Air & Waste Management Association
Mother Lode Chapter

NCPA Lodi Energy Center Plant Tour
January 30, 2013
Schedule

• Overview of NCPA
• Technology Overview
• Plant tour
Joint Action – The Foundation

“To use any power common to the public agencies that are parties to this Agreement that will make more efficient the use of the powers of the individual member agencies in the purchase, generation, transmission, distribution, sale, interchange and pooling of electrical energy and capacity among themselves, or with each other, or with others, and any other power reasonably necessary and appropriate to aid in the accomplishment of any of these purposes.”

JOINT POWERS AGREEMENT
History of NCPA

- **1950’s – 1960’s**
  - PG&E price
  - PG&E refusal to wheel
  - Uncertain future

- **1970’s**
  - Lawsuits - PG&E transmission access
  - 10 years of litigation success
  - 7777 case - settled 1992
  - Geothermal and hydro projects started

- **1983**
  - PG&E Interconnection Agreement signed
NCPA Supply Sources

- Projects
  - Hydroelectric
  - Geothermal
  - Combustion Turbine No. 1
  - Combustion Turbine No. 2
  - Lodi Energy Center

- Member Allocations
  - Western Area Power Administration

- Market Purchases
NCPA Members

Cities of:
- Alameda
- Biggs
- Gridley
- Healdsburg
- Lodi
- Lompoc
- Palo Alto
- Redding
- Roseville
- Santa Clara
- Ukiah
- Bay Area Rapid Transit District
- Placer County Water Agency
- Plumas-Sierra REC
- Port of Oakland
- Truckee-Donner PUD

Dispatch Aggregated Resources
And contracts to meet loads
Over dispersed area
NCPA Governance

Member Board/Council
- Designated Official
  - Standing Committees
    - Finance
    - Legislative & Regulatory
    - Legal
  - General Counsel
    - NCPA COMMISSION
      - NCPA General Manager
        - NCPA Assistant General Managers
          - AD HOC Committees (As Needed)
            - NCPA Staff
              - Executive Committee
                - Member Utility Directors

Colors:
- Green: Long term decisions
- Blue: Budget/Agency Oversight
- Purple: Day to day operations

(Plus multiple technical level ad hoc committees)
Hydro Generation

- Project Completed -1989
- Combined Generation Capacity: 259 MW
- Used for capacity, load following & peaking
- 6 MW’s of CEC Qualified Renewable Energy
- Zero Carbon Energy Credit for Entire Output
- Fuel: Water
- Collierville 253 MW
  - 2 @ 126.5 MW
  - 40 Miles of Transmission Line
  - 2065 Acre Feet of Storage at McKays Reservoir
- Spicer 6 MW
  - 2 @2.75 mw units
  - 1@0.5 mw unit
  - 189,000 acre feet of storage @ Spicer
- License: Through 2032 with option to extend
- Debt Paid Off: 2032
Combustion Turbine Generation

- Project Completed – 1985
- Value is primarily Capacity and Peaking Energy during needle peaks
- 2-24.8 MW units located in Alameda
- 1-24.8 MW unit located in Lodi
- 2-24.8 MW units located in Roseville
- Fuel: Gas
- Expected Life: 2026
- Debt Paid Off: FY 2011
Combustion Turbine Project No. 1
Roseville Site
Combustion Turbine Project No. 2

• Project Completed 1996
• Summer Peaking Energy and Capacity
• One 49.9 MW unit STIG
  – 1 – LM5000 Aeroderivative, steam-injected gas turbine with HRSG
  – 9000 Btu/kwh Heat rate

• Fuel: Gas
• Expected Life: 2026
• Debt Paid Off: FY 2026
• CT #2 is located in Lodi next to Interstate 5
Combustion Turbine Project No. 2 (STIG) Summer Peaking Power
Geothermal Generation

- Geothermal Project No. 1-Plant Completed 1983
  - Two plants 110 MW, currently producing 60 mw’s
- Geothermal Project No. 2- Plant Completed 1986
  - Two plants 110 MW, currently producing 52 mw’s.
- Projects are producing Baseload renewable energy
- Debt Paid Off: FY 2011
- Expected Life: Beyond 2030
- Fuel Geothermal Steam
  - 67 production wells & 10 injection wells
  - 102 miles of underground well pipe
  - 8 miles of steam gathering pipe
  - Effluent Pipeline Project – 6,400 gpm
    - 5 miles of injection pipe
    - 3 Pump stations
    - Horizontal injection well
Geothermal Project No. 2
Geysers Effluent Pipeline Solar Projects

Two Solar Projects under development to power the Effluent Pipeline

First Project is at the Southeast Treatment Plant

1 MW Photovoltaic

Expected Commercial Operations Date Fall 2008

Provides about 1/3 the Power needed for the Pump Station

8 acres of property

Second is at the Bear Canyon Zero Pump Station

1 MW Photovoltaic

Expected Commercial Operations Date Fall 2009

Provides all of the power needs for the Bear Canyon Zero Pump Station

8 acres of property
Lodi Energy Center

• 296 MW Siemens Flex-30 Combined Cycle Power Plant

• Application for license filed with the California Energy Commission in September 2008; license issued in April 2010.

• Gas turbine can reach full load (approx. 200 MW) within 30 minutes after a cold start.
Gas Turbines for Power Generation

• Simple cycle
• Combined cycle
• Cogeneration
• Duct Firing
• Duty Cycles
  – Base load
  – Intermediate load
  – Peaking
Simple Cycle Gas Turbines

Efficiency: <30% to 41% (HHV)  Exhaust temp: 800°F to 1150°F

Source for graphic:  www.cogeneration.net
Combined Cycle Power Plants

Efficiency: <45% to 54% (HHV)    Exhaust temp: 160°F to 200°F

Cogeneration

• Topping cycle
  – Generally a gas turbine followed by a heat recovery steam generator producing process steam

• Bottoming cycle
  – Generally an industrial process (boiler, kiln) producing heat, following by a heat recovery steam generator producing steam to drive a steam turbine to make electricity
Gas Turbine Output vs Ambient Temperature

Gas Turbine Efficiency vs Load

Source: LMS100;
Reciprocating Gas Engine (Wartsila 18V50DF) vs LM 6000 Turbine
Part Load efficiency

Shaft Efficiency Versus Power Output

4 x Wärtsilä 18V50DF

1st Engine
2nd Engine
3rd Engine
4th Engine

LM6000
Duty Cycles

• **Base Load**
  – Generally combined cycle plants
  – Typically operate 24/7/365
  – Slow start (4-6 hours from cold shutdown)

• **Intermediate Load**
  – Either quick-start combined cycle or efficient simple cycle
  – May cycle daily or weekly
  – May be used for voltage support or load following

• **Peaking**
  – Generally simple cycle
  – Typically operate < 8 hours per day during peak months
Combined Cycle Power Plants

Efficiency: <45% to 54% (HHV)  
Exhaust temp: 160°F to 200°F

Emission Control Technologies

• Dry Controls
• Wet Controls
• Catalytic Controls
Emission Control Technologies
Dry Controls

• Conventional (diffusion) combustors
• Dry low-NOx (premix) combustors
Combustors

Combustors on a GE 7H gas turbine.
GE DLN 2.6 Combustion System

6 Premix Burners - Five identical outer burners, one smaller center nozzle.

During different machine cycle conditions, PM1, PM2, PM3 are flowed in varying combinations to give correct Fuel / Air.

Quaternary Pegs are located circumferentially around the combustion casing.
PSM LEC III Combustion System

100% Fuel

Primary Mode
Ignition to 30% Load

1600°F
Firing

50% Fuel

Lean-Lean Mode
30% to ~75% Load

1900°F
Firing

50% Fuel

Transfer Mode
~75% Load

Premix Mode
~75% to 100% Load

(30 Seconds)

82% Fuel

2020°F+
Firing

13% Fuel
Emission Control Technologies
Wet Controls

• **Water injection**
  – Can reach NOx levels as low as 42 ppmc
  – Increases power output with some efficiency loss
  – Decreases combustor life if water impinges on combustor walls

• **Steam injection**
  – Can reach NOx levels as low as 10-15 ppmc
  – Increases power output with no efficiency loss
  – No significant decrease in combustor life
Emission Control Technologies
Catalytic Controls

• Catalytic combustors
• Selective catalytic reduction
• Oxidation catalysts
• SCONOx
Cataytic Combustors

- Extension of pre-mix combustor technology
- Uses oxidation catalyst to combust fuel in a flameless environment
- Virtually eliminates thermal NOx: <2-3 ppmc
- Commercially available for only one small turbine model (<2 MW)
- Combustion stability and turn-down capability are key design issues
Selective Catalytic Reduction

• Controls NOx through reaction with ammonia
• Available in low temperature (300°F to 550°F), medium temperature (500°F to 850°F), and high temperature (800°F to 1100°F) designs
• Medium temperature designs result in longest catalyst life and lowest backpressure impacts
SCR Installation in an HRSG

SCR Installation in an HRSG
Oxidation Catalysts

• Add little to CO control capabilities of turbines equipped with DLN combustors, except during startups/shutdowns

• Needed to meet BACT requirements for turbines equipped with diffusion combustors, water or steam injection

• Effective on organic HAPS; little benefit for unburned fuel (which is mostly methane and ethane)
SCONOx (Emerachem EMx™ Catalyst System)

• Catalyst system includes the following:
  – Guard bed (to capture sulfur compounds)
  – Oxidation catalyst (to oxidize VOC, CO, NO)
  – Adsorption bed coated with potassium carbonate (to capture NO₂)
• Adsorption bed capacity is 12-15 minutes
  – Regeneration provided through \( \text{H}_2 \) (from reformer) or \( \text{CH}_4 \) (from natural gas)
  – Regeneration requires reducing atmosphere; thus module under regeneration must be isolated from exhaust using dampers
  – If regeneration uses \( \text{H}_2 \), steam source is needed for the reformer
SCONOx (Emerachem EMx™ Catalyst System) (cont’d)

• Catalyst system requires physical cleaning/recoating approximately every 3000-4000 hours of operation

• 2-4 day job, depending on unit size/configuration

• System is in operation in Massachusetts (1 unit); San Diego (1 unit); Los Angeles (1 unit); Redding (1 unit)

• Largest turbine installation is 43 MW
PLANT TOUR