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BOURNS COLLEGE OF ENGINEERING - CENTER FOR ENVIRONMENTAL RESEARCH & TECHNOLOGY (CE-CERT):

Distinguished by more than 50 years of high-impact research, UCR has become a leading institution exploring issues critical to growing communities at home and abroad. CE-CERT is the largest research center on campus, bringing together multiple disciplines to address society's most pressing challenges in energy, environment, and transportation. The CRNG will leverage on-going research and collaborations at CE-CERT in order to maximize impact.

From working to understand how emissions impact air quality to developing the technologies needed to improve solar and other renewable power sources, CE-CERT research teams are engaged in one or more of these five focus areas:

Clean Air | Sustainable Transportation | Renewable Fuels | Renewable Energy & Smart Grids | Climate Change

SUPPORTING AGENCIES

Southern California Gas Company
A Sempra Energy utility®

South Coast AQMD

National Center for Sustainable Transportation

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CENTER FOR RENEWABLE NATURAL GAS

INTRODUCTION AND FOCUS AREAS

The Center for Renewable Natural Gas (CRNG) focuses on improving technology and reducing barriers to achieve widespread commercial production and utilization of RNG in California and beyond. The goal of the Center is to collaborate with public and private industry stakeholders to develop, validate, and improve RNG technologies, and to implement pilot-scale demonstration and testbeds to vet the viability of new technologies.

FACILITATING RNG ADOPTION FROM LAB TO MARKET

DEVELOPMENT → DISSEMINATION → IMPLEMENTATION

CORE BENEFITS OF RNG

GHG Reduction | Energy Storage Solution | Improved Public Health | Vehicle Emission Reduction | Economic/ Job Development | Sustainable Waste Management

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DEVELOPING CALIFORNIA'S RNG MARKET

KEY BENEFITS AND OPPORTUNITIES

Renewable Natural Gas (RNG) is pipeline quality gas that is fully interchangeable with fossil natural gas but is produced from a renewable feedstock and can be used as a 100% substitute for, or blended with, conventional natural gas. RNG is an important alternative fuel that has an existing and mature storage and transportation infrastructure and is a viable alternative transportation fuel, including in the heavy-duty sector. When used in lieu of fossil methane, RNG dramatically reduces the carbon footprint of gas combustion; some organic feedstocks produce RNG with a significantly negative carbon footprint (Table 1). Despite considerable potential, current RNG contribution as a substitute for fossil gas is very small. A concerted effort by all stakeholders is needed to realize the economic and environmental potential of RNG. This is the purpose and mission of the new Center for Renewable Natural Gas (CRNG).

ENERGY SOURCE: WIND / SOLAR

Focus Areas : 2 3 4

Harvesting Process: Power-to-Gas Production

Overview:

- Enables unlimited amounts of renewably-generated power to be stored indefinitely, transported to regions of energy demand using existing natural gas infrastructure, and dispatched when and as we need it

ENERGY SOURCE: FOREST BIOMASS

Focus Areas : 1 4

Harvesting Process: Thermochemical RNG Production

Overview:

- Wildfires, largely fueled by dead trees, are responsible for 52% of California's black carbon emissions, more than all diesel vehicles and power plants combined
- In addition to reducing the risk of wildfires, converting forest biomass to power can lead to much needed job creation

ENERGY SOURCE: LIVESTOCK & DAIRY MANURE

Focus Areas : 4 5

Harvesting Process: Anaerobic Digestion

Overview:

- California's 1.7 million dairy cows produce more than 50% of the state's methane emissions, a highly potent GHG
- Converting dairy waste to energy reduces GHG emissions, provides income to dairy farmers and helps protect local air, water, and soil quality

ESTIMATED RNG ENERGY POTENTIAL

≈7,000 MW of renewable electricity – enough to power more than 5 million homes

≈2.2 billion gasoline gallon equivalents of low carbon transportation fuels

Source: Bioenergy Association of California (BAC), November 2014. Decarbonizing the Gas Sector: Why California Needs a Renewable Gas Standard.

Transportation Fuel	Carbon Intensity*
Diesel	102.01
Gasoline	99.78
Hydrogen from Natural Gas	105.65
Electricity – CA Grid	105.16
Natural Gas	80.59
Corn Ethanol	80.18
Biodiesel	13.93 to 61.94
Renewable Diesel	16.89 to 39.06
RNG - Landfill Gas	34.82
RNG - Wastewater Biogas	7.75
RNG - Food/Green Waste Biogas	-22.93
RNG - Dairy Biogas (Prospective)	-272.97

*Carbon lintensity measured in grams CO2e per megajoule energy

Source: California Low Carbon Fuel Standard: 17 CCR 95488 - Table 6; California Air Resources Board, "LCFS Illustrative Fuel Pathway Carbon Intensity - Determined using CA-GREET 2.0", presented September 17, 2015

ENERGY SOURCE: FOOD & GREEN WASTE

Focus Areas : 1 4 5

Harvesting Process: High Solids Anaerobic Digestion (HSAD)

Overview:

- The majority of the organic waste being disposed in landfills is food waste and yard clippings
- This organic material can be used in dedicated HSAD facilities to produce high-quality RNG, which is one of the few RNG sources with a negative carbon footprint (identified by the Air Resources Board)

ENERGY SOURCE: LANDFILLS

Focus Areas : 4

Harvesting Process: Aerobic decomposition

Overview:

- Nearly 50% (16 million tons) of waste decomposing in California's landfills could be used to produce energy
- Using this waste to generate electricity would reduce annual CO_2 emissions from fossil fuels by approximately 7 million metric tons
- Waste-derived fuels are among the lowest carbon fuels identified by the Air Resources Board

ENERGY SOURCE: WASTEWATER

Focus Areas : 4 5

Harvesting Process: Anaerobic Digestion

Overview:

- Converting biomethane from California's 500+ wastewater treatment plants to electricity and fuels would reduce the state's annual GHG emissions by more than 1 million metric tons
- Using the digested material in place of inorganic synthetic fertilizer (which requires roughly 0.22 gallon of fossil fuels per pound of inorganic nitrogen to produce) would significantly reduce GHG emissions

	CRNG Focus Areas	Goals
1	High Yield Thermochemical RNG Production	Develop cost-effective technologies to commercially produce fuel-grade RNG from carbonaceous waste (forest biomass, agricultural residue, etc.); Address wide-scale adoption barriers such as feedstock logistics/pretreatment challenges, tar formation, gas cleanup, and high capital costs
2	Power-to-Gas Production	Develop cost-effective systems to convert excess renewable electricity into hydrogen or methane as a means to increase the renewable energy content of the pipeline infrastructure while addressing grid capacity and storage issues
3	Methanation Pathways	Optimize hydrogen conversion to methane, especially in the power-to-gas context where direct hydrogen injection into pipeline or long term hydrogen storage is not viable
4	Life Cycle and Techno-Economic Analysis	Conduct systems-level analyses of RNG production pathways to evaluate greenhouse gas and criteria pollutant emissions, material and energy balances (efficiencies), and commercial viability (economics)
5	Anaerobic Digestion	Optimize digestion pathways and technology options and address logistic and cost issues associated with feedstock collection and conversion