<table>
<thead>
<tr>
<th><strong>Docket Number:</strong></th>
<th>17-IEPR-10</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Title:</strong></td>
<td>Renewable Gas</td>
</tr>
<tr>
<td><strong>TN #:</strong></td>
<td>217807</td>
</tr>
<tr>
<td><strong>Document Title:</strong></td>
<td>Attachment to Email From George Minter</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Filer:</strong></td>
<td>Stephanie Bailey</td>
</tr>
<tr>
<td><strong>Organization:</strong></td>
<td>SoCalGas</td>
</tr>
<tr>
<td><strong>Submitter Role:</strong></td>
<td>Public</td>
</tr>
<tr>
<td><strong>Submission Date:</strong></td>
<td>6/2/2017 8:32:48 AM</td>
</tr>
<tr>
<td><strong>Docketed Date:</strong></td>
<td>6/2/2017</td>
</tr>
</tbody>
</table>
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.

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
- South Coast AQMD
- National Center for Sustainable Transportation

**CONTACT**

For more information about CRNG, please contact:

Dr. Arun Raju
Director, Center for Renewable Natural Gas
O: 951-781-5686
C: 909-910-6577
arun@engr.ucr.edu

**CORE BENEFITS OF RNG**

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

**FACILITATING RNG ADOPTION FROM LAB TO MARKET**

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.
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:  
- 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:  
- 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:  
- California’s 1.7 million dairy cows produce more than 95% 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.

**ENERGY SOURCE: WASTEWATER**
Focus Areas:  
- 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 fertilizer emissions.

**ENERGY SOURCE: LANDFILLS**
Focus Areas:  
- The majority of the organic waste being disposed in landfills is food waste and yard clippings.
- This organic material can be used in dedicated ISAD facilities to produce highly-quality RNG, which is one of the few RNG sources with a negative carbon footprint (identified by the Air Resources Board).

**ENERGY SOURCE: FOOD & GREEN WASTE**
Focus Areas:  
- Waste-derived fuels are among the lowest carbon fuels identified by the Air Resources Board.
- Using this waste to generate electricity would reduce annual CO₂ emissions by approximately 7 million metric tons.

**ENERGY SOURCE: HIGH SOLIDS ANAEROBIC DIGESTION**
Focus Areas:  
- The majority of the organic waste being disposed in landfills is food waste and yard clippings.
- 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 fertilizer emissions.

**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

**CRNG Focus Areas**

<table>
<thead>
<tr>
<th>Focus Areas</th>
<th>Goals</th>
</tr>
</thead>
</table>
| 1 | CRNG Focus Areas  
High Field 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, fuel formation, gas cleanup, and high capital costs. |
| 2 | Power-to-Gas Production  
Develop cost-effectively 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. |

**Transportation Fuel Carbon Intensity**

<table>
<thead>
<tr>
<th>Source</th>
<th>RNG - Dairy Biogas</th>
<th>RNG - Landfill Gas</th>
<th>RNG - Waste Water Biogas</th>
<th>RNG - Food/Trash Waste Biogas</th>
<th>RNG - US Renewable Natural Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Intensity*</td>
<td>22.93</td>
<td>28.82</td>
<td>22.93</td>
<td>32.97</td>
<td>102.01</td>
</tr>
</tbody>
</table>

*Carbon intensity measured in grams CO₂e per megajoule energy