Air & Waste Management Association Mother Lode Chapter

NCPA Lodi Energy Center Plant Tour

January 30, 2013

Schedule

- Overview of NCPA
- Technology Overview
- Plant tour

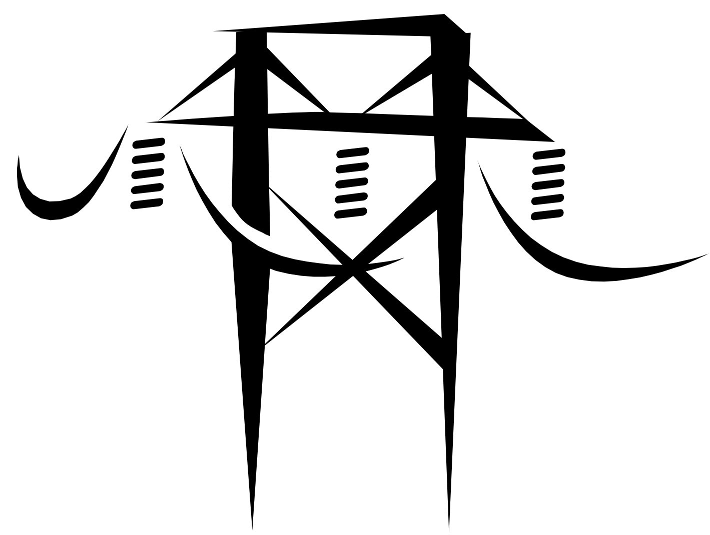
Joint Action – The Foundation

– "**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."

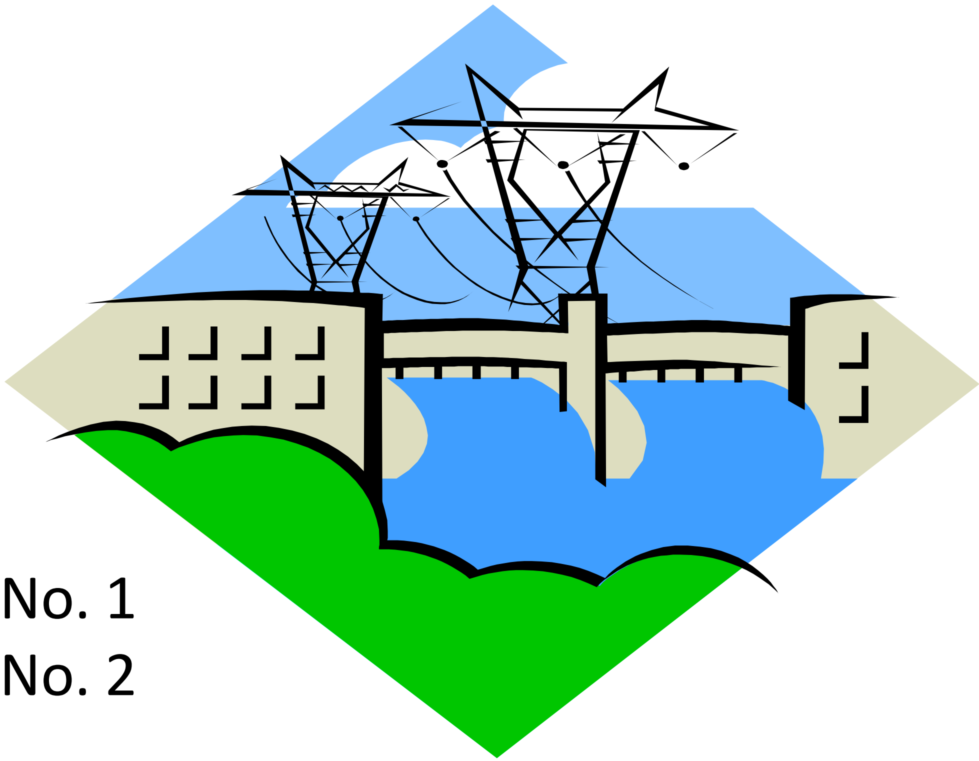
JOINT POWERS AGREEMENT

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



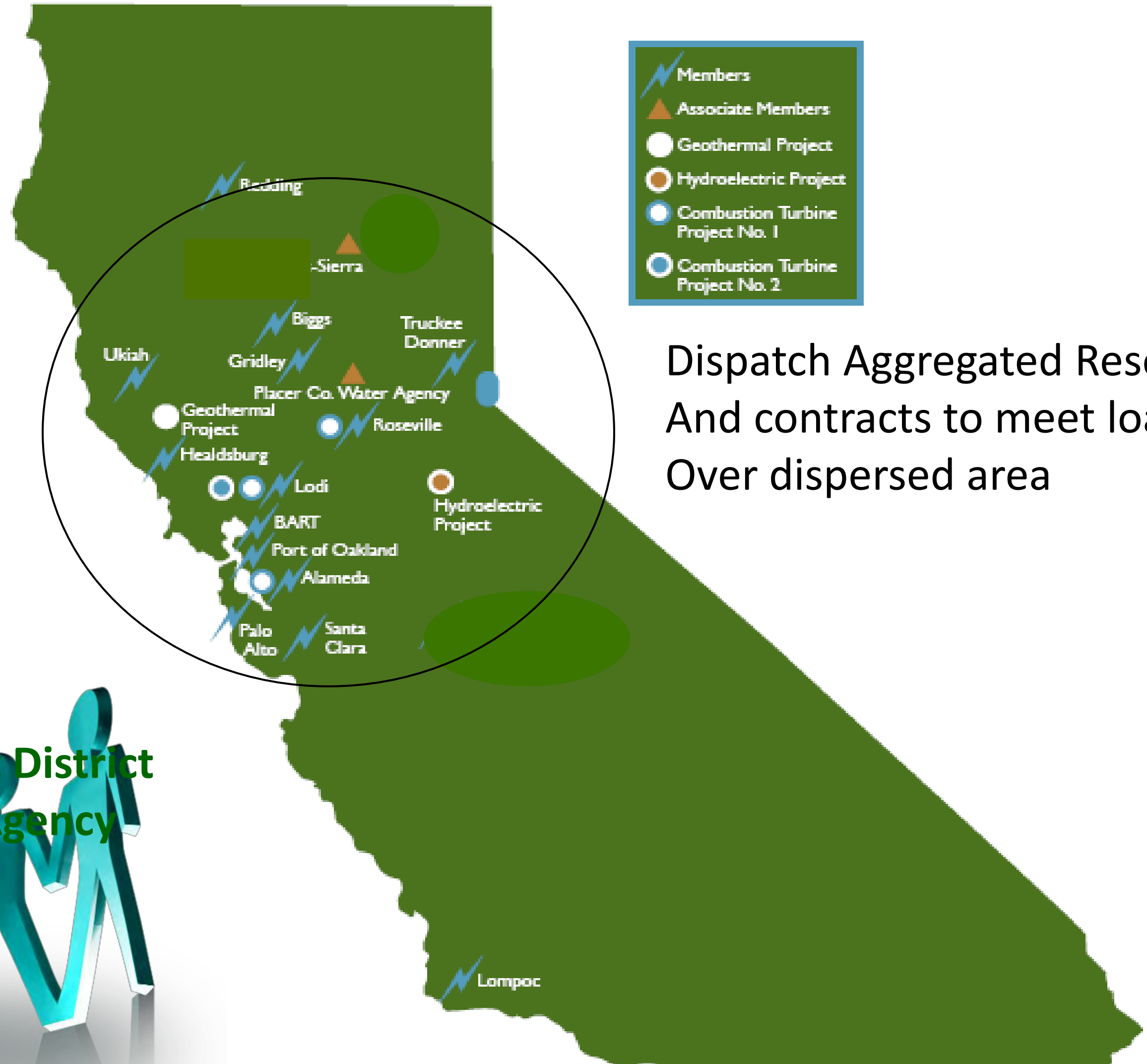
- Projects
  - Hydroelectric
  - Geothermal
  - Combustion Turbine No. 1
  - Combustion Turbine No. 2
  - **Lodi Energy Center**
- Member Allocations
  - Western Area Power Administration
- Market Purchases

NCPA Members

Cities of:

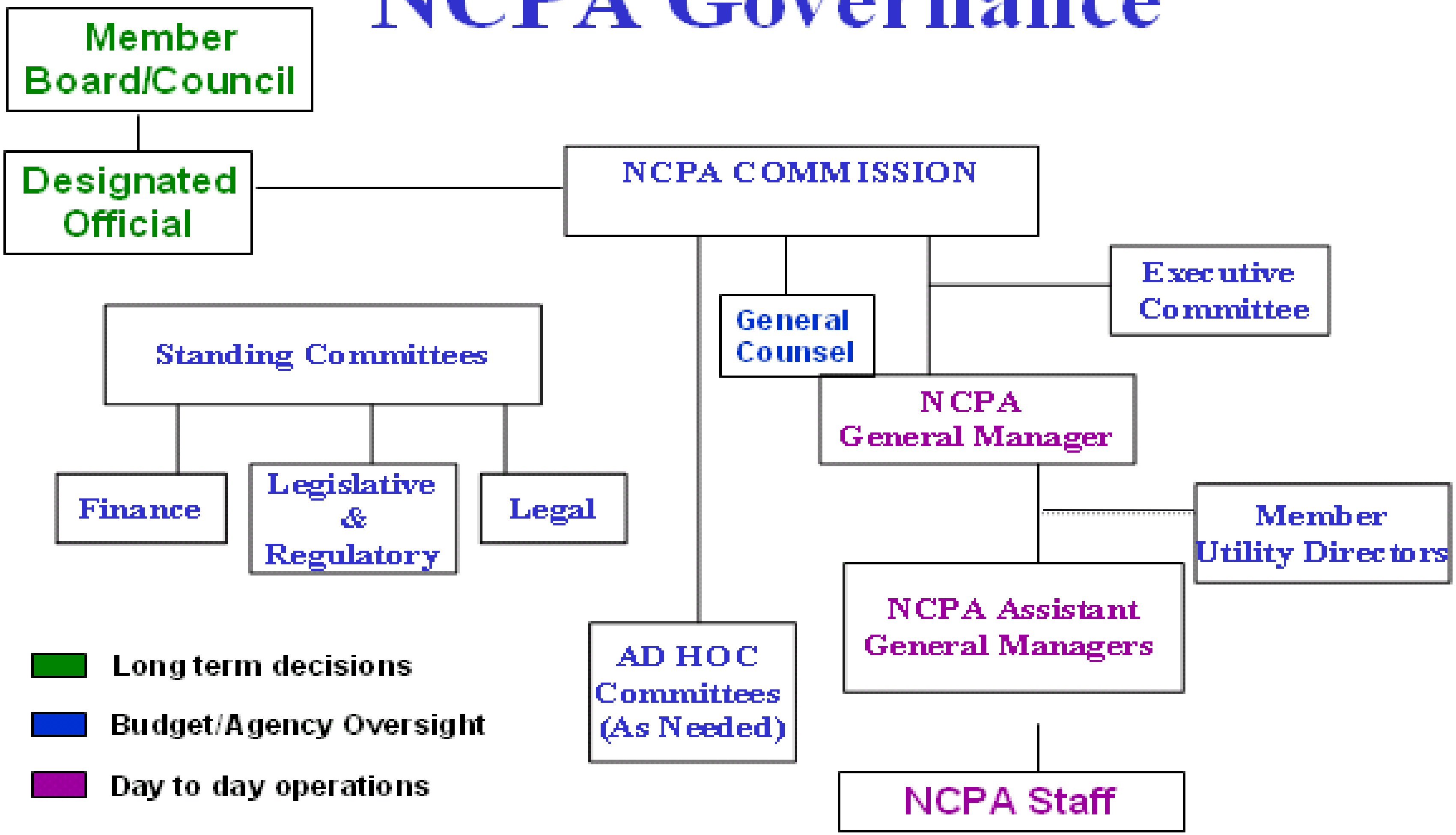
- **Alameda**
- **Biggs**
- **Gridley**
- **Healdsburg**
- **Lodi**
- **Lompoc**
- **Palo Alto**
- **Redding**
- **Roseville**
- **Santa Clara**
- **Ukiah**

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



(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


Beaver
Creek
PH
McKays
Micro
Turbine

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

Southeast Treatment Plant Solar Project

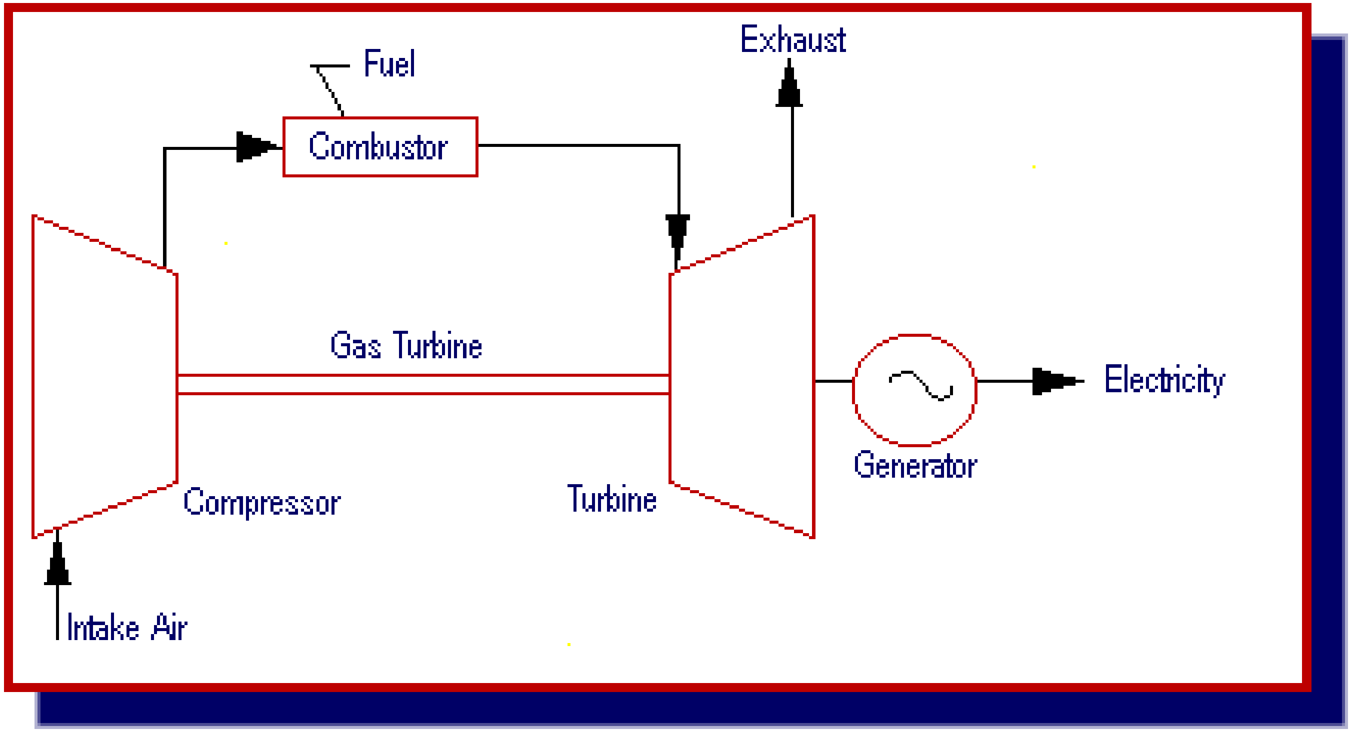
Lodi Energy Center

- 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

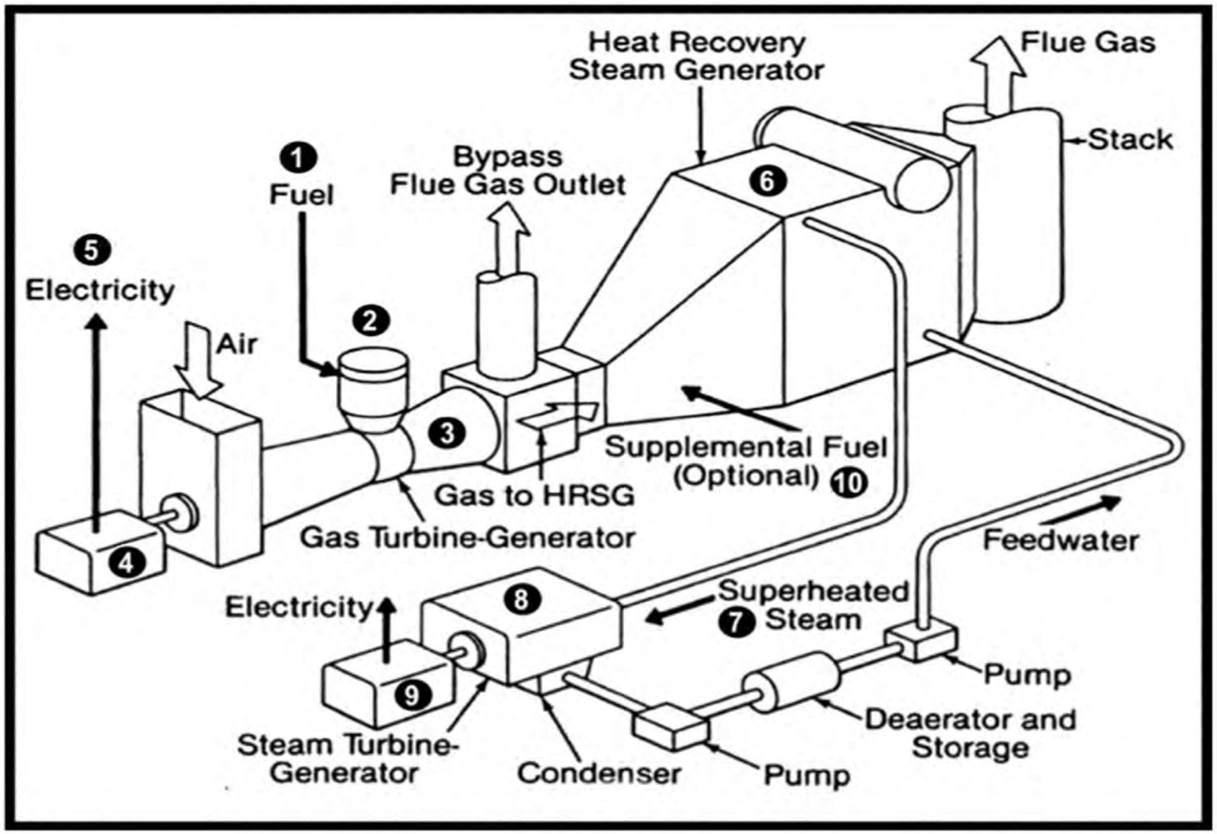


Efficiency: <30% to 41% (HHV)

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**

Source for graphic: Adapted from "Steam: Its Generation and Use". 40th Ed. Babcock & Wilcox.

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

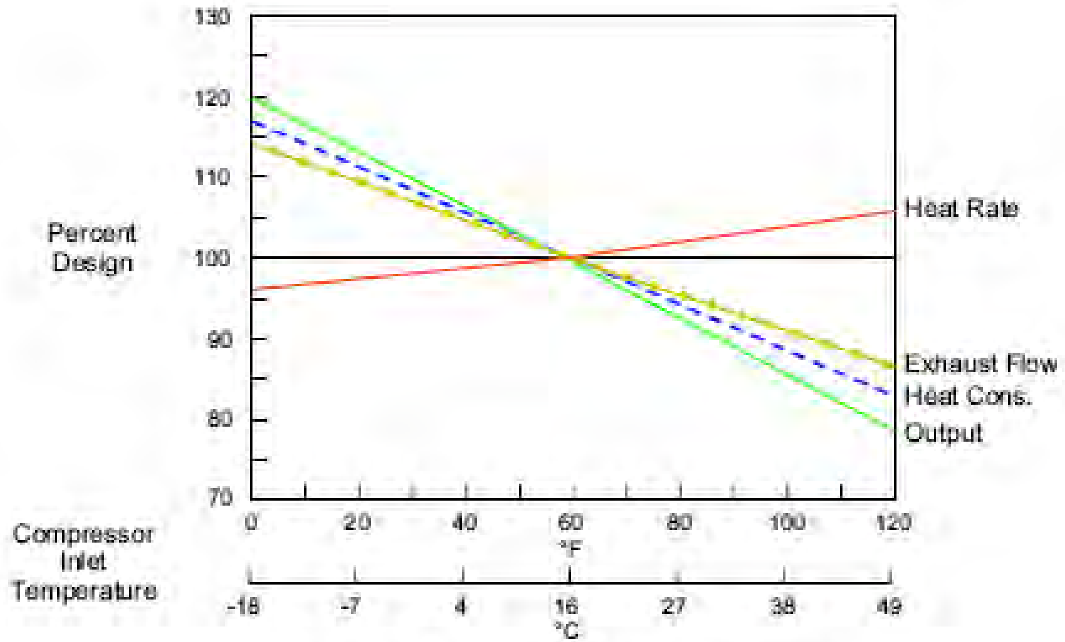
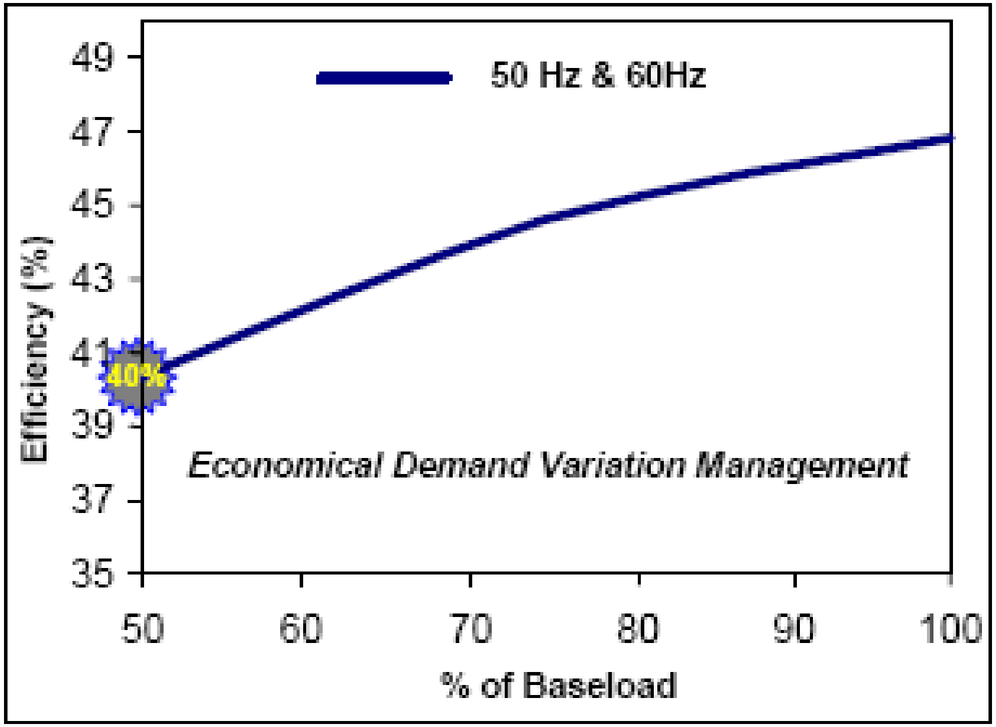


Figure 9. Effect of ambient temperature

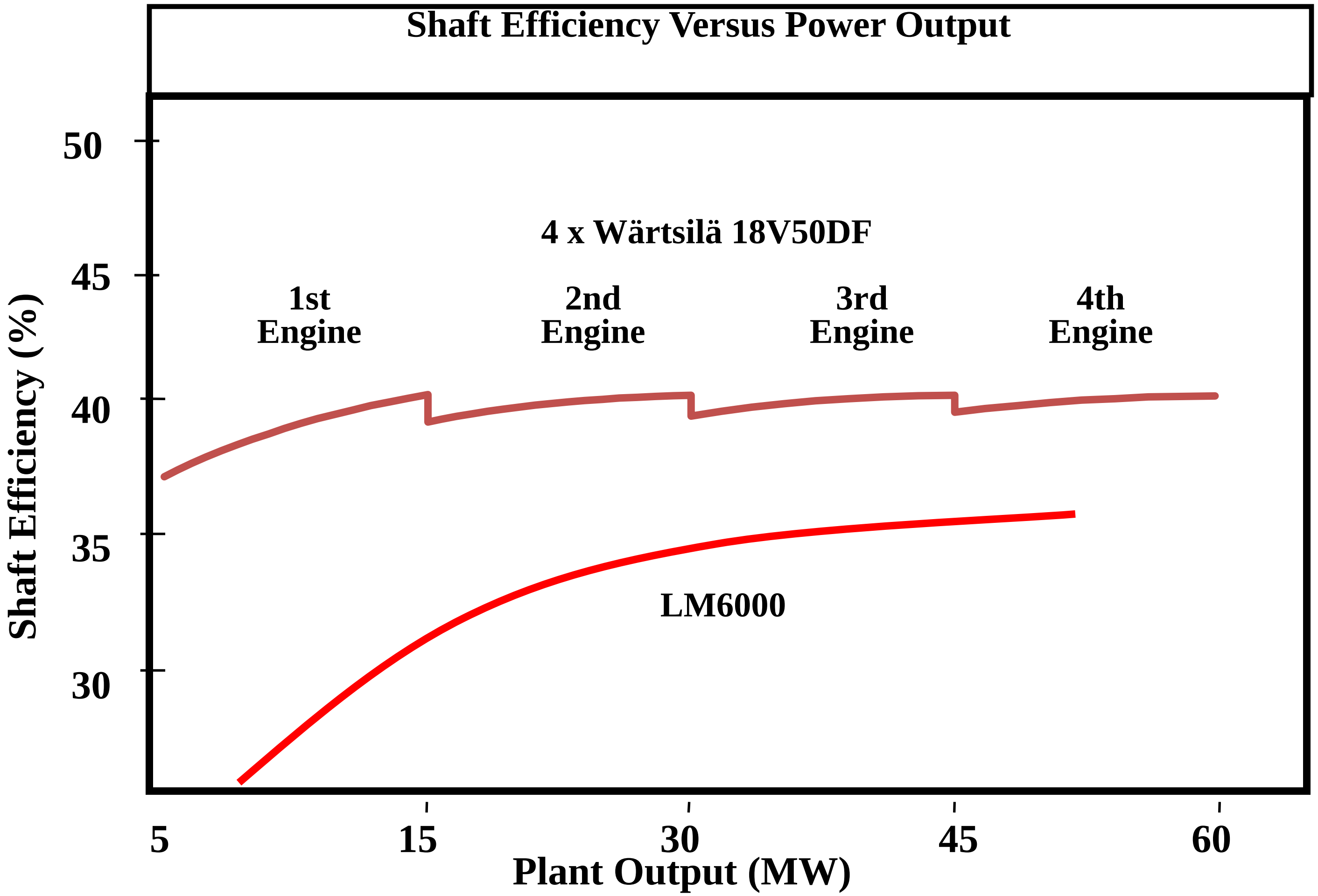
Source: http://www.gepower.com/prod_serv/products/tech_docs/en/downloads/ger3567h.pdf

Gas Turbine Efficiency vs Load



Source: LMS100; http://www.gepower.com/prod_serv/products/tech_docs/en/downloads/ger4222a.pdf

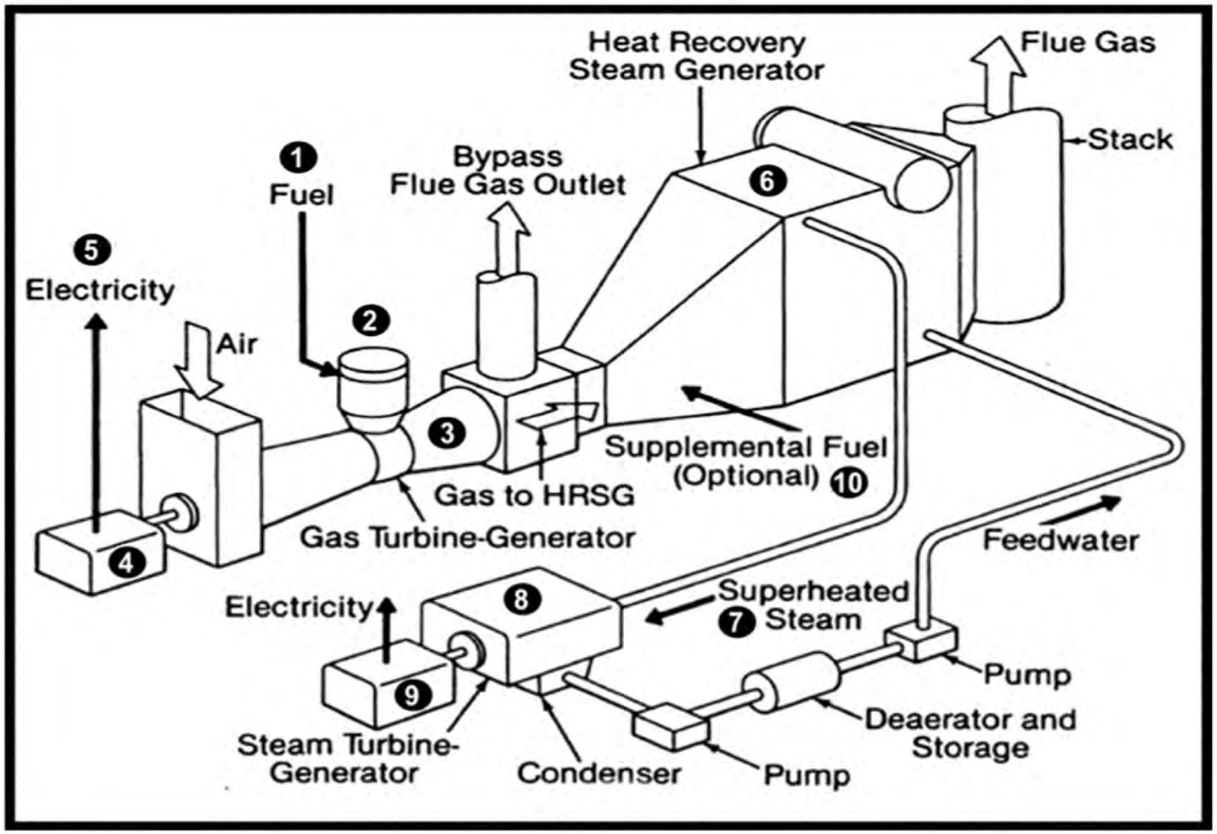
Reciprocating Gas Engine (Wartsila 18V50DF) vs LM 6000 Turbine
Part Load efficiency



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**

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Emission Control Technologies

- Dry Controls
- Wet Controls
- Catalytic Controls

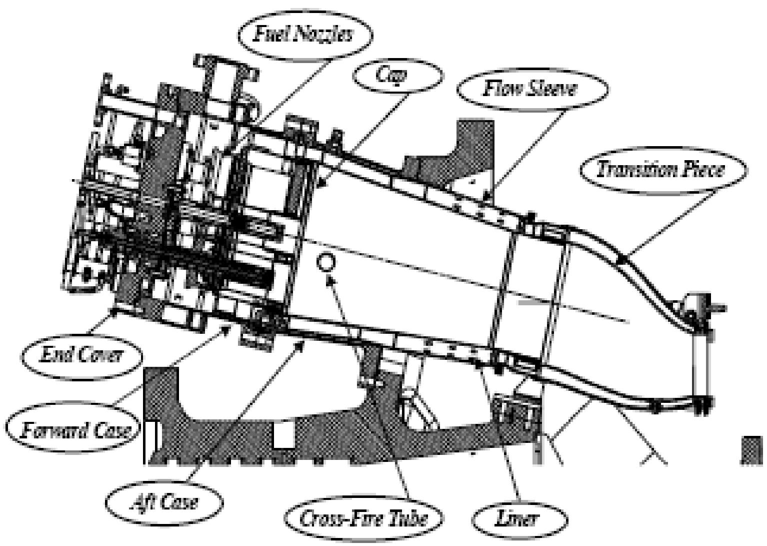
Emission Control Technologies
Dry Controls

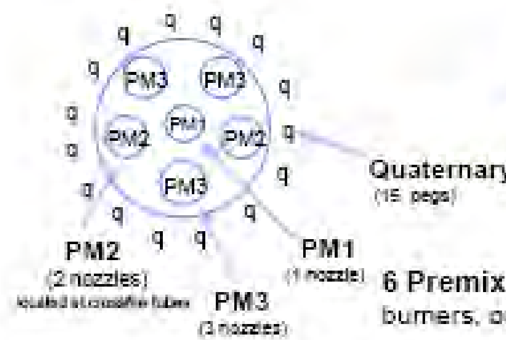
- Conventional (diffusion) combustors
- Dry low-NOx (premix) combustors

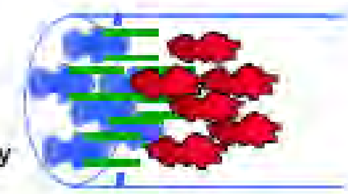
Combustors

Combustors on a GE 7H gas turbine.

GE DLN 2.6 Combustion System





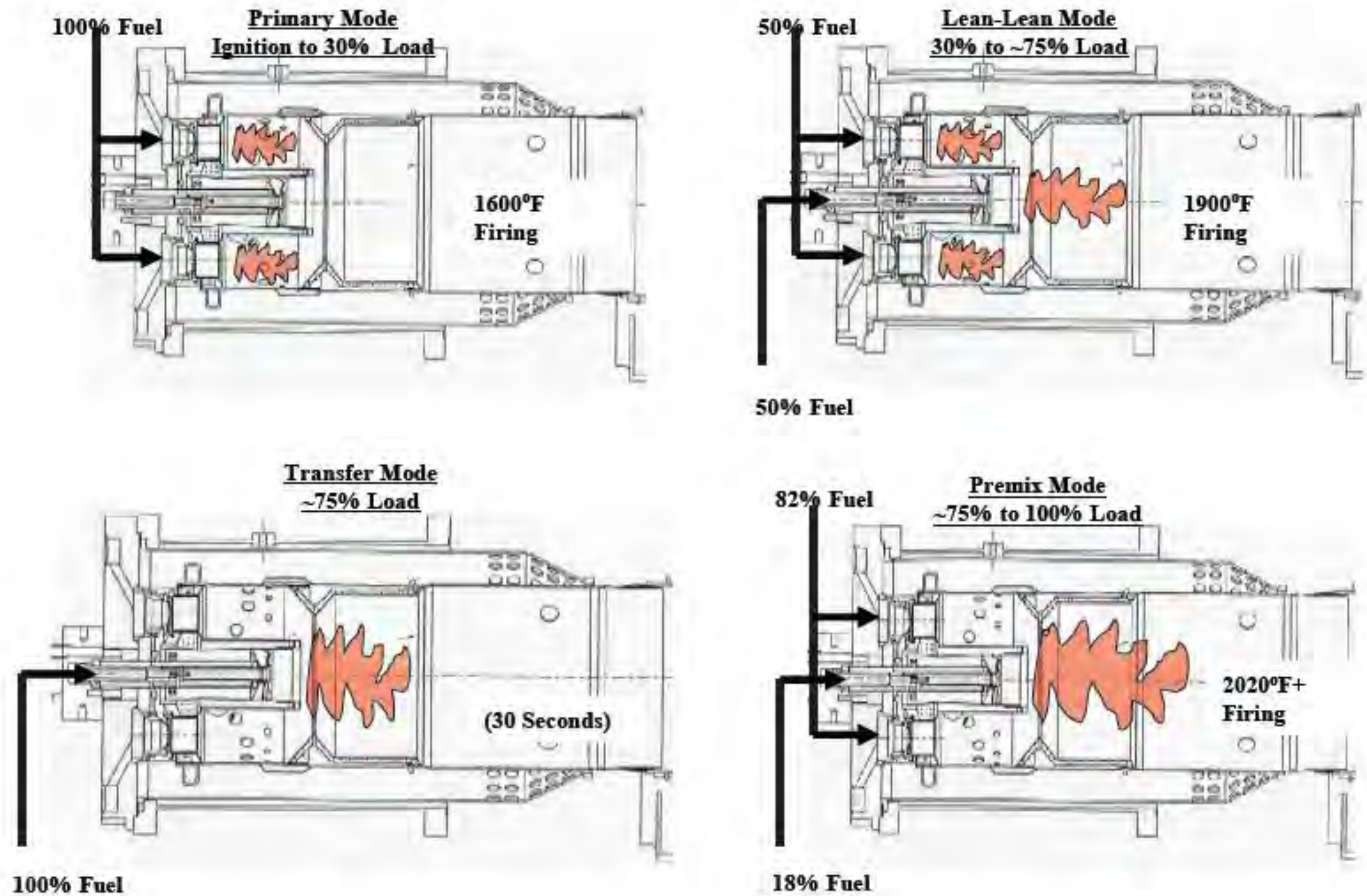


6 Premix Burners - Five identical outer burners, one smaller center nozzle.

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



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

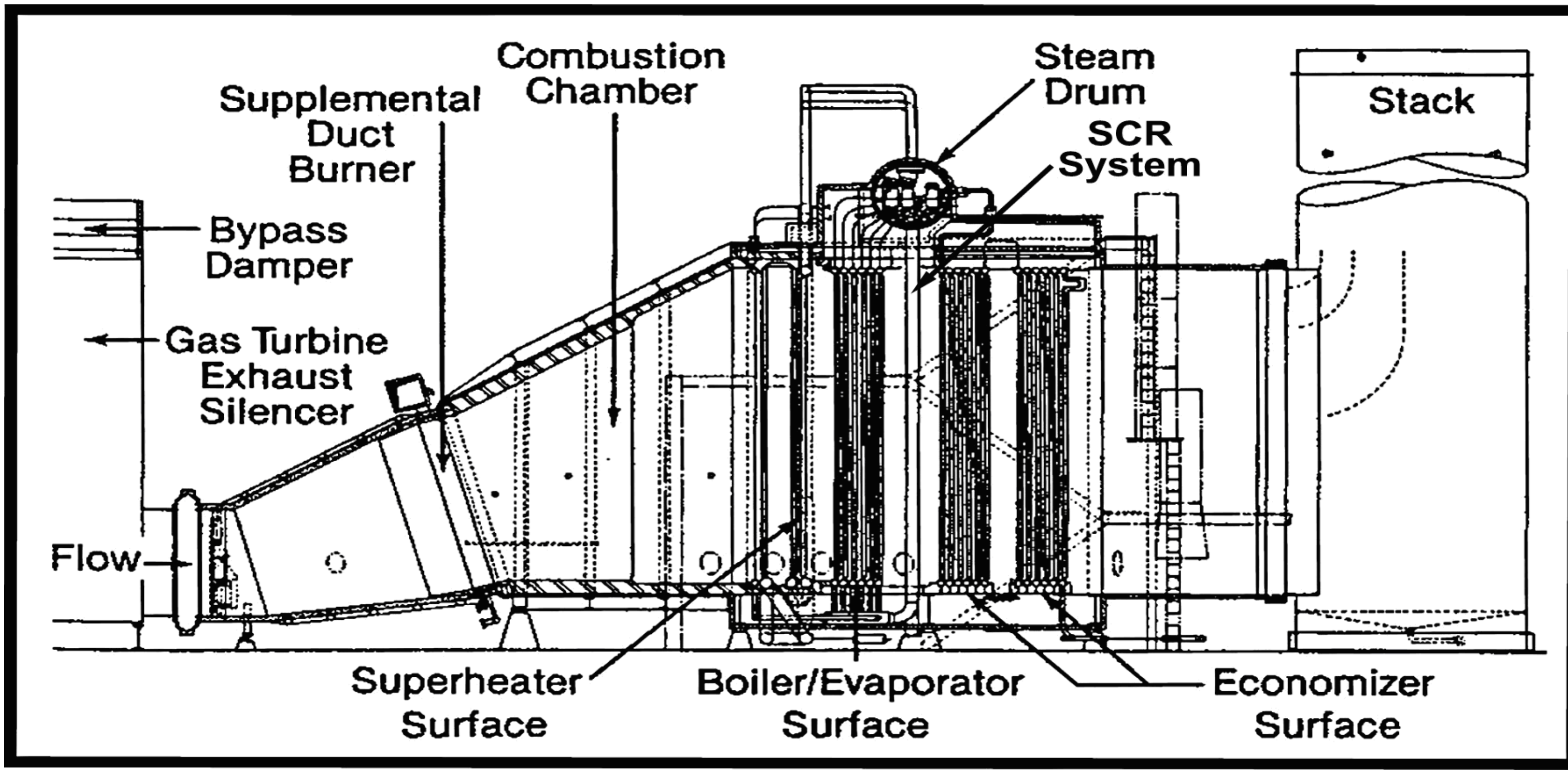
Catalytic Combustors

- 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



Source: Adapted from "Steam: Its Generation and Use". 40th Ed. Babcock & Wilcox.

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^{TM} 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 NO_2)

SCONOx (Emerachem EMx^{TM} Catalyst System) (cont'd)

- Adsorption bed capacity is 12-15 minutes
  - Regeneration provided through H_2 (from reformer) or CH_4 (from natural gas)
  - Regeneration requires reducing atmosphere; thus module under regeneration must be isolated from exhaust using dampers
  - If regeneration uses H_2, steam source is needed for the reformer

SCONOx (Emerachem EMx^{TM} 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 Massachussetts (1 unit); San Diego (1 unit); Los Angeles (1 unit); Redding (1 unit)
- Largest turbine installation is 43 MW

PLANT TOUR