Sustainable Conservation

CA Dairy Biogas – Opportunities for Biomethane Energy

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Who Is Sustainable Conservation?

- Environmental non-profit organization
- 20 Employees
- Collaborative solutions
- Focus on agriculture
- Grant funded – no industry money

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CA Dairy Industry

- CA Largest Dairy State in Nation
  - 1.7+ Million Cows on about 1800 farms
- 1 or every 5 gallons milk in U.S.
- 65 billion lbs/yr of manure from cows
- Significant opportunity for energy generation

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Where Are All the Cows?

- Geographic concentration
  - San Joaquin Valley
  - About 1000 cow average
- Air quality
  - extreme not attainment area for ozone
- Methane from cows
  - Over million metric tons

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Volume of Methane Available in CA

- 23 billion potential cu.ft/yr from ag biomass
  - 2.2 billion gallons gasoline equivalent
- About two third from dairies
  - 14.6 billion cu ft/yr

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Types of Digesters

- Complete Mix
  - Above ground & heated (3-10%)
- Plug Flow
  - Scrape dairies (10-13% solids)
  - Usually in ground & heated
- Covered Lagoons
  - Flush dairies (1-3% solids)
  - Typically earthen pond
  - Most common in San Joaquin Valley

How to Create Value from Biogas - 4 Options for Methane Digesters

1. Biogas to electricity
2. Biomethane for biofuel
3. Biomethane for renewable natural gas for pipeline injection
4. Cover lagoon, flare gas and capture greenhouse gas value

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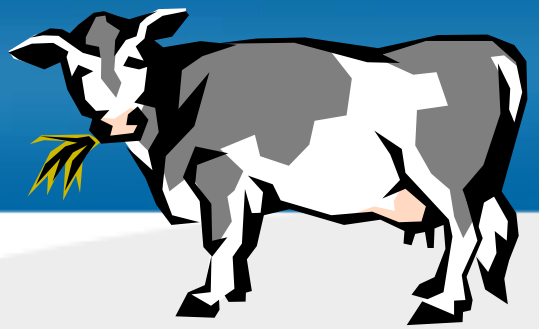
Dairy Methane for Electricity Generation



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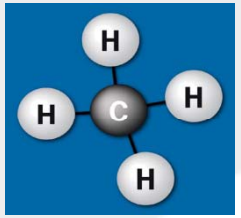

- Potential Benefits for CA
  - Cleaner air from NH3, H2S & VOC destruction
- Current Utility Contracts to Buy Power
  - About 10 cents/kWh
- Permitting as barrier
  - Air District requirements are most stringent in world

According to the National Renewable Energy Lab (NREL)

- Dairy digester engine generators may have **significantly less** lifecycle NOx emissions than central combined cycle gas turbines;
- They also **destroys** ozone forming VOCs and PM forming NH3 & H2S;
- Currently technology removes ~**95% NOx** –
  - BACT at ~ 98% was based on salesman claims

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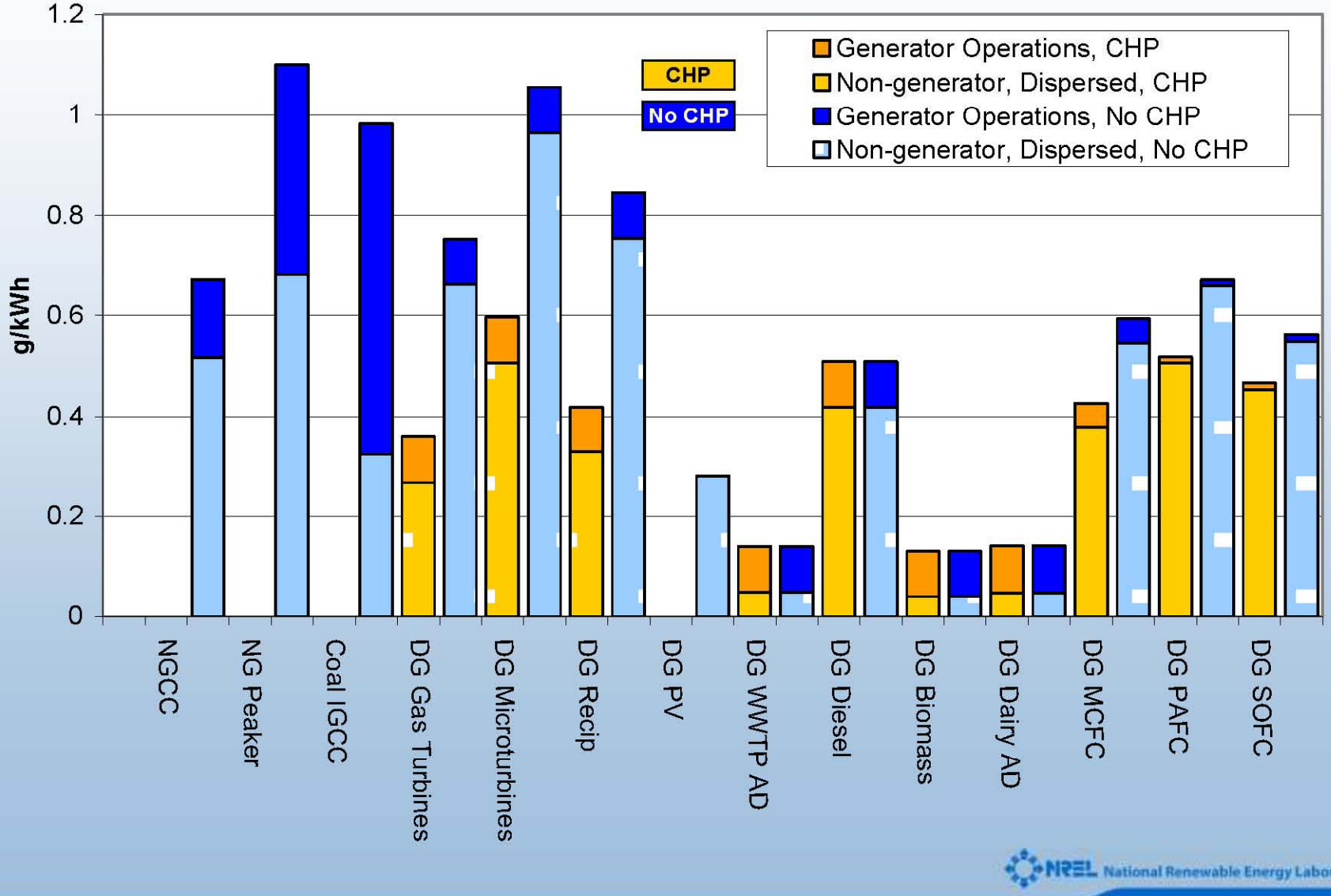
Results - CHP

Life Cycle NOx Emissions



How Digesters Compared to Other Distributed Generation (DG)?

- **Base load power (vs wind & solar)**
- **Destroy methane in creating electricity**
  - In addition to offsetting fossil fuels
- **Electricity from biogas has highest benefit-cost ratio***
  - Nearly twice photovoltaics

*Source: California Public Utilities Commission

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Outcome: Digesters are Stalled

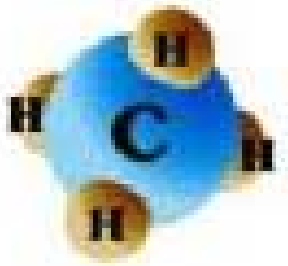
- About 18 digesters funded in total
- Little over a dozen became operational
- In 2009 six dairy digester shutdown
- Regulations are the biggest reason
  - Likely no new digesters for electricity production

Alternative Use for Biogas (only ~ 60% methane)

Biogas Upgrading to Make Biomethane

- Purification process to allow higher use
- Biomethane is renewable natural gas (CH4)

Dairy Manure → Biogas → Biomethane



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CA Dairy Now Injecting Biomethane into Natural Gas Pipeline

- Biogas is made into “pipeline quality” biomethane displacing fossil natural gas
- H2S, CO2 and H2O removed
- Must meet utility standards for quality and quantity

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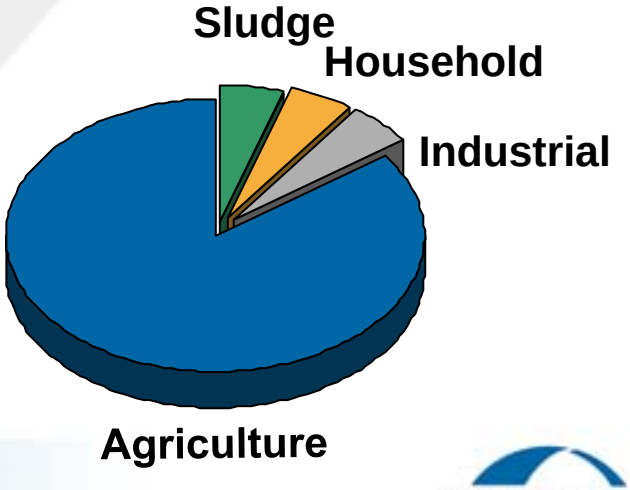
Sweden Biomethane Pioneer

World leader in biomethane production

- Nearly three dozen large biogas plants
- Pipeline injection supplements natural gas imports
  - Goal: to displace all natural gas use with biomethane
- Over 30 biogas refueling stations



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What CA Dairies are Doing to Develop Biomethane Resource

- BioEnergy Solutions (Bakersfield based)
  - One system installed on Alpers Dairy
  - Over a dozen dairies under contract

- Several dairy clusters including
  - Fresno, Kern (Shafter), Tulare County, Chowchilla
- Requires large dairy 10,000+ cows or clusters
- Financing as barrier to new installations

Microgy Co-Digestion Projects

- Microgy has permits to build up to 8 plants generating approx 6400 (MMBTUs)
- Two clusters in Fresno County
- One cluster in Kings County
- Offsite waste requirement
  - Over 2 years to get Water Board permits
- Construction stopped on all projects

Biomethane for Pipeline Injection

- PG&E has contracts to buy
- Sempra Energy negotiated purchase
- Success depends in part on
  - Location near pipeline
  - Price of Natural Gas
  - Regulatory requirements

- Financing has stalled projects
  - Price of natural gas has fallen significantly

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Biomethane for Transportation

- Displaces diesel fuel and reduces air pollution (benefit in Central Valley)
- Potential for highest net energy yield
  - No distillation required
- Could easily supply all CA natural gas vehicles
  - Nearly 15 billion cu ft. potential
  - About 1.4 billion gallons gasoline

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Rob Hilarides - California Dairymen Leading by Example

- First Dairymen in the U.S. to run milk trucks on biomethane from manure
- Converted two Peterbuilt trucks to CNG
- Hauls milk from Lindsay to Hilmar CA – distance of 300 miles round trip
- Estimated cost of >$2/gallon equivalent

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Hilarides Biomethane Truck

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Environmental Benefits

Overcoming Challenges

- Only ~1% of CA dairies have digester
- CA regulations closing digesters
  - Half a dozen shut down this year
- Economics dependent on utilities & regulations
  - Investors are pulling out of CA
- State Agencies are acting at cross purposes
  - Air Districts likely to be determining factor

Conclusion

- Digesters are the most environmentally friendly renewable energy and fuel technology available
- There will always be trade-offs
  - Greenhouse Gas↓↓ air pollution↓ odors↓ NOx↑
- Need to overcome regulatory and other barriers

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