NOx Reduction Technologies

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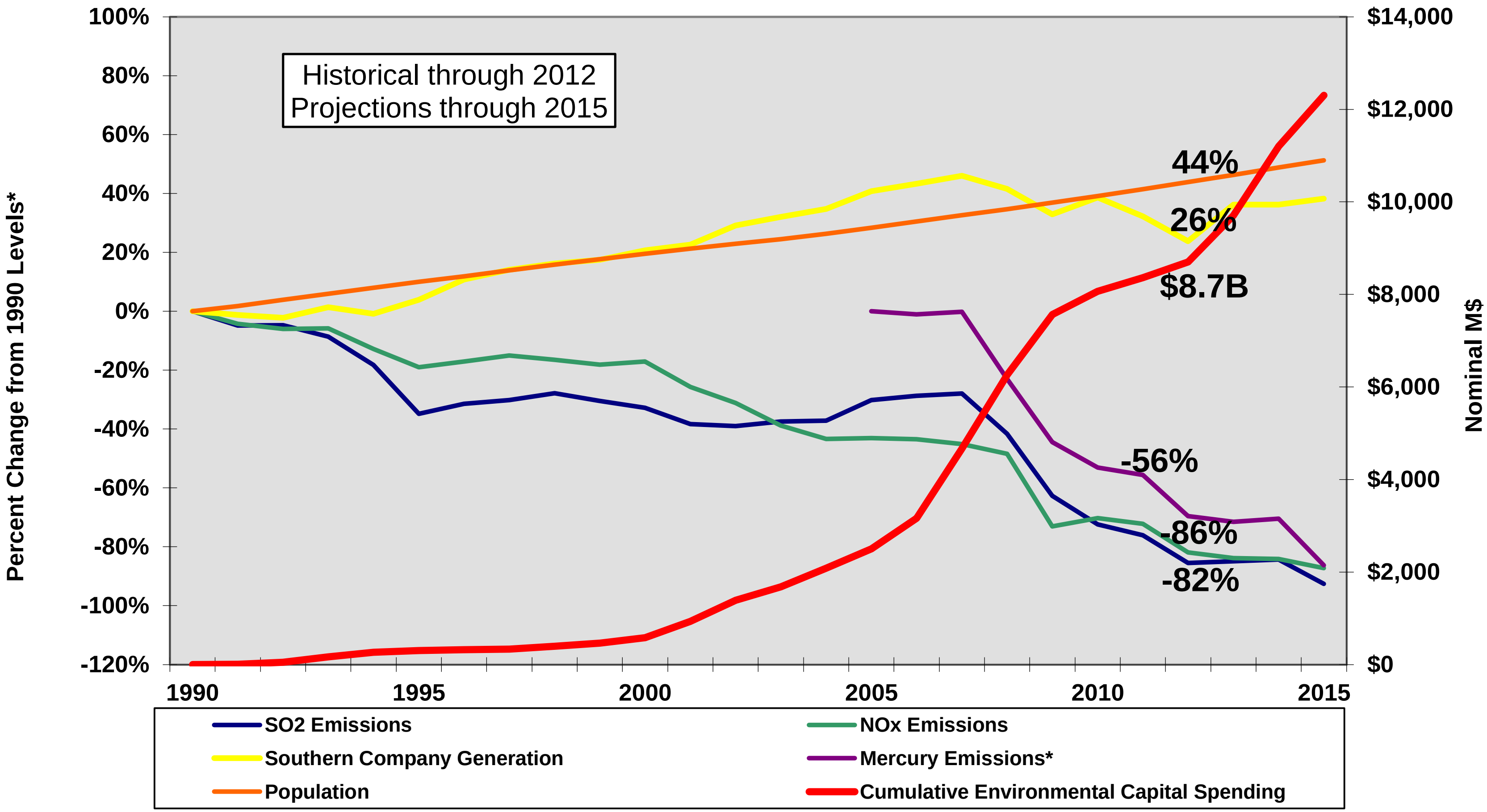
Emissions and Environmental Capital Expenditures
Historical and Projected*



* For Mercury, percent change from 2005.

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NO_X Reduction Alternatives

- Low-NOx Burners (LNB)
- LNB + Overfire Air (OFA)
- Simulated OFA (Burners Out Of Service)
- Coal switching
- Natural Gas (general & seasonal)
- Reburn
- Selective Catalytic Reduction (SCR)
- Selective Non-Catalytic Reduction (SNCR)
- Repowering
- Retirement

NOx Burner Goals

- Control mixing of fuel and air in the furnace to reduce NOx emissions while:
  - efficiently burning the fuel
  - maintaining steam flow, temperatures and pressures
  - not compromising reliability
  - limiting impacts on maintenance.

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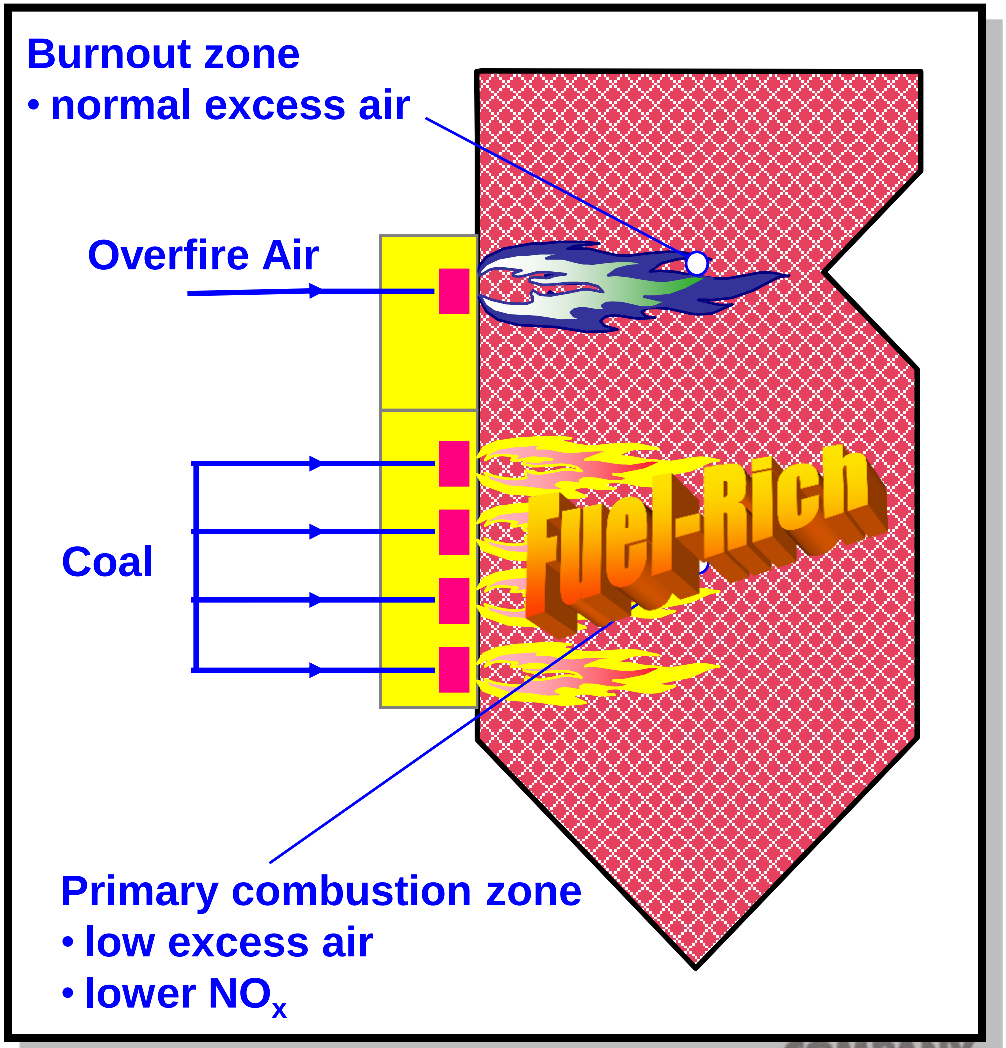
NOx Reduction in Low NOx Burners

- The three T's of Low NOx Combustion
  - Time
  - Temperature
  - Turbulence
- Time in the Low NOx burner is extended by increasing the initial flame length while maintaining early ignition
- Low NOx burners reduce peak flame temperatures
- Turbulence is controlled by imparting swirl on the various air streams which in turn controls the fuel/air mixture

Overfire Air

- Carbon likes O_2 more than nitrogen
- 10 to 30% of the total combustion air injected above the top burner level
- Deprive main flame of oxygen
- Fuel nitrogen converted to N_2
- Can be used with LNB to increase NOx reduction by 10 to 25%



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Southern Company LNB Efforts

- Two DOE Advanced Combustion Techniques demonstrations (wall fired and tangentially fired application)
- One additional wall fired demonstration as an EPRI collaboration.
- Demonstration of advanced on-line optimization systems.
- Approximately 35 commercial installations of Low NOx combustion systems.
- Emission range from 0.20 to 0.45 lb/MMBtu

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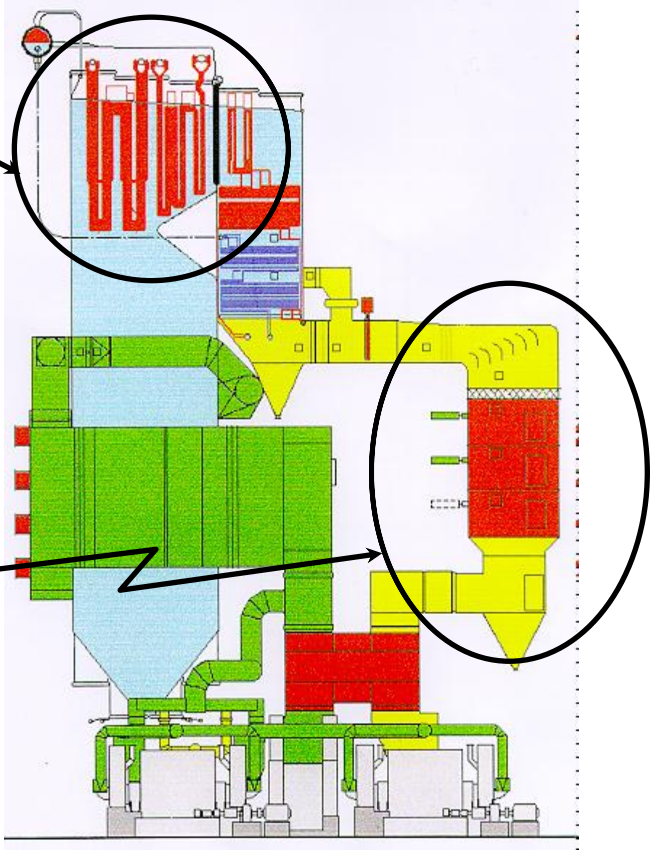
SCR System Overview

Selective Non-Catalytic Reduction

- 1600 - 2000 °F
- 15 - 40% Reduction
- >5 ppm NH_3 Slip
- $8 - $20/kW Capital Cost
- $800 - $2500/ton Levelized Cost

Selective Catalytic Reduction

- 550 - 750 °F
- 50 - 90% Reduction
- <5 ppm NH_3 Slip
- $80 - $150/kW Capital Cost
- $1500 - $5300/ton Levelized Cost

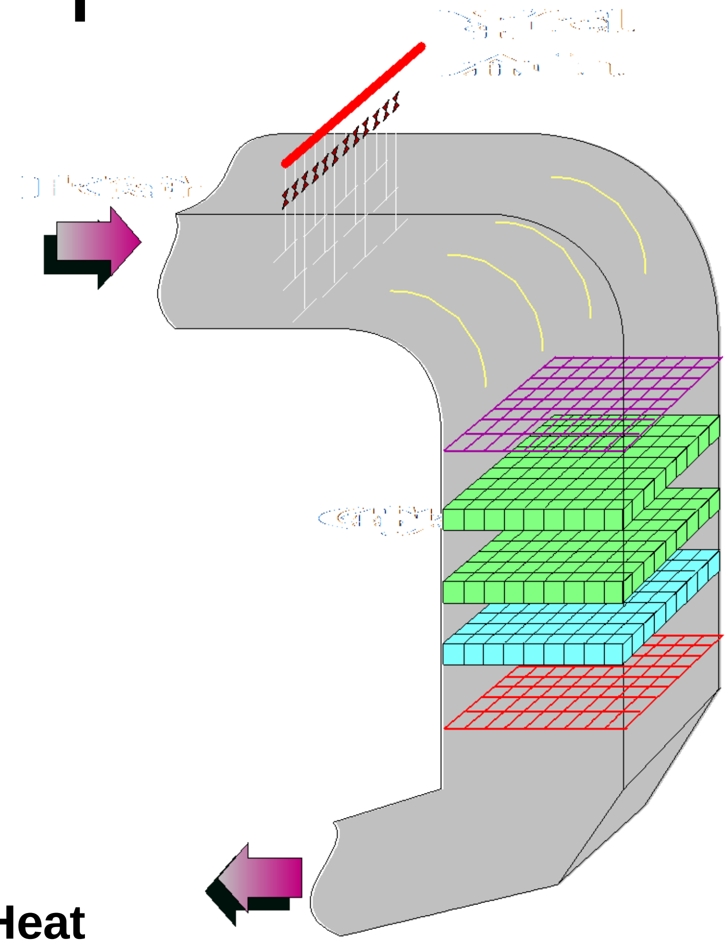


Southern Company SNCR Efforts

- Initial demonstration at APC Plant Barry
- Nine commercial installations
- Typical performance 15% - 20% NOx reduction

SCR Principles of Operation

- The SCR process works by injecting ammonia into flue gas as a reagent for reducing nitrogen oxides of NO
- Flue gas passes over a fixed bed catalyst installed in a reactor
- Ammonia reacts with nitrogen oxides on the catalyst surface to form molecular nitrogen and water



$4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$ + Heat

$2NO_2 + 4NH_3 + O_2 \rightarrow 3N_2 + 6H_2O$ + Heat

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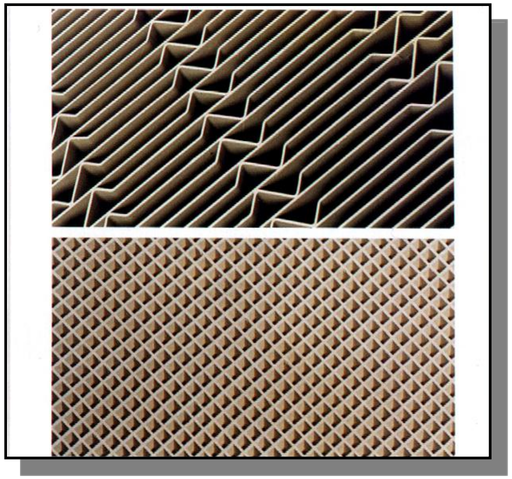
Catalyst Performance Requirements

- High activity over a wide temperature range
- High selectivity (low SO_2/SO_3 conversion rate)
- Thermal stability
- Mechanical stability
- Low pressure loss
- Recyclable / disposable
- Resistant to deactivation mechanisms



Southern Company SCR Efforts

- Pilot SCR demonstration at Gulf Power Plant Crist
- Commercial installation at SEI Birchwood Plant
- Approximately 20 commercial installation to date
- Emission less than 0.01 lb/MMBtu

Southern Company SCR Philosophy

- SCR Emission Performance
  - 85% NOx Reduction
  - 2 ppm NH3 Slip with NOx and Slip Distribution
  - 16,000 Hour Catalyst Life
  - 1% SO_2 to SO_3 Oxidation (maximum)
  - Pressure Drop Determined on Plant by Plant
- Use Combination of Cold Flow and CFD Modeling
- Maximize Use of Modularized Design & Construction
- Volume Procurement of SCR Components

Major SCR Issues

- Catalyst Selection and Catalyst Management
- Flyash and Popcorn Ash Pluggage
- Boiler Turndown and Dispatch Restrictions
- SO2/SO3 Oxidation Rate
- Understanding Hg Oxidation

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QUESTIONS ?