# Low Carbon Resources

## Implementing biogas, hydrogen and technologies for distributed generation and transportation

ENERGY OUTLOOK WHITE PAPER
WORKING GROUP MEETING

Ron Kent
Technology Development Manager

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South Coast Air Quality Management District
21865 Copley Drive Diamond Bar, CA 91765

Southern California Gas Company
A Sempra Energy utility®

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# Biogas Upgrading

**Operations – October 2012**

- Run Time: 132 hr
- Ave Feed Flow:177 scfm
- Ave Product Flow: 101 scfm
- Ave Product Quality: 99.0% methane
- Ave Methane Recovery: 89%
- Ave Product H2S: 0.4 ppm
  (Rule 30 limit is <4.0 ppm)

# Waste to Energy

**Project Description**

Design, install, and operate an innovative, small-scale waste-to-energy bioenergy system that:

- Integrates Concentrated Solar Power (CSP) and Hydrothermal Processing (HTP)
- Convert dairy manure into low-carbon, high-quality renewable natural gas (RNG) for injection into the pipeline

**Efficient, Small Footprint Approach**

- Extracts up to 80 percent of the energy in the dairy manure
- Solar steam generator provides 30,000 therms of energy in a year—enough to offset more than 20,000 gallons of diesel fuel oil—in a total footprint of only one acre. Greatly reduced footprint in comparison to less efficient systems—such as anaerobic digesters
- Minimal onsite storage because the RNG can be injected immediately NG pipelines

**Collaboration Partners**

- CEC
- Genifuels Corp. (Hydrothermal Processing System)
- Hyperlight Energy (Solar Thermal System)
- Energy Solutions (Techno-Economic Analysis)
- National Renewable Energy Laboratory (Solar Thermal Optimization)

**Skid-mounted HTP system**

**Hyperlight Solar Thermal System**

# Thermal Energy Storage

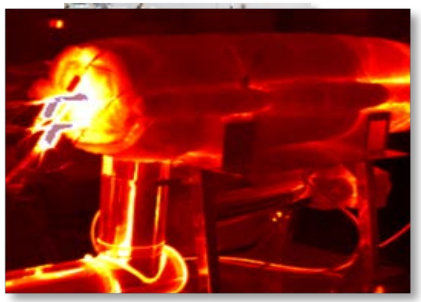
## Purpose

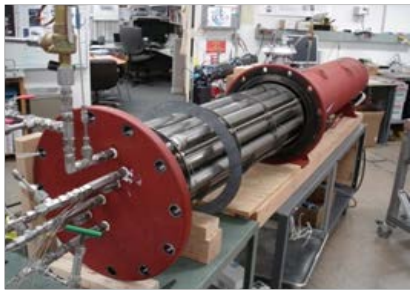
- Develop and demonstrate an innovative, low-cost thermal energy storage system (TES) meets DOE cost goals and California Energy Commission renewable energy targets.
- Demonstrate the TES technology at SDSU Brawley in connection with a natural gas/solar thermal adsorption chilling system and potentially a fuel cell CHP system.

## Deliverables

- Functional elemental sulfur thermal system for testing
- Computer code
- System operations report

| Thermal Storage for NG CHP and Solar Heating Systems | |
|---|---|
| **Collaboration Partners** | UCLA/CEC/DOE ARPAe |
| **Location** | UCLA/SDSU Brawley |
| **Duration** | 36 Months |
| **Start Date** | Jan-15 |
| **Planned End Date** | Dec-18 |
| **CEC Budget** | $1.5 Million + $300k SCG |
| **DOE ARPAe Budget** | $625k + $125k SCG |





# Algae Flue Gas Clean-up

**Purpose**

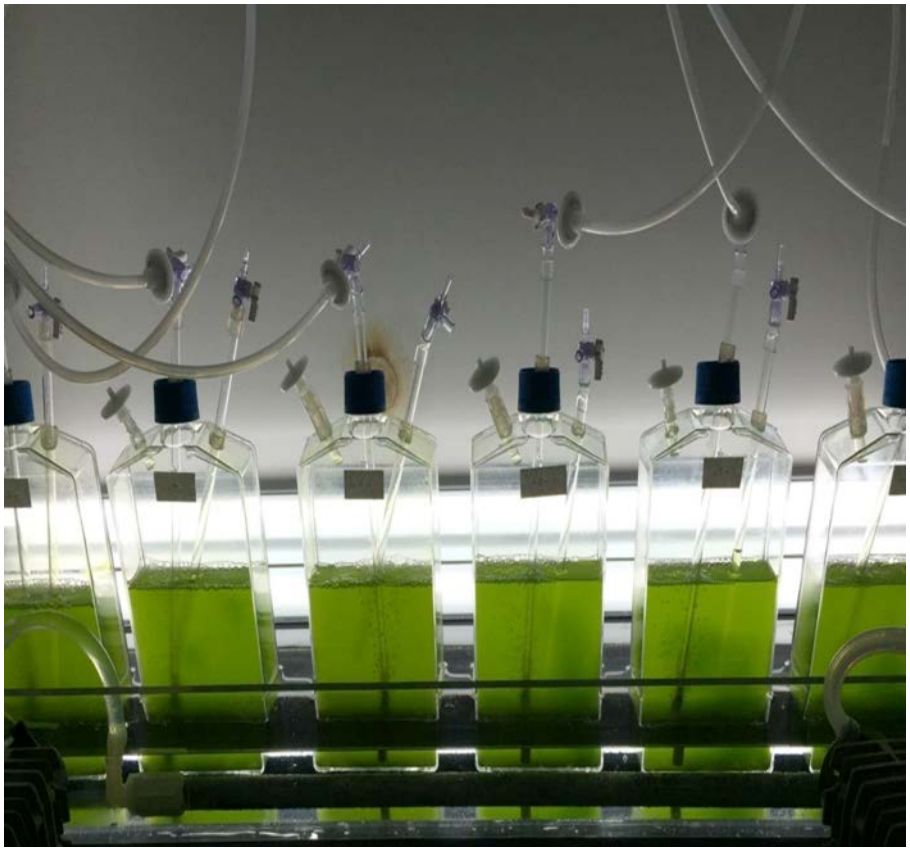
» Assess the efficacy of using algae to capture and recycle flue gas from natural gas engines and other prime movers.

**Deliverables**

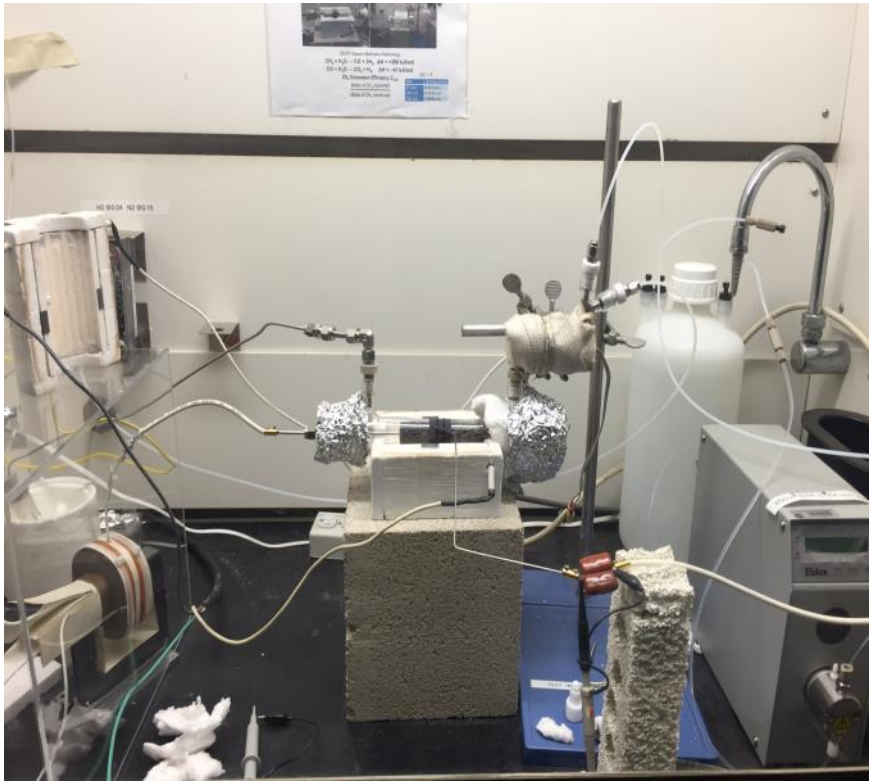
» Functional lab-scale system

» Test data

» Design and FEED study for a commercial pilot system

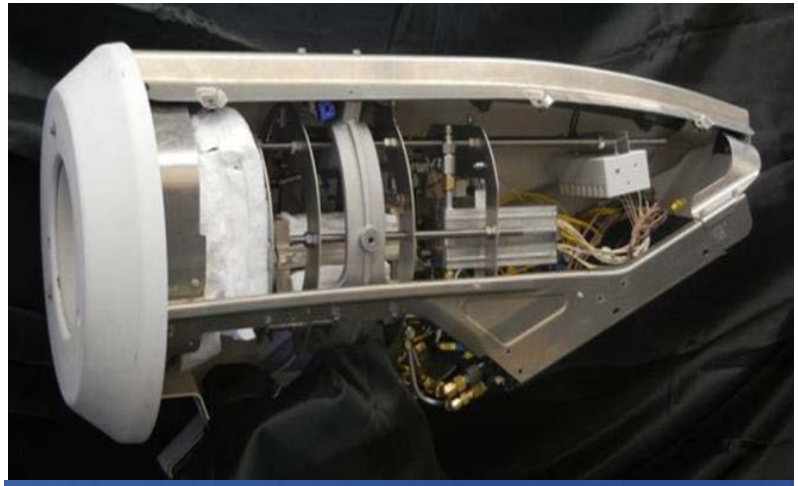


# Distributed H2



Catalytic Non-Thermal Plasma

Steam-Methane Reforming



# Solar-Thermal Catalytic H2 Generation

- Low-cost hydrogen from
- Methane, water and solar energy
- 20% - 30% renewable H2

# Power to Gas - NREL

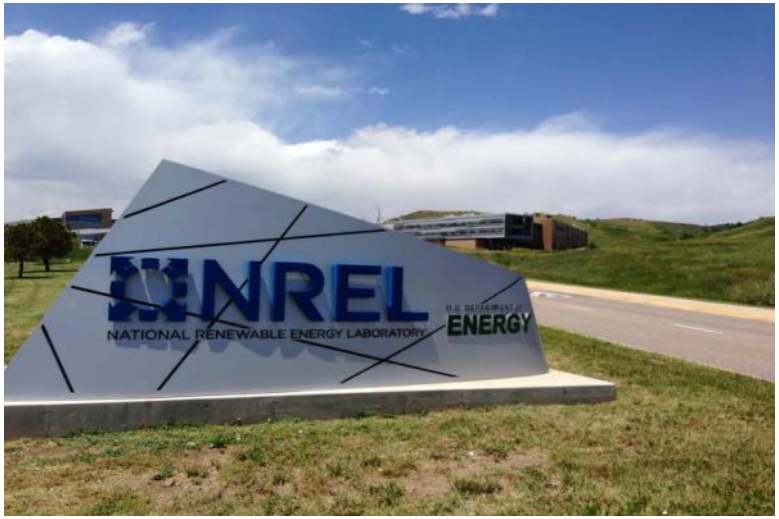
**Objective:**

- Enable higher penetrations of solar power generation using the natural gas pipeline system for energy storage.
- This project has two primary elements
  - Electrolyzer / methanation hardware characterization and testing in a full-up grid-simulation environment
  - Modeling of P2G economics based on value provided to the grid in various operating scenarios

**Deliverables**

- Design, build, install, test and demonstrate systems for:
  - Electrolysis
  - Methanation
- Measure and model system performance and provide modeling and test reports
- Assessment of cost/benefit or the system as a grid resource

| P2G Solar Energy Storage RD&D | |
|---|---|
| Collaboration Partners | NREL/SoCalGas |
| Location | Golden, CO |
| Duration | 18 Months |
| Start Date | Sept 2014 |
| Palnned End Date | March 2016 |
| Budget | $900,000 |
| Co-funding | 50/50 |



# Power-to-Gas – NFCRC/UCI

**Purpose**

» Develop a deep understanding of the physical, chemical and energy dynamic attributes of H2 blending necessary to achieve commercial P2G deployments for storage and distribution of excess wind and solar energy.
  - This is a logical next step from SoCalGas' CRADA with NREL that focuses on P2G grid integration

**Deliverables**

» Design, build, install and test systems for:
  - PV and electrolysis integration
  - H2 blending and pipeline injection

» Determine impacts of H2 injection on natural system gas components

| P2G Solar Energy Storage & Distribution RD&D | |
|---|---|
| **Collaboration Partners** | UCI/SoCalGas |
| **Location** | UCI - NFCRC |
| **Duration** | 18 Months |
| **Start Date** | Dec-14 |
| **Planned End Date** | Jun-16 |
| **Electrolyzer Size** | 60kW |
| **Budget - Hydrogen Only** | $2.5 Million |
| **Phase II*** | TBD |

*Pending CEC and/or DOE support, an anaerobic digester and a methanation unit will be added in Phase 2.

# Oxy-fuel Zero Emissions Power

**Purpose**

» Develop cost-competitive zero emissions power using advanced oxy-fuel combustion technology. Developed by Clean Energy Systems (CES)

**Deliverables**

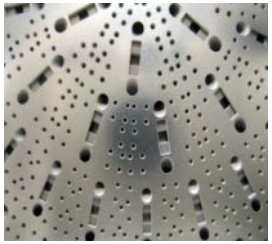
» Technology demonstrations

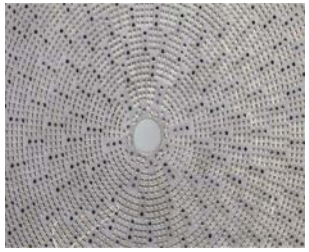
» Operational power plant

» CO2 sales to EOR operations in California

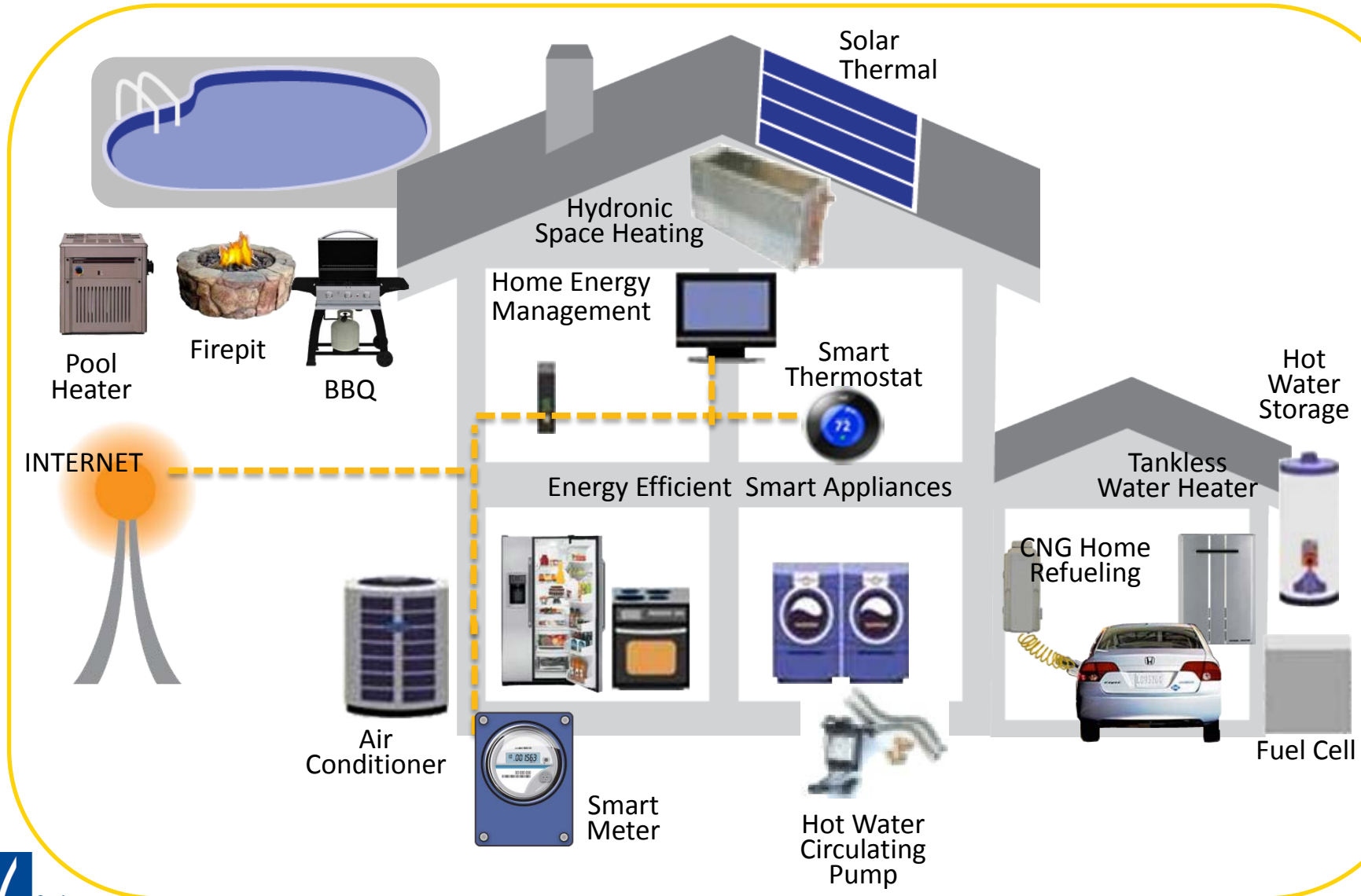
| Clean Energy Systems Zero Emissions Oxy-fuel Power Plants | |
|---|---|
| **Collaboration Partners** | Paxton, DOE, CEC, |
| **Location** | Sacramento, Bakersfield |
| **Duration** | Multi-year |
| **Start Date** | January 2006 |
| **Planned End Date** | December 2016 |








# Projected Smart ZNE Home



# Alternative Fuel HD Vehicles








Heavy Duty Trucks

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# Alternative Fuel MD/LD Vehicles