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Digester Gas-Fired Combined Heat and Power: Technologies and Challenges

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*California Energy Commission Workshop
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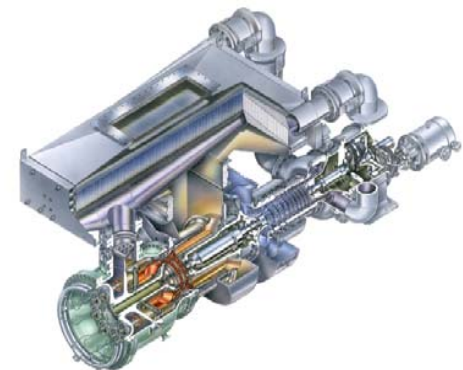
Presentation Overview



- ⌘ Sanitation Districts and Its Energy Management Program
- ⌘ CHP Technologies for Digester Gas
- ⌘ Sanitation Districts Biogas Facilities
- ⌘ Challenges and barriers

Districts Energy Management Program

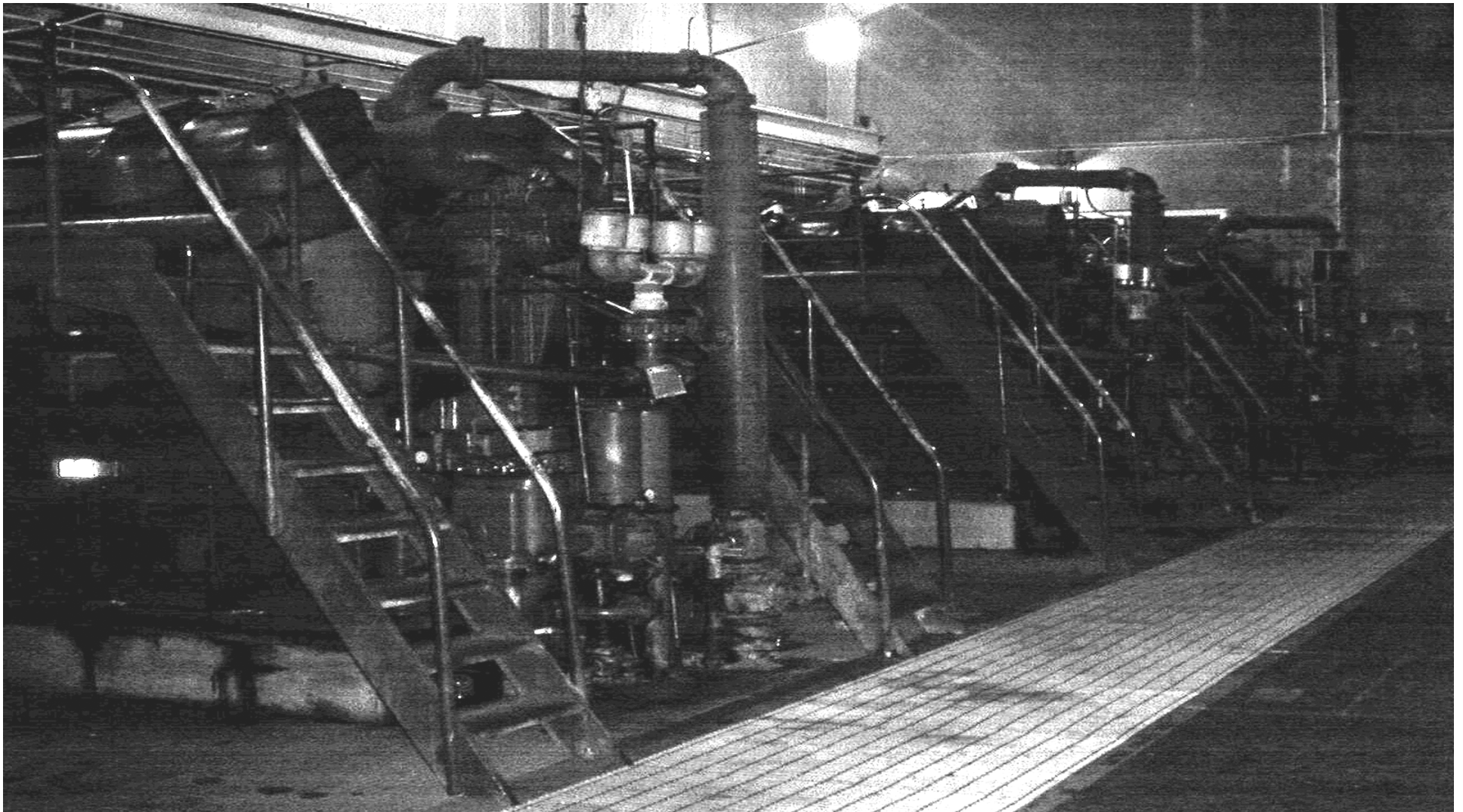
- ⌘ Maximum development of bio-gas resources
- ⌘ Minimize energy usage
- ⌘ Minimize procurement cost and maximize sales income
- ⌘ Demonstrate new technologies that reduce air emissions



Wastewater Treatment Facilities Map



IC POWER ENGINE INSTALLED at JWPCP in 1938



Combined Heat and Power Equipment for Digester Gas



⌘ Gas Turbines 1 MW to 15 MW*

⌘ IC Engines 25 kW to 3 MW

⌘ Fuel Cells 200 kW to 2 MW

⌘ Microturbines 30 kW to 250 kW

*Electrical output per unit

Existing Districts Digester Gas-Fired Facilities



⌘ Boilers

- ☒ Hot water or steam for digester heating
- ☒ At all facilities with digester gas

⌘ Turbines

- ☒ JWPCP 22 MW CHP (400 MGD)

⌘ Engines

- ☒ Valencia 400 kW CHP (12.5 MGD)
- ☒ Shut down Feb 2009

⌘ Microturbines

- ☒ Lancaster 250 kW CHP (10 MGD)

⌘ Fuel Cell

- ☒ Palmdale 250 kW CHP (15 MGD)
- ☒ 5-year demonstration period ends in 2009

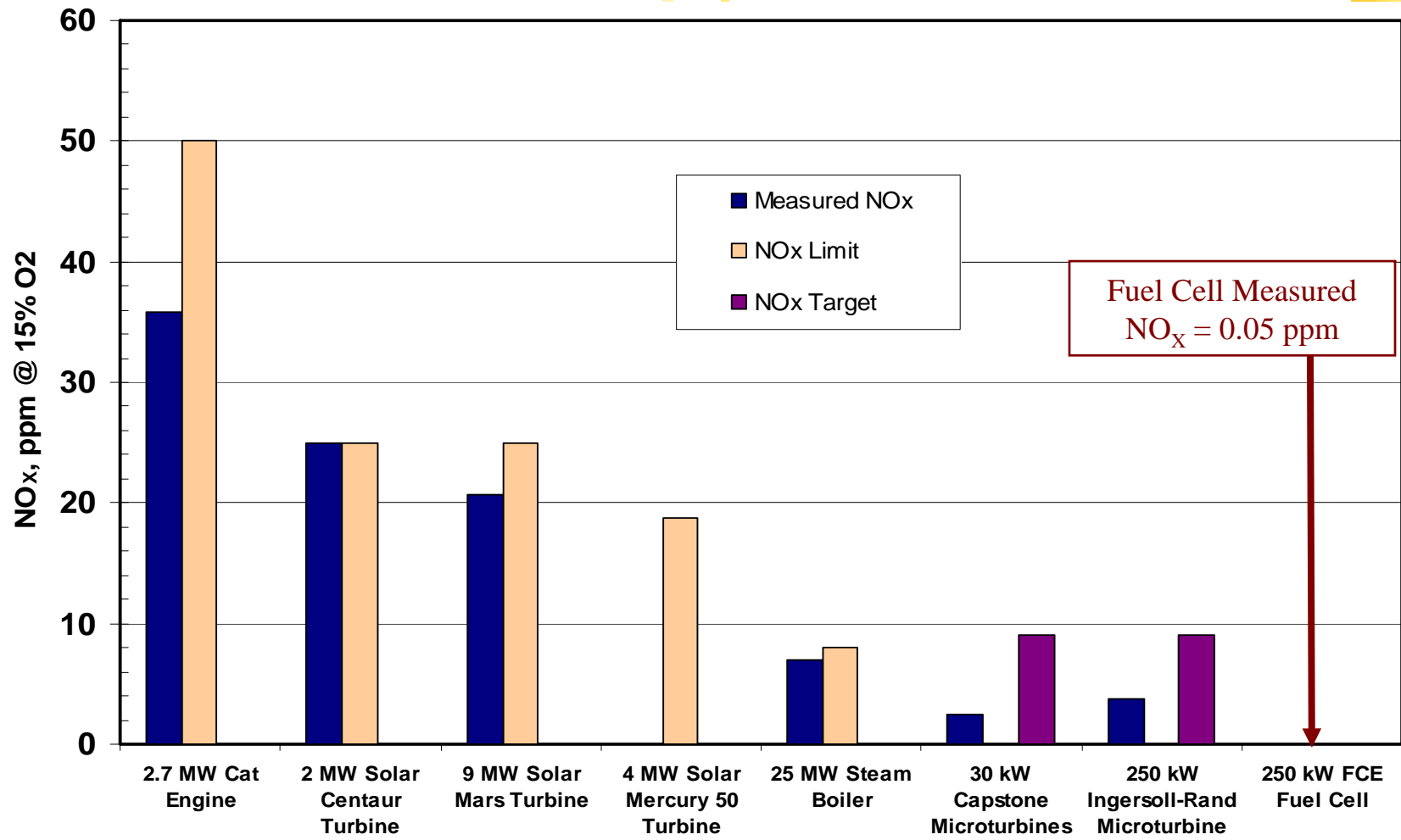
Digester and Landfill Gas-to-Energy Cost Summary Comparison

	Installed Cost (\$/kW)	Operating Cost (\$/kWh)	Power Production Cost* (\$/kWh)
Gas Turbines	\$2,000- \$4,500	\$0.020- \$0.035	\$0.06-\$0.09
IC Engines	\$1,700- \$3,000	\$0.015- \$0.035	\$0.04-\$0.08
Microturbines	\$3,000- \$4,500	\$0.016- \$0.06	\$0.06-\$0.10
Fuel Cell**	\$7,000- \$9,000	\$0.035- \$0.08	\$0.16-\$0.20

*10 year write down @5%

**Fuel cells eligible for \$4,500 rebate from PUC if used for on site power

NO_x Emissions from LACSD Biogas-to-Energy Facilities



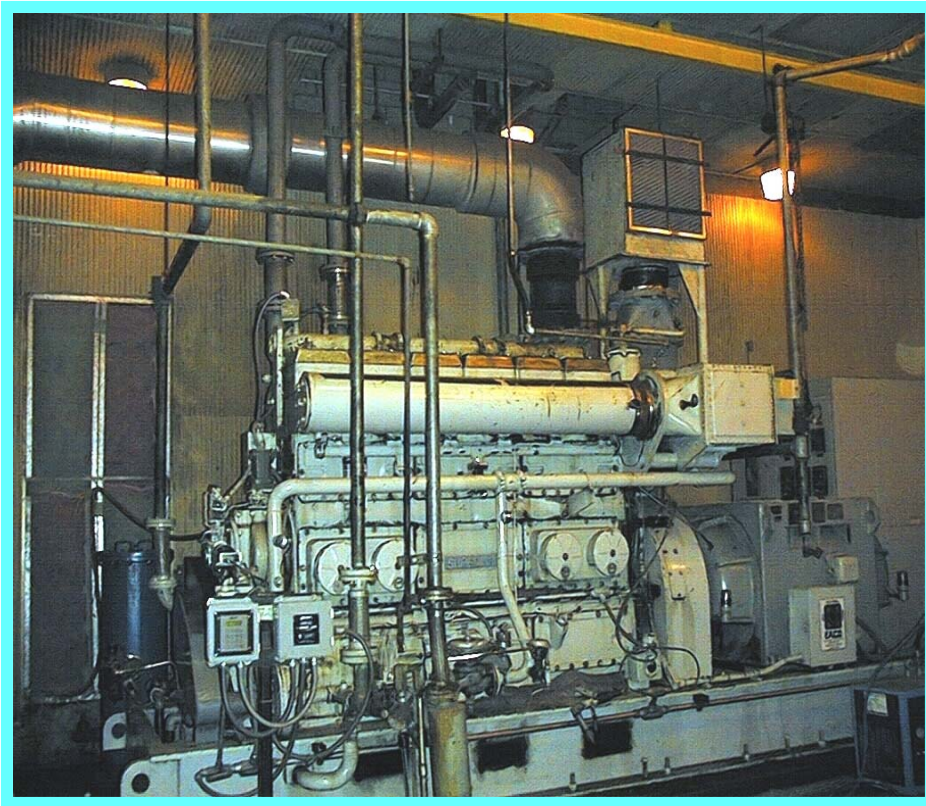
JWPCP Total Energy Facility



Location - Carson, California
Combined Cycle Cogeneration
Power Plant

- ☒ (3) 9 MW Solar Mars T-13000 gas turbine generators
- ☒ (1) 3 MW DeLaval HJT steam turbine generator

IC Engine Cogeneration Facility at Valencia WRP



Location - Valencia, CA

- ⌘ 500 kw Cooper-Superior Model 6GTLA Engine Generator
- ⌘ Steam used to heat digesters

Lancaster Microturbine Project



- ⌘ Ingersoll Rand microturbine
- ⌘ 250 kW gross, 32% efficiency (LHV)
- ⌘ Heat recovery to heat water for digesters
- ⌘ Combined heat and power efficiency 51%
- ⌘ Capital cost \$684k
- ⌘ 40% of cost recovered from California Self Generation Incentive Program (SGIP)
- ⌘ Microturbines no longer eligible for SGIP

Palmdale Fuel Cell Project



- ⌘ Fuel Cell Energy molten carbonate fuel cell
- ⌘ 250 kW, 47% efficiency (LHV)
- ⌘ Heat recovery to heat water for digesters
- ⌘ Combined heat and power efficiency 73%
- ⌘ Capital cost \$1.9 million (before 50% rebate)
- ⌘ 50% of cost recovered from SGIP

Projects Ending in 2009




⌘ Valencia Cogeneration Facility

- ☑ Engine subject to SCAQMD Rule 1110.2
- ☑ Unable to cost-effectively comply with requirement for advanced engine controls

⌘ Palmdale Fuel Cell

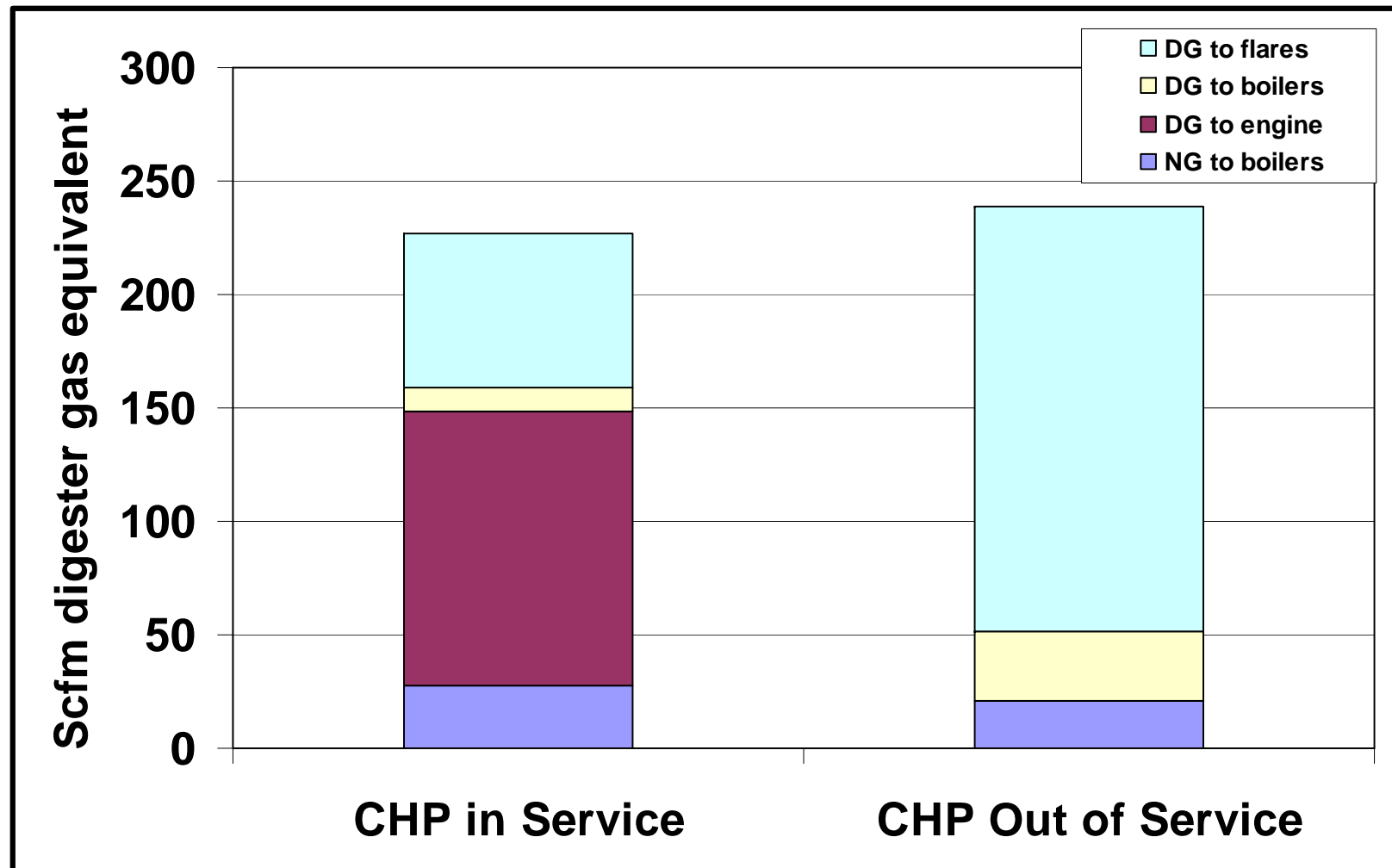
- ☑ Reaching end of 5-year demonstration project and O&M contract
- ☑ Unit is not in satisfactory condition for continued commercial operation

Valencia WRP-Current Status



- ⌘ Engine has been shut down
- ⌘ Installation of digester gas-fired boilers has been delayed by SCAQMD permitting moratorium
- ⌘ All digester gas is being flared while natural gas is purchased for boilers
- ⌘ High Btu conversion being studied but may not be economical

Valencia Gas Usage Before and After Shutdown of CHP Facility



Emission and Cost Impact of CHP Shutdown at Valencia



	CHP In Service	CHP Out of Service
GHG Emissions, tpy CO₂ equivalent	278	1,841
NOx, tpy	2.1	2.1
Cost impact, \$/yr	Baseline	\$525,000 additional cost

Replacement Projects for Valencia and Palmdale



⌘ Fuel Cells

- ☒ Cannot physically fit at Valencia; economics marginal at Palmdale

⌘ Microturbines

- ☒ Economics marginal at both facilities
- ☒ Economics would be positive if SGIP finding were still available

Replacement Projects for Valencia and Palmdale



⌘ Engines

- ☑ Not cost-effective in SCAQMD territory
- ☑ Appear to be cost-effective for Palmdale

⌘ Natural Gas Conversion

- ☑ Limited by economies of scale
- ☑ Not viable for Palmdale, marginal for Valencia

Project Barriers



⌘ Project Size

- ☒ Facilities < 1 MW are tough to justify economically

⌘ Next Generation of Engine Emission Rules

- ☒ Engines are the historical workhorse of small CHP
- ☒ Gas cleanup and back-end catalysts are not yet demonstrated; costs probably eliminate economic viability
- ☒ Highlights GHG vs. criteria pollutant policy conflict

Project Barriers, ctd



⌘ Delays in Approval of a Tradable Renewable Energy Credit (REC) System

- ☒ PUC approval on hold pending legislation
- ☒ Renewable distributed generation currently does not count toward RPS goals
- ☒ Proposed projects cannot count on REC income for planning purposes

⌘ Capital

- ☒ Economic times
- ☒ For the Districts, available capital is currently going to upgrade water treatment to meet new discharge limits

Contact Info



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