# Low Emission Digester Success Stories in the San Joaquin Valley

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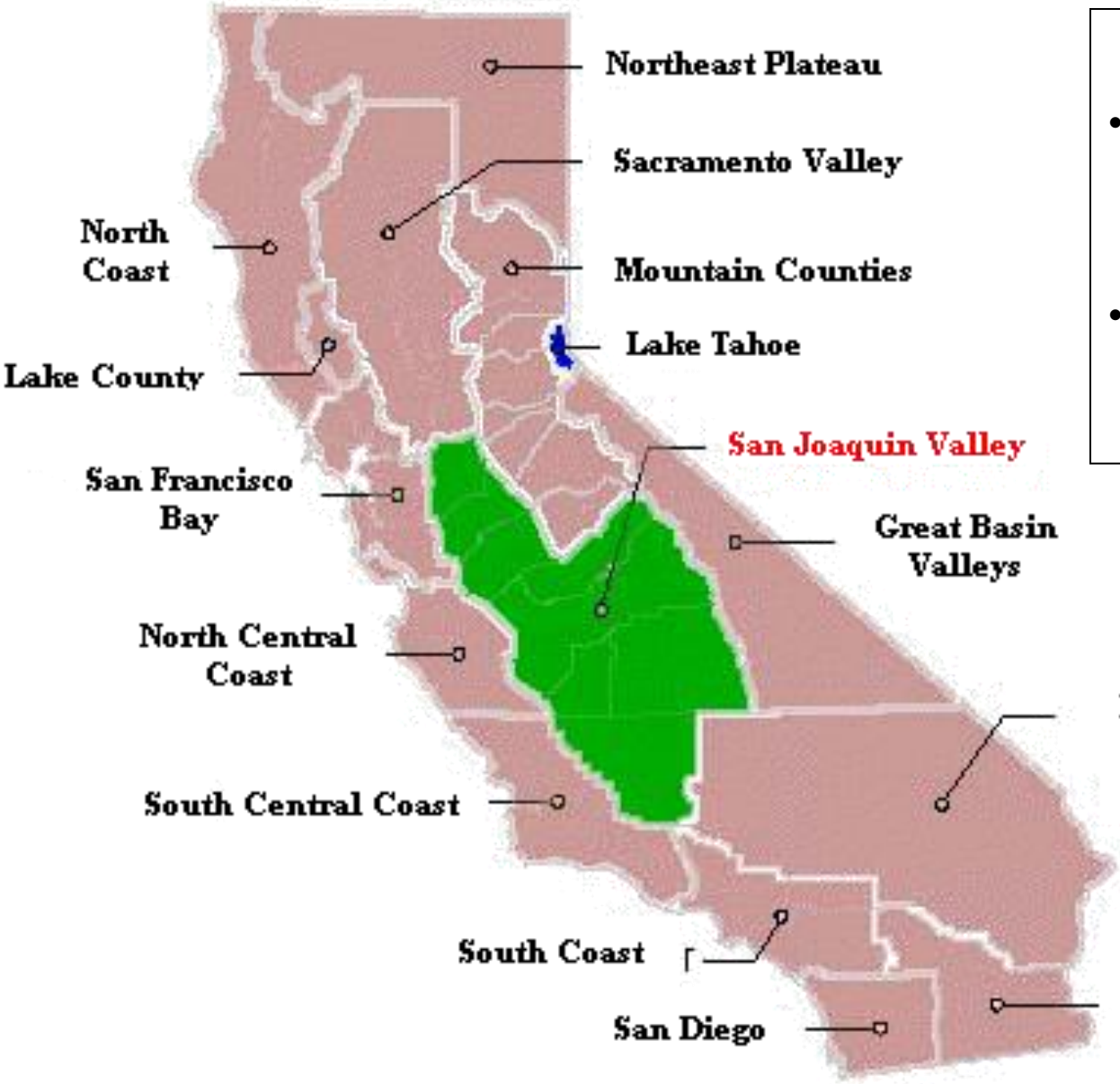


## San Joaquin Valley

- Hot, sunny summers
  - VOC, NOx
  - Ozone Problem
- Cool, foggy winters
  - Particulate problem

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# Federal & State Air Quality Regulations

- Federal Clean Air Act Requires the District to achieve clean air, or
  - Huge fees on local industry
  - Lose federal highway funds
  - Feds take over local air program
- Federal and State regulations require Best Available Control Technology (BACT) for new or modified equipment to minimize emissions increases

# Benefits of the Use of Biogas

- Increased renewable energy
  - Power production
  - Pipeline injection
  - Mobile source fuel
- Displacing fossil fuels
- Reductions in greenhouse gas emissions
- Landfill diversion
- Job creation
- Potential for VOC reductions

# Challenges to the Use of Biogas

- Contaminants (gas quality, water vapor, H2S, siloxanes in municipal/landfill biogas, etc.) have historically hindered use of add-on emission controls
- Turn-of-the-century BACT emissions level for NOx from biogas engines was 5-10 times higher than BACT for natural gas engines and ~20 times BACT for a central power plant
  - 2000-era BACT for biogas engines: 0.6 g-NOx/bhp-hr or 50 ppmv NOx (lean burn engine with no added controls)
  - BACT for natural gas engines: 5-9 ppmv NOx
  - BACT for central power plant: 2.5 ppmv NOx (gas turbine with SCR or equivalent)

# Example: Dairy Potential

- 1.84 million Dairy Cows (milk & dry) in California
- 87% of California Dairy Cows - 1.6 million Dairy cows in the San Joaquin Valley
- Estimated California Dairy Digester Potential: ~889 dairies; ~2,375,000 MW-hr per year
- Without advanced emission controls potential increase of ~5 tons-NOx/day in the SJV
- Total NOx Reductions from Stationary Sources in SJV Attainment Plan: 8.2 tons/day by 2023

# Current Low Emission Biogas Engine Projects in the San Joaquin Valley

- Rich burn engines with NSCR
  - Dairy digester gas at Gallo Cattle Company in Atwater
  - Winery Waste Digester Gas at Woodbridge Winery
- Lean Burn Engines with SCR
  - Dairy digester gas at Fiscalini Farms in Modesto

# NSCR (3-way Catalysts) for Biogas–Fired Engines

- Rich burn engines possibly lower efficiency than lean burn engines
- Inexpensive compared to other controls
- Precise control of air to fuel ratio required
- More sensitive to contaminants than SCR

# Gallo Cattle Company Digester Gas-Fired Engine with NSCR

# Summary of Latest Source Test for Gallo Dairy Digester Engines (Jan 2012)

| Permit N-1660-7: 453 bhp digester gas-fired IC Engine with NSCR | | |
|---|---|---|
| Parameter | Result | Permit Limit |
| NOx, ppmvd @ 15% O2 | 4.6 | -- |
| NOx, g/bhp-hr | 0.085 | 0.6 |
| CO, ppmvd @ 15% O2 | ~164 | -- |
| CO, g/bhp-hr | 1.818 | 2.65 |
| VOC, ppmvd @ 15% O2 (as methane) | <0.14 | -- |
| VOC, g/bhp-hr | <0.001 | 0.25 |
| Fuel H2S, ppmv | 13.1 | 75 |

| Permit N-1660-9: 575 bhp digester gas-fired IC Engine with NSCR | | |
|---|---|---|
| Parameter | Result | Permit Limit |
| NOx, ppmvd @ 15% O2 | 5.47 | 9.0 |
| NOx, g/bhp-hr | 0.090 | 0.15 |
| CO, ppmvd @ 15% O2 | 637.36 | 1,100 |
| CO, g/bhp-hr | 6.378 | -- |
| VOC, ppmvd @ 15% O2 (as methane) | 0.25 | 20 |
| VOC, g/bhp-hr | 0.001 | -- |
| Fuel H2S, ppmv | 13.1 | 59 |

# Summary of Latest Woodbridge Winery Biogas Engines (Nov 2011)

| Permit N-2321-649: 122 bhp digester gas-fired IC Engine with NSCR | | |
|---|---|---|
| **Parameter** | **Result** | **Permit Limit** |
| NOx, ppmvd @ 15% O2 | 0.75 | 11 |
| NOx, g/bhp-hr | -- | 0.15 |
| CO, ppmvd @ 15% O2 | 2.12 | 70 |
| CO, g/bhp-hr | -- | 0.60 |
| VOC, ppmvd @ 15% O2 (as methane) | < 0.14 | 51 |
| VOC, g/bhp-hr | -- | 0.25 |
| Fuel H2S, ppmv | 8.3 | 25 |

| Permit N-2321-650: 122 bhp digester gas-fired IC Engine with NSCR | | |
|---|---|---|
| **Parameter** | **Result** | **Permit Limit** |
| NOx, ppmvd @ 15% O2 | 1.83 | 11 |
| NOx, g/bhp-hr | -- | 0.15 |
| CO, ppmvd @ 15% O2 | 2.11 | 70 |
| CO, g/bhp-hr | -- | 0.60 |
| VOC, ppmvd @ 15% O2 (as methane) | < 0.14 | 51 |
| VOC, g/bhp-hr | -- | 0.25 |
| Fuel H2S, ppmv | 8.3 | 25 |

# SCR for Biogas–Fired Lean Burn Engines

- Lean burn engines generally have higher efficiency than rich burn engines
- Urea tank required
- Ammonia slip must be minimized
- More expensive than NSCR
- Generally SCR systems more resistant to contaminants than NSCR

# Fiscalini Farms Dairy Digester Gas-Fired Engine with SCR

# Summary of May 2012 Source Test for Fiscalini Farms and Dairy Engine

| Permit N-6311-9: 1,057 bhp lean burn digester gas-fired IC Engine with SCR | | |
|---|---|---|
| **Parameter** | **Result** | **Permit Limit** |
| Pre-Catalyst NOx, ppmvd @ 15% O2 | 76.04 | - |
| Pre-Catalyst NOx, g/bhp-hr | 1.109 | - |
| Post-Catalyst NOx, ppmvd @ 15% O2 | 5.63 | 11 |
| Post-Catalyst NOx, g/bhp-hr | 0.082 | 0.15 |
| % NOx reduction | 92.7% | - |
| CO, ppmvd @ 15% O2** | 112.82 | 210 |
| CO, g/bhp-hr | 1.00 | 1.75 |
| VOC, ppmvd @ 15% O2 (as methane) | 14.77 | 28 |
| VOC, g/bhp-hr | 0.075 | 0.13 |
| Ammonia, ppm @ 15% O2 | 1.36 | 10 |

# Compressed Digester Methane as Vehicle Fuel

- One installation in the Valley, Hilarides Dairy
- No need to be near a pipeline
- Replaces combustion of diesel fuel, so no new NOx emissions.

# Hilarides Dairy Bio-methane Powered Milk Trucks





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# Other Low-Emission Technologies for Biogas Issued Permits by the District

- **SCR Systems for biogas from food and agricultural wastes**
- **Greenguard "Virtual Lean Burn" Engines** – Engines with EGR, very low exhaust O2, and NSCR to reduce emissions
- **Hydrogen Injection** – ultra lean burn engines using hydrogen to stabilize combustion
- **Biomethane Pipeline Injection**

# District Promotion of Low Emission Biogas Technologies

- Support demonstrations of solutions that will increase renewable energy production while meeting the Valley's air quality needs
- Provide District funding to renewable energy projects that further reduce emissions
- Work with other agencies to find ways to remove barriers and fund or partially fund promising low-NOx proposals
- Previously issued permits with flexible emission limits to applicants that wanted to test innovative low-emission biogas technologies

# Air District Contacts

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Permitting issues:

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Grants, funding issues:

- Samir Sheikh, Director of Emissions Reduction Incentive Programs
- Kevin Wing, Air Quality Grants Specialist