

# Development, Demonstration and Testing of Low-NOx Natural Gas Engines in Port Yard Trucks w/ Development of Innovative Gas Composition Sensor

CEC PIER Grant #PIR-16-016

*Natural Gas Vehicle Technical Forum*

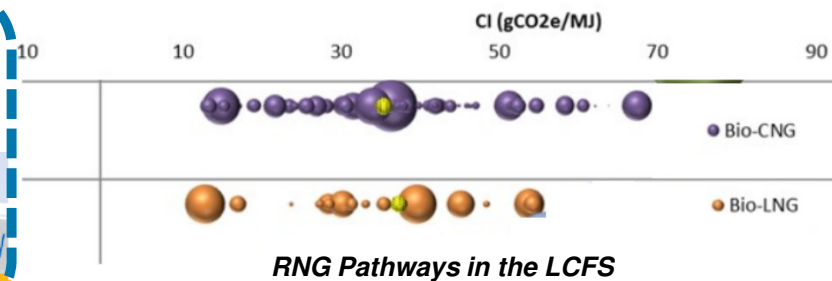
*February 21, 2018*



Prime Contractor:



Subcontractor:



# GNA Overview

Clean Transportation & Energy Consultants | [www.gladstein.org](http://www.gladstein.org)



**25 YRS**

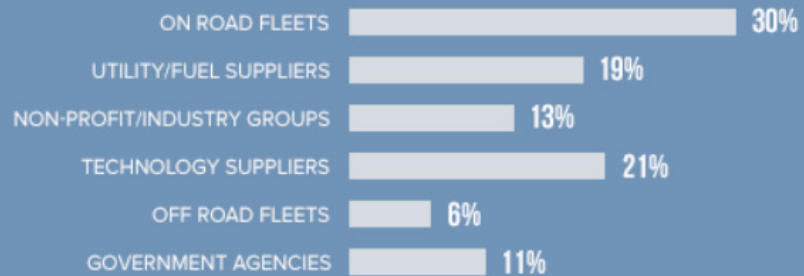
of clean transportation  
experience



**421M**

dollars in secured  
funding for clients

## WHO GNA WORKS WITH



# ACT Expo is GNA's next major clean energy & transportation event



In partnership with:  
**FleetOwner**

## Advanced Clean Transportation Expo

CONFERENCE **APRIL 30 - MAY 3, 2018** EXPO **MAY 1 - MAY 2, 2018**  
LONG BEACH CONVENTION CENTER LONG BEACH, CALIFORNIA



**3500+**

clean transportation  
stakeholders

**650+**

registered fleet  
operators

**250+**

sponsors and  
exhibitors

**60+**

advanced vehicles on  
display

**18+**

co-located industry  
events & workshops

**125+**

expert industry  
speakers

**gna** GLADSTEIN,  
NEANDROSS  
& ASSOCIATES

CLEAN TRANSPORTATION & ENERGY CONSULTANTS



## Project Background and Purpose

- **Yard Trucks:** leading source of emissions in port CHE operations
- Low-NOx NG Engines w/ RNG: **immediately available, ultra-clean**

| Engine   | Displ. | NOx Certification Level        | Commercialization for Hostlers      | Early Deployments (Ports) |
|----------|--------|--------------------------------|-------------------------------------|---------------------------|
| ISL-G NZ | 8.9L   | <b>OLNS 0.02</b> (-90%, "NZE") | Available since '16 (special order) | 20 for EverPort (May)     |
| ISB6.7 G | 6.7 L  | <b>OLNS 0.10</b> (-50%)        | Recently available (special order)  | None to date              |

- For CHE applications, neither has undergone real-world operational experience or in-use emissions testing
- ISB 6.7L version is more **“right-sized”** for yard hostler applications
- **Gas composition:** another potential barrier
  - HD off-road engines in CA will increasingly be operated on RNG (**problematic variation in gas composition?**)

## Workhorse CHE at Container Terminals

- Unloading a small container ship requires approximately **8 yard hostlers** and **3 top picks**
- Example\* terminal moving 800,00 TEU annually:
  - 14 Post-Panamax cranes
  - **110 yard hostlers**
  - 23 top picks
- There are approximately **1,700 operational hostlers** serving the two San Pedro Bay Ports
- Typically need to operate for **two shifts** between fueling events

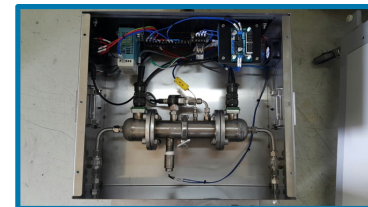
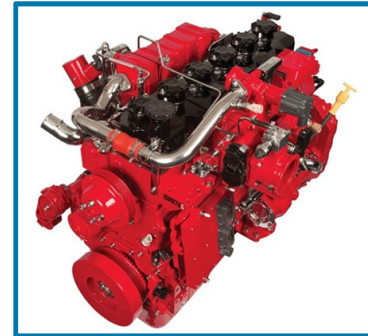
\*At full throughput capacity, with backups / redundancy



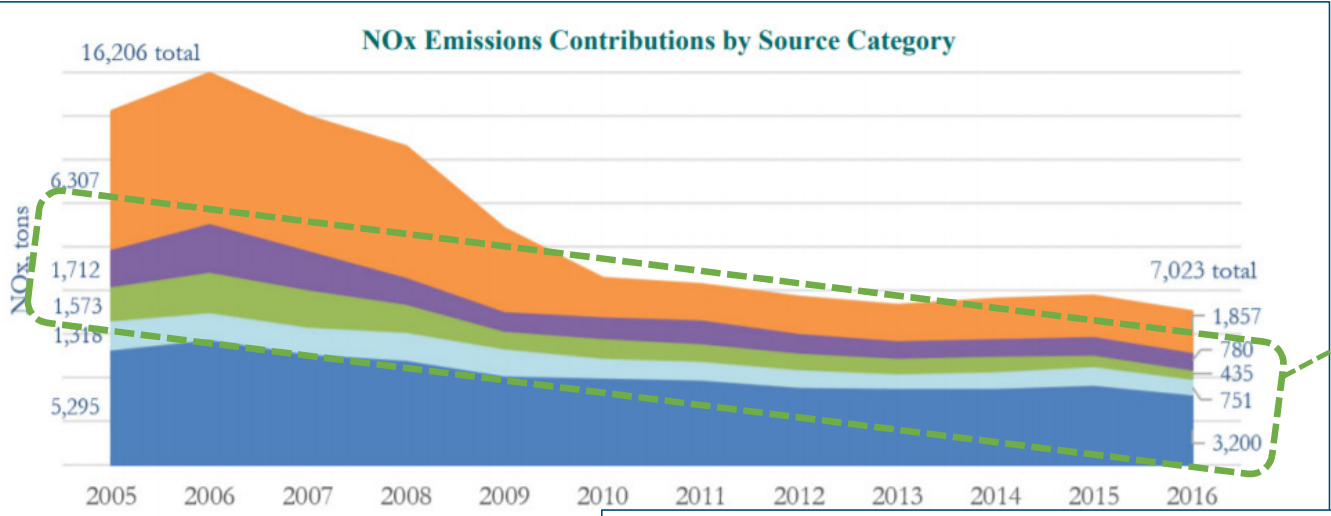
## Project Background and Purpose (continued)

### Three Overarching Project Objectives:

- 1) **Purchase and demonstrate** two LNG yard hostlers with “right-sized” low-NOx CWI ISB6.7 G engines
  - Feed into San Pedro Bay CAAP feasibility assessments
- 2) **Conduct** comparative chassis-dyno testing
  - Baseline diesel, NZE 8.9L LNG, battery-electric
- 3) **Improve and bench-test** innovative gas composition sensor technology under development by UCR CE-CERT

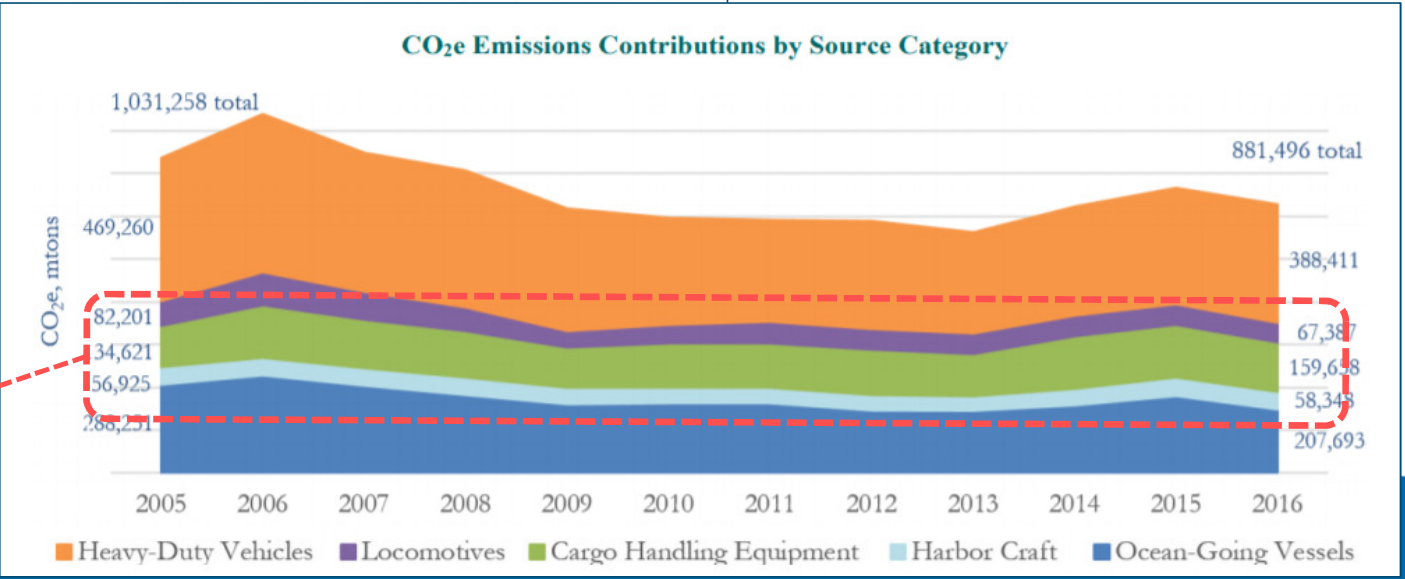


# CHE NOx & GHG Emissions at the Port of Los Angeles, 2005 to 2016



NOx emissions are **declining** (a wide array of successful control approaches)

GHG emissions have **increased slightly** (greater activity has offset improved fuel efficiency)



# Mitigating Emissions from Heavy-Duty Vehicles and Engines

This project addresses **three of the four approaches** to **reduce emissions** (criteria, GHGs) and/or **displace petroleum fuel** from heavy-duty vehicles and equipment:



3. Efficient Drivetrain  
(future hybridization)

4. Effective Exhaust Aftertreatment

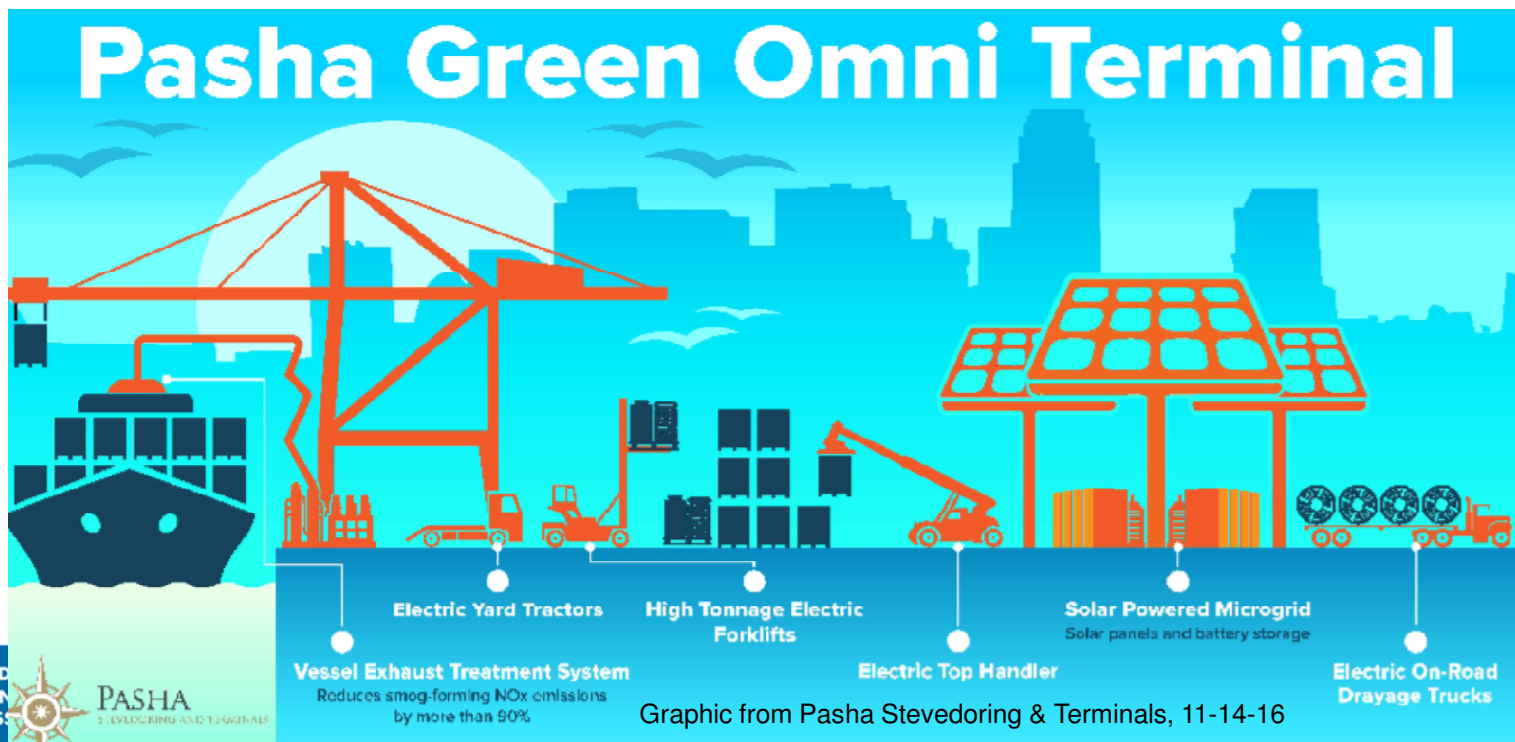
2. Optimal Engine / Power Plant  
Design (with “right sizing”)

1. Clean Burning Fuel  
(and technology to properly combust it)



## Wait, aren't the San Pedro Bay Ports going **all-electric** for CHE?

- Hostlers (and other CHE) can be conducive for HD ZEV platforms
- MTOs (e.g. at Pasha) are testing BEVs, FCVs for hostlers, large forklifts, and top handlers
- However, significant **challenges** remain (**INFRASTRUCTURE**)
- Clearly, **NZE CHE (w/ low-CI fuel)** are also extremely important pathways



## What does the CAAP say about ZE CHE?



- Ports have adopted a “**goal**” to maximize use of ZE CHE technology platforms by 2030
- However, the Ports see **uncertainty** about commercialization timeline
- Therefore, they have built in **flexibility to modify specific requirements**
  - Final decisions will be based on **rate of technological progress**
  - Ports will conduct tri-annual “**feasibility assessments**” about CHE
- 2018 CHE Feasibility Assessment is just getting underway
  - Input for CARB’s potential ZE CHE regulation (**100 percent by 2030**)?

## Overview of Project Tasks and Timeline

- **Purchase and deploy** two LNG hostlers w/ “right-sized” OLNS-certified ISB6.7
  - Document viability to compete with diesel (similar engine size)
  - Help pave way for CWI to **certify ISB6.7 to NZE status**
- **Conduct comparisons\*** in real-world service at Port of LA host site(s)
  - *\*As available: Capacity 8.9-L NZE, baseline diesel, battery-electric*
- **Conduct emissions and performance testing** at UCR CE-CERT (chassis dyno)
- **Advance** CE-CERT’s development and testing of innovative NG sensor

**Project timeline:** ~32 months (ending in Q1 2020)

# Project Technical Advisory Committee

| Organization / Agency / Company              | Role / Representing        |
|--|----------------------------|
| South Coast AQMD - TAO                       | Government – Local         |
| National Renewable Energy Lab                | Government – Federal       |
| Port of Los Angeles                          | Port Authority / Landlord  |
| Pacific Merchant Shipping Association (PMSA) | Trade Org for MTOs         |
| EverPort Terminal Services                   | End Users                  |
| California Cartage                           |                            |
| Cummins Westport, Inc.                       | Engine OEMs                |
| Cummins Engine Company                       |                            |
| Clean Energy / CNGVP                         | RNG Provider / Trade Org   |
| SoCal Gas                                    | Local Gas Utility          |
| Renewable Natural Gas Coalition              | RNG Expert / Trade Org     |
| California Energy Commission                 | Project Funder / Oversight |
| Gladstein, Neandross & Associates            | Prime Contractor           |
| UC-Riverside CE-CERT                         | Subcontractor              |





# Role of the Technical Advisory Committee (TAC)

## 1. The TAC provides guidance in **project direction**, which may include:

- Scope and methodologies
- Timing
- Coordination with other projects

### Such guidance may be based on TAC's:

- Technical area expertise;
- Knowledge of market applications; and/or
- Knowledge of linkages between project work and related other past, present, or future projects

## 2. The TAC can also:

- Review products and provide recommendations (adjustments, refinements, enhancements)
- Evaluate tangible benefits to CA / recommend how to enhance them
- Provide recommendations regarding commercialization, market pathways and info dissemination



# Part 1:

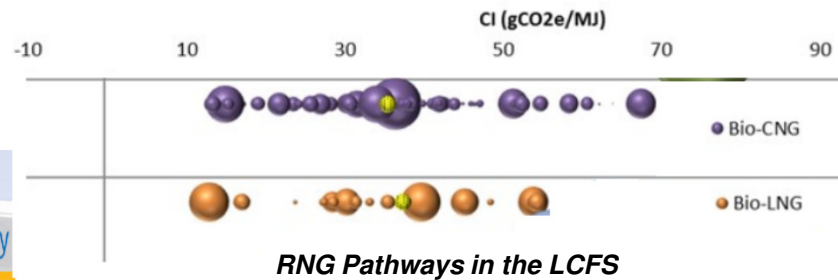
## Field Demonstration of Two LNG Yard Hostlers with CWI 6.7L Engines Certified to CARB OLS (0.1 g/bhp-hr)



Prime Contractor:



Subcontractor:



## Key Issue Encountered (Leading to Delayed Timeline)

- The core task is to procure two LNG hostlers with CWI 6.7 OLNS engines
- Capacity Trucks provided a preliminary quote for GNA proposal to CEC (Dec. 2016), but **later expressed hesitation to proceed**
- No other hostler OEM (Kalmar, AutoCar, TICO) expressed interest, either
- **Apparent overarching reason:** hostler industry perceives a lack of market for this platform (SoCal is “going towards zero emissions only” for CHE)
- GNA and key stakeholders (POLA, PMSA) engaged extensively with Capacity
- In January, Capacity decided to “**step up**” (TICO also expressed interest)
- Firm quote from Capacity to build the two LNG hostlers is **expected this week**

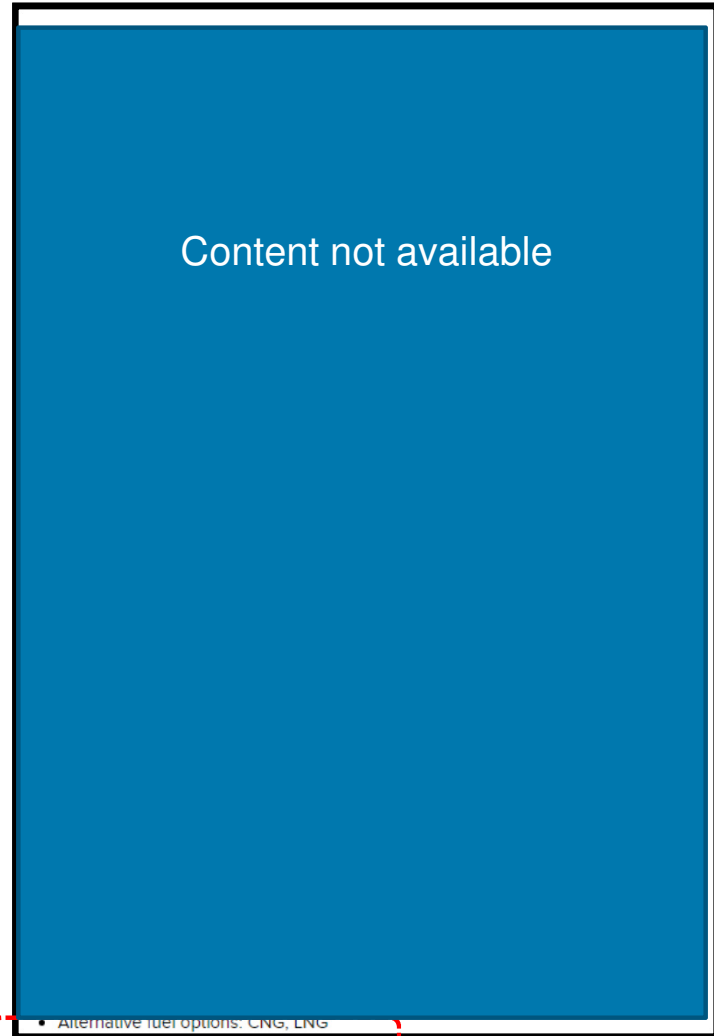
# Snapshot of Commercial Yard Hostler Options:

What do hostler OEMs advertise about NG yard truck offerings?

Capacity: **Not much.** 

- Mentions “alternative fuel options” for CNG and LNG
- Special order status
- **No mention of CWI ISL-G NZ**
  - Despite Capacity building 20 for POLA-EverPort project funded by CEC
- **No mention of OLNS-certified CWI ISB6.7 G option**

**Note:** CWI apparently intends to phase out its standard NG engines for OLNS-certified versions . . . including for this application.





# Snapshot of Commercial Yard Hostler Options (cont'd)

Kalmar-Ottawa: “Available in LNG and CNG models”

- Describes available option of ISL G engine
- Does not mention OLNS versions (ISL G NZ or ISB6.7) as options

Content not available

# Snapshot of Commercial Yard Hostler Options (cont'd)

## TICO: **BREAKING NEWS!**

- Is offering a “range of fuel options” for lower-emitting yard hostlers, including:
  - CWI ISB6.7 G (CNG or LNG) certified to 0.1 g/bhp-hr OLNS
  - Partnership with Power Solutions International (PSI) for hostlers with 8.8L **LPG or CNG** engine (special order)
- TICO: ISB6.7 G hostlers are “fully approved and tested”
- TICO is **producing >300 units in 2018** (at least 250 for UPS)



*Photo and information courtesy of TICO, 2-20-18*

## What do the Hostler OEMs Advertise About NG Yard Trucks? (cont'd)

### AutoCar: “Optional ISL-G (CNG/LNG)”

- Does not mention either OLS version (ISL G NZ or ISB6.7) as an option

Content not available



## Part 2: Emissions Testing Plan (to be developed)

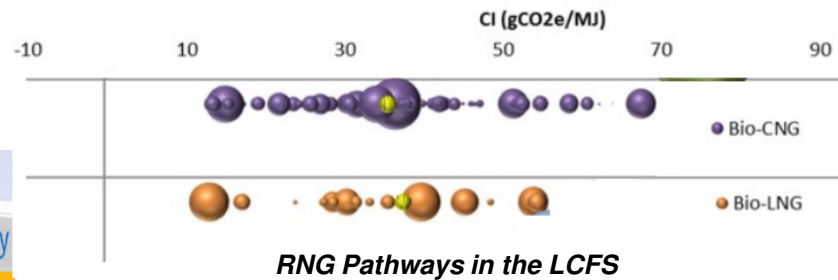


Prime Contractor:

**gna** GLADSTEIN,  
NEANDROSS  
& ASSOCIATES

Subcontractor:

**UCR** College of Engineering- Center for  
Environmental Research & Technology







# Part 3:

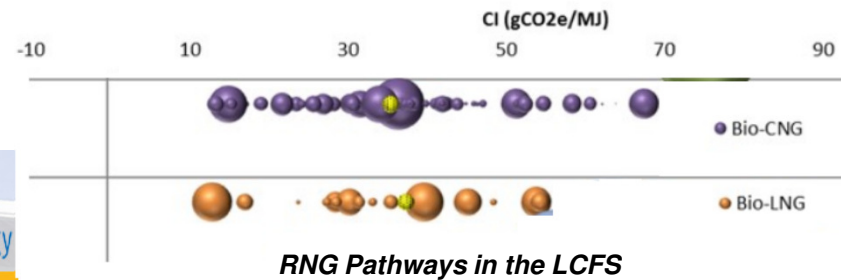
## UCR CE-CERT Gas Composition Sensor (Separate Presentation by Dr. Kent Johnson)



Prime Contractor:



Subcontractor:



# Thank You!



GNA gratefully acknowledges:  
1) Funding support from CEC and 2) Technical guidance from Peter Chen and Jerry Wiens

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