science, business, and policy. By bringing together students from different disciplines, CE-CERT encourages cross-pollination of ideas and approaches, resulting in unique and effective solutions to complex environmental challenges. In addition, CE-CERT supported the research and thesis efforts of 47 engineering graduate students, providing them with access to cutting-edge technology and expert guidance. Overall, CE-CERT offers a dynamic and inclusive learning environment where students can develop their skills, build their network, and make a positive impact on the world.

## CE-CERT 2022-23 SCHOLARSHIP RECIPIENTS

CE-CERT is proud to announce the recipients of the 2022-2023 Scholarship Awards totaling \$39,500. We would like to congratulate them on their hard work and thank our generous donors who made these awards possible.

### ESTHER F. HAYS GRADUATE FELLOWSHIP

- Ryan Drover, Chemical & Environmental Engineering
- Sahar Ghadimi, Chemical & Environmental Engineering
- Chas Frederickson, Mechanical Engineering
- Zhengwei Bai, Electrical & Computer Engineering

### COLIN E. HACKETT GRADUATE AWARD

- Jacqueline Garrido, Electrical & Computer Engineering

### SALIM KHAN AWARD

- Afsara Tasnia, Chemical & Environmental Engineering

### WILLIAM R. PIERSON/FORD GRADUATE AWARD

- Tianbo Tang, Chemical & Environmental Engineering

### MILLER DURBIN RESEARCH AWARD

- Hanwei Zhu, Chemical & Environmental Engineering

### FORD MOTOR COMPANY UNDERGRADUATE AWARD

- Andrea Delgado, Environmental Sciences

### G. NEAL RICHTER SCHOLARSHIP IN ENERGY INNOVATION

- Luis Fernando Enriquez-Contreras, Electrical Engineering

### ATMOSPHERIC PROCESSES LABORATORY (APL) AWARD

- Zihan Zhu, Chemical & Environmental Engineering

### TRANSPORTATION SYSTEMS RESEARCH (TSR) AWARD

- Zhouqiao Zhao, Electrical Engineering

## NCST DISSERTATION AWARD

- Abdullah Fuad Un-Noor
- Jacqueline Garrido
- Roland David Oswald
- Zhensong Wei
- Zhouqiao Zhao

## STUDENT AWARD HIGHLIGHTS



### COLIN E. HACKETT GRADUATE AWARD RECIPIENT

**Jacqueline Garrido**  
Electrical & Computer Engineering

Jacqueline recently presented at the 2021 ITSC conference in Indianapolis on her carbon-based pricing strategy and pattern recognition predictions that consider CO<sub>2</sub> emission rates from the grid, Carbon Allowance Prices (CAP), Time-of-Use rates (TOU), building power usage, and renewable energy generation. She and her team are also planning to embed the carbon-based pricing forecast into the level 2 EV chargers located at CE-CERT to test this pricing strategy. Their goal would be to measure the response and changes in charging behavior from the drivers by studying their willingness to pay.



### ESTHER F. HAYS GRADUATE FELLOWSHIP RECIPIENTS

**Ryan Drover**  
Chemical & Environmental  
Engineering

As a Ph.D. student at UCR, Ryan have worked on collaborative health exposure studies with the UCR School of Medicine (SoM) and the multidisciplinary BREATHE Center, with Dr. Miller in marine emissions, and with Dr. Cocker and Carter in the Atmospheric Processes Lab on the ozone formation potential of industrial chemicals. Educating the public on the mechanisms of working towards better outcomes is Ryan's passion. He is confident that these programs will provide him with structured training to engage between science and policy while he is able to leverage the academic environment while at UCR.



### ESTHER F. HAYS GRADUATE FELLOWSHIP RECIPIENT

**Sahar Ghadimi**  
Chemical & Environmental  
Engineering

Sahar and her team are currently investigating the physiochemical properties of primary and secondary emissions of several in-use heavy-duty vehicles (HDVs) in a 30 m<sup>3</sup> mobile atmospheric chamber. She and her team are also investigating the SOA yield from a-pinene precursor — one of the most abundant biogenic emissions in the troposphere — in an atmospheric chamber under continuous NO injection over 24 hours. This experimental condition provides different NO<sub>x</sub> levels with constant branching ratios (p) which mimic the ambient conditions described by global Geos-Chem results. She will utilize this award to boost her environmental knowledge though prepping for the FE and PE exams, purchasing additional books, and attending conferences and meetings.



### ESTHER F. HAYS GRADUATE FELLOWSHIP RECIPIENT

**Chas Frederickson**  
Mechanical Engineering

Chas's current research studies the operational patterns of various non-road equipment and marine vessels. In the non-roadsides of his research, he studies the activity of construction, agricultural, and cargo transfer port equipment. In the marine vessel side of his research, he focuses on harbor craft vessels and their operational patterns within their resident harbor. He hopes to expand his research to incorporate ocean going vessels. This category of marine vessels makes up a large portion of the marine vessel population. They also provide unique research challenges that will broaden his testing experiences.



## ESTHER F. HAYS GRADUATE FELLOWSHIP RECIPIENT

**Zhengwei Bai**  
Electrical & Computer Engineering

Zhengwei's current research is on object perception for autonomous driving with an emphasis on 3D object detection, tracking and reconstruction based on deep learning-based methods by utilizing high-resolution sensors, like camera or LIDAR. He is also currently the main contributor for a research project (named Cyber Mobility Mirror, i.e., CMM) funded by the Toyota InfoTech Lab. He is currently designing a cooperative object detection method by collecting LIDAR data from vehicle side and roadside to improve the object detection performance.



## G. NEAL RICHTER SCHOLARSHIP IN ENERGY INNOVATION RECIPIENT

**Luis Fernando Enriquez-Contreras**  
Electrical & Computer Engineering

Luis's current research is focused on microgrid management. His goal is that every EV and microgrid should utilize the same software and protocols with free software that any company, individual community, and research group can utilize to ensure that future electric vehicles have the capability to work seamlessly in a microgrid eco-system. By creating a free and open-source Python library for integrating various components into an intelligent microgrid developed specifically for transportation loads, he hopes to integrate all the microgrid components and make a smart network that can be utilized for all types of microgrids. He believes his creation will eventually spawn a community willing to create microgrids to reducing costs for NGOs, governments, and benefit our environment.



## WILLIAM R. PIERSON/ FORD GRADUATE AWARD RECIPIENT

**Tianbo Tang**  
Chemical & Environmental Engineering

Tianbo's current research includes emissions testing of ultra-low NOx Achates trucks using AVL PEMS systems and a mobile emissions laboratory. His goals are to better understand the real-world emissions and performance benefits of heavy-duty Class 8 diesel trucks equipped with an opposed piston engine and compare it with a baseline diesel Class 8 truck. One of his major future studies will involve hydrogen (fuel cell) which will focus on testing the primary emissions from vehicles using hydrogen as fuels. He looks forward to continuing this work and further developing his own expertise in the field by reading vehicle emissions-related literature and eventually publishing his own findings in journals.



## SALIM KHAN AWARD RECIPIENT

**Afsara Tasnia**  
Chemical & Environmental Engineering

Afsara's research focuses on the measurement and analysis of volatile organic compounds (VOCs) emitted from biogenic, anthropogenic, and pyrogenic sources. Currently, she is working on characterizing the anthropogenic VOC (AVOC) emissions in Los Angeles (LA) basin, where historically vehicular emission was the major source of anthropogenic emission. She has also actively take part in LAAQC'2022 campaign to be held during summer 2022 to compare between the AVOC emission profiles for during and post pandemic scenarios. Her future research involves characterizing biogenic VOC (BVOC) emission profiles from the Alaskan Arctic to collect ambient air samples to fill in knowledge gap regarding the interdependency of terrestrial BVOC and climate change.





## FORD MOTOR COMPANY UNDERGRADUATE AWARD RECIPIENT

**Andrea Delgado**  
Environmental Sciences

Andrea's research focuses on the utilization of low-cost instrumentation to track personal and ambient air quality trends within the westside community of San Bernardino, CA surrounding the BNSF San Bernardino Railway (SBR). As Lead Undergraduate Researcher, she worked alongside the project specialist and graduate student in research protocol, low-cost instrumentation deployment, technical troubleshooting of air pollution monitors, PM2.5 data analysis, participant scheduling, community meetings, and education curriculum. She currently guides undergraduate students who deploy research equipment, relay data collection protocols, and disseminate health surveys. She aspires to engage in efforts to decrease the impact of future human activities on our environment via sustainable efforts that minimize city carbon footprints, improve community resiliency, and move towards net-zero developments and carbon neutrality in California.



## MILLER/DURBIN FELLOWSHIP RECIPIENT

**Hanwei Zhu**  
Chemical & Environmental  
Engineering

Hanwei has been in the AQMD 200 Vehicles Study since 2018, focused on HDDVs (Heavy-Duty Diesel Vehicles) within the country, including testing using portable emissions measurement systems (PEMS), portable activity measurement systems (PAMS), chassis dynamometer emissions testing, and on-road testing with an emissions trailer. With CE-CERT's support, he would like to go beyond the realm of the emissions testing and provide him a chance to present his research at major conferences and workshops across the country. He will be attending the 31<sup>st</sup> CRC Real World Emissions Workshop as a presenter sharing his research.



## ATMOSPHERIC PROCESSES LABORATORY (APL) AWARD RECIPIENT

**Zihan Zhu**  
Chemical & Environmental  
Engineering

Back in 2020, Zihan led a team to a 3-months long field campaign at Atmospheric Radiation Measurement (ARM) program's Southern Great Plains (SGP) site in Oklahoma studying and measuring measured particle growth and related characteristics. Her passion in studying Aerosol is propelling her to lead another project in the TRACER campaign at the Atmospheric Radiation Measurement Climate Research Facility this summer.



## TRANSPORTATION SYSTEMS RESEARCH (TSR) AWARD RECIPIENT

**Zhouqiao Zhao**  
Electrical & Computer Engineering

Zhouqiao is currently pursuing a Ph.D. at CE-CERT to deepen his knowledge and develop his research skills in intelligent transportation. His current research evokes personalized vehicle automation, vehicle cooperation in mixed traffic condition, cooperative perception, small-scale autonomous vehicle platform design, and large-scale eco-dispatching.

# FACULTY & STAFF

## ATMOSPHERIC PROCESSES LABORATORY

- David Cocker, Professor of Chemical & Environmental Engineering
- Don Collins, Professor of Chemical & Environmental Engineering and CE-CERT Director
- Kelley Barsanti, Associate Professor of Chemical & Environmental Engineering
- Roya Bahreini, Professor of Environmental Sciences, and CE-CERT affiliate faculty
- Will Porter, Assistant Professor of Environmental Sciences, and CE-CERT affiliate faculty
- Cesunica Ivey, CE-CERT affiliate faculty
- Jinsheng Zhang, Visiting Researcher

## BIOENERGY, BIOREDEFINING, AND BIOMATERIALS TEAM (SUSTAINABLE FUELS)

- Charles M. Cai, Research Faculty and Adjunct Professor of Chemical & Environmental Engineering
- Brent Scheidemantle, Staff Research Associate

## BIONANOTECHNOLOGY

- Ashok Mulchandani, Distinguished Professor, W. Ruel Johnson Chair in Environmental Engineering

## EMISSIONS AND FUELS RESEARCH GROUP

- Kent Johnson, Research Faculty
- Mark (Tom) Durbin, Research Faculty
- Wayne Miller, Research Faculty
- Georgios Karavalakis, Research Faculty (Professor as of July 2023)
- Heejung Jung, Professor of Mechanical Engineering
- Robert Russell, Research Faculty
- David Cocker, Professor of Chemical & Environmental Engineering
- Zisimos Toumasatos, Postdoctoral Researcher
- Mark Villela, Research & Development Engineer Supervisor
- Daniel Gomez, Research & Development Engineer
- Marcos Alvarez, Research & Development Engineer
- Dan Hartnett, Development Technician

## GREENHOUSE GAS LAB

- Francesca M. Hopkins, Assistant Professor of Environmental Sciences

## SOUTHERN CALIFORNIA RESEARCH INITIATIVE FOR SOLAR ENERGY

- Alfredo A. Martinez-Morales, Research Scientist
- Miroslav Penchev, Project Scientist
- Taehoon Lim, Project Scientist
- Tahir Cetin Akinci, Visiting Scholar

## SUSTAINABLE FUELS INITIATIVE

- Arun S.K. Raju, CE-CERT Associate Director of Operations, Research Faculty and Adjunct Professor of Chemical & Environmental Engineering
- Kent Johnson, Research Faculty
- Alfredo A. Martinez-Morales, Research Scientist

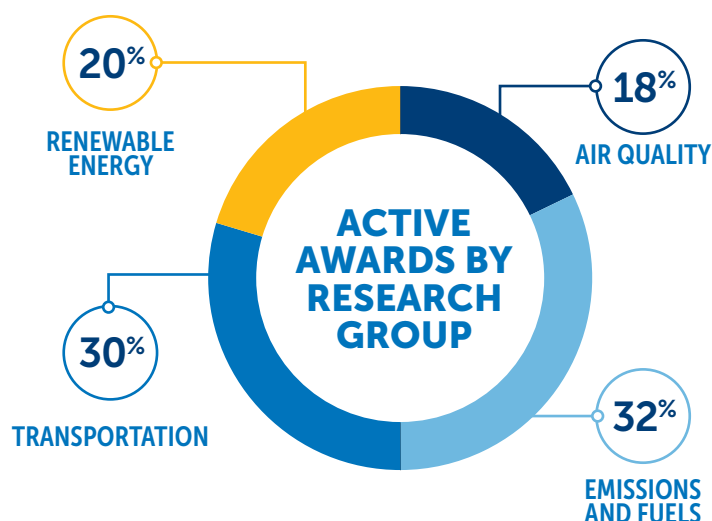
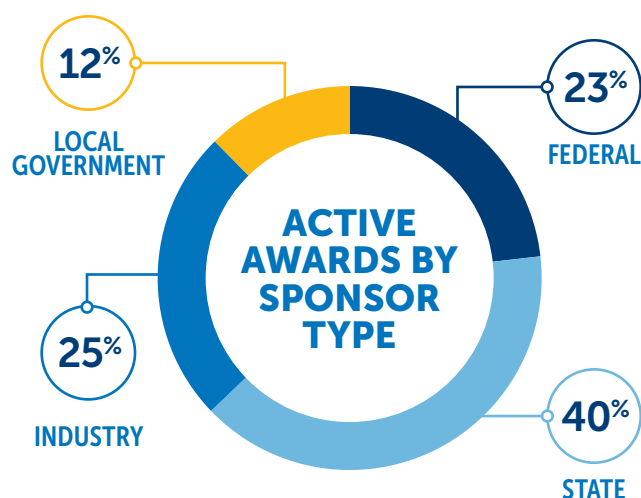
## SUSTAINABLE INTEGRATED GRID INITIATIVE

- Sadrul Ula, Research Faculty

## TRANSPORTATION SYSTEMS

- Matthew Barth, Professor of Electrical & Computer Engineering, and BCOE Associate Dean for Research and Graduate Education
- Kanok Boriboonsomsin, CE-CERT Associate Director of Finance & Administration, Research Faculty
- Guoyuan Wu, Research Faculty and Adjunct Professor of Electrical & Computer Engineering
- Peng Hao, Research Faculty
- George Scora, Research Faculty
- Konstantinos Karydis, Associate Professor of Electrical & Computer Engineering

# 2022 ACTIVE PROJECTS



TOTAL ACTIVE PROJECT FUNDING: **\$37,747,760**

CE-CERT's active research portfolio continues to expand, driven by a number of research thrust areas and sponsors. In 2022, CE-CERT's active research portfolio of over 100 projects totaled over \$37 million.

## AIR QUALITY

**Community Air Grant Proposal for J.W. North High School in Riverside, California** | Air Resources Board | Nicole Cleary

**Environmental Chamber Experiments to Improve Secondary Organic Aerosol Model Prediction**

Air Resources Board | David Cocker

**Assessment of greenhouse gas and air quality benefits of dairy digester installation in California**

California Energy Commission | Francesca Hopkins

**Mapping Aerosol Processes across Houston during convective cell events** | Baylor University | Don Collins

**Understanding the impact of pollution aerosol from Los Angeles/Long Beach on clouds and radiation in and upwind of the EPCAPE study domain** | Department of Energy | Don Collins

**Toward Air Quality and Climate Resilience in West San Bernardino**

Center for Community Action and Environmental Justice | Cesunica Ivey

**The Influence of NO<sub>x</sub> on SOA and Ozone**

Coordinating Research Council | David Cocker

**Development and Evaluation of Databases and Estimation Methods for Predicting Air Quality Impacts of Emitted Organic Compounds** | Coordinating Research Council | William Carter

**Direct measurement of small particle growth and aging at SGP** | Department of Energy Office of Science/Office of Basic Energy | Don Collins

**Catalytic NO and CO Emission Control Unit for Small Off-road Engines** | Environmental Protection Agency | David Cocker

**Updates to and Condensation of State-wide Air Pollution Reach Center (SAPRC) atmospheric chemical mechanism**

Air Resources Board | William Carter

**Using Observations of Gaseous Compounds in the LA Basin during COVID-19 to Elucidate Sources and Atmospheric Processes Affecting Urban Air Quality** | National Oceanic and Atmospheric Administration | Kelley Barsanti

**Collaborative Research: ICARUS - Index of Chamber Atmospheric Research in the United States**

National Science Foundation | David Cocker



**Understanding the Sources and Formation Regimes of Present-day PM<sub>2.5</sub> to Mitigate Particulate Pollution in California**  
Air Resources Board | Don Collins

**Harnessing Graphical Processing Units (GPUs) to Accelerate the Computational Efficiency of Air Quality Modeling Systems for Four-Dimensional Ai** | National Science Foundation | Cesunica Ivey

**Toxicant Production and Mitigation in the Electronic-Cigarette**  
Portland State University | Kelley Barsanti

**Understanding and Mitigating Wildfire Risk in California**  
UC Berkeley | Kelley Barsanti

**Ultrafine aerosol particle formation and impacts in Houston during TRACER** | UC Irvine | Don Collins

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## EMISSIONS & FUELS

**Heavy-Duty Inspection and Maintenance Referee Program**  
Air Resources Board | Thomas Durbin

**In-Use Off-Road Engine 'Real' Data Analysis**  
Air Resources Board | Georgios Karavalakis

**Real-world tire and brake wear emissions**  
Air Resources Board | Heejung Jung

**In-Use Gas Can Testing** | Air Resources Board | Georgios Karavalakis

**Heavy-Duty Vehicle Testing and Data Analysis**  
Eastern Research Group, Inc | Thomas Durbin

**Heavy-Duty Optional Low NO<sub>x</sub> Vehicle Testing**  
Air Resources Board | Thomas Durbin

**Fuel Cell Truck Evaluation** | Cummins | Kent Johnson

**Emission Testing and Test Method Development for Commercial Harbor Craft and Ocean-Going Vessels**  
Air Resources Board | Kent Johnson

**Renewable Diesel Agricultural Engine Testing**  
Air Resources Board | Thomas Durbin

**Smog Check Performance Report**  
California Department of Consumer Affairs | Thomas Durbin

**Medium and Heavy-Duty EV Deployment - Data Collection**  
Calstart | Kent Johnson

**Demonstration of Sensor Technologies for On-Road and Off-Road Heavy-Duty Diesel Vehicles**  
Air Resources Board | Kent Johnson

**Measurement of Criteria Emissions from the MARAD RRF Vessel Cape Henry** | Department of Transportation Maritime Administration | Kent Johnson

**Heavy-Duty Vehicle Testing and Data Analysis**  
Eastern Research Group, Inc. | Thomas Durbin

**NO<sub>x</sub> Sensor Evaluation and Support: Sensor Performance and Aging Behavior in Real World**  
Eastern Research Group, Inc. | Kent Johnson

**Evaluation of Hydrogen-Natural Gas on Engine Performance and Durability** | South Coast Air Quality Management District  
Georgios Karavalakis

**Optimized Hybrid Ultra-Low NO<sub>x</sub> Class 8 Heavy Duty Natural Gas Truck** | Gas Technology Inst. | Kent Johnson

**Plasma-Enhanced Electrostatic Precipitation of Diesel Particulates using High Voltage Nanosecond Pulses**  
National Science Foundation | Heejung Jung

**Evaluation of Hydrogen-Natural Gas on Engine Performance and Durability**  
Southern California Gas Company | Georgios Karavalakis

**In-Use Emissions Testing and Fuel Usage Profile of On-Road Heavy-Duty Vehicles**  
South Coast Air Quality Management District | Thomas Durbin

**Onboard Sensing, Analysis, and Reporting (OSAR): Phase 1 Sensor Evaluation on Heavy Duty Trucks** | South Coast Air Quality Management District | Kent Johnson

**Investigate Effects of Ethanol-Gasoline Fuel Blend on Criteria Emissions and Secondary Organic Aerosol (SOA) Formation from Light-Duty Vehicles** | South Coast Air Quality Management District  
Georgios Karavalakis

**Data Collection and Analysis under the California Air Resources Board (CARB) Zero-and-Near-Zero Emissions Freight Facility Grant** | Tetra Tech, Inc. | Thomas Durbin

**Pasha Green Omni Terminal Project performance Testing**  
Tetra Tech, Inc. | Thomas Durbin

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## TRANSPORTATION

**UCR EcoCAR EV Challenge Team**  
US DOE | Matthew J Barth

**Durability and Performance of Zero-Emission and Near-Zero-Emission Off-Road Equipment**  
Air Resources Board | Kanok Boriboonsomsin

**Evaluating the Impacts of Clean Miles Standard on Transportation System** | USC METRANS | Peng Hao

**Vehicle Miles Traveled and Emissions Impacts of On-Demand Delivery Services**  
California Polytechnic State University, San Luis Obispo | Peng Hao

**OMEGA: Objective Measurement/Monitoring/Mitigation of Emissions from Goods Movement and Impacts on Air Quality**  
South Coast Air Quality Management District | Matthew J Barth

**UCR Technical Support of Caltrans ZEV Tool**  
CALTRANS | Michael Todd

**Data Collection and Analysis in Riverside Clean Car Share**  
City of Riverside | Peng Hao

**City of Rialto: Smart Cities Plan to Mitigate Impacts of Warehousing and Logistics** | Southern California Association of Governments | Kanok Boriboonsomsin

**Decentralized and Cooperative Traffic Signal Network for Freight Energy Efficiency, Safety, Sustainability, and Public Health** | Xtelligent, Inc | Kanok Boriboonsomsin

**Monitoring, Modeling, and Mitigating Emissions and Air Quality Impacts of Goods Movement in Inland Southern California Environmental Justice Communities** | State of California Justice Department | Matthew J Barth

**Connected Eco-Driving for Heavy-Duty Conventional and Plug-In Hybrid Electric Trucks** | Volvo Truck Corporation | Kanok Boriboonsomsin

**Mobile Robotic Lab for In-Situ Sampling and Measurement** | National Institute for Food and Agriculture | Konstantinos Karydis

**Extracting Dynamics from Limited Data for Modeling and Control of Unmanned Autonomous Systems** | National Science Foundation | Konstantinos Karydis

**Evaluation of Potential Higher Emissions Events for Heavy-duty CNG Vehicles** | South Coast Air Quality Management District | Matthew J Barth

**Air Quality & Climate Research Training Program** | South Coast Air Quality Management District | Matthew J Barth

**Center for Advancing Research in Transportation Emissions, Energy and Health** | The Texas A&M University System | Kanok Boriboonsomsin

**UCR Innovation Corridor Smart Sensing** | Toyota Motor North America, Inc. | Matthew J Barth

**National Center for Sustainable Transportation** | US DOT | Matthew J Barth

**Evaluating the Effectiveness of 'SmartPedal' Systems for Vehicle Fleets** | CALTRANS | Scora, George

**Low-Carbon Transportation Incentive Strategies Using Performance Evaluation Tools for Heavy-Duty Trucks and Off-Road Equipment** | UC ITS | Kanok Boriboonsomsin

**Connectivity-Based Cooperative Ramp Merging in Multimodal and Mixed Traffic Environment** | METRANS | Wu, Guoyuan

**Volvo Low Impact Green Heavy Transport Solutions (LIGHTS)** | Volvo Truck Corporation | Kanok Boriboonsomsin

## RENEWABLE ENERGY

**Salton Sea Geothermal Lithium Recovery Demonstration Project** | Berkshire Hathaway Energy Renewables Inc. | Arun S.K. Raju

**Developing a MHD ZEV Infrastructure Blueprint for the South Coast** | California Energy Commission | Arun S.K. Raju

**Hydrogen Blending Impacts Study** | California Public Utilities Commission | Arun S.K. Raju

**Eastside Climate Collaborative Transformative Climate Communities Initiative** | City of Riverside | Arun S.K. Raju

**Southern California Energy Innovation Network (SCEIN) 2.0** | Cleantech San Diego Association | Arun S.K. Raju

**A Green Approach to Pulping Hemp for Construction** | Environmental Protection Agency | Charles Cai

**Critical Resilience for Fire and Emergency Facilities with the Soboba Band of Luiseno Indians** | Grid Alternatives | Alfredo Martinez-Morales

**Enabling California's Resilient Tribal Communities with Mobile Renewable Power** | Grid Alternatives | Alfredo Martinez-Morales

**Advanced Technologies for Biomass Deconstruction and Lignin Valorization** | Oak Ridge National Laboratory | Charles Cai

**Speeding Anaerobic Digestion with CO<sub>2</sub> Microbubbles** | Southern California Gas Company | Arun S.K. Raju

**Renewable Syngas Methanation** | Taylor Energy | Arun S.K. Raju

**Lignin-derived Carbon Storing Foams for High Performance Insulation** | University of Tennessee | Charles Cai

**Advancing the National Bioeconomy through Regional Sun Grant Centers** | University of Tennessee | Charles Cai

**A Catalytic Process to Convert Municipal Solid Waste Components to Energy** | Worcester Polytechnic Institute | Charles Cai

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## CALTESTBED LEAD INVESTIGATORS

**Future Motors** | Sadrul Ula

**Umida AG** | Sadrul Ula

**KIGT** | Michael Todd

**Stasis Group, Inc** | Michael Todd

**Alpine Hydromet** | Michael Todd

**Rejoule** | Michael Todd

**Enzinc** | Alfredo Martinez-Morales

**Sylvatex** | Michael Todd

**Cyclonatix** | Sadrul Ula

**GreenTech Motors** | Sadrul Ula



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