Better Truck Options for CA Dairies

CALSTART Headquarters, Solar Installation Celebration – June 25, 2012

Outline

1. What is CALSTART and Why Are We Here?
2. Clean Truck Options – Getting Started Today
3. Ultimate Dairy Trucking Solution – Opportunities & Challenges
4. Next Steps

CALSTART Members. Making clean transportation happen. Join today.

PARTIAL LISTING

CalHEAT
TRUCK RESEARCH CENTER

California Hybrid, Efficient Advanced Truck (CalHEAT) Research Center

Comprehensive Study to Determine If and How Truck Sector Could Significantly Reduce Emissions by 2030 – and Be On Pathway to Meet State's 2050 Goals

www.calheat.org

6 Truck Categories – Based on Tech Applicability

Class 7/8 Tractors

Over the Road

- Younger Trucks; High Annual VMT
- Mostly higher average speed, highway driving

Short Haul/ Regional

- Between cities; Drayage; Day Cabs
- Includes second use trucks; trucks with smaller engines

Class 3-8 Vocational Work Trucks

Urban

- Cargo, freight, delivery collection
- Lower VMT; Lower Average speed; Lots of stop start

Rural/ Intracity

- Cargo, freight, delivery collection
- Higher VMT; Higher Avg speed; Combined urban/ highway

Work site support

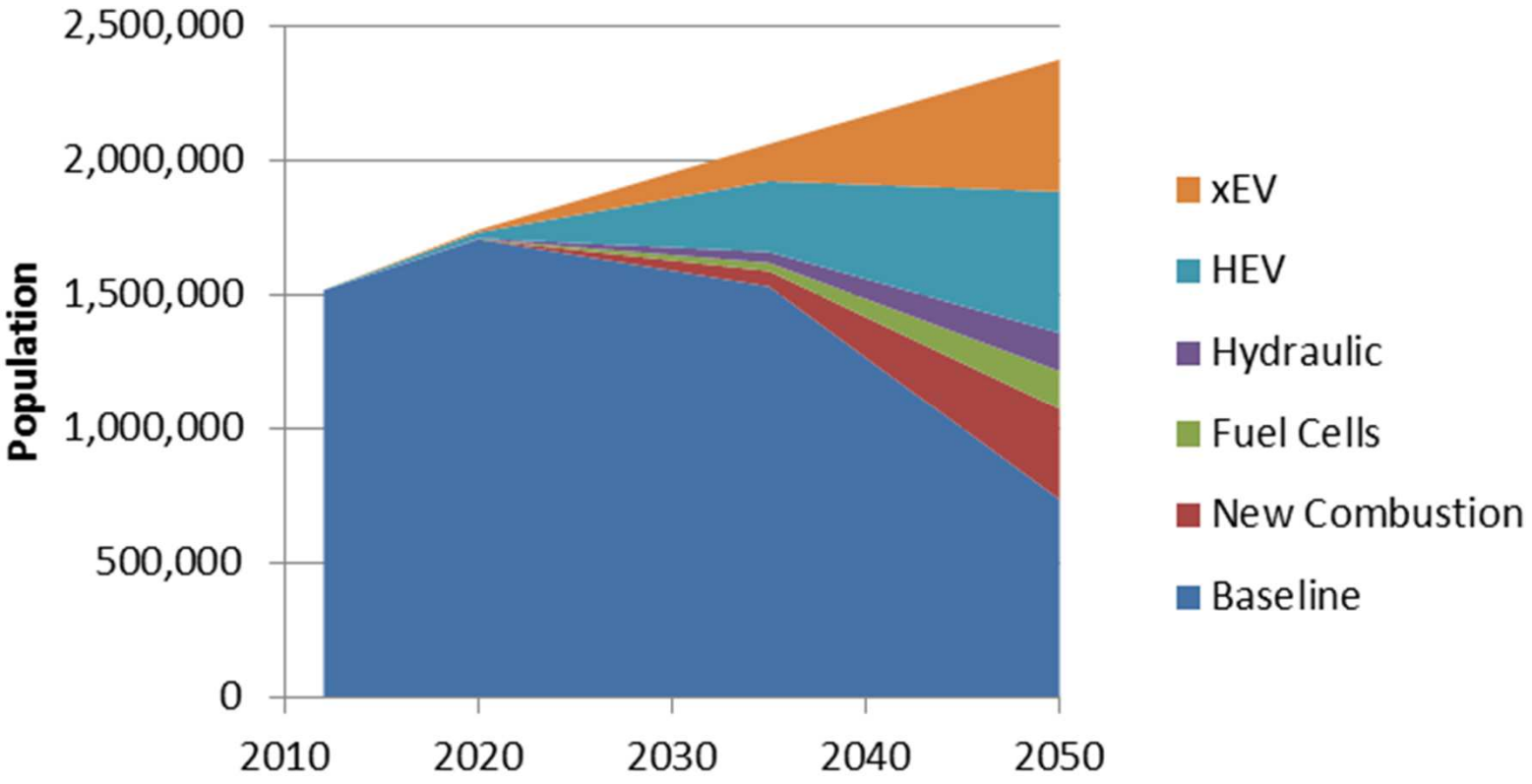
- Utility trucks, construction, etc.
- Lots of idle time; Lots of PTO use

Class 2B/3

Pickups/ Vans

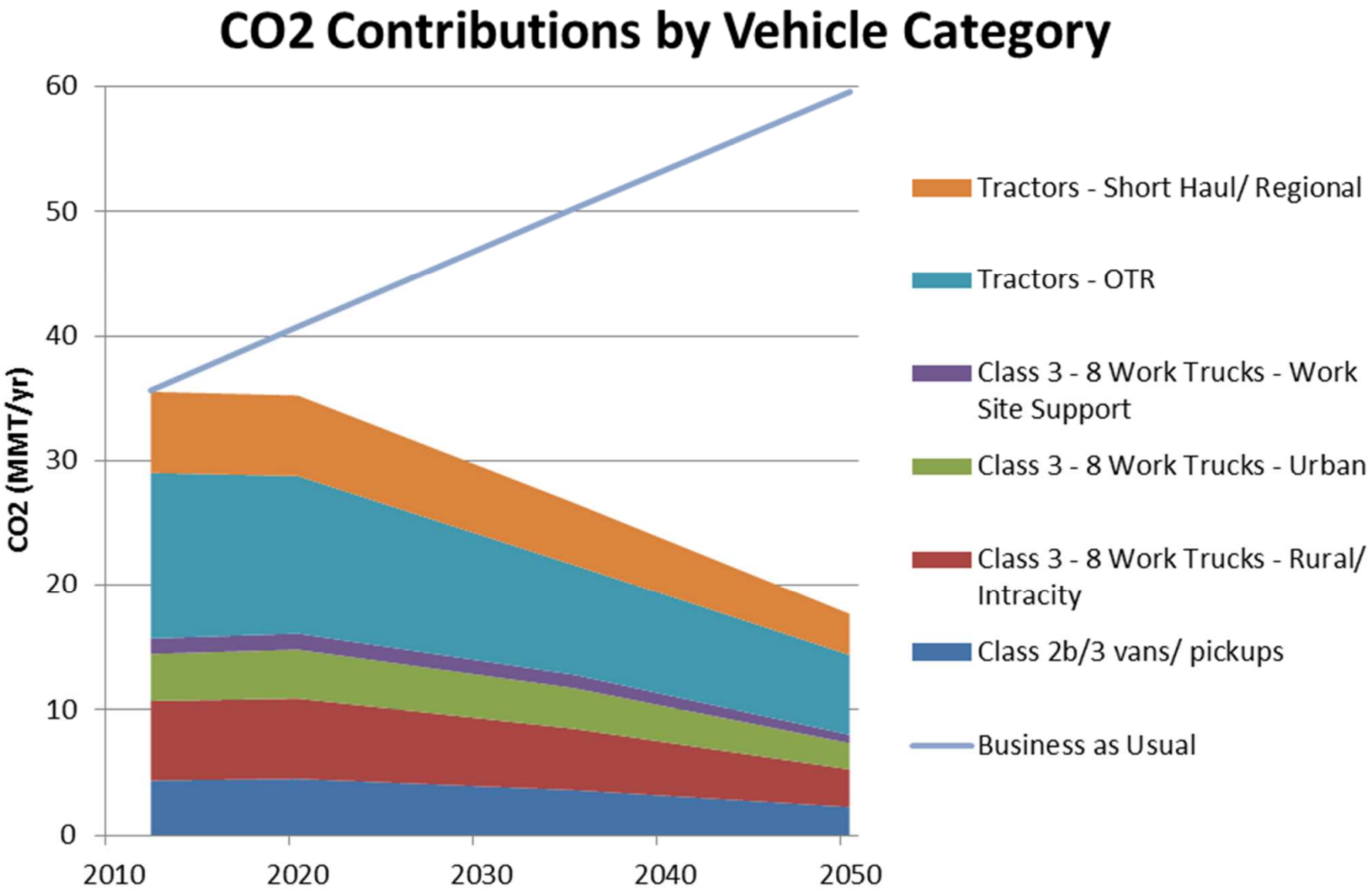
- Commercial use; Automotive OEMs & volumes

Technology Adoption



All Truck Categories

CO2 Reduction from Roadmap



Clean Truck Options – Getting Started Today

Do you know what your duty-cycle is?

Powers Distributing (Michigan)

21 Class 8 Hybrid Trucks

"We are close to where we want to be in terms of fuel consumption improvements. And Eaton and the OEMs have been very supportive."

Joseph Dinverno
Delivery/Fleet Manager

Where Hybrids Make Sense (&$)

- **Lots of Stops and Starts:** Service stops and traffic stops, utilize the electric motor
- **Low Average Speed:** Around 25MPH or less than 50% highway driving
- **Lots of Miles:** Sizable opportunity to displace fuel consumption

Extreme Route Example:

ROUTE DESCRIPTION:	Highway	Stop and Go
Hybrid Suitability	NO	YES
Non-Hybrid MPG	9	5.5
Hybrid MPG	9.5	7
% FE Increase	5.6%	27.3%
Annual Mileage	30,000	25,000
Gallons Saved Per Year	175	974
Fuel Cost	$4.15	$4.15
Savings Per Year	**$728.07**	**$4,042.21**

EATON
Powering Business Worldwide

California Incentives for Hybrid Trucks

Gross Vehicle Weight	Incentive Per Truck
19-19,500 Lbs.	$20,000
33,000-38,000 lbs.	$25,000

2-3 Year Payback

www.californiahvip.org

Will Expand Hybrids in Fleet

750 hybrid trucks in fleet today

Right route – right application

Driver training critical

Improving the Eaton Hybrid Value…

Now Available:

- Increased Battery Capacity
  - New battery pack has **2.7x** increased capacity.
  - 5 to 10% fuel economy gain in motive applications
    - Improved performance
    - Better regenerative braking
    - Extended operating driving range
    - Extended battery state of charge range
  - New battery pack is 50 pounds lighter

EATON
Powering Business Worldwide

Not All Hybrids Are Hybrid Electric

- Parker Hannifin, Freightliner Custom Chassis, Morgan Olson moving into production of a series hydraulic hybrid for delivery cycles
- Just starting field validation testing – have seen 40-60% fuel economy improvement
- Major delivery fleets in first deployments

Hybrid + Biodiesel Even Better

Powers Distributing compliments its hybrid investment with extensive use of bio-diesel fuel, pouring B20 in the warmer summer months and B5 in the winter.

As Fred Dufour looks out at Monarch Beverage's diesel fueling station, he knows that in only a couple of years, it will nearly be all gone. "The need for diesel, that is." -- Trucking Info., March 19, 2013

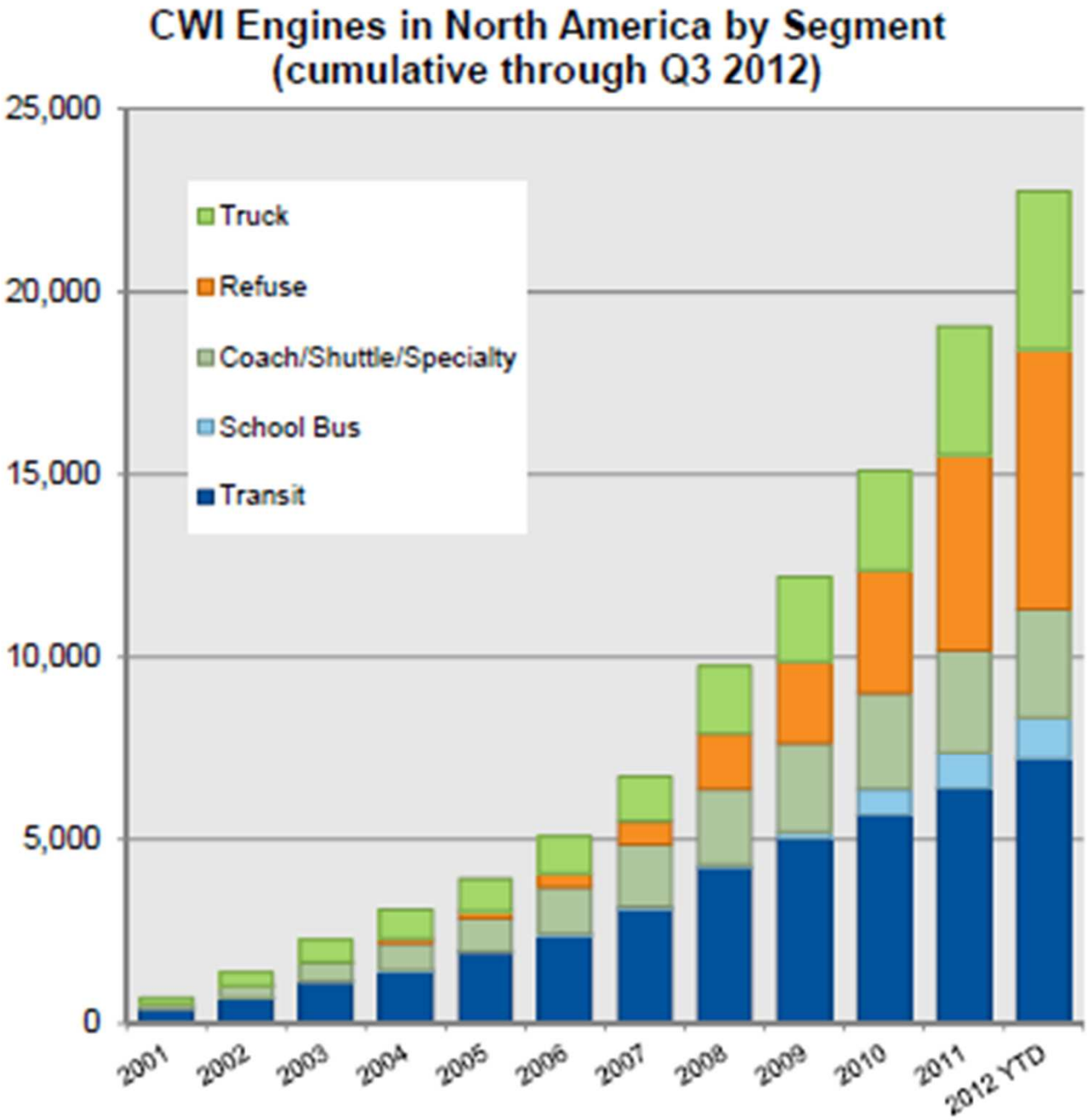
MONARCH
BEVERAGE COMPANY
1947

- 1 million gallons of diesel today
- 100,000 gallons in 2015
- 1,500 tons fewer of GHG's by 2015
- 60% lower fuel costs per year = $2.5 million in savings
- 2.3 year payback

Coca Cola's analysis shows tandem axle vehicles present the *best opportunity* for CNG application…

- 32,500 miles annually (tandem axle only)
- Deploy near existing infrastructure (w/partner) and large shop sites
- Drivers to fuel on route
- Eco-trained drivers

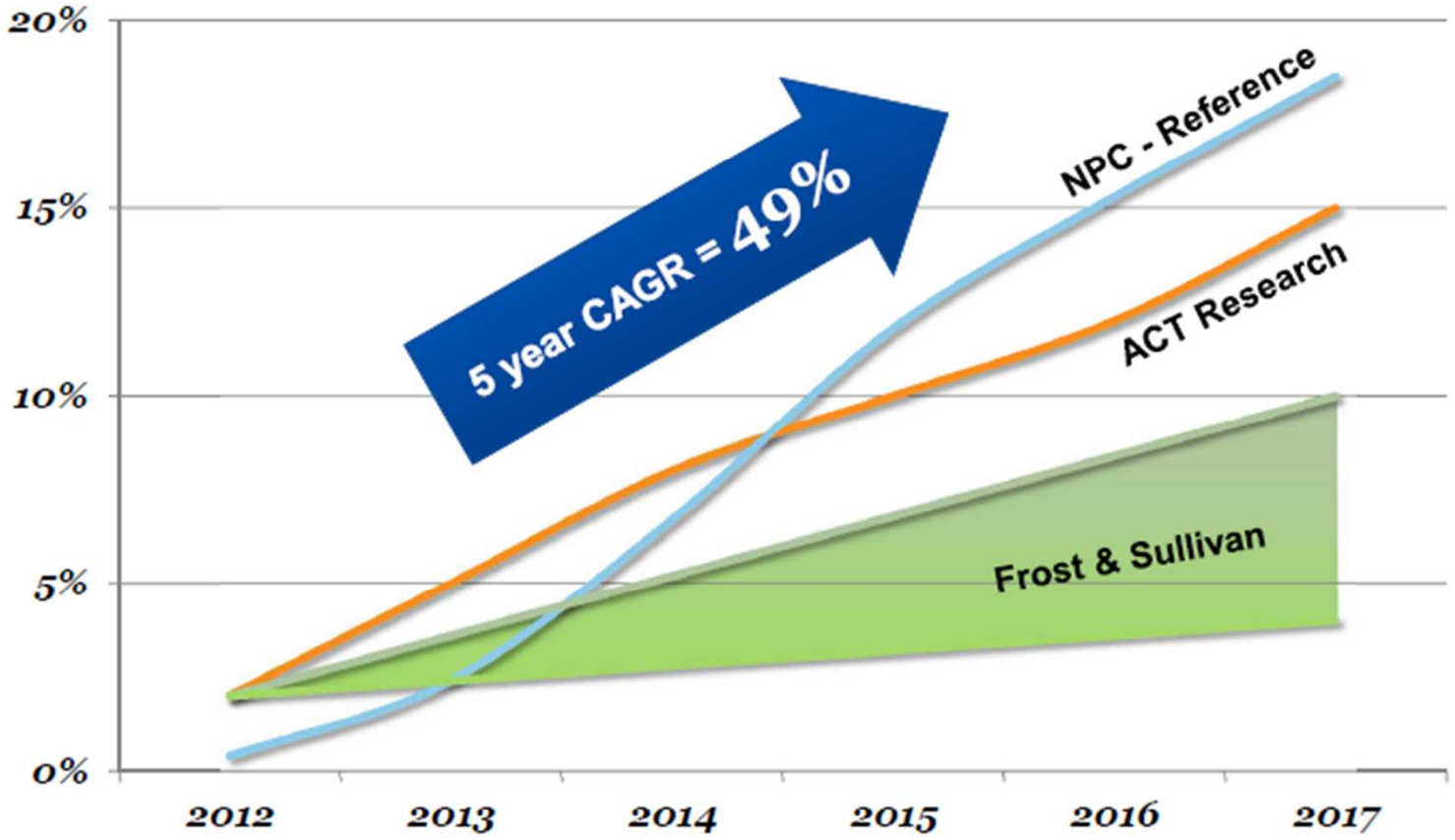
Source: CCR Fleet Ops Data



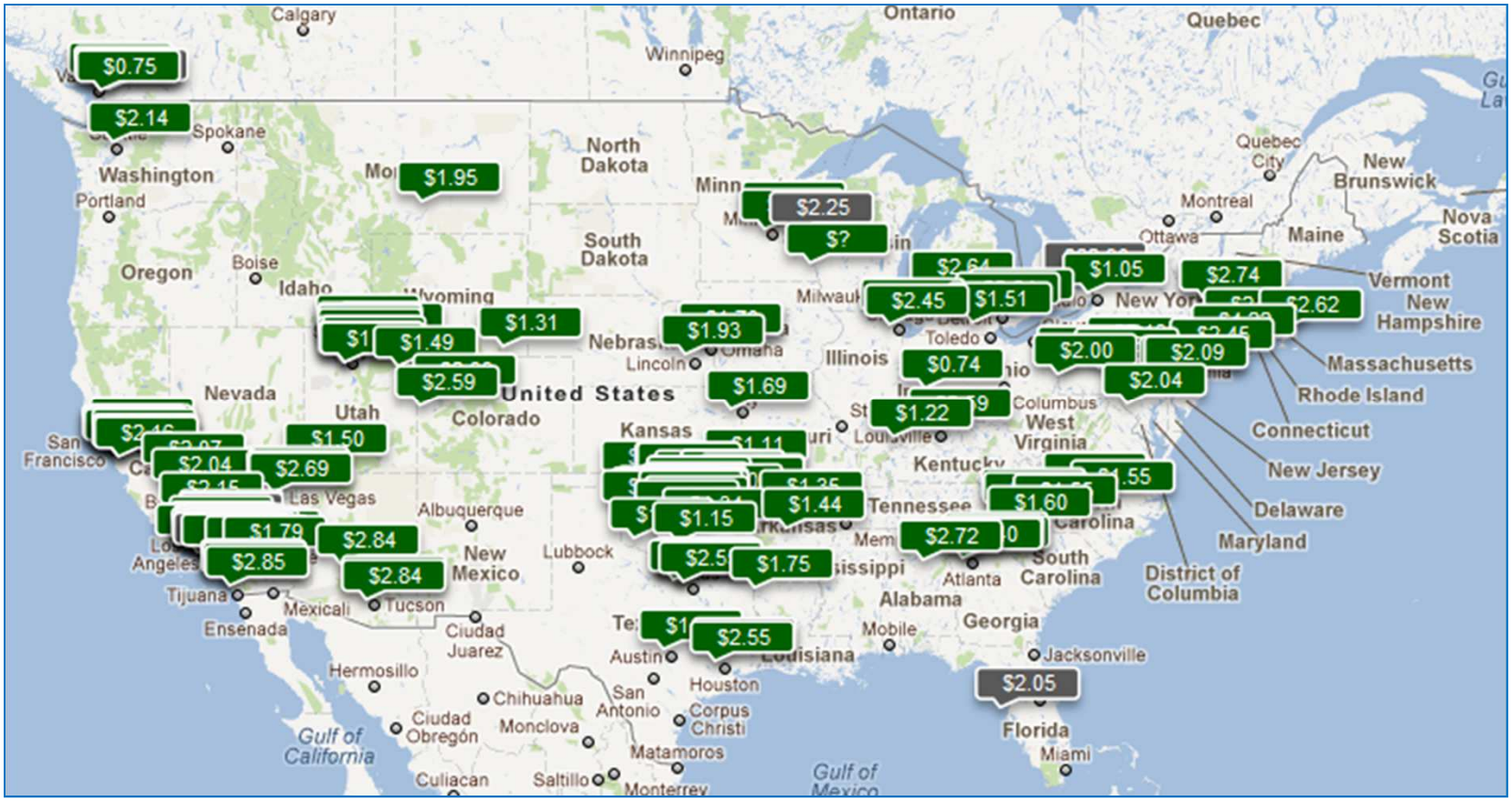
NGV Sales Growing Rapidly

Market Forecast

North American Class 8 Natural Gas Trucks



Low Cost NG = Good Truck Economics



Courtesy: CNGPrices.Com

$1.25-1.75 lower cost per diesel gallon equivalent

CNG In A Box

GE imagination at work

Why is NG So Cheap Now?

- New tech: Hydraulic fracturing ("fracking") + horizontal drilling + better mapping capability
- MIT Study: environmental risks can be minimal if industry adopts best practices

North America:

Natural Gas Offerings for the Trucking Market

GVW	≤ 66,000 lbs.	≤ 80,000 lbs.	≥ 80,000 lbs.
Engine size	8.9L	11.9L	15L
Current engines	ISL G	ISX12 G	Westport 15L

Kenworth

T440	T470	T660	T800B	T800SH	W900S
					
9	*9*	*12*	*15*	*12*	*9/12*

Freightliner

M2 - 112	SD - 114	Cascadia
		
9	*9*	*12*

Mack

Granite / Pinnacle

12

Navistar

TranStar

9

Peterbilt

320	382	384	365	367	386	388
						
9/12	*9*	*9/12*	*9/12*	*15*	*15*	*15*

Volvo

VNM	VNL
	
9	*12*

legend

9
CWI ISL G 9L

12
CWI ISX12 G

15
Westport 15L

Freightliner Natural Gas

- Cascadia NG – ISX12G
- M2 112 NG (LNG & CNG) ISL 6 G
- 114SD NG ISL G 8.9
- FCCC NG chassis

Kenworth Natural Gas

- T 800 (LNG)
- T 440, T470, W900S – CNG or LNG

Peterbilt Natural Gas

- Models 384, 365 and 320 in natural gas
- ISL G; adding ISX 12 G

Volvo Natural Gas

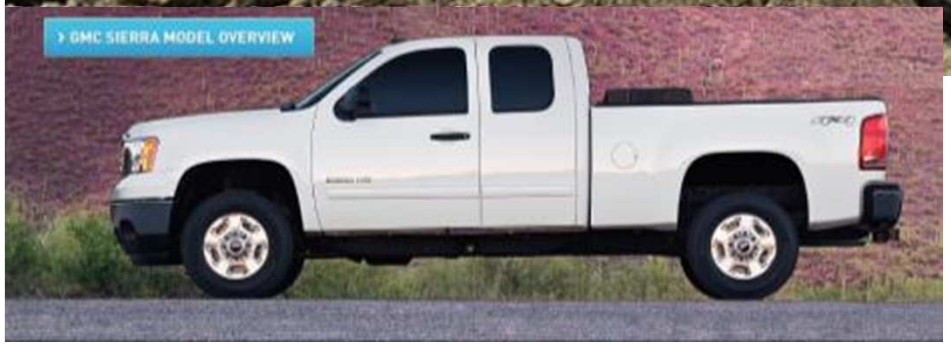
- Developing OWN 13 liter D13 LNG engine for 2014
- Adding natural gas option for VNL tractor (ISX12 G)
- ISL G engine in VNM
- Has unique diesel-methane bi/dual-fuel trucks in Europe
  - FM 460, 13 liter engine
  - Can operate up to 75% methane, 25% diesel
- **Global partnership with Shell Oil on LNG marketing**

Mack Natural Gas

- Adding Mack Pinnacle on highway NG truck, using ISX 12 G; NG Granite in late 2013
- UPS buying 700 LNG tractors

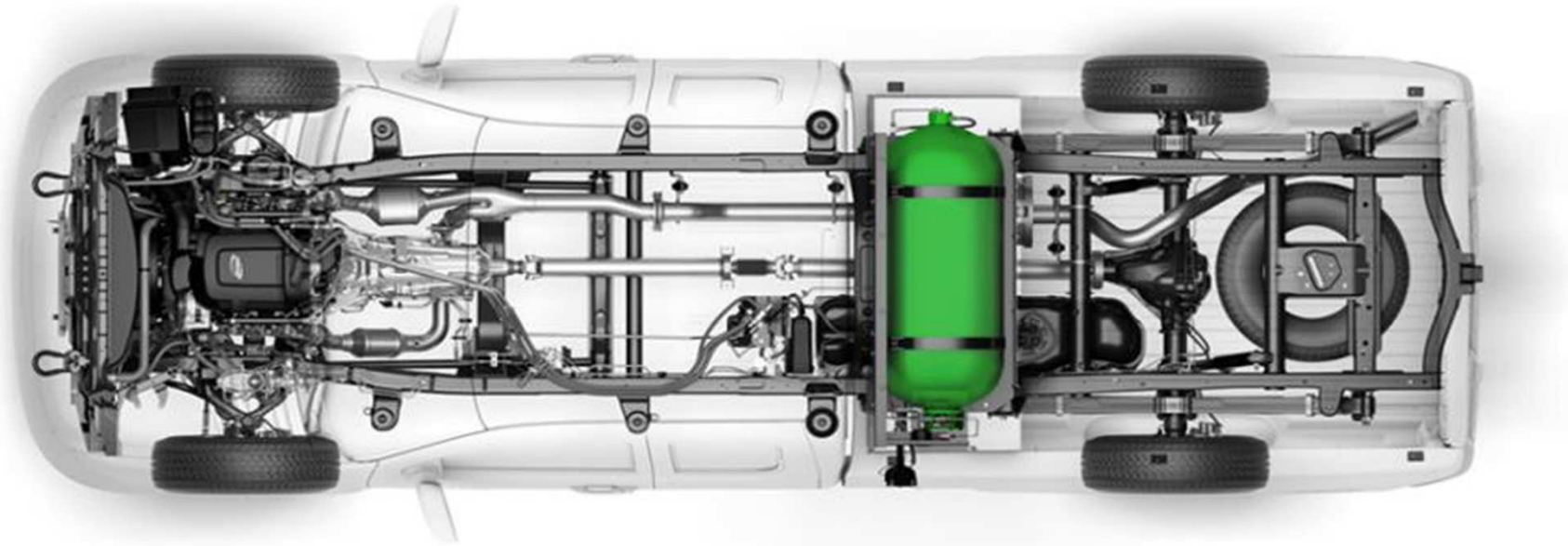
Four LD Natural Gas OEM Products

- Honda Civic NG
- Dodge Ram 2500
- Chevy Silverado
- Ford F-250
- Ford's Transit will be shipping with gaseous fuel-ready engines



Bi-fuel is Back! CNG and Gasoline

- 17 GGE NG fuel tank
- 36 GGE gasoline tank
- NG-ready engine (hardened valves, valve seats)



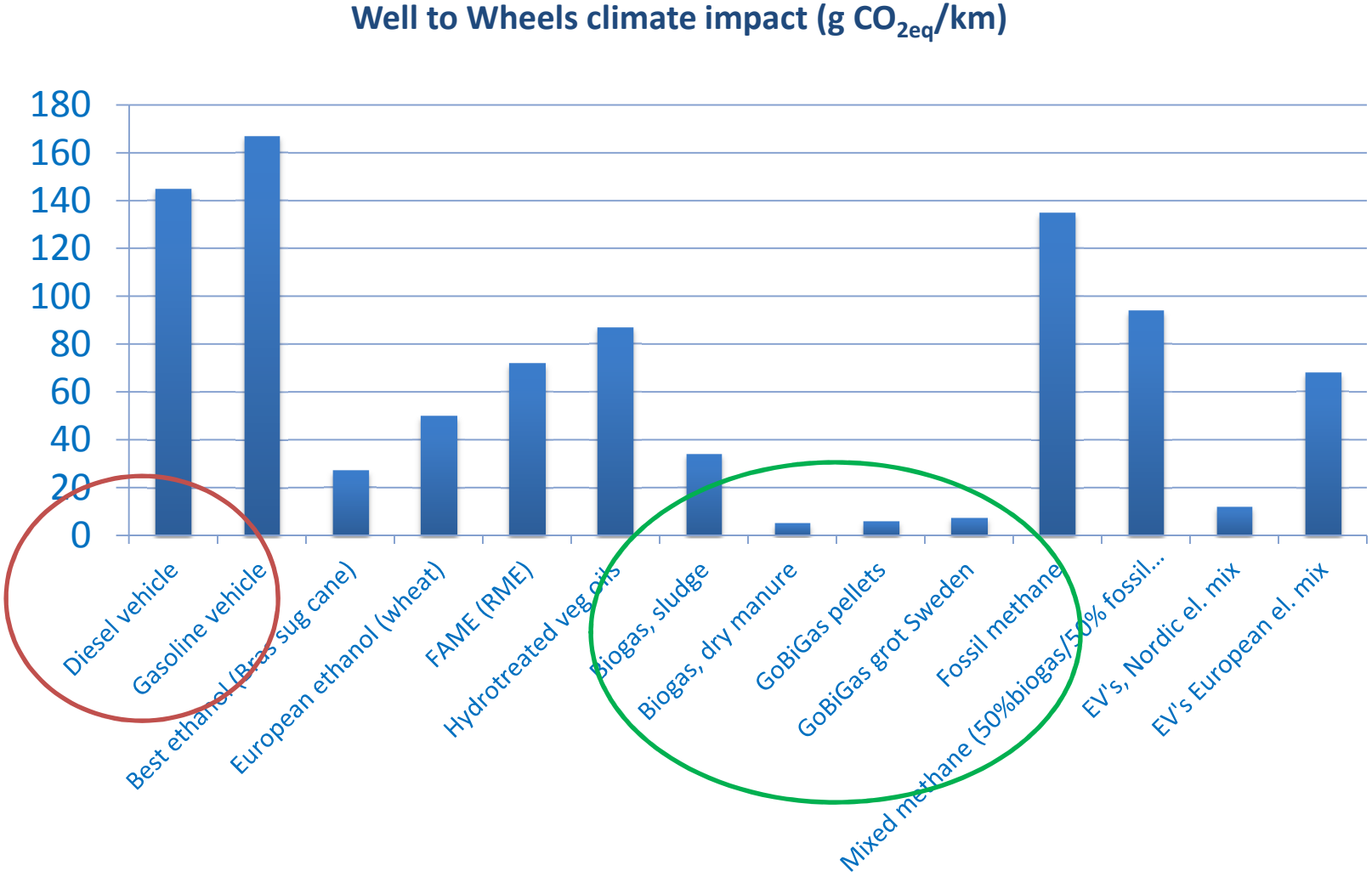
NG Upfitters/QVMs-QCMs

- Ford uses QVMs for alt fuels – provides gaseous fuel ready engine
- Clean Energy Fuels-BAF
- Altech-Eco
- Impco Automotive
- Landi Renzo USA with Leggett and Platt
- Venchurs Vehicle Systems
- Westport LD
- Roush CleanTech


NG Tech Improvement Opportunities:
Optimized Engine for NG
Nextgen Storage
NG Hybrids
Assistant Secretary of the U.S. Army, Katherine Hammack, Examines WrightSpeed Natural Gas Hybrid Truck – HTUF Conference, Charlotte, N.C. - October 2012

Ultimate Dairy Trucking Solution – Opportunities & Challenges

RNG Has Huge GHG-Benefits



Source: Well-to-Wheels rapport 2011, APPENDIX 1, Summary of WTW Energy and GHG balances,
and Renewable electricity consumption (CSI 031/ENER 030) - Assessment published Apr 2012. European Environment Agency

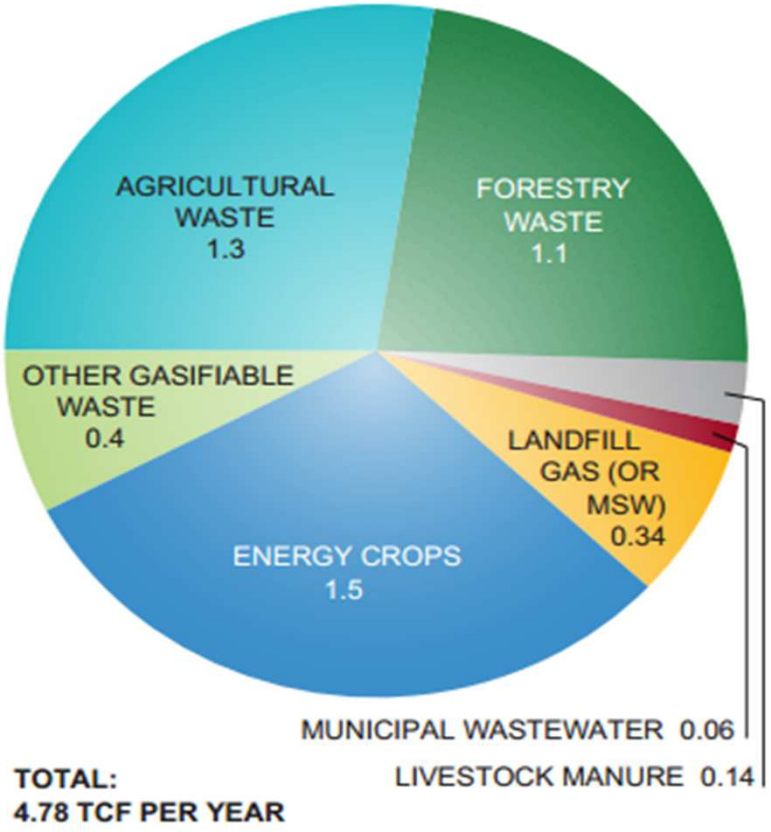
The plant

» supplies the transport sector with 60 GWh of biogas annually, which corresponds to the need of 6,000 cars driving 17,000 km/år.

» realises the possibility for heavy duty transports to use a clean and waste-based fuel.


Lidköping Biogas
Sweden's first production plant for
Liquefied Biogas (LBG)

Why RNG is Well-Suited to Transportation



Practical Potential RNG Feedstock Capacity in the U.S. 2035-2050 Estimates (tcf per year)

- Arguably the only carbon neutral fuel for the transport sector
- Leverages existing gas network to distribute a renewable fuel
- Co-location of captive fleets with waste streams
- Recognition of the untapped value of waste streams
- Suitable for all on-road vehicle applications
- Negligible land/water use impact compared to purpose grown bio-fuels

Figure Source: NPC (2012) " Advancing Technology for America's Transportation Future" www.npc.org

RNG Cost Estimates Delivered to Pipeline

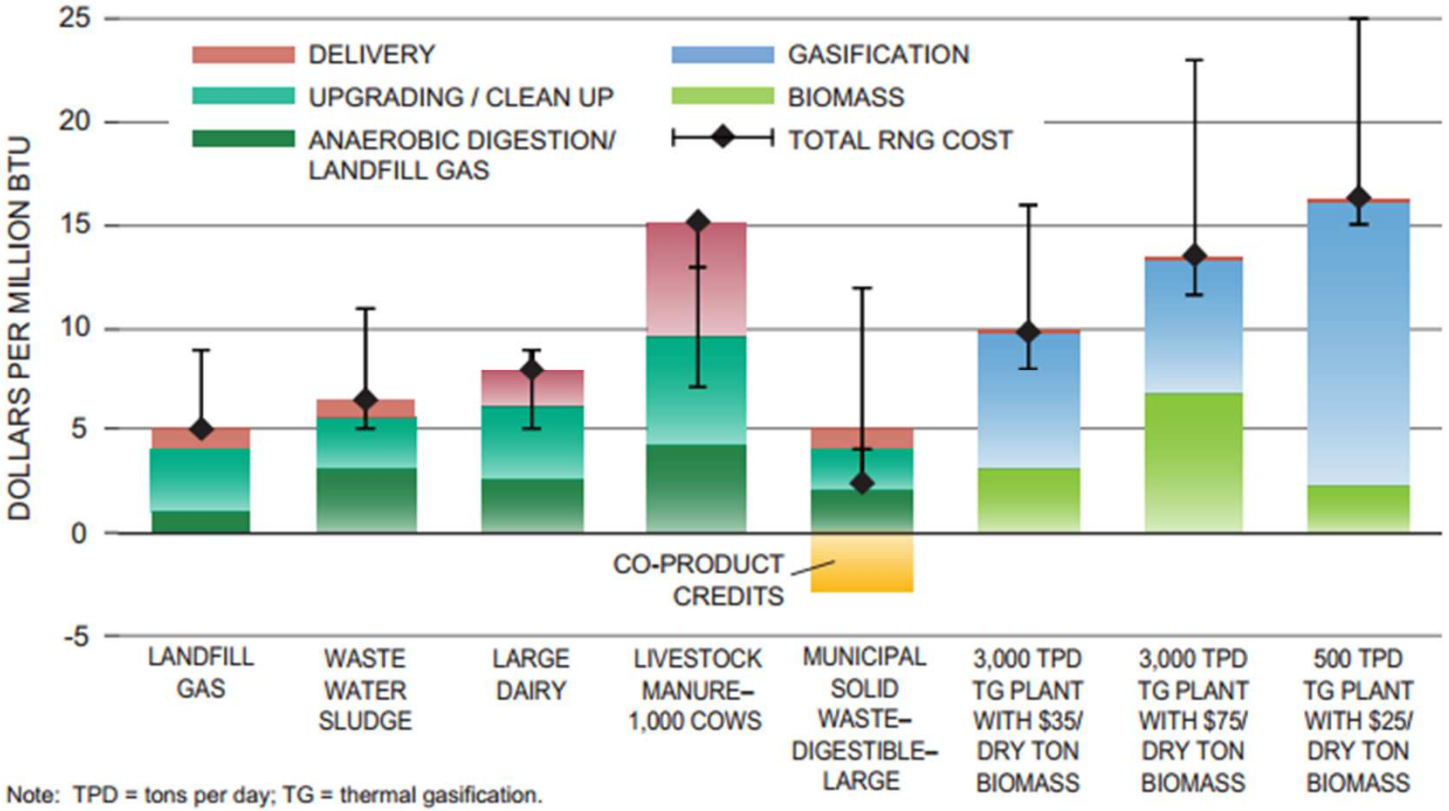
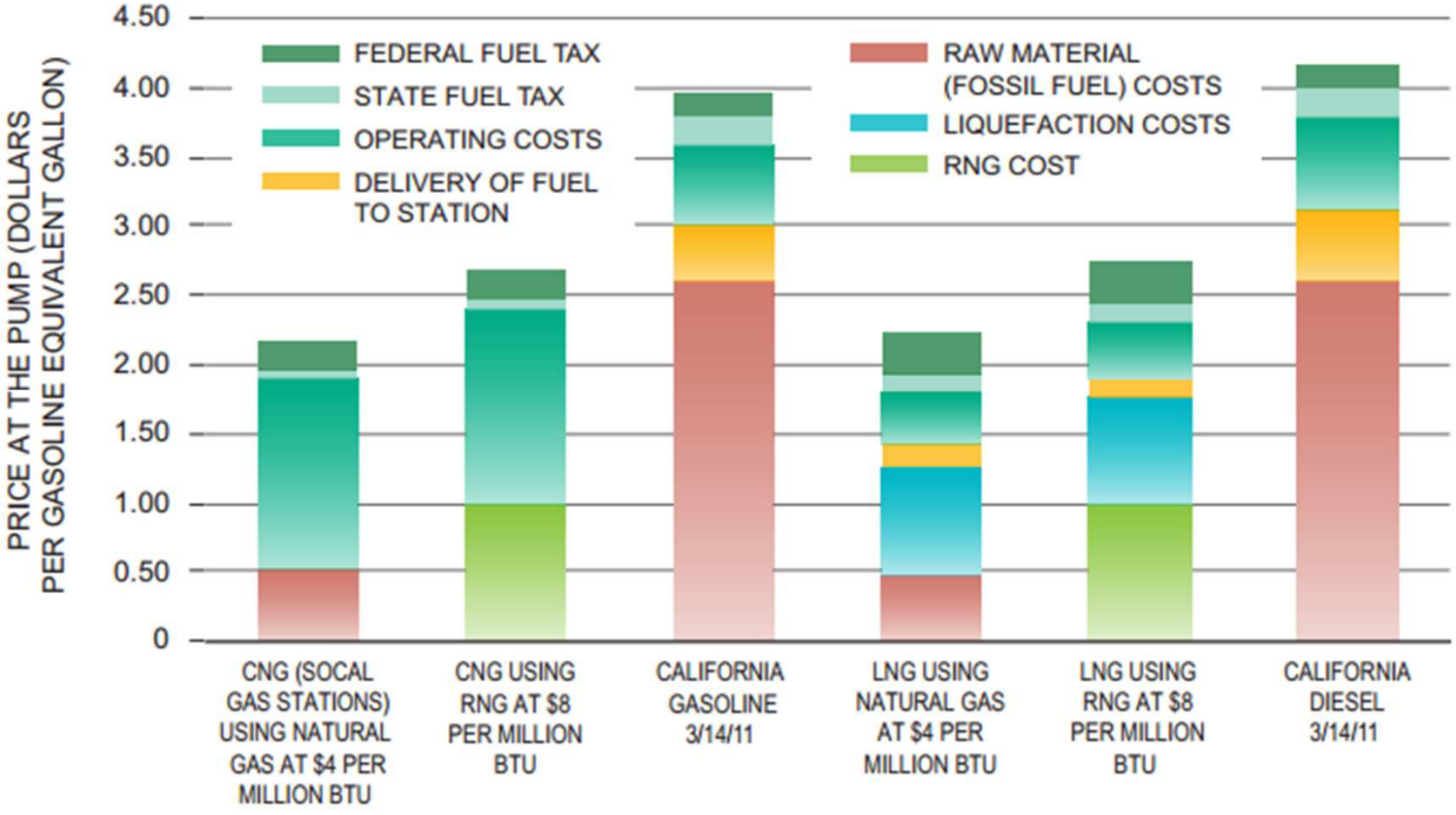


Figure Source: NPC (2012) "Advancing Technology for America's Transportation Future" www.npc.org

Retail Price of RNG for Transportation (California)

Cost Competitive with Gasoline and Diesel



Source: NPC (2012) "Advancing Technology for America's Transportation Future" www.npc.org

Potential for Deep GHG Emission Reductions

Source	RNG Fuel	Fuel % WTW GHG Savings	Notes
Landfill Gas (LFG)	CNG vs. Gasoline	80 – 101%	Argonne 2010 GREET analysis of various LFG cases. GREET 1.8d.1 default is 98%.
	LNG vs. Diesel	77 – 98%	Argonne 2010 GREET analysis of various LFG cases. GREET 1.8d.1 default is 97%.
Dairy Manure	CNG vs. Gasoline	70 – 90%	CARB 2009 GREET analysis: 85% better than gasoline.
	LNG vs. Diesel	70 – 81%	CARB CI data March 2011. 81% with 90% efficient liquefaction.
Anaerobic Digestion — Hay/Switchgrass/ Straw/Stover	CNG vs. Gasoline	75 – 81%	GHGenius 2009 Biomethane results.
Anaerobic Digestion – General	CNG vs. Gasoline	63 – 200%	UK study range. High end is liquid manure.
Thermochemical Conversion of Biomass		74 – 92%	Lacking solid studies. UC Davis 2006 has this range using LEM. California Energy Commission demonstration project cites 85%.

Source: NPC (2012) "Advancing Technology for America's Transportation Future" www.npc.org

RNG Production Estimates and Unit Cost

California (2011) – Anaerobic Digestion Case

Scenario	**Renewable Gas** (MMBTU/year)				**RNG Cost** ($/MMBTU)		
	Landfill Gas	Livestock Manure	Waste Water	Total	Landfill Gas	Livestock Manure	Waste Water
Low	28.39	8.69	0.28	37.36	6.22	8.87	14.72
Aggressive	56.8	29	0.8	86.6	5.18	7.22	10.87
NPC RNG Cost Estimates (USD)*					5 to 9	4 to 13	5 to 11

Source: The American Gas Foundation (2011) "The Potential for Renewable Gas: Biogas Derived from Biomass Feedstocks and Upgraded to Pipeline Quality" http://www.gasfoundation.org/ResearchStudies/agf-renewable-gas-assessment-report-110901.pdf
NPC Data from RNG Topic Paper, available at http://www.npc.org/FTF_Topic_papers/22-RNG.pdf

CA Energy Commission Investments Supporting Early Growth of RNG for Transportation Market

Central Valley RNG Plants Supported with CEC $

» Northstate Rendering

- Northstate Rendering is awarded $5,456,150 in grant funding with a match share of $5,740,950 to construct an **anaerobic digestion facility in Oroville, CA that can accommodate animal and slaughterhouse remains.** The facility will produce biomethane from rendering waste, which will be compressed and supplied to an on-location fueling station that feeds the CNG to a fleet of 14 trucks. The surplus biomethane will be injected into the gas pipeline at the facility to supply CNG fueling stations throughout California. The project is estimated to produce 54.1 million cubic feet of biomethane per year to displace 378,550 DGE and reduce 20,300 tons of CO2 emissions annually.
- »

Central Valley RNG Plants Supported with CEC $

- **Pixley Biogas, LLC**
- Pixley Biogas is awarded $4,672,798 with a match share of $4,810,802 to construct a biogas facility adjacent to the existing Calgren Renewable Fuels ethanol production facility in Pixley, CA. The **biogas facility will use anaerobic digestion of cow manure from three local dairies** to produce 266 mmBTU of biogas daily. The biogas produced will then be used to offset 13.1 percent (147,070 mmBTUs annually) of the total natural gas consumption at the Calgren facility, which would cause an immediate drop of 5.74 percent in the GHG intensity of the ethanol produced on a Well-to-Wheels basis.
-

Central Valley RNG Plants Supported with CEC $

- **Clean World Partners, LLC**
  Clean World Partners is awarded $6,000,000 to increase Sacramento Bio-Refinery's capacity from 25 tons per day (TPD) to 100 TPD. This project will result in diverting 100 TPD of **source-separated food waste from landfills to produce 566,000** diesel gallon equivalent of renewable natural gas and generate 3.17.million kilowatt hours of electricity every year.
-

Central Valley RNG Plants Supported with CEC $

- **Tulare County Compost & Biomass Inc.**
- Tulare County Compost and Biomass is awarded $4,787,694 to validate direct “digester-to-pump” biomethane as a viable and replicable model to boost California’s quantity of renewable transportation fuel. The objectives of this project are to: process 40,000 tons per year of **mixed organic feedstock material;** convert the feedstock through high solids anaerobic digestion to 83,000 MMBTUs of renewable natural gas gross production, with net production available for sale of 660,000 gasoline gallon equivalent (GGE); construct and operate an on-site CNG fueling station; confirm economic and technical assumptions of the project to stimulate replication.

Emerging Credit Opportunities

- Renewable Fuel Standard – RIN Credits
- CA Low Carbon Fuel Standard

RNG Summary

- Interchangeable with fossil Natural Gas
- More expensive than fossil Natural Gas
- Enormous carbon benefits – carbon credit opportunities starting to emerge
- CEC funding helping to build industry

Next Steps

2 Bills Pending In CA Legislature - $2B in Funding for Clean Transportation

SB 11 (Pavley, Canella) & AB 8 (Perea, Skinner):

Extend CA clean vehicle and fuel incentive funding thru 2023

Join the List of Supporters! Contact: Jamie Hall, CALSTART Policy Director

jhall@calstart.org or (510) 307-8774

Senator Fran Pavley

Assemblyman Henry Perea

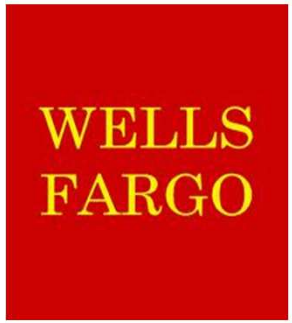
Current Supporters of AB 8 and SB 11 Include

- Western Growers Association
- California Farm Bureau
- Nisei Farmer's League
- Western State Petroleum Association
- Natural Resources Defense Council
- Coalition for Clean Air

CALSTART Investor Council (CIC)

new initiative **to increase successful private sector investment in clean transportation tech**

GLOBAL ENVIRONMENT FUND



What Could We Do Together?

- Conduct duty-cycle analysis and find best of the available solutions for today
- Develop program to produce and blend RNG with NG for use in trucks
- Identify and secure state funding for development and test of nextgen technology
- Develop fleets goals
- Pursue new financing strategies
- Create action oriented working group
- Support AB 8 and SB 11

Fleet Goals From Just One Sector

- Coca Cola: Reduce $C0_2$ Footprint 15% by 2020
- Pepsi: Beginning in 2010 - Grow 3% per year but cut oil dependence by 50% by 2020
- Monarch Beverage: 85% Natural Gas by 2015
- What is the goal for your fleet?

?’s

Summary

- Economical truck and fueling options exist today
- Dairy trucking operation home run solution emerging
- Carbon value policies important – investors ready to engage
- Time is ripe for action oriented collaboration

Cleaner And Better

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