Pollution control and power generation for low quality renewable fuel streams

Grant CEC EPC-14-031

2015 EPIC Innovation Symposium
Folsom, CA

ADVANCED POWER & ENERGY PROGRAM
UNIVERSITY of CALIFORNIA · IRVINE

Vincent McDonell

3 December 2015

Outline

- Project overview
- Key challenges targeted
- Core innovation
- Results to date
- Relation to ongoing State activities
- Recommendations

© Advanced Power and Energy Program 2015

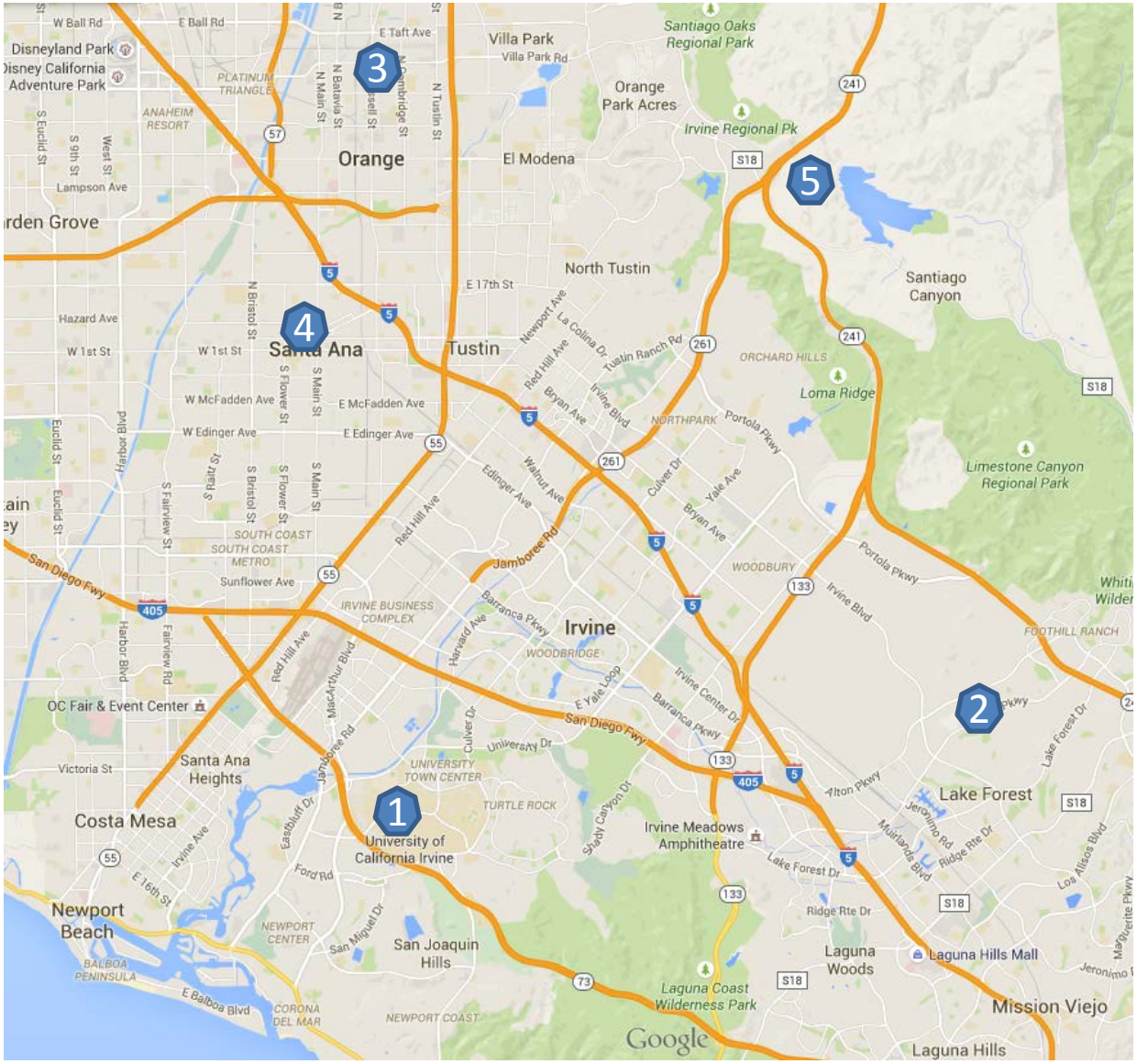
Project Overview

- **Goals***
  - **Deploy and demonstrate a novel strategy for using low quality biogas to (1) reduce emissions and (2) generate electricity through the use of advanced oxidation technology combined with a gas turbine**
- **Team**
  - **Advanced Power and Energy Program (University of California, Irvine)**
  - **Ener-Core (Irvine, CA)**
  - **ES Engineering (Orange, CA)**
  - **Orange County Waste & Recycling (OCWR)**
    - ✓ **Santiago Canyon Landfill**

*Submitted to EPIC PON-14-305: Demonstrating Bioenergy Solutions that Support California's Industries, the Environment, and the Grid--Group 1—Advanced Pollution Control Equipment and Low Emission Generators
$1.5M CEC funded project + $440K cost share

© Advanced Power and Energy Program 2015

Project Overview



1 Advanced Power & Energy Program, University of California · Irvine

2 ENER-CORE

3 environmental services

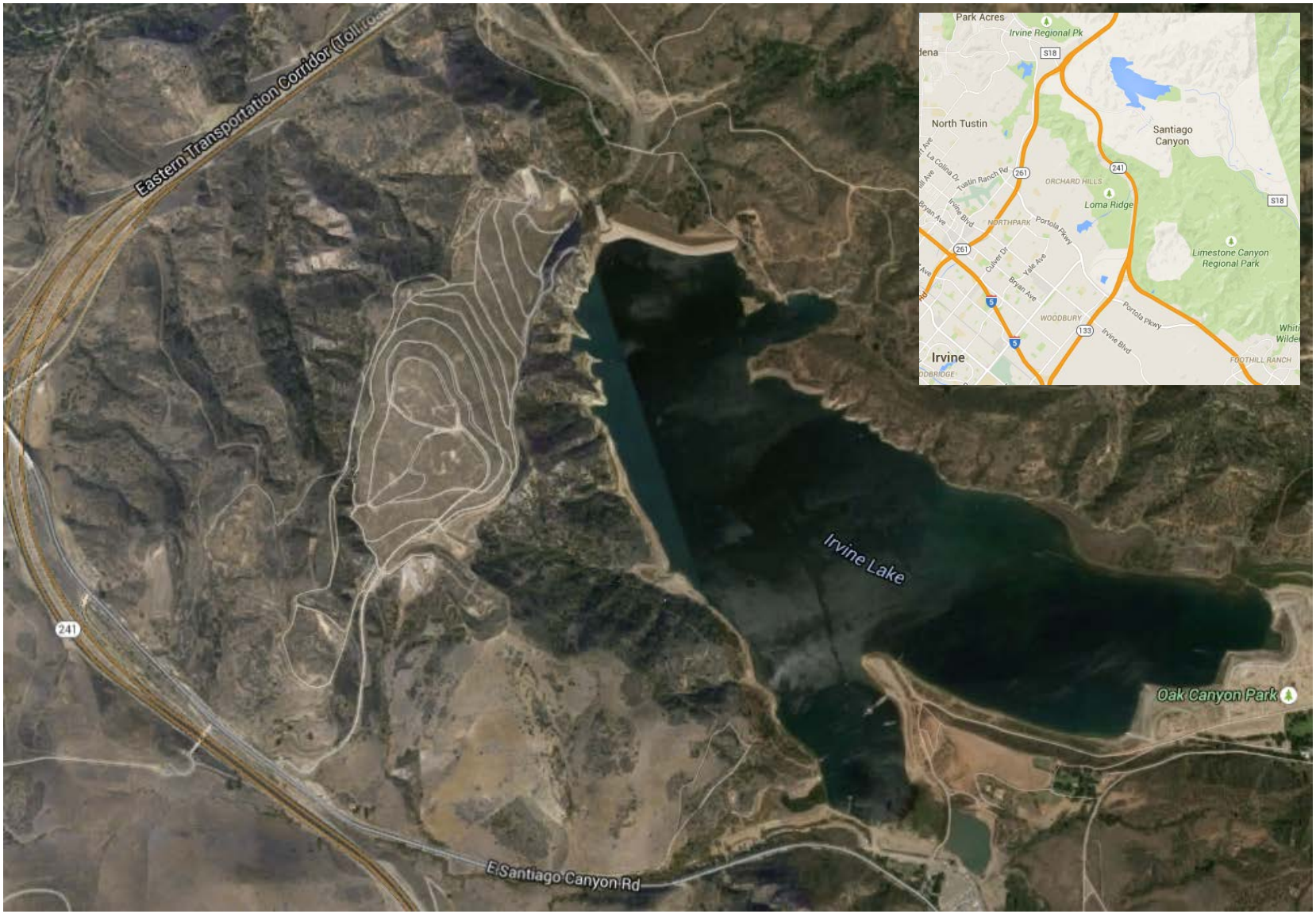
4 OC Waste&Recycling

5 Santiago Canyon Landfill (Closed)

All locations within 20 minutes of each other!

© Advanced Power and Energy Program 2015

Project Overview



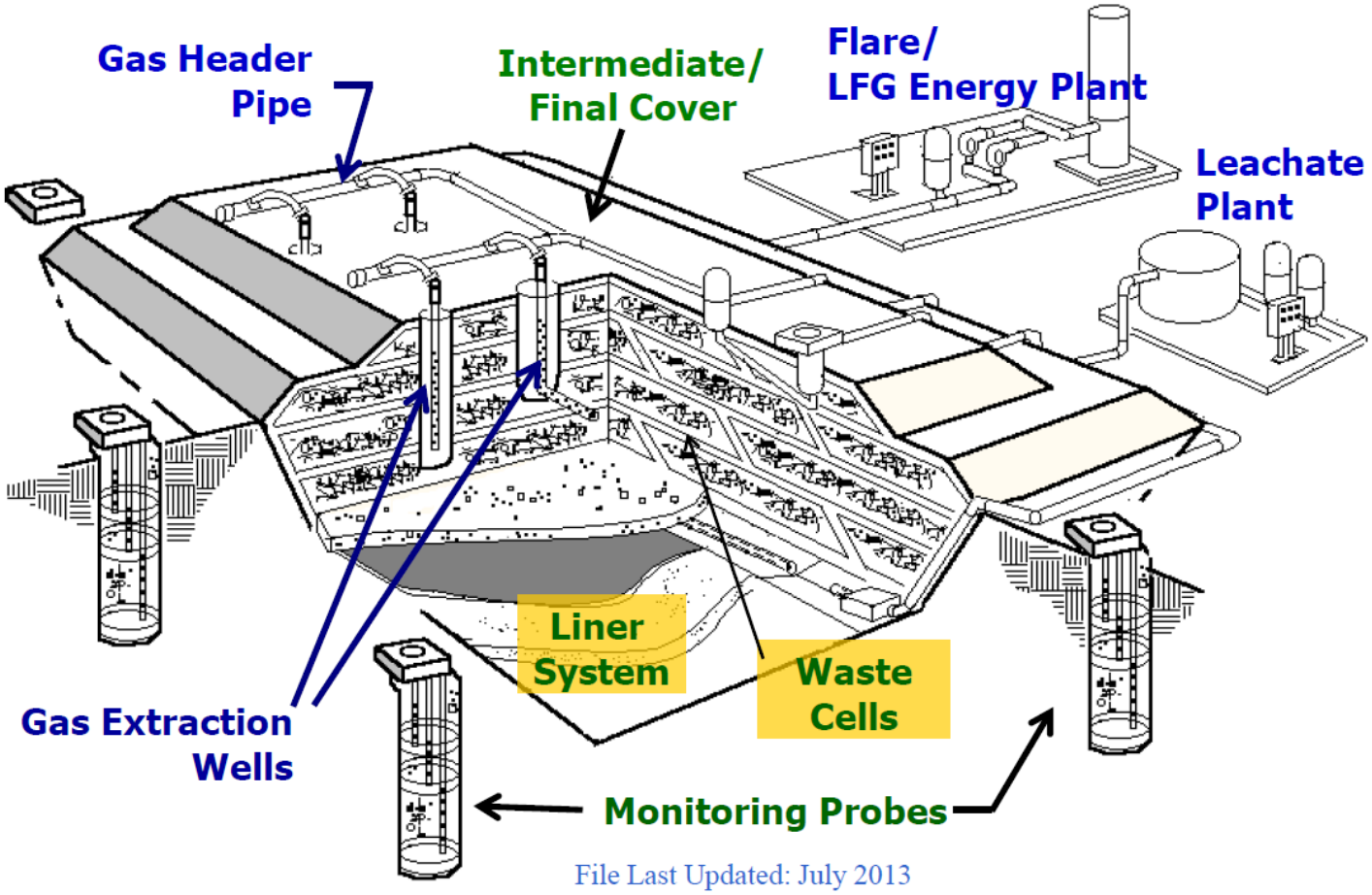
© Advanced Power and Energy Program 2015

Project Overview

View to South

© Advanced Power and Energy Program 2015

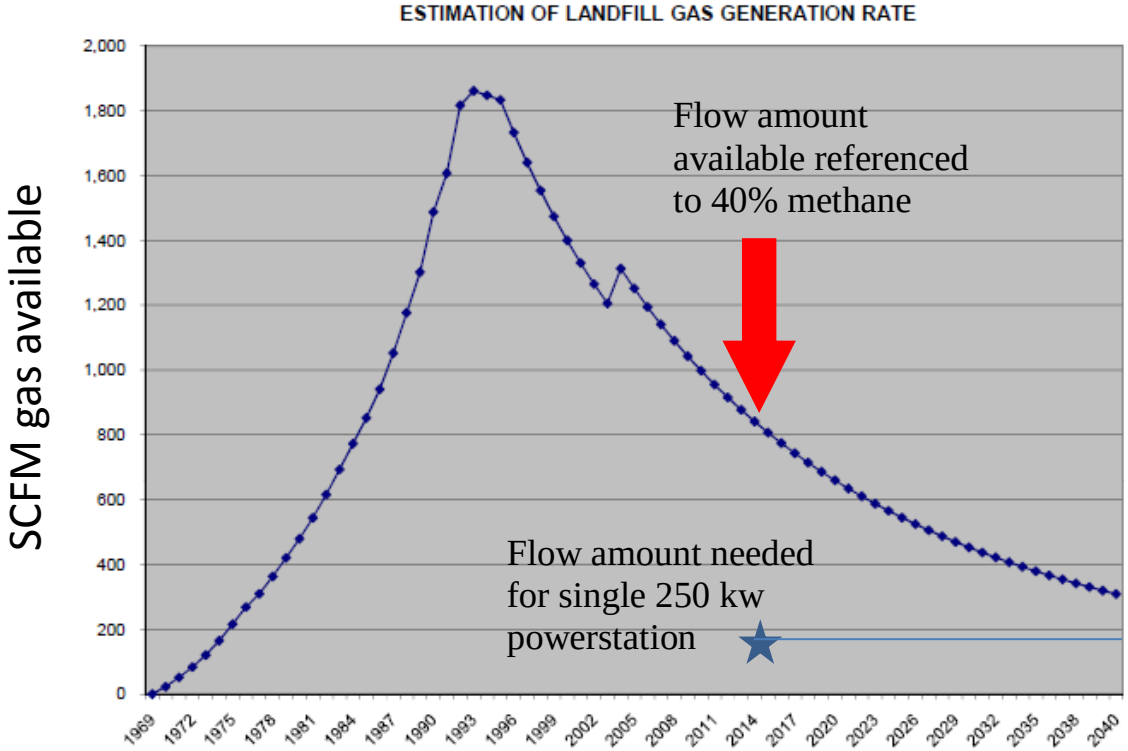
Project Overview



© Advanced Power and Energy Program 2015

Challenges Addressed

- **Landfills generate biogas from decomposing material**
  - **The quality and flow of gas varies with time**
  - **Santiago Canyon Characteristics (EPA Landgem Model)**
    - ✓ **Reduced Flow and reduced methane content (i.e., reduced gas quality)**



Equipment can provide benefits beyond 2040

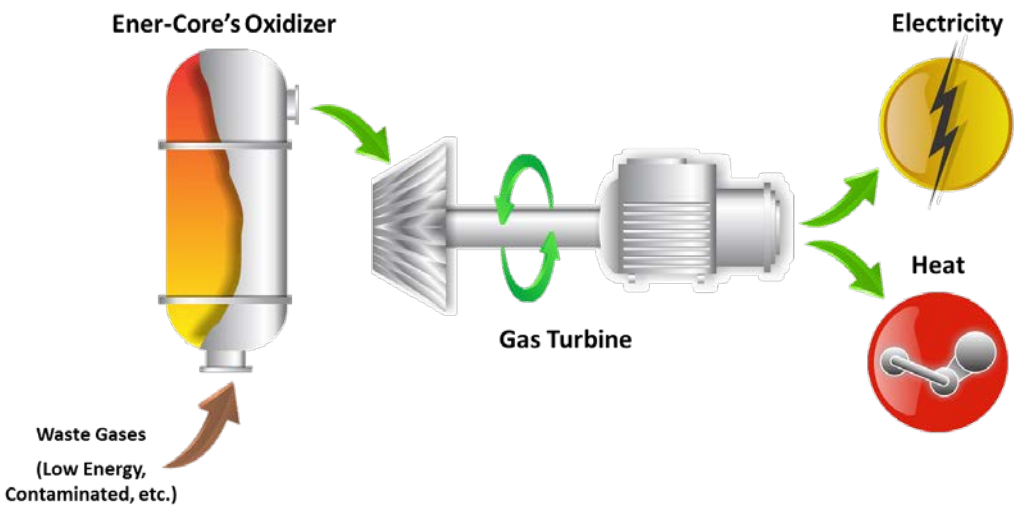
Producing electricity using low quality biogas that can only be flared at current time

Ultralow pollutant emissions

© Advanced Power and Energy Program 2015

Core Innovation

Ener-Core's Oxidizer technology replaces the combustor in a traditional gas turbine.



Contaminated fuels *(Siloxanes, Hydrogen, etc.)* By using oxidation rather than combustion, the technology can handle fuels with higher levels of contaminates. Specifically, tolerances to hydrogen and Siloxanes are higher than for combustion based power generation solutions.

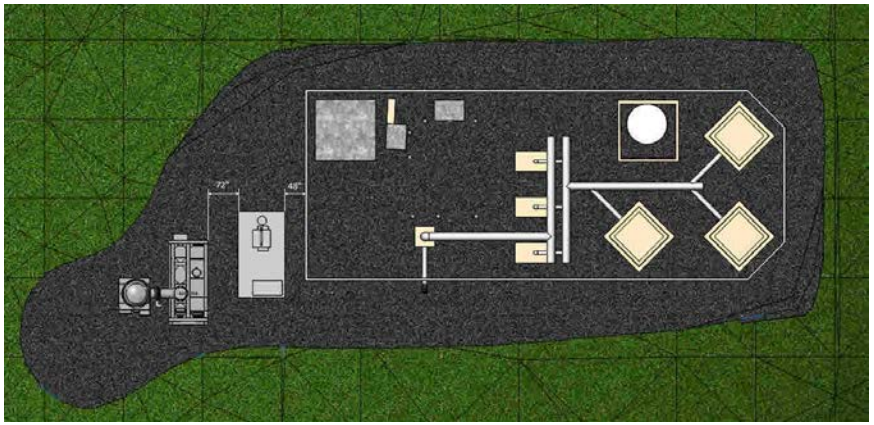
Pollution Destruction *(99% destruction efficiency)* The technology can be used in lieu of a traditional thermal abatement technology (flares, scrubbers, etc.) to destroy gases emitted by industry while simultaneously producing electrical and thermal energy.

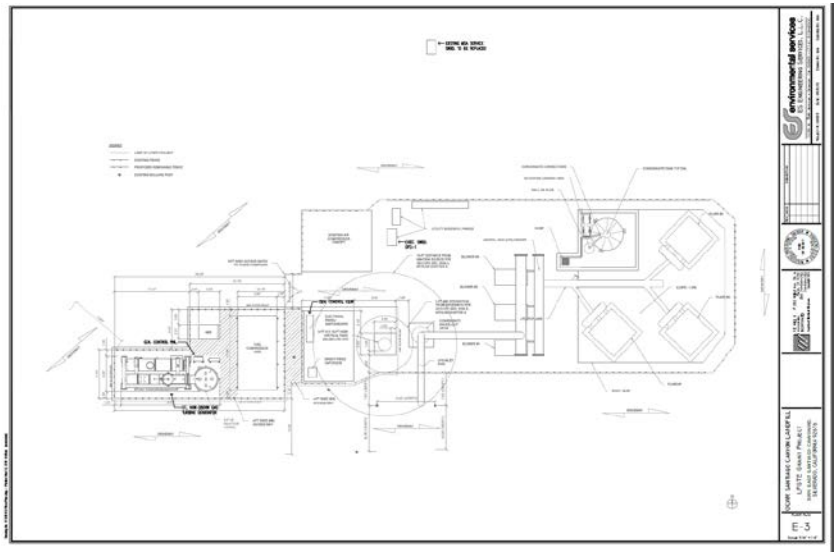
Low Emissions *(<1 ppm NOx & CO)* Using an oxidizer in place of a combustor allows for lower emissions than traditional power generation equipment. Typically, to achieve these emission levels power producers use post-combustion technologies (SCR, CO Catalyst, etc.)

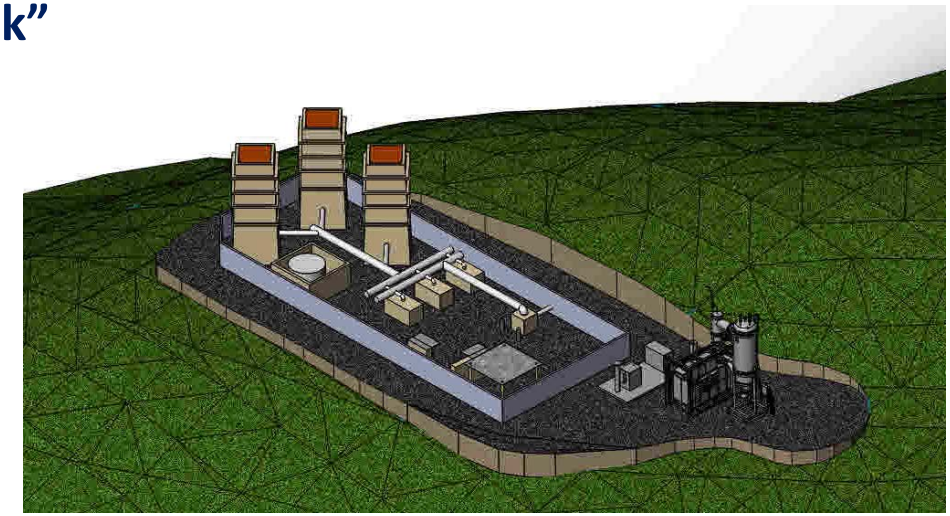
Low Energy Fuels *(25 to 2,600 btu/scf)* The Ener-Core Power stations can operate on lower energy density fuels than traditional power gen technologies. This technology can operate (without supplemental fuel) on gases with energy densities as low as 15 btu/scf.

Progress to Date

- Site Engineering completed
- Permits Applied for
  - Air, Fire, Construction
- Interconnect w/SCE
  - In process
  - Working to stay on "fast track"
- Key components ordered





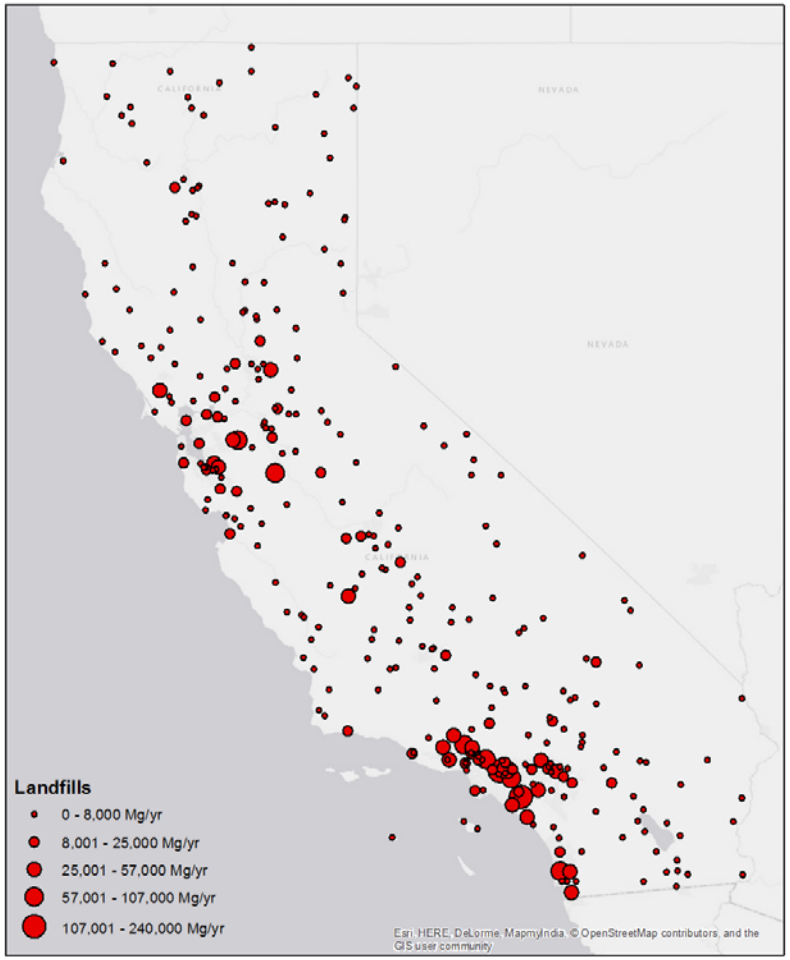


Equipment Siting: Targeting March 2016

© Advanced Power and Energy Program 2015

Opportunities Relating to Ongoing State Activities

Landfill Biogas Resources



- **Candidate sites for this technology could generate 350MW per year**
  - **~500,000 homes**
- **1400 tons/yr reduction in NOx**
- **Reduced GHG via renewable fuels**
- **Supports specific CA policy**
  - **AB32—1990 GHG levels by 2020**
  - **Clean Energy Job Plan**
  - **AB1613: Waste Heat and Carbon Emissions Reduction Act**
  - **SB 350—50% Renewables by 2030**
- **Orange County Policy**
  - **Energy Resource Goal 2.1—Local Energy resource development**
  - **Air Resource Goal 1.1—Attain air quality standards**

© Advanced Power and Energy Program 2015

Recommendations

- **Support to explore technology scalability**
  - **250 kW and 2 MW version currently available which creates opportunities for modular installation**
  - **250 kW system operational in Netherlands for 2 years**
  - **1st 2 MW system commercial deployment on track for 2016 with Pacific Ethanol**
- **Support to explore use of other low quality waste gases with the oxidizer technology**
  - **Applications include alternative fuel production plants and existing refinery operations**
  - **High hydrogen content gases need further research for operability in the oxidizer**
  - **Laboratory testing using various fuels would be helpful**

© Advanced Power and Energy Program 2015

For Further Information….

- **Vincent McDonell**
  - **949 824 5950 x11121**
  - **mcdonell@apep.uci.edu**
  - **www.apep.uci.edu**

© Advanced Power and Energy Program 2015

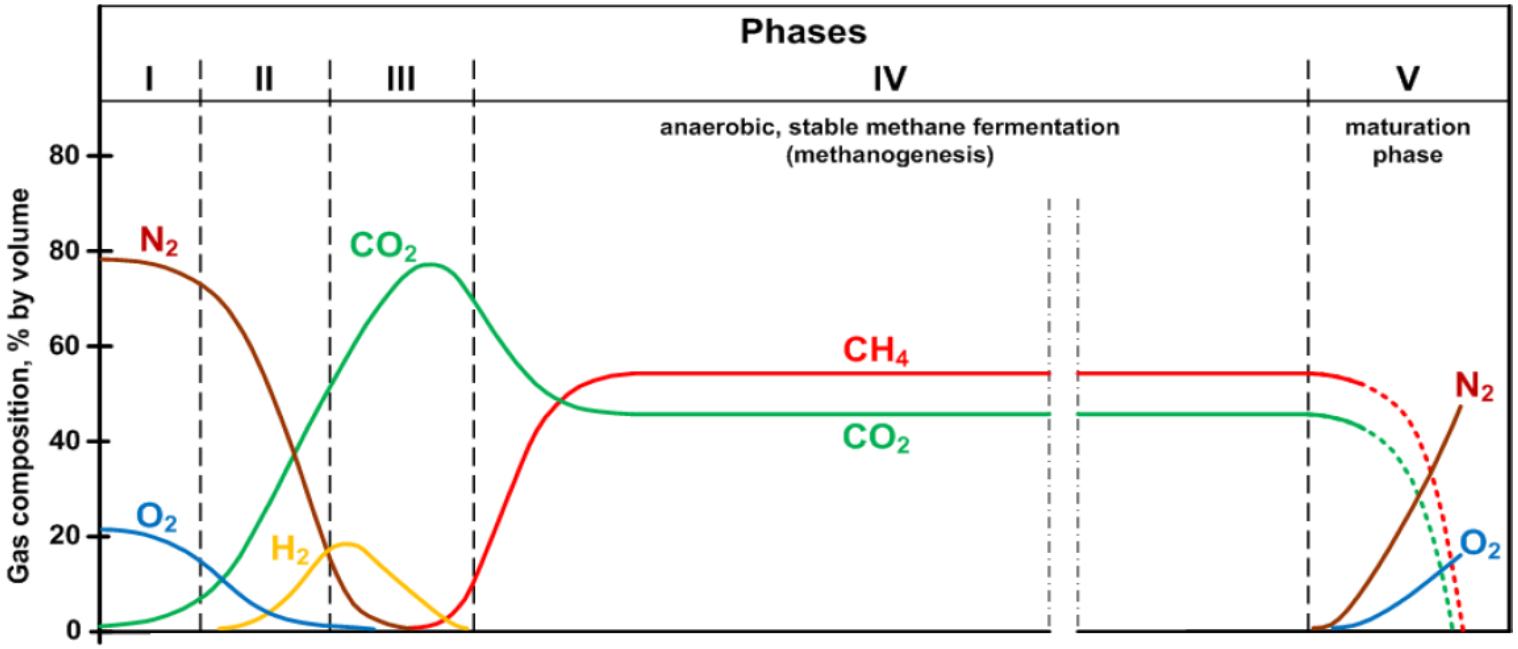
Backup Slides

- **Typical landfill gas composition behavior**
- **Santiago Canyon Gas Composition**

© Advanced Power and Energy Program 2015

Background

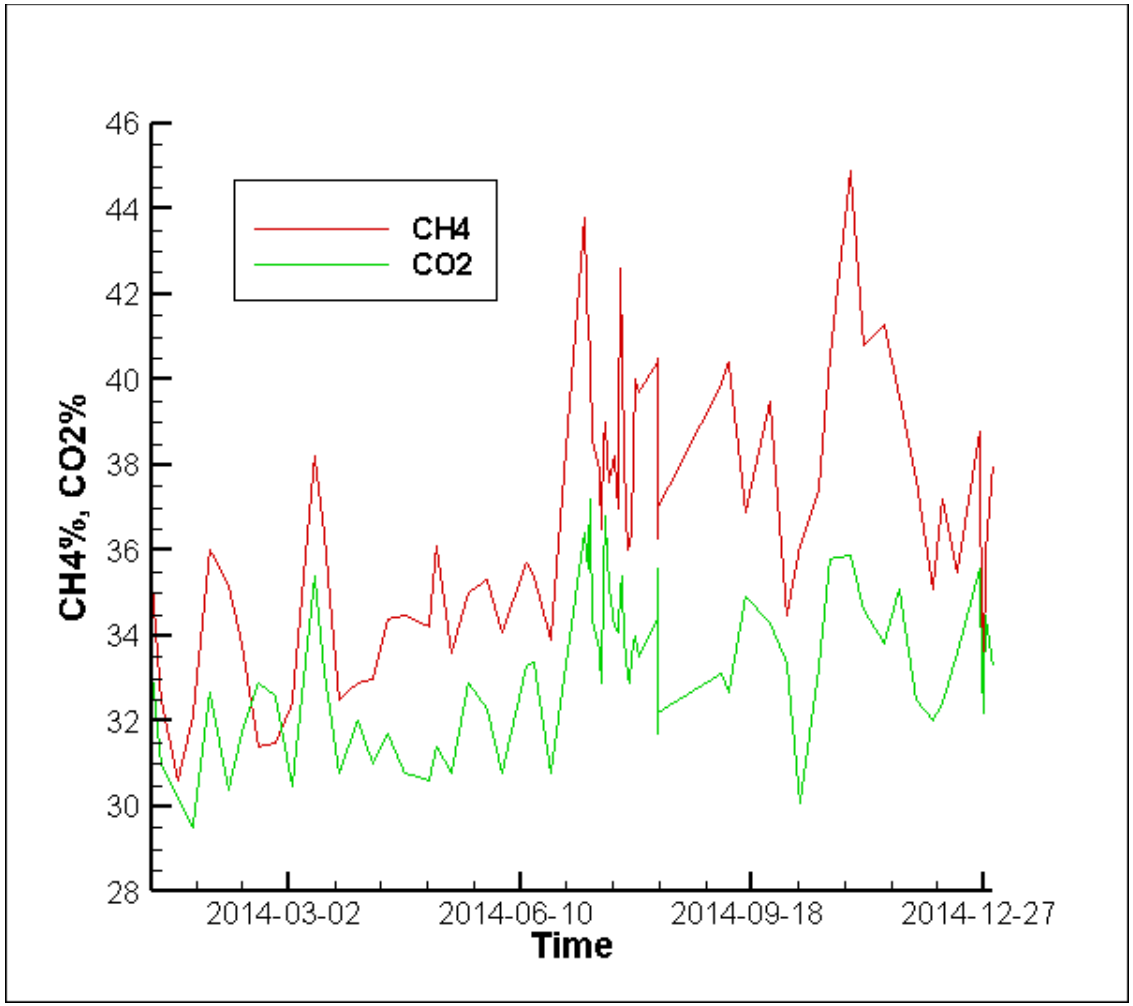
- **Typical landfill gas composition behavior**



I = New waste, the initial adjustment, aerobic conditions
II = Transition phase, the beginning of anaerobic decomposition
III = Acid phase, hydrolysis and acidogenesis
IV = Methane fermentation phase, strictly anaerobic, methanogenesis
V = Maturation phase: air intake, methane oxydation to CO2 and air phase

© Advanced Power and Energy Program 2015

Santiago Canyon Gas Composition



© Advanced Power and Energy Program 2015