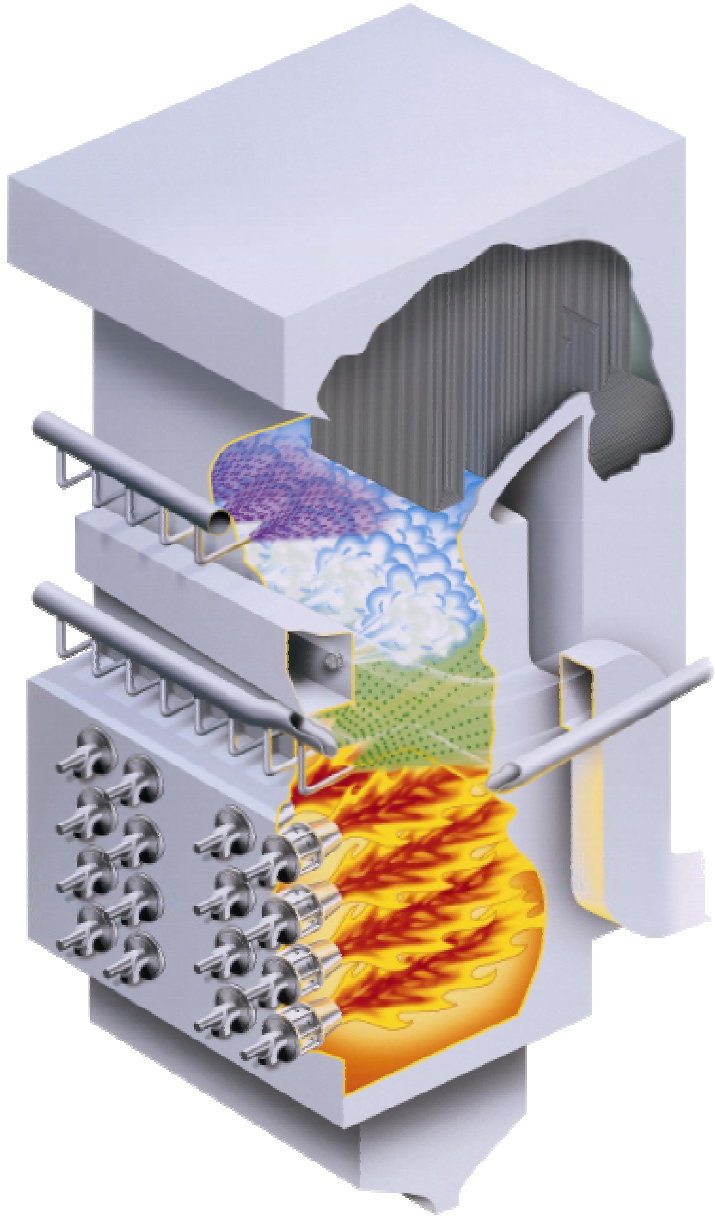
Mercury Control Using Combustion Staging



GE Environmental Services

DOE/NETL
Mercury Control Technology R&D
Program Review
July 13, 2005

imagination at work

Outline

Project	DOE Contract	Period of Performance
Mercury reduction via coal reburning at Green station	DE-FC26-03NT41725	1/23/2003 – 1/22/2005
Mercury reduction via air staging (SOFA) at Lee station	DE-FC26-05NT42310	6/27/2005 - 12/26/2006

U.S. DOE Contracting Office Representative Dr. P. Botros

Integrated approach to mercury control

- **Enhancement of naturally occurring mercury removal and oxidation on fly ash to provide consistent Hg removal efficiency**
  - **carbon in fly ash is an effective mercury sorbent**
  - **carbon in fly ash formed under staging conditions may be more reactive**
    - ✓ **LNB, SOFA, Coal Reburning**
  - **mercury removal is more effective at T < 300 ^{o}F**

- **Small amount of activated carbon injection to trim mercury emissions**

Integrated approach

CO/O_2 sensors

Combustion sensors

Deep staging without increase in CO emissions

ack

Duct Humidification

APH

ESP

Fuel

Air

AC injection

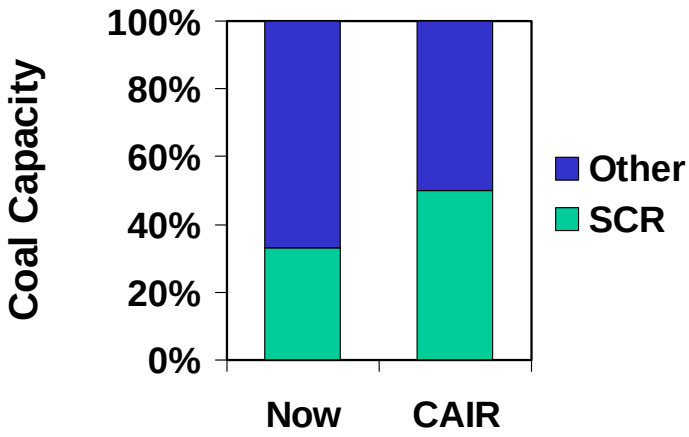
- LOI 6-12%
- Improve carbon reactivity
- Improve Hg oxidation

Combustion Modifications

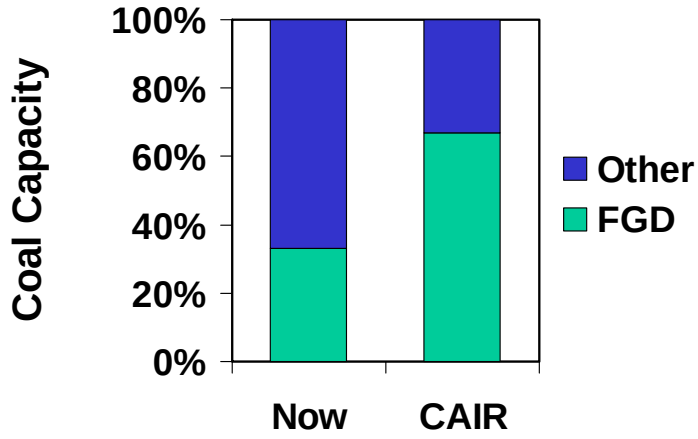
- LNB
- SOFA
- Reburning

Industry response to CAIR/CAMR

NO_x



SO_x



Mercury cap
38 ton

CAMR

Units	Mercury Control	Technology
Base load	>80%	SCR/FGD Fabric Filter
Small units	<80%	Integrated approach

Preliminary Field Evaluation of Mercury Control Using Combustion Modifications

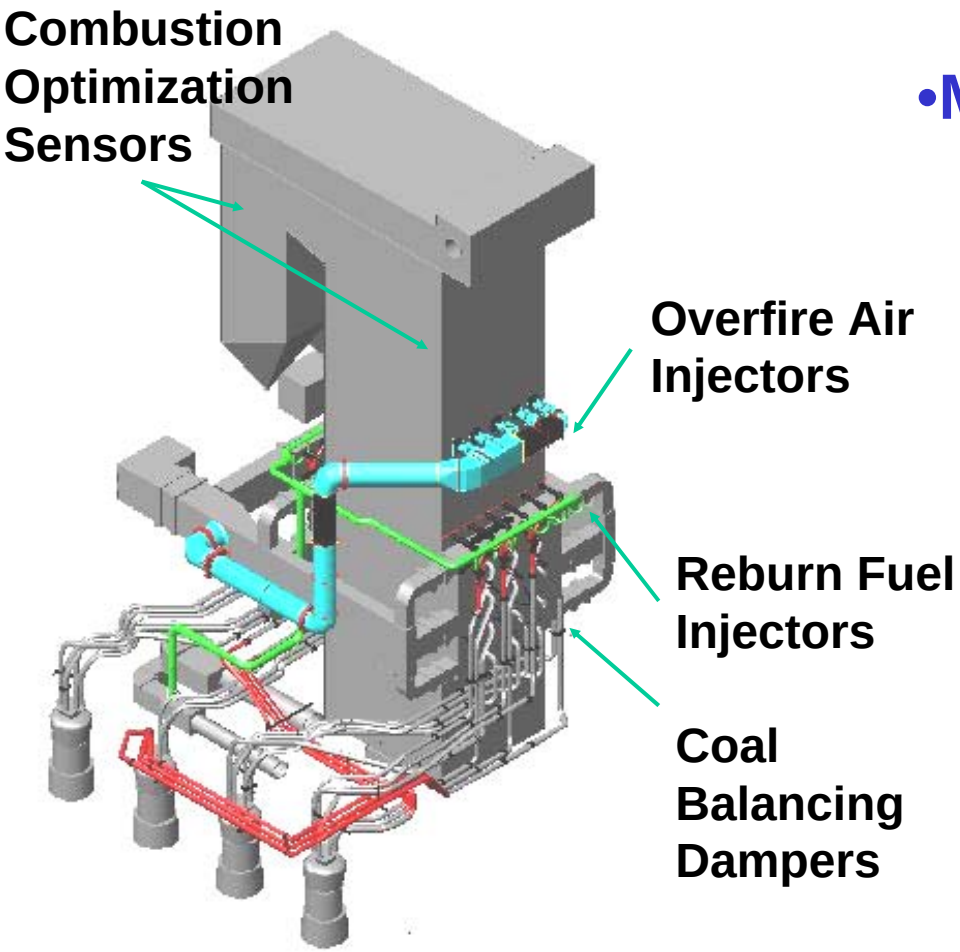
Mercury Control via Coal Reburning

DOE Contract No. DE-FC26-03NT41725

January 23, 2003 – January 22, 2005

Program at Green station

- **Green Station Unit 2**
- **Capacity: 250 MW**
- **Fuel: Bituminous coal**



- **Reburning project**
  - **Coal reburn system**
  - **OFA system**
  - **Coal dampers**
  - **Combustion sensors**

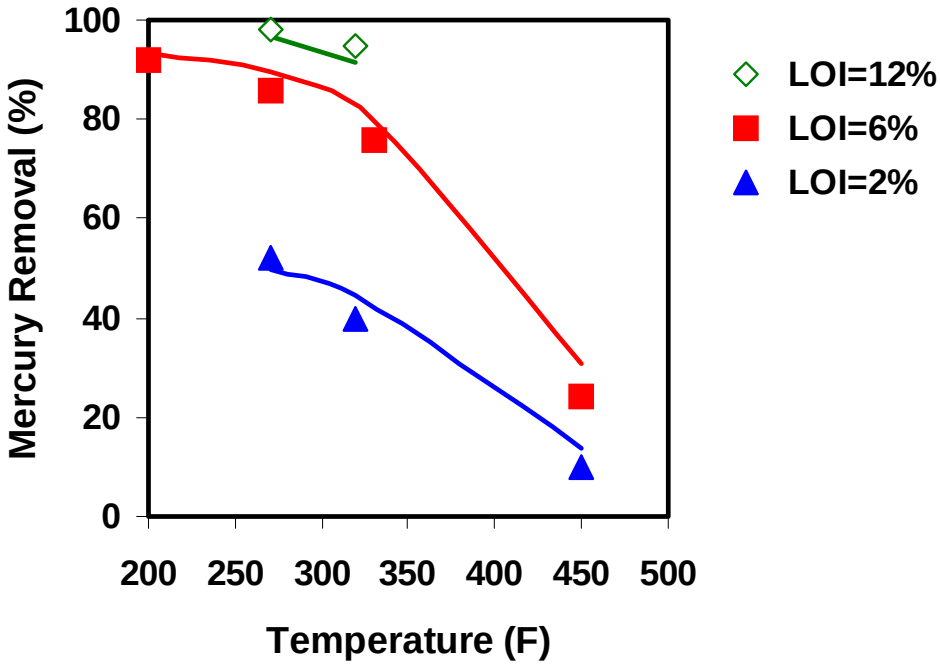
- **Mercury project**
  - **Effect of LOI**
  - **Effect of temperature**
  - **Effect of combustion conditions**
  - **Optimization**

Test variables:
- Ruburn settings
- OFA settings
- Burner settings
- BOS
- Load

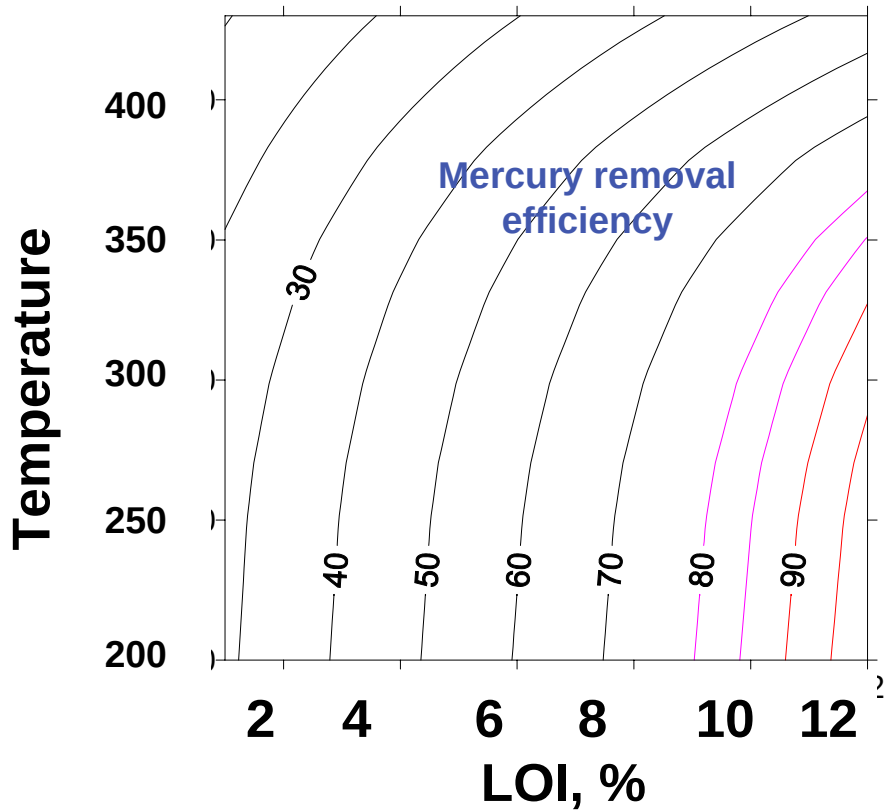
Pilot-scale data

- Boiler Simulator Facility ($1x10^6$ Btu/hr, 300kW)
- Simulation of combustion conditions and time-temperature profile in full-scale utility boiler

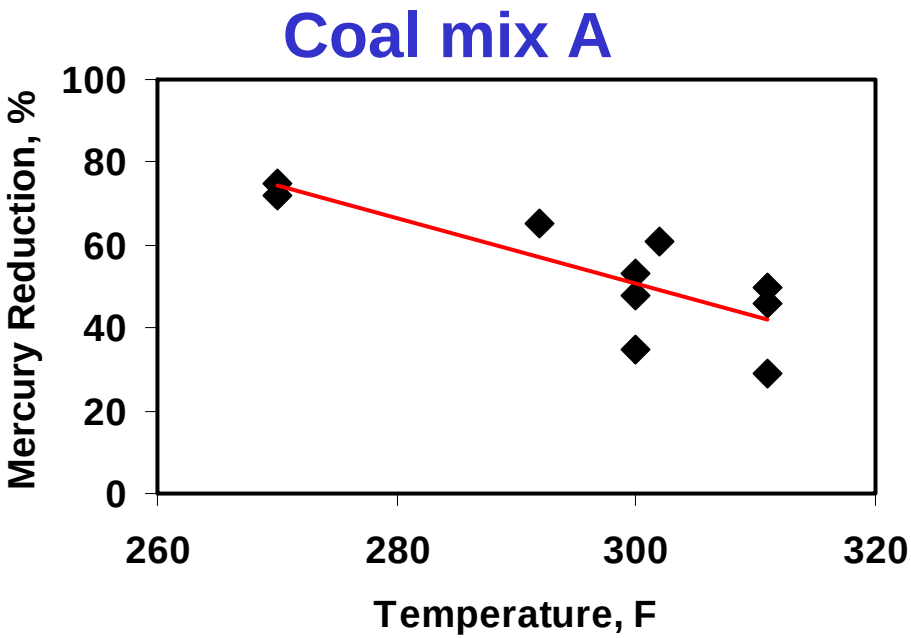
Effects of LOI and ESP temperature

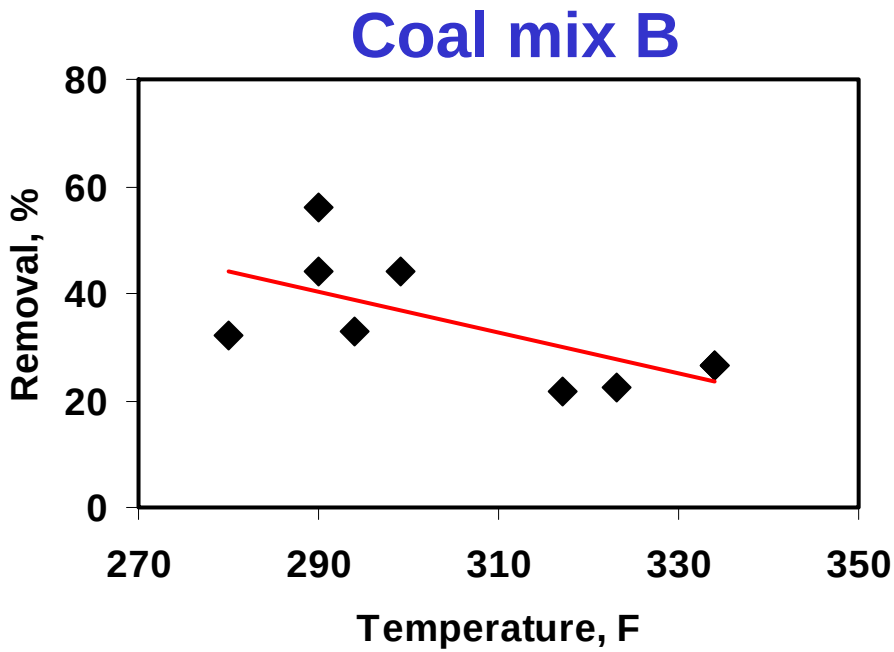


Mapping of process conditions



Effect of ESP temperature on mercury removal

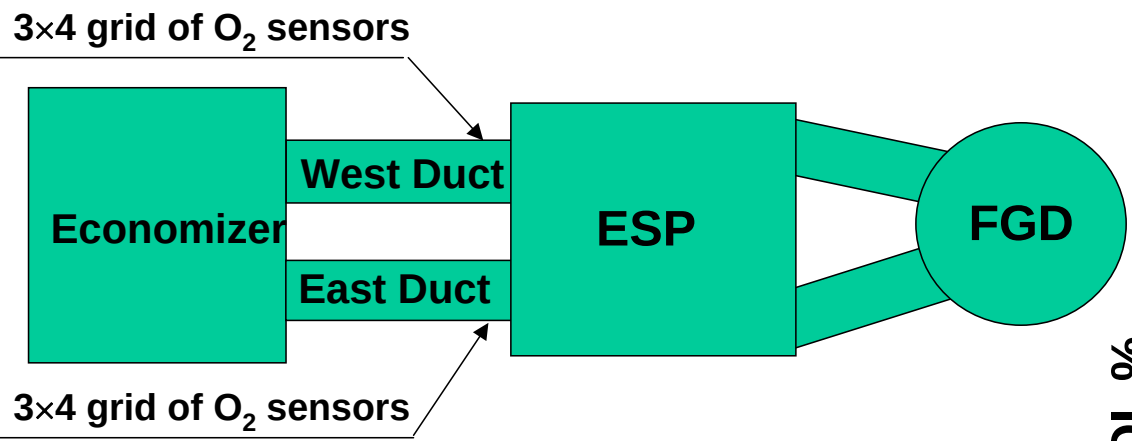


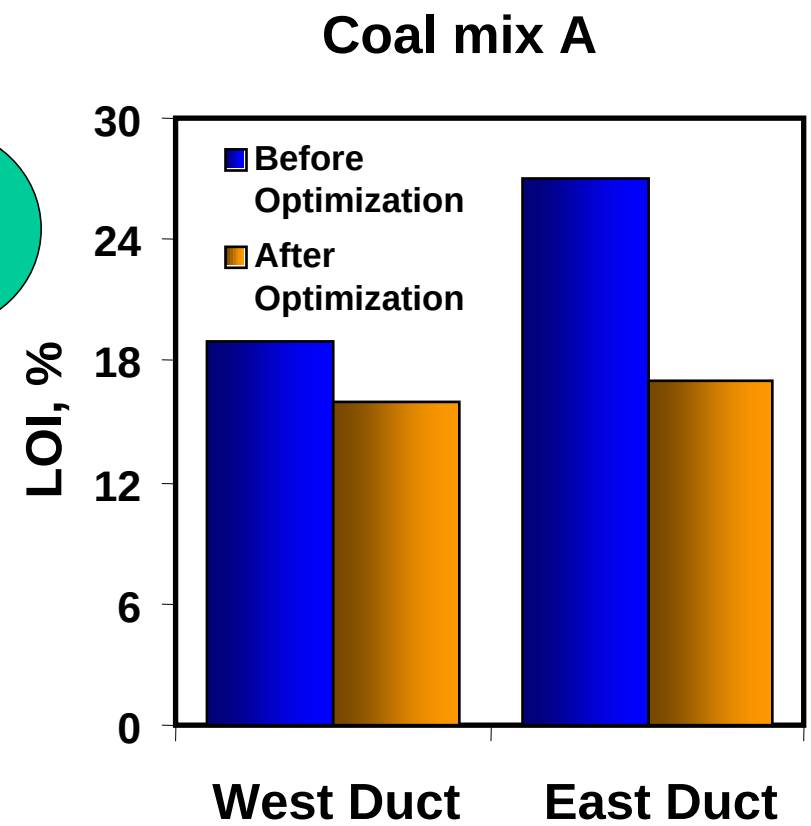


Decreasing ESP temperature improves mercury removal

Enhancement of naturally occurring Hg removal while minimizing LOI

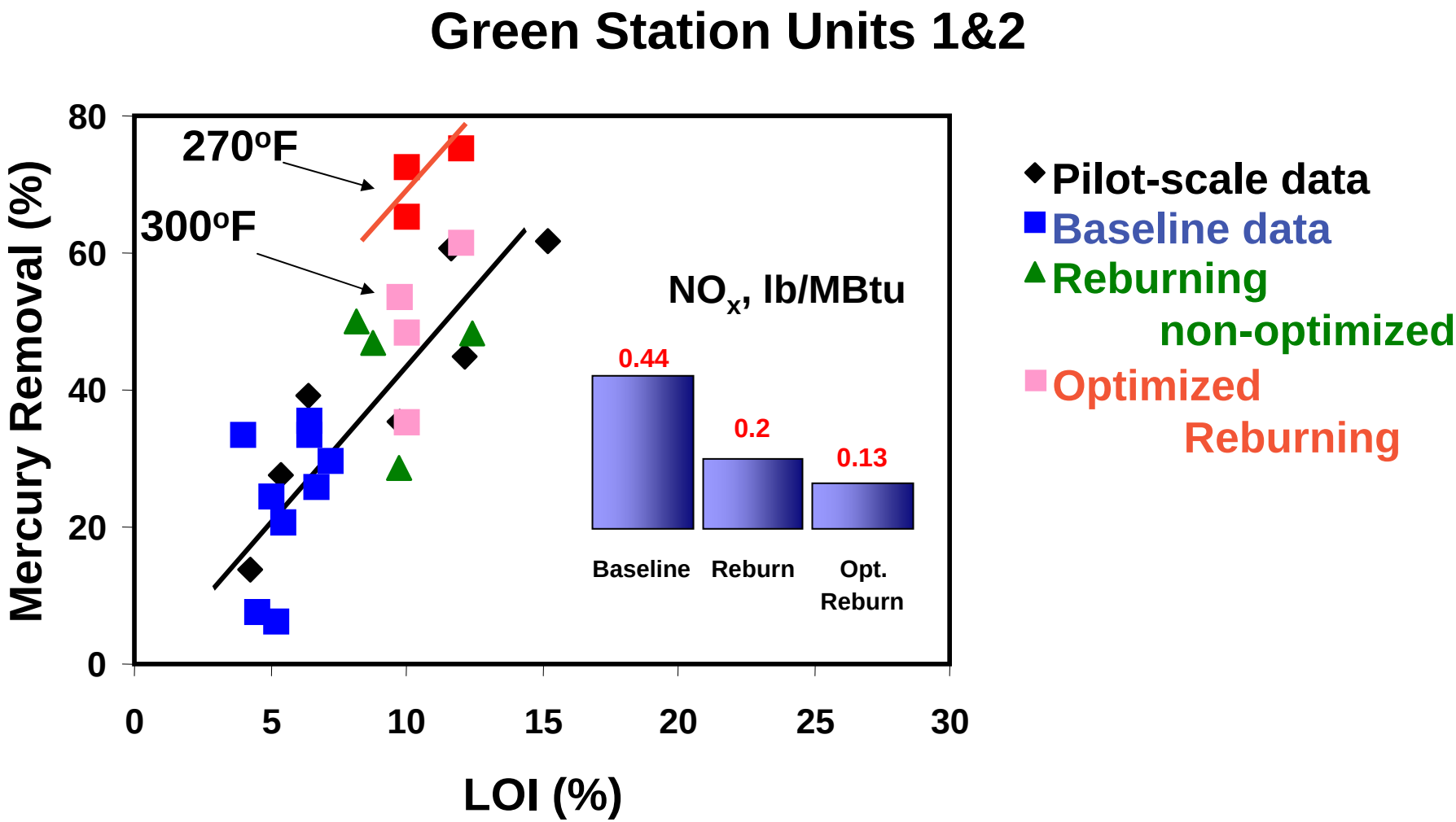
Green Unit 2





- **Coal line balancing**
  - **Manually operated coal line balancing dampers**
- **Burner tuning**
  - **Oxygen balance at the economizer exit grid**

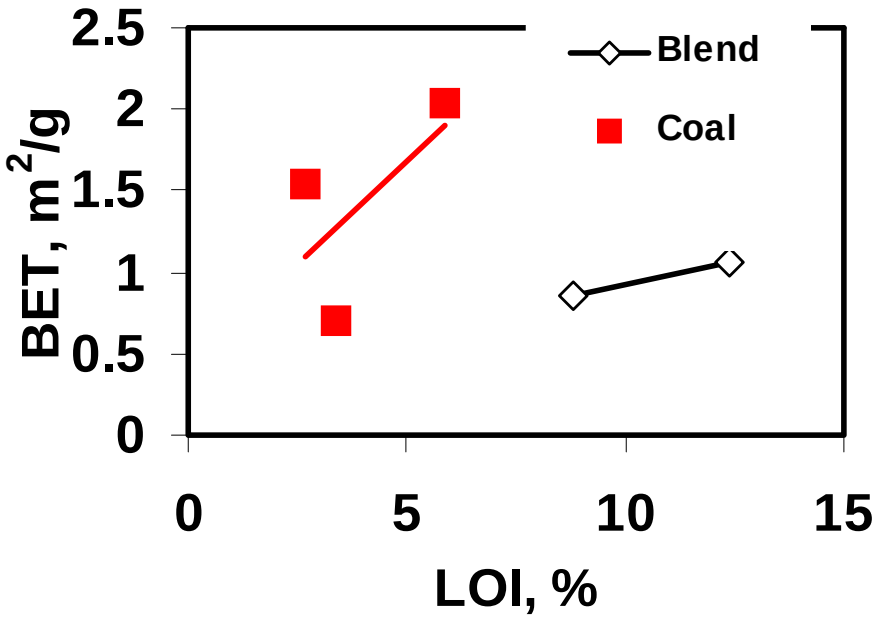
Summary of pilot- and field data



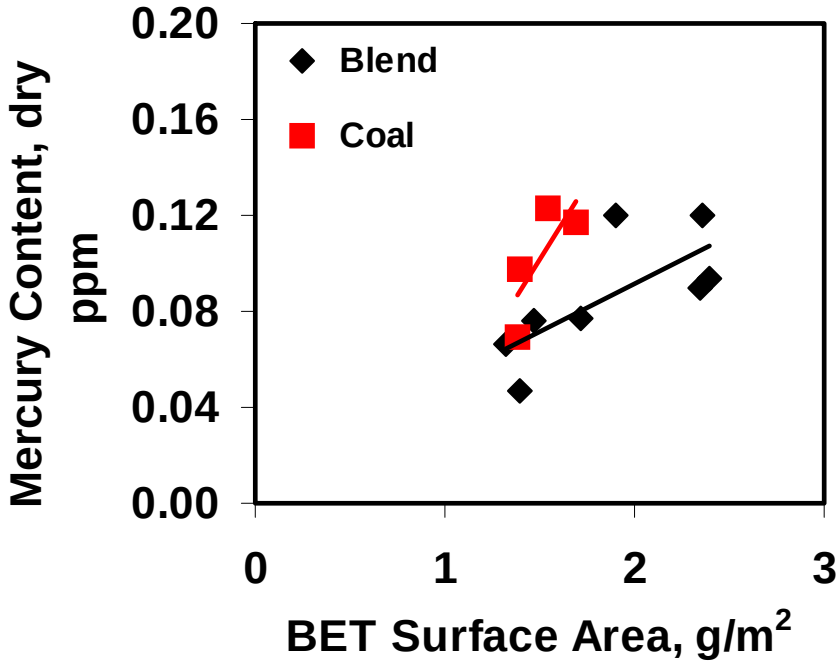
Up to 80% Hg removal at optimized conditions

Mercury absorption on fly ash

Fly ash surface area vs. LOI



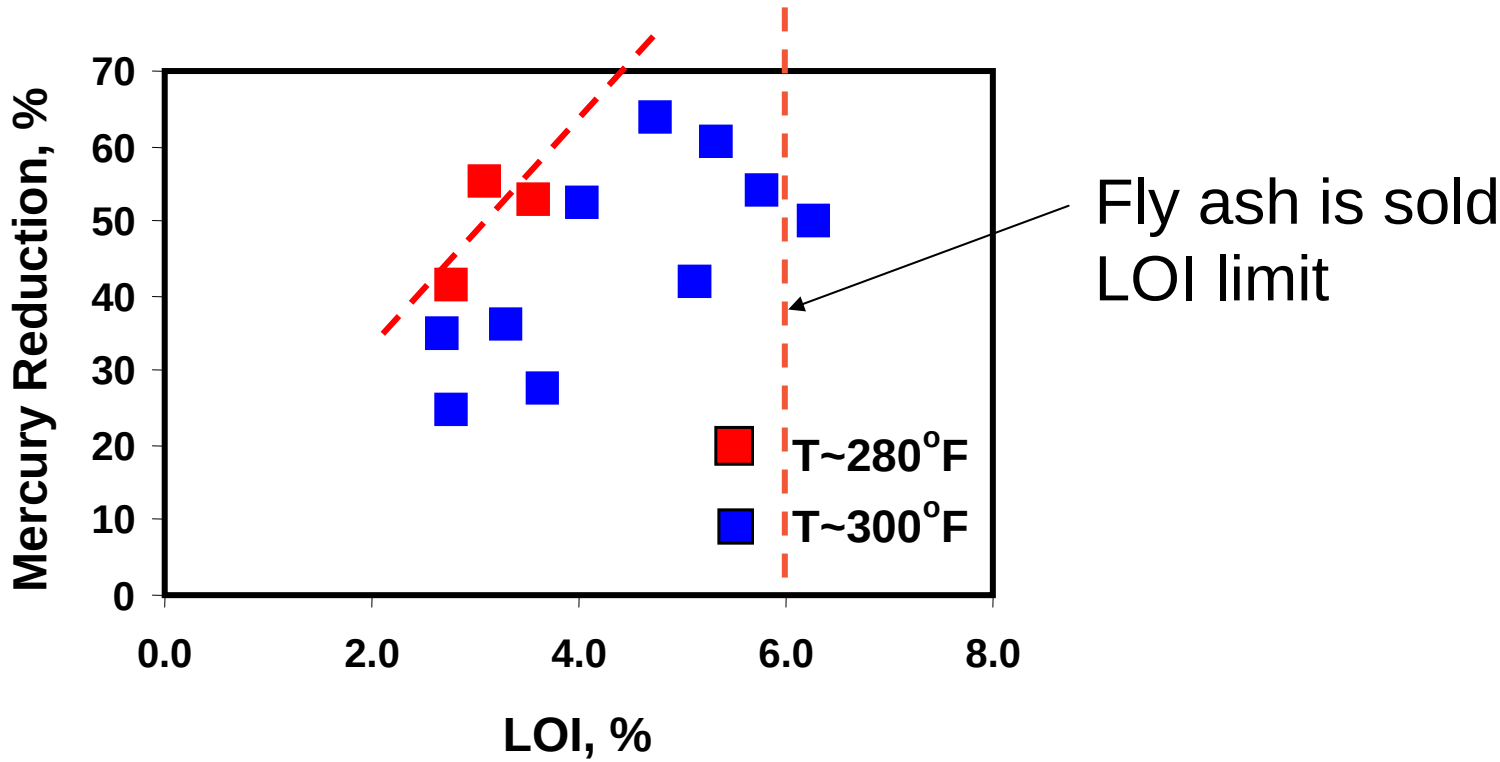
Mercury in ash



Mercury reduction in air staging

- Dual furnace 200 MW t-fired unit equipped with SOFA
- Low sulfur bituminous coal
- c-s ESP

- Carbon tubes (EPA method 324)
- ESP inlet and outlet

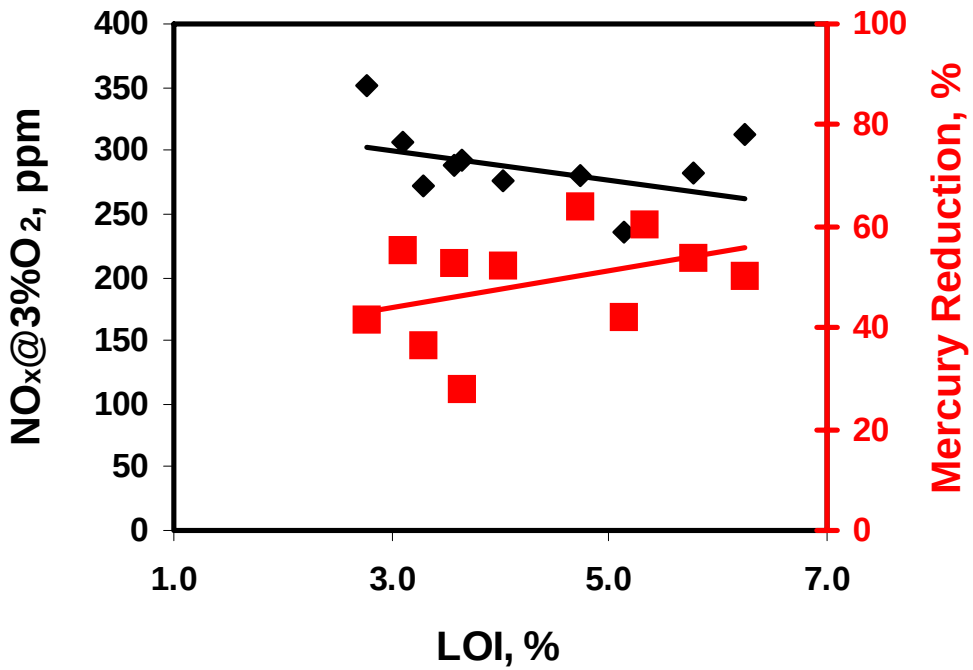


Mercury removal increases with LOI increase

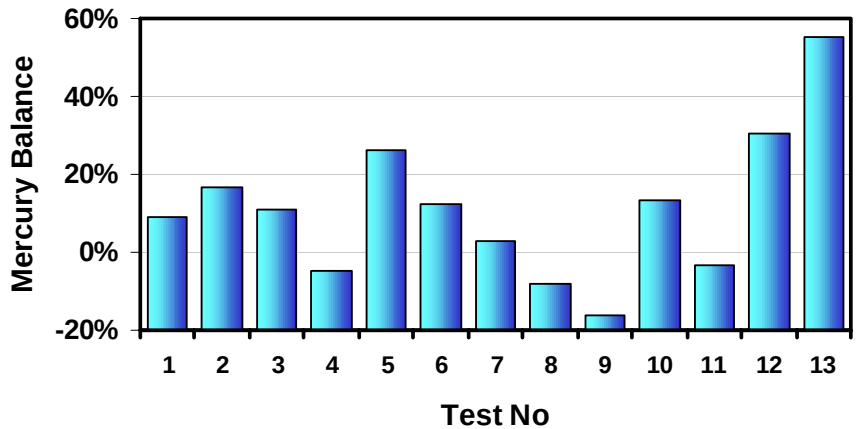
Decreasing temperature improves mercury removal

Mercury and NO_x emissions (SOFA)

Mercury and NO_x Emissions



Mercury Balance



±20%

Demonstration of an Integrated Approach to Mercury Control at Lee Station

Mercury reduction via air staging (SOFA)

Contract DE-FC26-05NT42310

June 27, 2005 - December 26, 2006

Mercury Control at Lee Station

- Lee station Unit 3
- Located near Golsdsboro, NC
- 250 MW opposed-wall fired
- E. Bituminous coal
- SO_3 conditioning system

Project Objectives:

(1) Demonstrate 70% mercury control from current emissions

- **the enhancement of "naturally" occurring Hg capture by fly ash**
- **duct humidification to lower ESP temperature**
- **AC injection upstream of the ESP will be used as a polishing step**

(2) Minimize or eliminate if possible AC injection rate

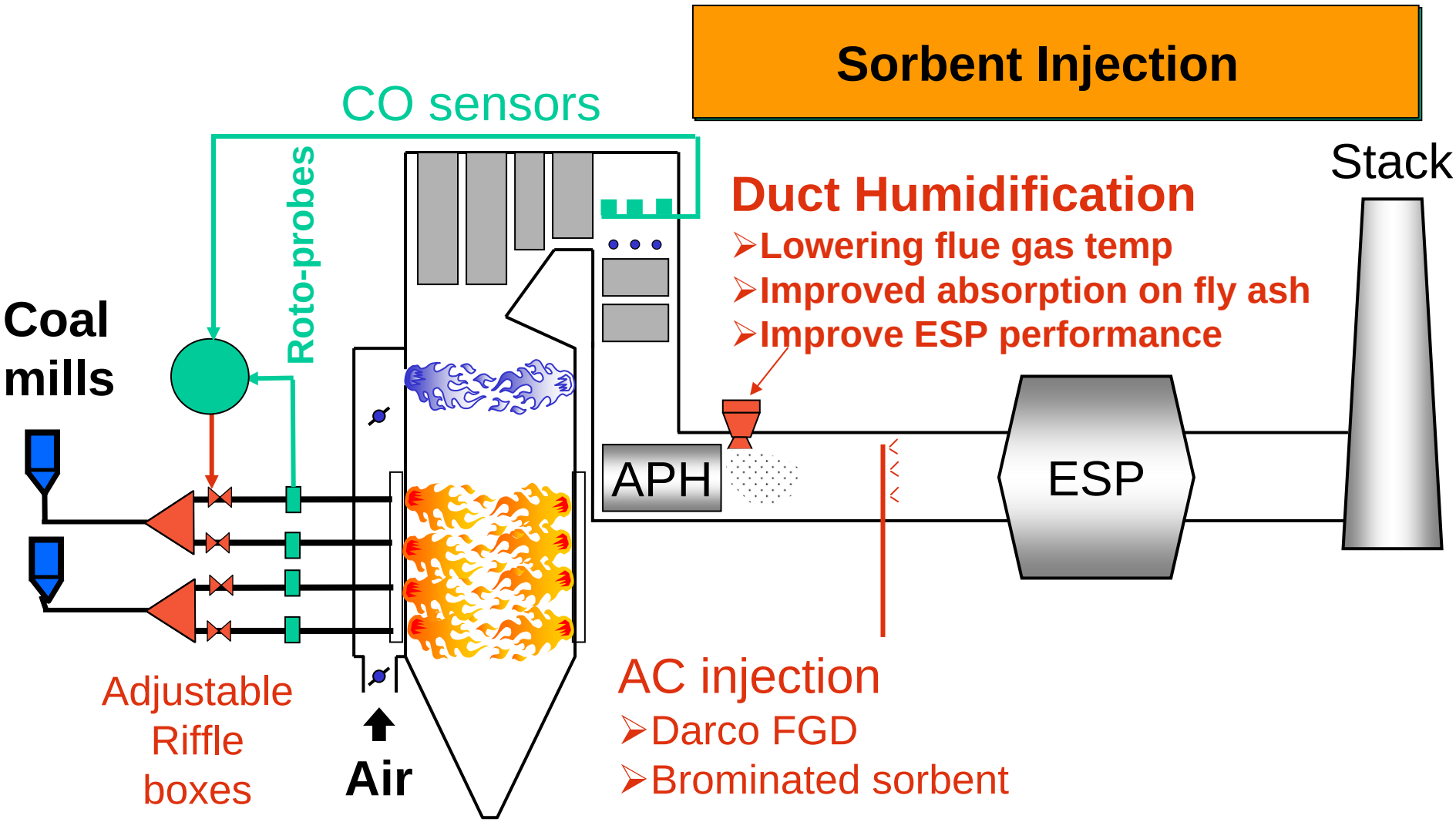
(3) Optimization of burners and the SOFA system

(4) Improve ESP performance by using duct humidification system

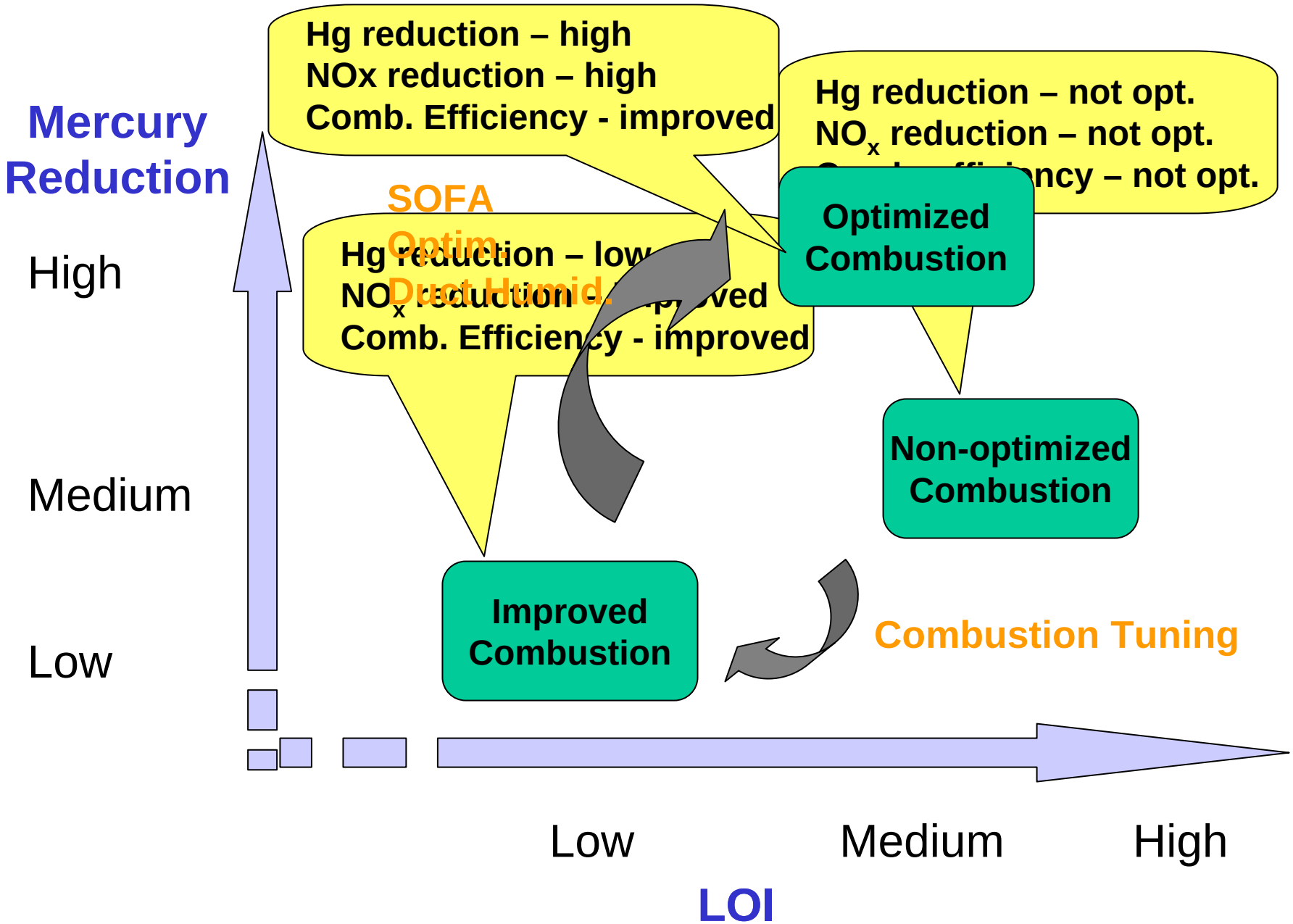
Project information

- Project participants
  - GE Environmental Services
    - EER, Santa Ana, CA – Overall lead, Combustion optimization
    - BHA Group, Kansas City, MO – Duct Humidification
    - Emissions Monitoring Group Hatfield, PA– Mercury measurements
  - Progress Energy
- Project funding $2.2M
  - $1.5M DOE NETL
  - $0.5M GE
  - $0.2M Progress Energy

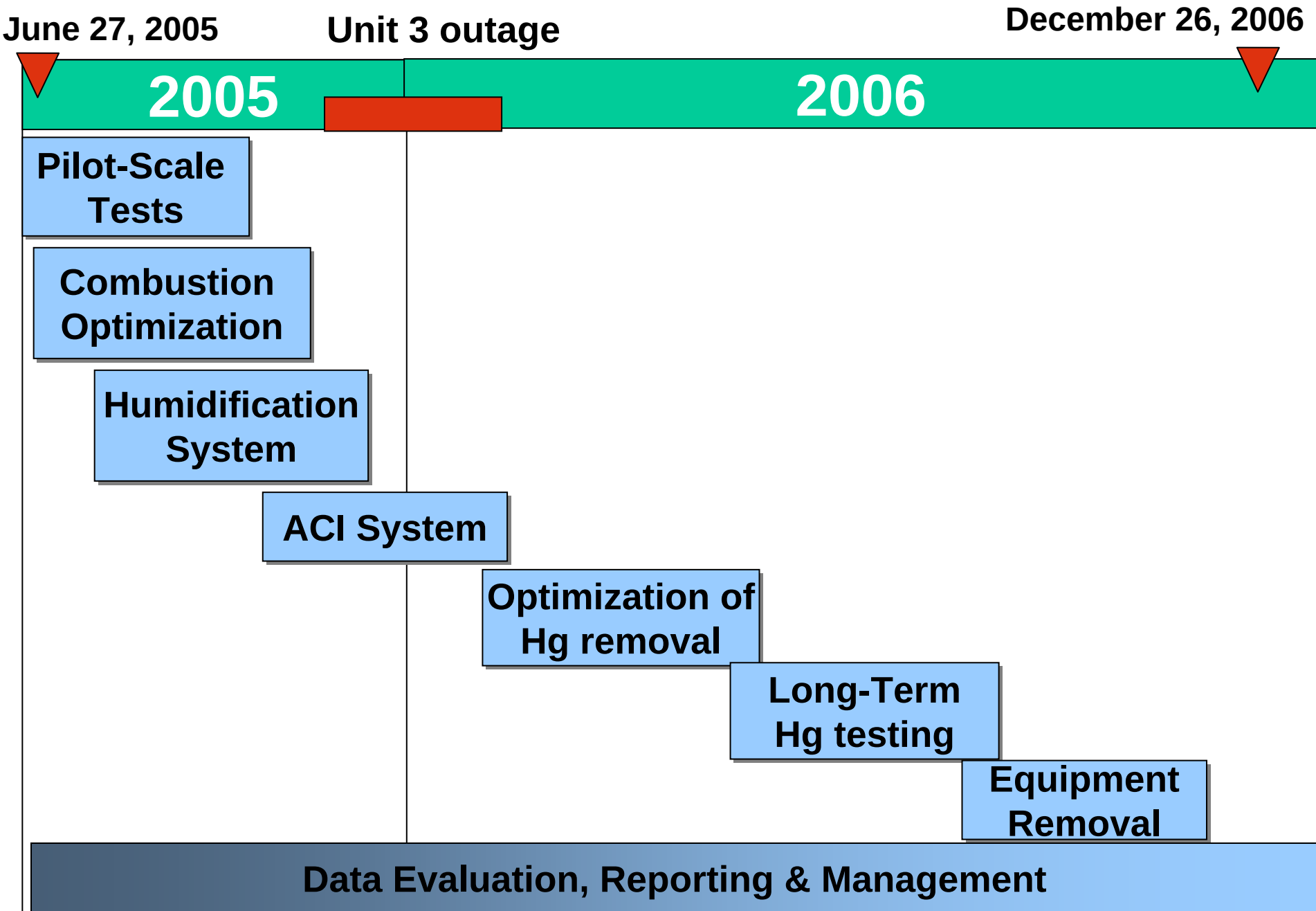
Mercury control at Lee station



Project strategy



Program schedule



Summary

- **Integrated approach is more economic in multi-pollutant control environment**
- **Enhancement of “natural” ability of fly ash may reduce mercury emissions by 60-80%**
- **Units not equipped with SCR or FGD are most likely to benefit from the approach**
- **Mercury solution is tailored to plant configuration**
- **Potentially reduced NO_x and CO emissions are co-benefits of the approach**