

Biomethane Resource Potential



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What We Do: CALSTART's 4-Part Role to Grow the Clean Transportation Industry

Industry Services

Providing value-add services to companies: timely information, partnering, new business opportunities, conferences, technology evaluation

Technology Commercialization

Identifying opportunities, building teams, securing funding, and advancing technology, vehicles, fuels, and systems

**Unique
Combination!**

Consulting: Clean Transportation Solutions Group

Helping ports, property developers, transit districts, and fleets seeking to implement cost-effective customized solutions

Policy

Advancing key policies, advising policymakers, and helping companies plan for the future



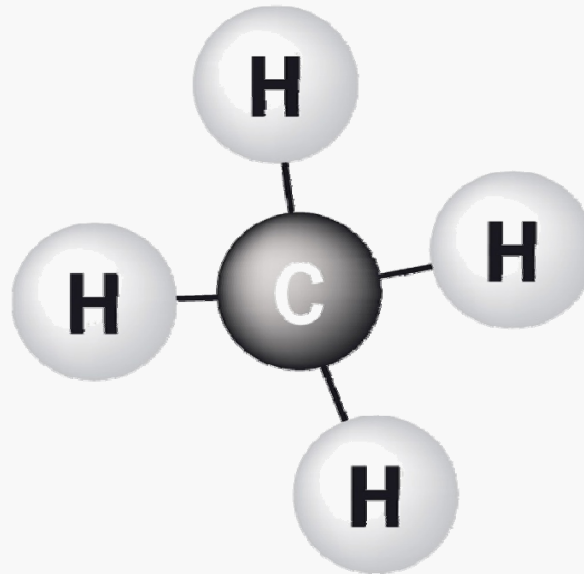
Natural Gas = Biogas With Some Important Exceptions

Methane

Natural gas

**Fossil
Fuel**

**Less GHG
Emissions**



**Both Good for
Air Quality!**

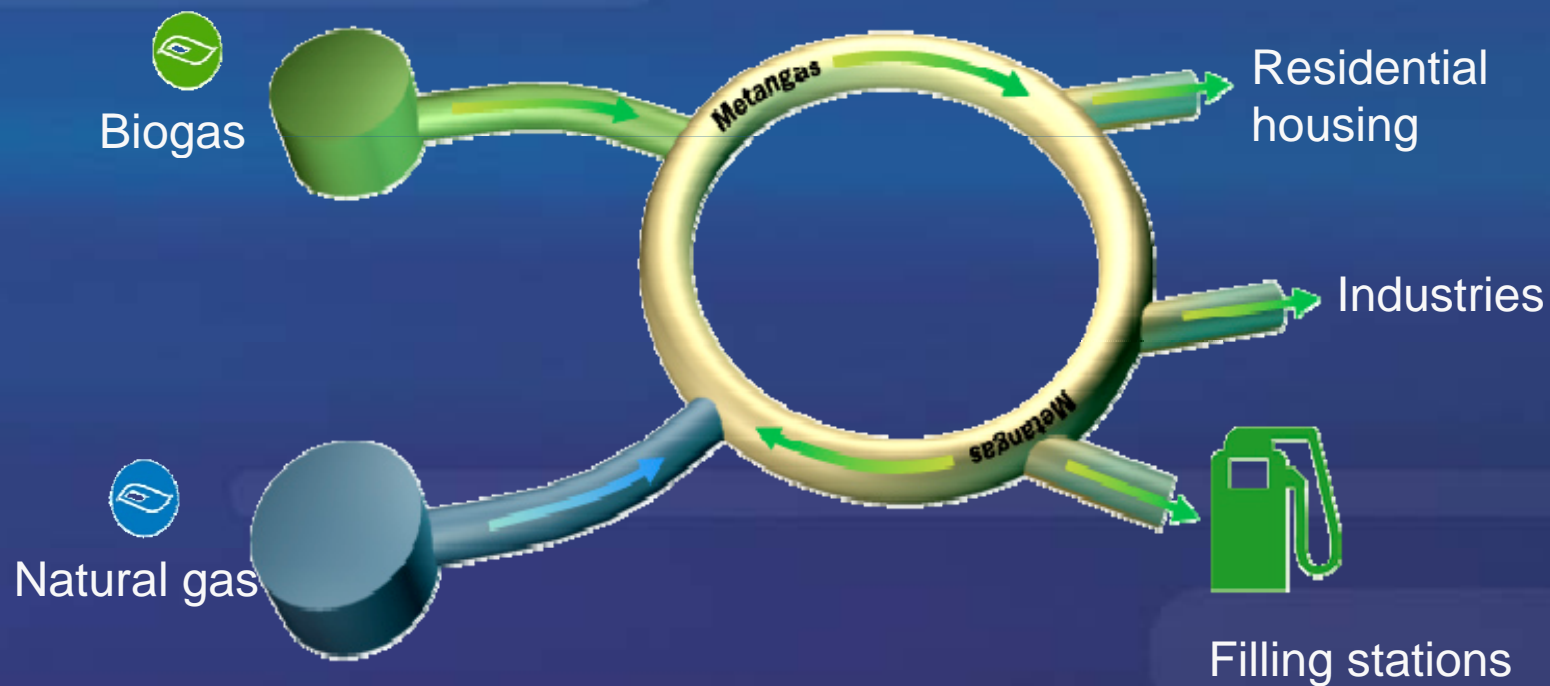
Biogas

**Renewable
Fuel**

**Net zero or
negative
GHG
Emissions**

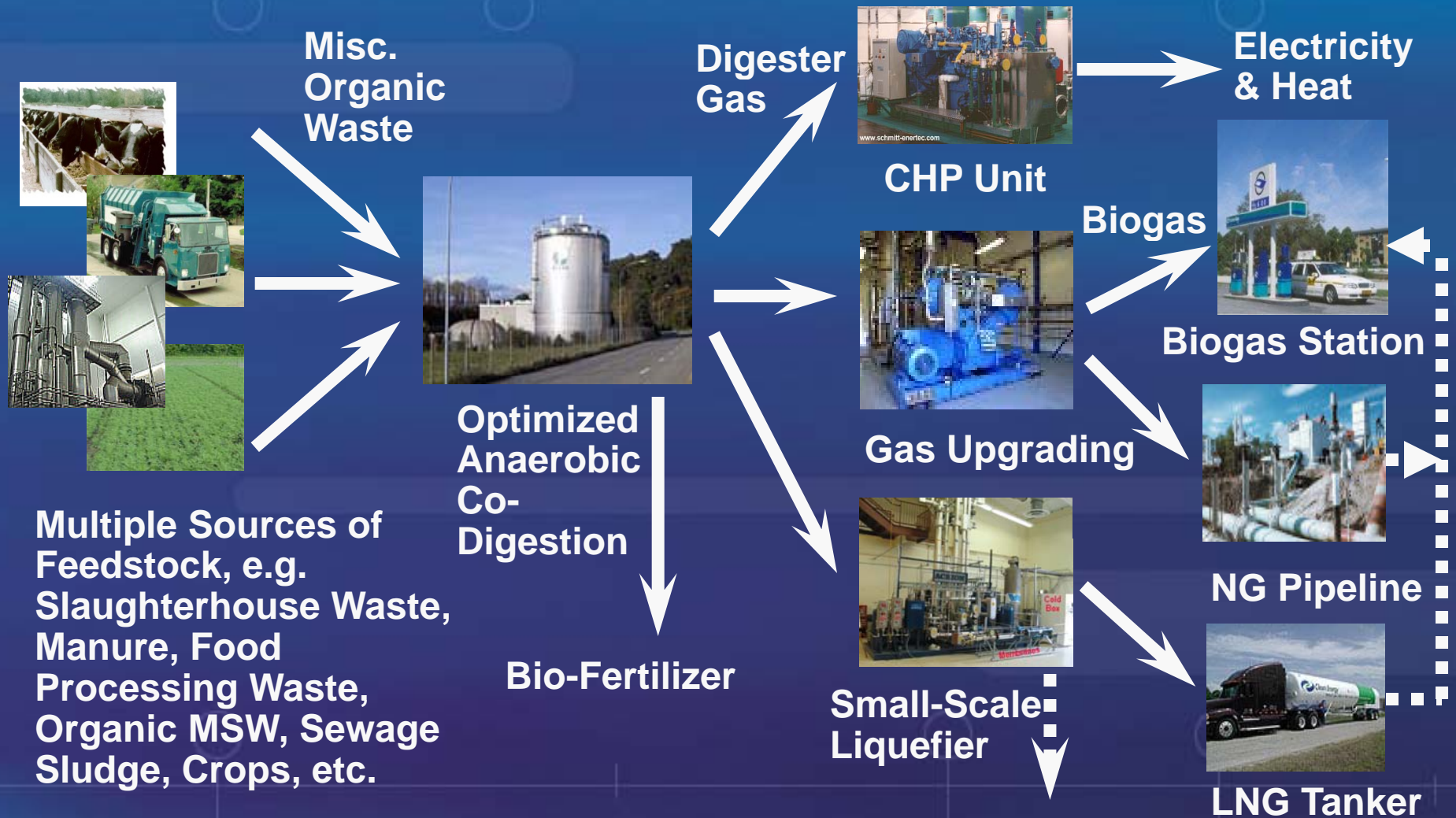


Green-Gas Principle





Modern Digester & Gas Upgrading Process Flow





Biomethane Potential in CA

According to U.C. Davis:

- Gross Methane Potential is
 - 125 Billion ft^3/Year
- Technical Methane Potential is
 - 23 Billion ft^3/Year
- Technical Methane Potential from Dairy Waste is
 - 14 Billion ft^3/Year
 - Enough to Fuel 250,000 Cars

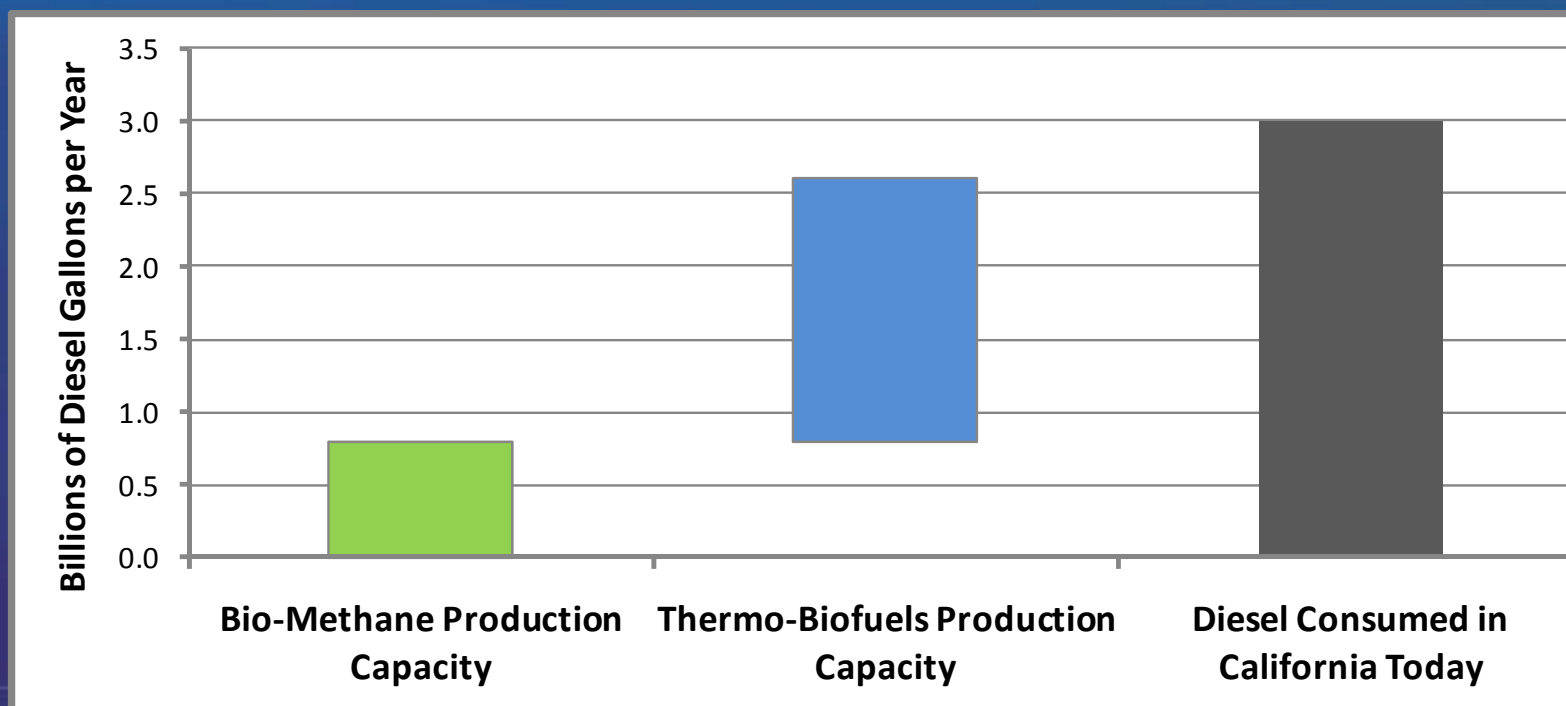


California's Renewable Natural Gas Supplies

2006 CEC Biomass Fuels Study showed slightly different estimates for the potential of California biomethane and other biomass fuels:

Biomethane: 106 BCF/year – 800 million DGE per year

“Thermo-Biofuels”: 1.8 billion DGE per year

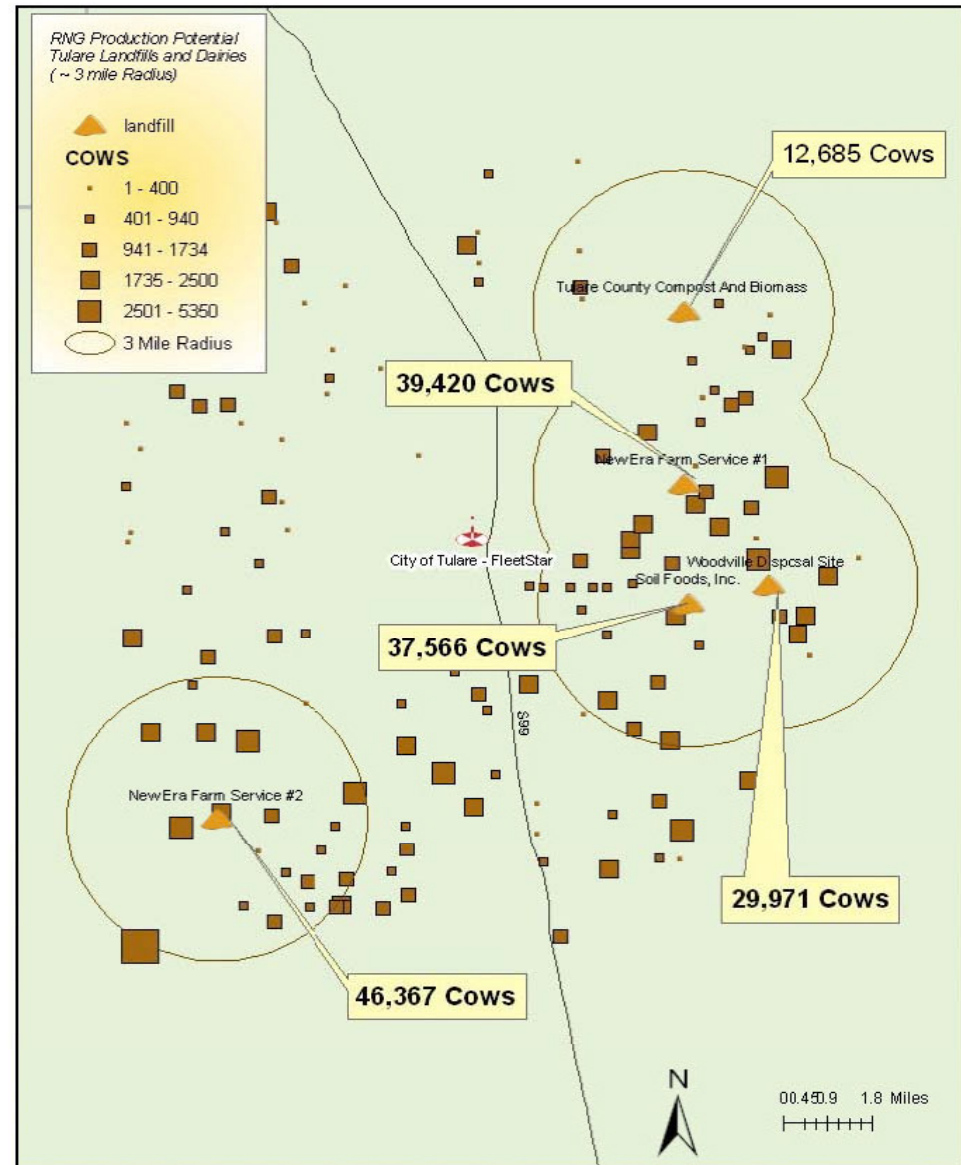




Tulare

- 165,000 Cows
- = 30,000 Cars
- 3 mi Circles

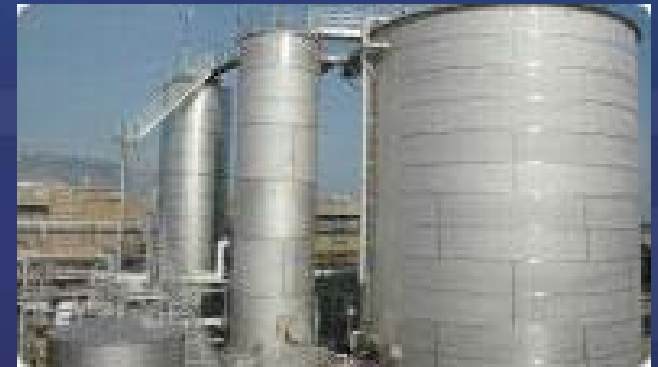
Proximity Analysis of Dairies to Infrastructure - City of Tulare CNG Station -





Dairy Biogas-to-Biomethane For Vehicle Fuel Project

- Funded by EPA & CARB
- Project team includes CALSTART, Western United Dairymen, Sustainable Conservation, UC Davis
- Dairy partners – Hilarides Dairy, Hilmar Cheese
- Goal: Upgrade biogas to biomethane & dispense at dairy for use in dairy's fleet
- 4 vehicles being tested for emissions & performance





PG&E Proceeding with Biomethane Pipeline Plan



- EPC (Microgy) signs agreement with PG&E allowing use of pipeline to transmit biomethane
- “This initiative is promising because it offers new supplies that are renewable, cost-effective, and located within the state,” Vice President of PG&E’s California Gas Transimission, Bob Howard



Landfill Biomethane

- One lb. MSW = .1 SCF landfill gas per year...2M tons in place in U.S., close to large markets
- Sonoma County Central Disposal Site – 5,000 DGE/day CNG (under construction)
- Bowerman Landfill (Orange County) – 5,000 DGE/day LNG
- Waste Management/Altamont Landfill – 13,000 LNG gallons/day (opens 2009)





Biomethane from Wastewater Treatment Plants

- 100 gallons of wastewater = 1SCF/day of biogas
- 16,000 wastewater treatment plants currently in U.S.
- All biogas capture used for CHP at facility
 - none yet for transportation



Biosyngas

- Recent studies identified significant potential
- Production is technically feasible but uneconomic w/o incentives
- Commodity costs vary widely depending on resource & given technology
- Additional research needed on technical & economic issues



In Western Sweden > 50% of the Methane Powering These Vehicles Comes From Bio-sources





Potential Benefits of “Green Gas” Program in CA/US

- Stronger environmental support for NGVs
 - Climate change will become the predominant driver going forward
- Stronger argument for NG as a transitional feedstock for hydrogen
- Environmental benefits of NG hybrids increase (and thereby provide greater justification for incremental cost)
 - On environmental basis could rival plug-in hybrid EVs depending on power generation mix
- Means for allowing utilities to meet renewable portfolio requirements

*Clean Transportation Technologies and Solutions*SM



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