

(UC Merced), quantifying and advancing soil sequestration capabilities on farmlands (UCOP), and improving efficiencies and developing tools for resilient forest management and carbon sequestration (UC Irvine). The fourth project will advance integrated technology solutions for thermal storage and residential space conditioning with low Global Warming Potential refrigerants in low-income and disadvantaged communities (EPRI).

Background:

In September 2017, Governor Brown signed AB 109, which amended the Budget Act of 2017 and included an appropriation to establish the Climate Change Research Program within the Strategic Growth Council (SGC).¹ The budget provided statutory direction to SGC to develop a Research Investment Plan to outline research needs, award grants on a competitive basis, and to include University of California, California State University, federally funded national laboratories in California, and private, non-profit colleges and universities in California as eligible applicants.

In development of the Climate Change Research Program, SGC staff conducted considerable outreach to state agencies, researchers, and other stakeholders. This outreach informed the development of the Research Investment Plan that guided investment in Round 1. The Research Investment Plan identified goals for SGC's research investments and outlined five priority investment areas:

- 1) Supporting and protecting vulnerable communities from the impacts of climate change.
- 2) Accelerating and supporting transitions to climate smart communities.
- 3) Integrating land use, conservation, and management into California climate change programs.
- 4) Increasing data accessibility and planning support for state, local, and regional climate change planning.
- 5) Low-GHG transformative technology development and deployment.

The Council approved the Research Investment Plan in January 2018 and awarded the first round of awards in July 2018. Round 1 awards focused on the first four priority areas.

In September 2018, the Council adopted an updated version of the Research Investment Plan. The updated Plan retains the structure of the original plan; however, it (a) includes new information to reflect newly published reports and initiatives, (b) provides for more general solicitation guidance, and it (c) creates continuity across the program to ensure the Research Investment Plan will remain active and pertinent for three years. After three years, staff will conduct outreach with state agencies, the research community, and other stakeholders to create a new plan to reflect research priorities and program goals.

Round 2

In June 2018, the Governor signed SB 856, which amended the Budget Act of 2018 and appropriated \$18 million for SGC to implement Round 2 of the Climate Change Research Program.² Of that amount, \$17.1 million is available for award through a competitive process. This

¹ https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB109

² http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB856

legislation allocated Greenhouse Gas Reduction Fund revenues to support “*research on reducing carbon emissions, including clean energy, adaptation, and resiliency, with an emphasis on California.*”³ The Governor’s January budget for 2018-2019 proposed that the funding be used for the California Climate Change Technology and Solutions Initiative. The Initiative helps to bridge the gap to new technologies, modeling, and analysis, leading to greater GHG emission reductions and resilience statewide.

Because Round 1 of the program did not address research priority area 5, Low-GHG Transformative Technology Development and Deployment, SGC staff took direction from the Governor’s January proposed budget to focus Round 2 solely on technology research and development. SGC staff included an amendment in the updated Research Investment Plan to create Innovation Center Research grants. The Council will award these grants to established research and development divisions within a Research Institution to develop transformative and scalable clean technologies that are widely seen as necessary to achieve the State’s 2030 and 2050 climate goals but that require significant breakthroughs to achieve market transformation. The Council approved this change to the Research Program’s goals in September 2018.

SGC released the grant solicitation for Round 2 on October 9, 2018. The solicitation requested research proposals that address research priority area 5, Low-GHG Transformative Technology Development and Deployment. The solicitation identified four specific goals for proposals:

- 1) Proposals should demonstrate potential to significantly reduce GHG emissions and should show potential to be easily replicable and scalable.
- 2) Awardees’ projects or portfolio of projects should provide a holistic approach toward addressing one or more of the identified priority investment areas.
- 3) Institutions should build strong and meaningful partnerships with the research and academic communities, private sector, and community-based organizations.
- 4) Institutions should ensure that innovative technologies have direct and indirect benefits to California’s most disadvantaged communities.

Proposals were due on November 9, 2018.

In addition to addressing the specific elements outlined above, as in Round 1, all proposals were also required to address the Research Program’s seven goals that leverage SGC’s role as a cross-agency body and guide its research investments:

- 1) Clear and demonstrated connection to the State’s climate change goals.
- 2) Supports low-income and disadvantaged communities and advances equitable outcomes.
- 3) Augments, build connections, and fill gaps across current research programs.
- 4) Produces outcome-based research linked to practical climate action.
- 5) Engages with the research community, community-based organizations and other stakeholders at every phase of the research.
- 6) Advances and develops common climate change research platforms.

³ *Id.* at Section 6.

amount. Staff will adhere to the following “guiding principles” when working with researchers to revise their research scope and budget. These principles are the same as were applied in Round 1 of the program.

1. Remains consistent with the original proposal.
2. Meets the threshold requirements as described in the original submission (facilitates GHG emissions reductions, addresses benefits to disadvantaged and low-income communities, and aligns with the program goals).
3. Continues to address one or more of the research priority interest areas described in the solicitation and address key questions, barriers, hurdles, or opportunities that contribute to the advancement of new or developing climate initiatives.
4. Demonstrates that these revisions would not affect the competitiveness of these projects in the competitive process.
5. Demonstrates a continued commitment to work with non-traditional partnerships and deliver a project that features a dynamic, collaborative set of partners.
6. No budget reductions will reduce the percentage of the budget spent on tasks supporting engagement activities. Engagement activities under the reduced budget must remain consistent in intent and scope with the proposed budget – to the fullest extent possible, we will work with grantees to maintain a similar percentage of the budget be allocated to engagement activities

Recommended Action

Staff recommends that the Council approve the action to fund four research proposals, representing \$17,100,000 in Greenhouse Gas Reduction Funds. More detailed summaries of the four research proposals can be found in [Appendix B](#) of this report.

Attachments:

- [Appendix A](#): List of 24 Proposal Submissions received (proposals recommended for funding shaded in green)
- [Appendix B](#): Summaries of the four research proposals recommended for funding

UNIVERSITY OF CALIFORNIA, OFFICE OF THE PRESIDENT

**CALIFORNIA COLLABORATIVE ON CLIMATE CHANGE SOLUTIONS:
 WORKING LANDS INNOVATION CENTER—CATALYZING NEGATIVE CARBON EMISSIONS**

PRINCIPAL INVESTIGATOR: Benjamin Z. Houlton, Ph.D., Director, Muir Institute of the Environment, Professor, University of California, Davis

<p>INNOVATION CENTER RESEARCH GRANT</p> <hr/> <p>\$ 4,711,267.24</p> <hr/> <p>Duration: 36 Months</p>	<p>RESEARCH INNOVATION FIELD</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> Carbon Dioxide Removal <input type="checkbox"/> Methane Reduction <input type="checkbox"/> Heating, Cooling, and Thermal Storage
<p>PARTNERS:</p>	<ul style="list-style-type: none"> ➤ University of California, Berkeley—Whendee Silver (co-PI), Rudy Grah Endowed Chair and Professor, Department of Environmental Science, Policy, and Management ➤ California State University, East Bay—Patty Y. Oikawa, Assistant Professor, Department of Earth and Environmental Sciences ➤ Lawrence Berkeley National Laboratory—Andrew Jones, Research Scientist and Program Lead, Earth and Environmental Sciences Area ➤ University of California, Merced—Tapan Pathak, Cooperative Extension Specialist, Sierra Nevada Research Institute
<p>RESEARCH ACTIVITIES</p>	<ul style="list-style-type: none"> ➤ The Working Lands Innovation Center’s objective is to scale and sustain CO₂ capture and GHG emissions reductions by deploying a suite of cutting-edge soil amendment technologies, driving substantial co-benefits for California growers, ranchers, Tribes, communities, the economy, and environment. WLIC’s research is focused on three technologies that aim to capture CO₂ with co-benefits: rock amendments in cropland and rangeland soil, carbon sequestration from compost applications to cropland and rangeland soil, and demonstration of combined CO₂ capture technologies: factorial combinations of compost, rocks and biochar amendments. WLIC will also conduct geo-spatial model analysis to identify best practices for scaling carbon removal statewide. These soil amendment technologies have not yet been tested together across the state, which will increase understanding of the carbon sequestration potential of soil.
<p>FACILITATES GREENHOUSE GAS EMISSIONS REDUCTIONS:</p>	<ul style="list-style-type: none"> ➤ When combined, the soil amendment technologies could capture 36-82 or more metric tons of California’s carbon dioxide emissions each year, with several billion tons of carbon dioxide sequestration potential worldwide. The Working Lands Innovation Center will use models and other tools to examine the total land resources available to achieve this level of scaling, and work with C4S to scale outside of the state.
<p>BENEFITS DISADVANTAGED AND LOW INCOME COMMUNITIES:</p>	<ul style="list-style-type: none"> ➤ WLIC’s demonstrations will: (i) maintain and protect agricultural economy in rural areas; (ii) promote opportunities for Tribal Nations to take advantage of our technologies and research through collaborative partnerships; (iii) create cleaner air and water in the Central Valley and Imperial Valley by improving fertilizer use efficiency; (iv) redesign organic waste streams converting problems into solutions; (v) restore soil health and protect the environment; (vi) enhance agricultural workforce development by demonstrating how amendments can improve yields with less water, helping with climate adaptation; (vii) increase the affordability of healthy food options by promoting soil health, crop resilience, and aiding in agriculture resilience; (viii) create opportunities for ranchers and farmers to financially benefit from cap-and-trade offsets through soil restoration practices and GHG reductions; (ix) develop new business opportunities in the area of soil amendment production, distribution, and innovation.

UNIVERSITY OF CALIFORNIA, IRVINE

INNOVATION CENTER FOR ADVANCING ECOSYSTEM CLIMATE SOLUTIONS

PRINCIPAL INVESTIGATOR: Michael Goulden, Ph.D., Professor of Earth System Science, UCI

INNOVATION CENTER RESEARCH GRANT	RESEARCH INNOVATION FIELD <input checked="" type="checkbox"/> Carbon Dioxide Removal <input type="checkbox"/> Methane Reduction <input type="checkbox"/> Heating, Cooling, and Thermal Storage
\$ 4,604,140.02	
Duration: 36 Months	

PARTNERS:	<ul style="list-style-type: none"> ➤ University partners: Stanford; UCs Merced, Davis, Berkeley; San Diego State ➤ Tulare Basin Wildlife Partners—Rob Hansen, TBWP Board President ➤ Blue Forest Conservation—Nick Wobbrock, Co-Founder and Partner ➤ U.S. Forest Service, Pacific Southwest Region—Randy Moore, Regional Forester ➤ U.S. Forest Service, Pacific Southwest Research Station—Chrissy Howell, Ecosystem Function and Health Program Manager
RESEARCH ACTIVITIES	<ul style="list-style-type: none"> ➤ This Innovation Center will develop the science and technology solutions needed to manage California’s natural lands for climate change, as there remain critical research gaps in understanding carbon cycles, uptake, and negative feedback under climate change. This proposal is responsive to state policy goals, including the Scoping and Forest Carbon Plans. The proposal aims to develop new knowledge through measurements and modeling, synthesize the resulting data to produce information and goals for a range of stakeholders, test and refine these tools and data in adaptive management, create valuation of benefits and advance implementation approaches, and finally, to communicate results through a range of outreach efforts for various audiences. The proposal is initially focused on montane forests in the Sierra Nevada and Southern California, aiming to grow the work of the Center beyond this award to address the same research questions for wildlands across the state.
FACILITATES GREENHOUSE GAS EMISSIONS REDUCTIONS:	<ul style="list-style-type: none"> ➤ Land management has the potential to simultaneously address both mitigation of GHG emissions and carbon sequestration, as well as adaptation to climate change by reducing wildfire spread, protecting watersheds, and increasing ecological and community resilience. The Innovation Center targets a low-risk, high-yield opportunity to reduce California’s GHG contribution, as a small improvement in management efficiency will have large benefits. Initial back-of-the-envelope calculations indicate a net state-wide uptake of several million metric tons CO2/yr. This enhanced sequestration could be done at little incremental cost, given the state’s ongoing investment in management; the goal is to help the state maximize its return on investment. The approach will increase co-benefits, which in many cases will accrue to low income and rural areas.
BENEFITS DISADVANTAGED AND LOW INCOME COMMUNITIES:	<ul style="list-style-type: none"> ➤ Improved wildland management offers multiple co-benefits that disproportionately aid low-income communities. Co-benefits include: 1. Reduced wildfire risk, as wildfires are increasingly impacting low-income parts of the state. 2. Maintaining water quantity through maintaining vegetation - climate assessments indicate significantly reduced water availability with climate change, which will impact agriculture and disadvantaged communities. 3. Maintaining a tourism-based economy- many rural areas around the proposed study sites depend on tourism, and improved wildland management will be needed to maintain these economies in rural California. 4. Developing direct employment and training opportunities to low income communities, prepare students for careers developing and implementing strategies for climate resilience.

UNIVERSITY OF CALIFORNIA, MERCED

MOBILE BIOCHAR PRODUCTION FOR METHANE EMISSION REDUCTION AND SOIL AMENDMENT

PRINCIPAL INVESTIGATOR: Gerardo C. Diaz, Ph.D., Associate Professor, School of Engineering, University of California, Merced

INNOVATION CENTER RESEARCH GRANT	RESEARCH INNOVATION FIELD
\$ 3,040,239.47	<input type="checkbox"/> Carbon Dioxide Removal <input checked="" type="checkbox"/> Methane Reduction <input type="checkbox"/> Heating, Cooling, and Thermal Storage
Duration: 36 Months	

PARTNERS:	<ul style="list-style-type: none"> ➤ University of California, Merced—YangQuan Chen, Ph.D. (Co-PI), Catherine Keske, Ph.D. (Co-PI), School of Engineering, Asmeret Berhe (Co-PI), Teamrat Ghezzehei, Ph.D. (Co-PI), Rebecca Ryals, Ph.D. (Co-PI), School of Natural Sciences ➤ Professional Traffic Solutions—Juan Banuelos, Field Consultant ➤ Nuevo Durango—Cesar Ramos, Farmer ➤ California Agriculture Resource Management—Greg Brooks ➤ Green Carbon Nexus—Thor Bailey, Business Development
RESEARCH ACTIVITIES	<ul style="list-style-type: none"> ➤ The overall goal of this proposal is to determine how biochar can be produced and used in a closed cycle agricultural application to reduce GHG emissions, ameliorate agricultural waste disposal problems, improve the quality of life in low-income and disadvantaged farming and adjacent communities, and identify means to gain acceptance among farmers of small-scale biochar production and use as a sustainable best practice for California agriculture. The research team will lead a full-system development and field demonstration of a mobile platform for at-source biochar production. A fraction of the biochar produced will be utilized to analyze optimal mixtures of biochar and animal manure with the purpose of reducing methane emission from composting facilities.
FACILITATES GREENHOUSE GAS EMISSIONS REDUCTIONS:	<ul style="list-style-type: none"> ➤ In 2016, agriculture generated around 8% of emissions in California, 34% from manure management. Dairy farms are the single largest contributor to California’s man-made methane production. The addition of biochar to manure composting reduces emissions from manure management by 27% to 32%. This means that a successful biochar practice has the potential to reduce methane emissions from manure management by at least 2.74 MMT CO₂ per year. In addition, a mobile platform will provide an alternative to open burning of agricultural waste that emits NOx and PM2.5, pollutants that are harmful to human health.
BENEFITS DISADVANTAGED AND LOW INCOME COMMUNITIES:	<ul style="list-style-type: none"> ➤ From an air quality perspective, residents will experience relief from the chronic malodorous smells from their proximity to dairy operations. As pyrolytic biochar production is not a biomass-combustion process, air quality will accrue from reduction and elimination of open field burning and biomass-fired power plant emissions. Additionally, low-income and disadvantaged community residents will also have improved employment prospects as closed loop biochar production and use will help improve agricultural productivity and profitability, stabilizing farming operations. Finally, to the extent that a surplus of biochar can be produced in the long term, additional employment prospects will materialize as the biochar industry expands.

ELECTRIC POWER RESEARCH INSTITUTE, INC.

INNOVATIVE LOW GHG RESIDENTIAL SPACE CONDITIONING TECHNOLOGIES

PRINCIPAL INVESTIGATOR: Sara Beaini, Engineer/Scientist III
 Electric Power Research Institute

INNOVATION CENTER RESEARCH GRANT \$ 4,744,353.28 Duration: 36 Months	RESEARCH INNOVATION FIELD <input type="checkbox"/> Carbon Dioxide Removal <input type="checkbox"/> Methane Reduction <input checked="" type="checkbox"/> Heating, Cooling, and Thermal Storage
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PARTNERS:	<ul style="list-style-type: none"> ➤ Treau—Vincent Romanin, CEO ➤ WattzOn—Martha Amram, CEO ➤ Central Valley Opportunity Center— Jorge DeNava, Jr., Executive Director ➤ City of Modesto—Jaylen French, Director
RESEARCH ACTIVITIES	<ul style="list-style-type: none"> ➤ This proposal aims to advance innovative space cooling technologies to benefit low-income and disadvantaged communities in California. Specifically, the proposal will advance Treau’s easy-install minisplit heat pump/air conditioner (AC) system, with low-GWP refrigerant, to a full system demonstration. To accelerate adoption of this and other energy-saving household technologies, the project will also establish innovative payment and financing solutions for Low Income and Disadvantaged Households. Furthermore, a critical component of this research is the partnership with WattzOn, which will serve to evaluate user behavior and better understand in-home use of these technologies in low income and disadvantaged households. Additional technological areas of research include building a low-cost residential space conditioning system with thermal energy storage using a low GWP refrigerant, developing and testing EPRI’s heat pump for more efficient heat exchangers with natural refrigerants, and developing and testing Treau’s oil-free membrane compressor for low-GWP heat pumps and ACs.
FACILITATES GREENHOUSE GAS EMISSIONS REDUCTIONS:	<ul style="list-style-type: none"> ➤ These technologies have the ability to increase the efficiency of HVAC and refrigeration systems an estimated 22%, as well as the ability to increase reliability and lower emissions due to escaped refrigerants. Furthermore, this technology should increase the penetration of heat pumps, which can lower space heating and water heating energy use by 50%, reducing overall household energy consumption. In total, replacing all heating with heat pumps and increasing all cooling efficiency by 22% would lead to a reduction of about 5 quadrillion BTU/year of energy use in the United States.
BENEFITS DISADVANTAGED AND LOW INCOME COMMUNITIES:	<ul style="list-style-type: none"> ➤ The research projects in this proposal provide low cost solutions for highly efficient HVAC equipment. The projects focus on product development specifically for low-income Californians. This proposal aims to support SGC’s mission to engage and support local communities by increasing equitable access to energy services and building systems that benefit low-income and underrepresented communities. The WattzOn projects aims to reverse the product innovation and design paradigm by providing a blueprint for innovators on market requirements, product fit, and financing alternatives that make energy saving technologies accessible to low income and disadvantaged communities. In order to achieve this, engagement will happen throughout the study period, to better understand user perspectives and needs.