

Worldwide Pollution Control Association

FirstEnergy ESP Seminar
November 27th – 28th, 2007

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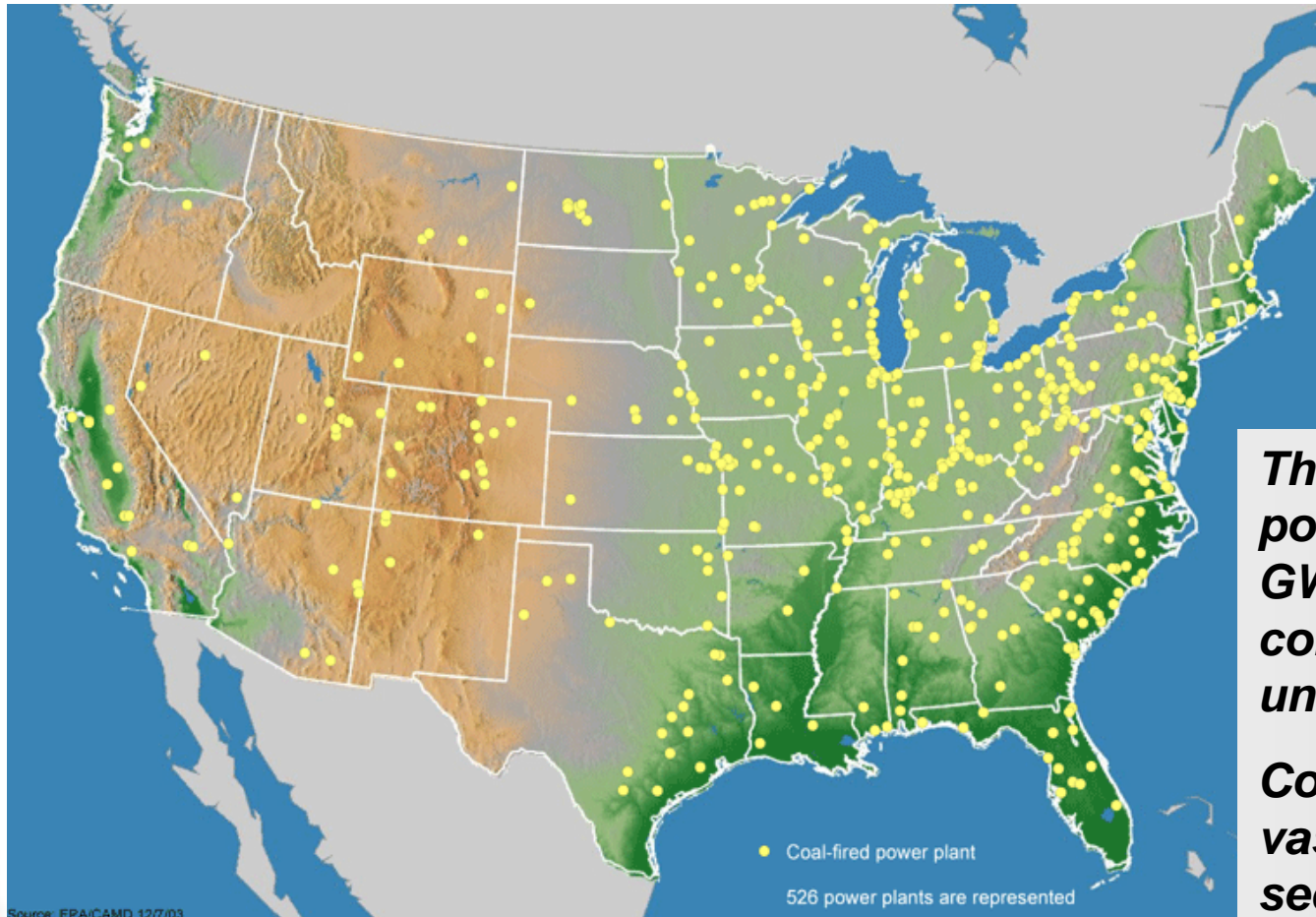
Generating Powerful SolutionsSM

Impact of SO_x, NO_x and Mercury Controls on ESP Performance

**WPCA Meeting
November 29, 2007**

Sam Kumar
Manager, Particulate Control

U.S. Coal-Fired Power Plants



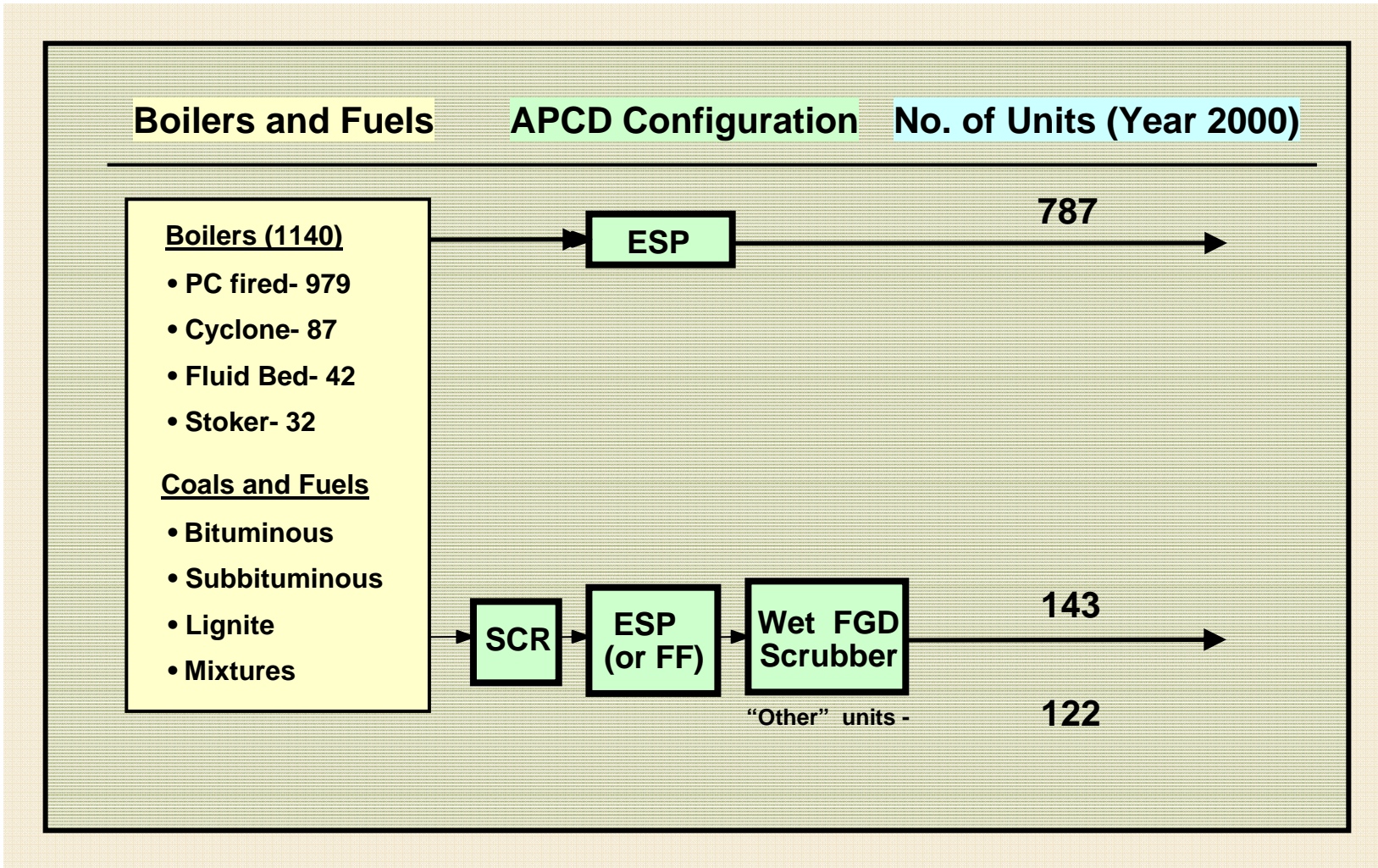
There are about 530 power plants with 305 GW of capacity that consist of about 1,300 units.

Coal plants generate the vast majority of power sector emissions:

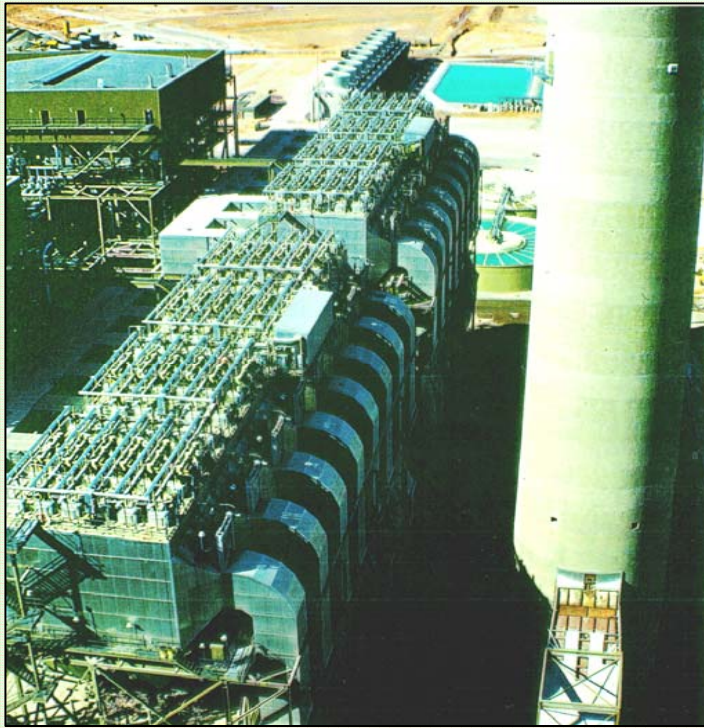
- 100% Hg
- 95% SO₂
- 90% of NO_x



More than 70% of Coal-Fired units use ESPs



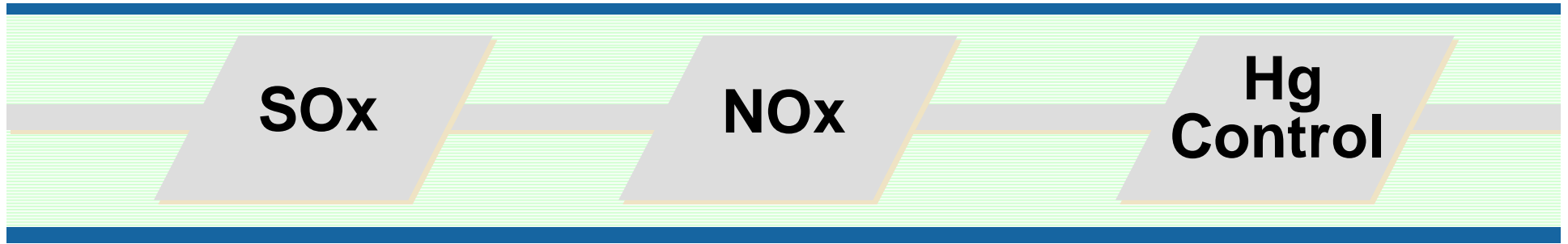
There is interest in making existing ESPs work – avoid new fabric filters



- ***Utilities have invested heavily in LNBS, SCRs and FGD systems***
 - **Utilities looking for means to benefit from these SO_x, NO_x retrofits for mercury and particulate control**
 - **Additional new fabric filters are expensive**
 - **Avoid high FF capital costs**
– 100 to 200 USD/kW
 - **Are there means to manage ESP impacts from SO_x, NO_x and mercury control?**



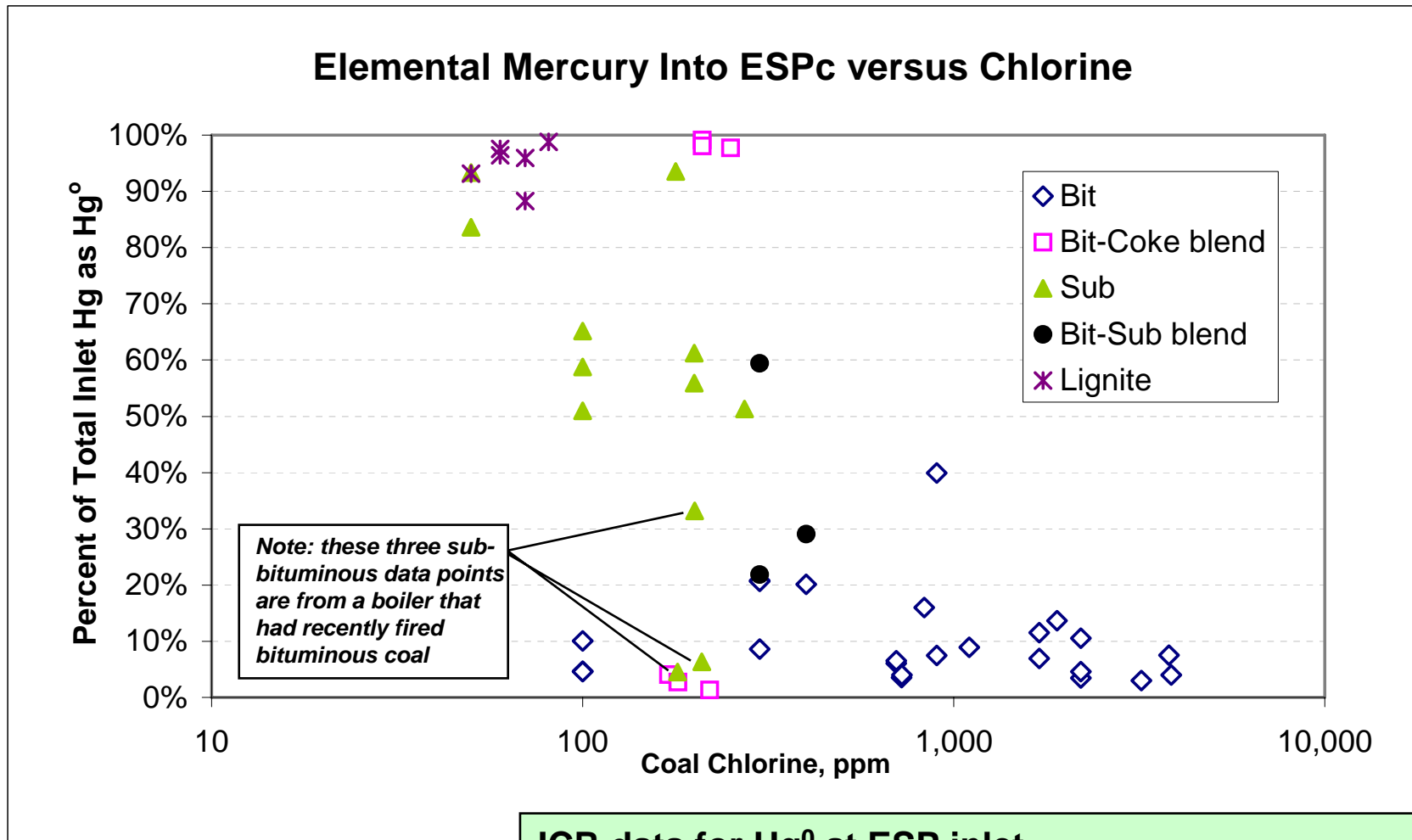
Changes to ESP Inlet Loading from...



- *There is interplay among SO_3 levels, carbon injection and mercury control*
- *Attempts to mitigate SO_3 could have particulate emission impacts*
- *Activated Carbon Injection (ACI) for mercury control may also have particulate emission impacts*



Chlorine vs. Mercury Speciation

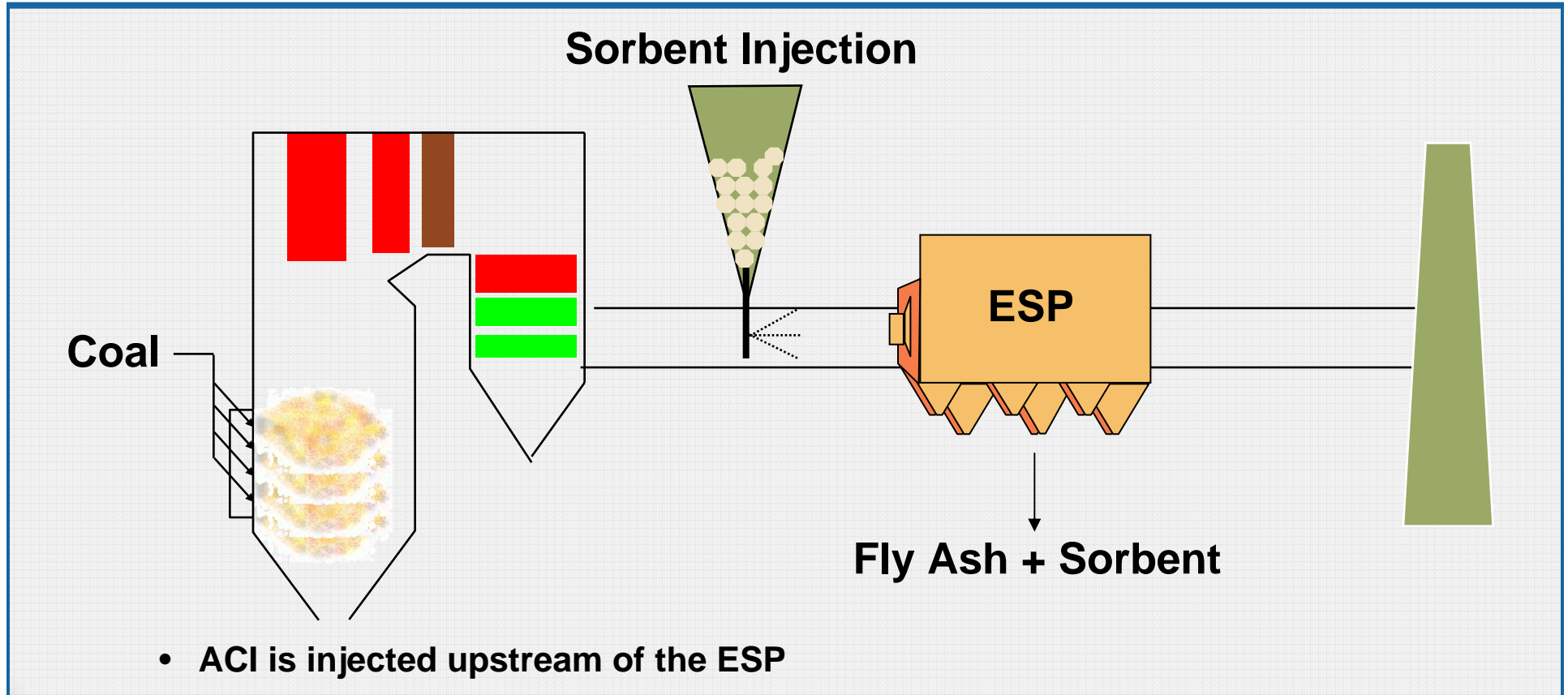


ICR data for Hg⁰ at ESP inlet

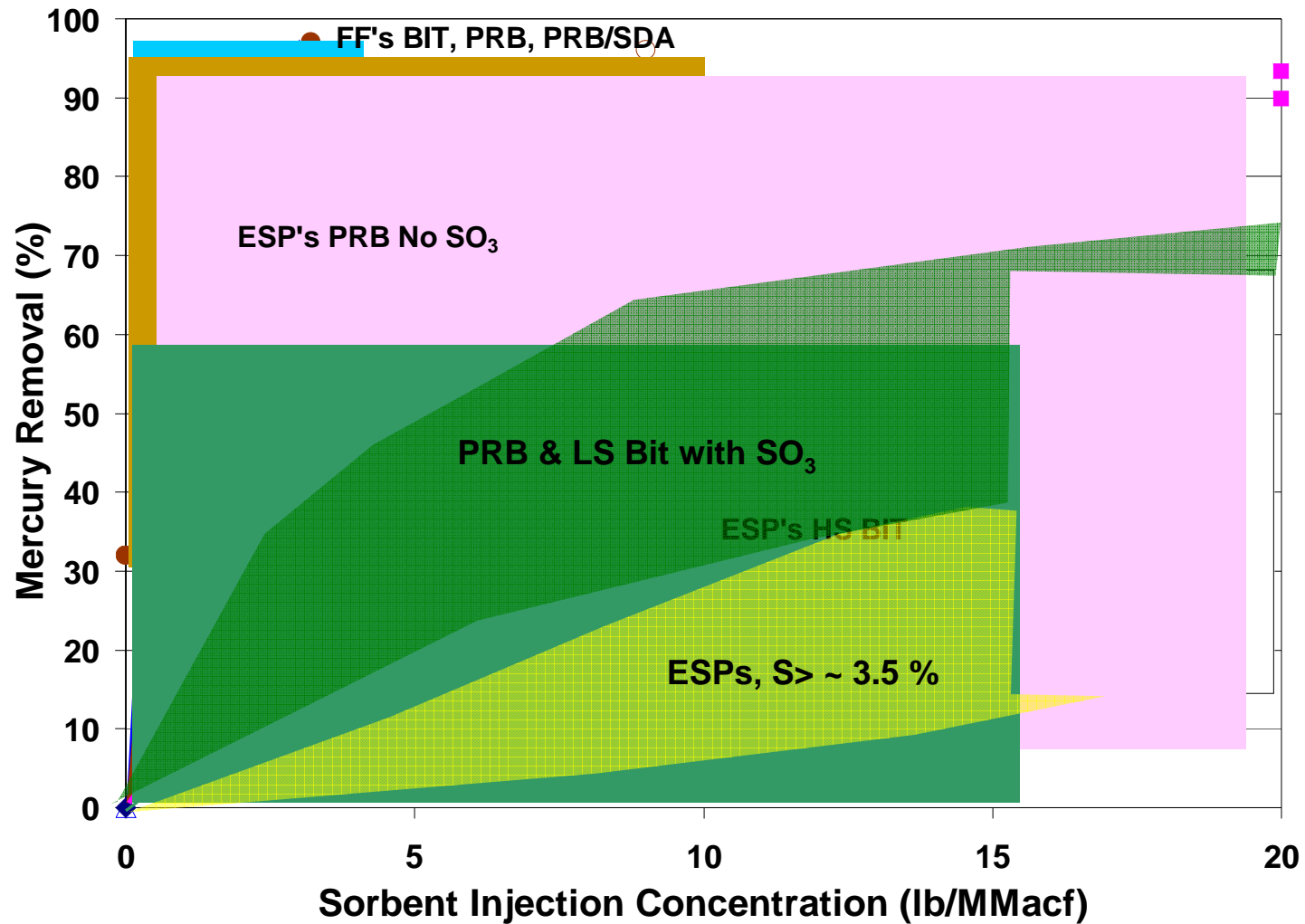
- Hg⁰ oxidation appears to be enhanced by chlorine
- Effect of chlorine is significant for all coal types
- Other important factors: temperature, carbon in fly ash



Sorbent Injection for Mercury Control



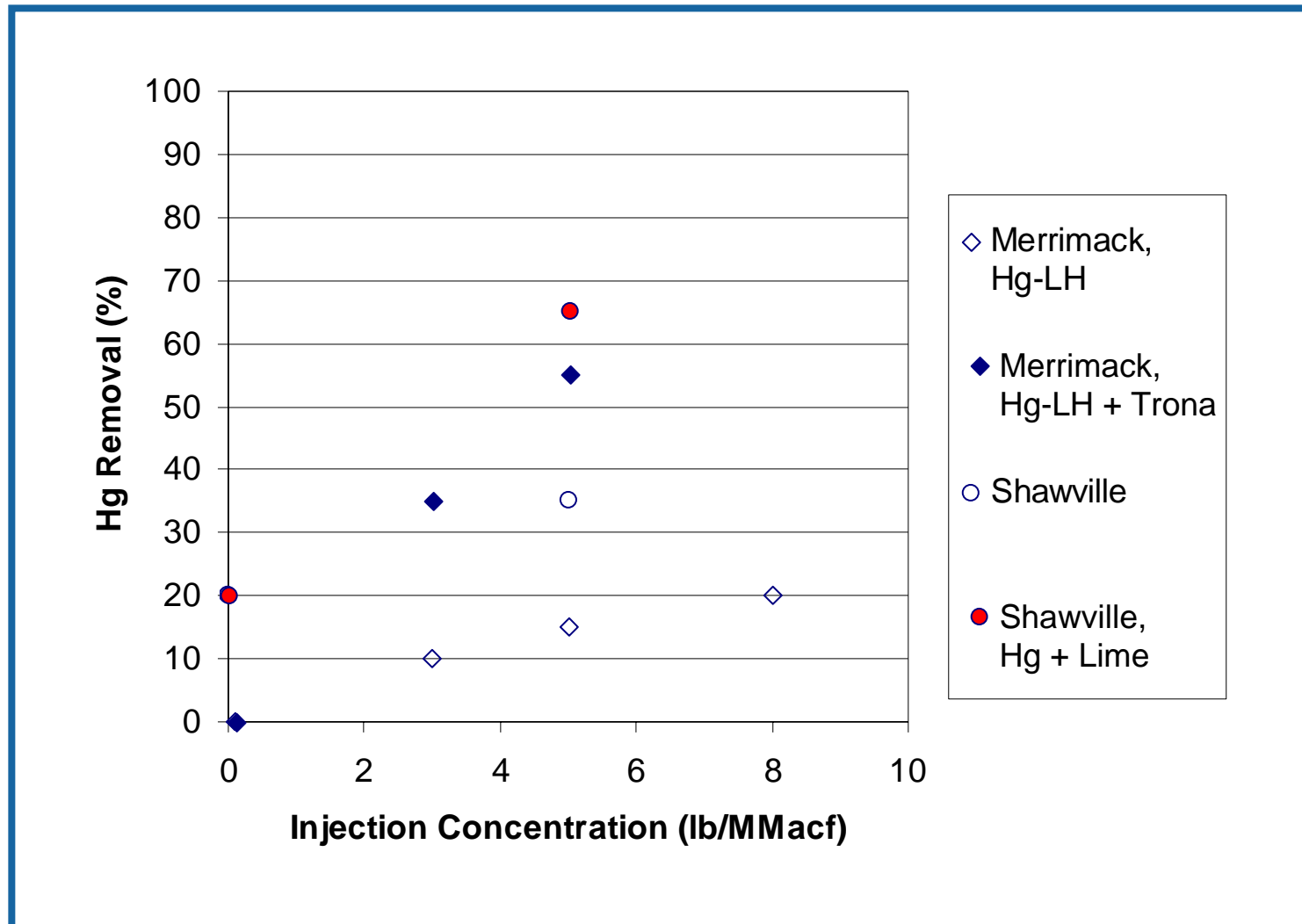
Mercury Reduction Trends with ACI on FF's and ESPs;



Source: ADA ES



Co-Injection with Alkaline Sorbents;



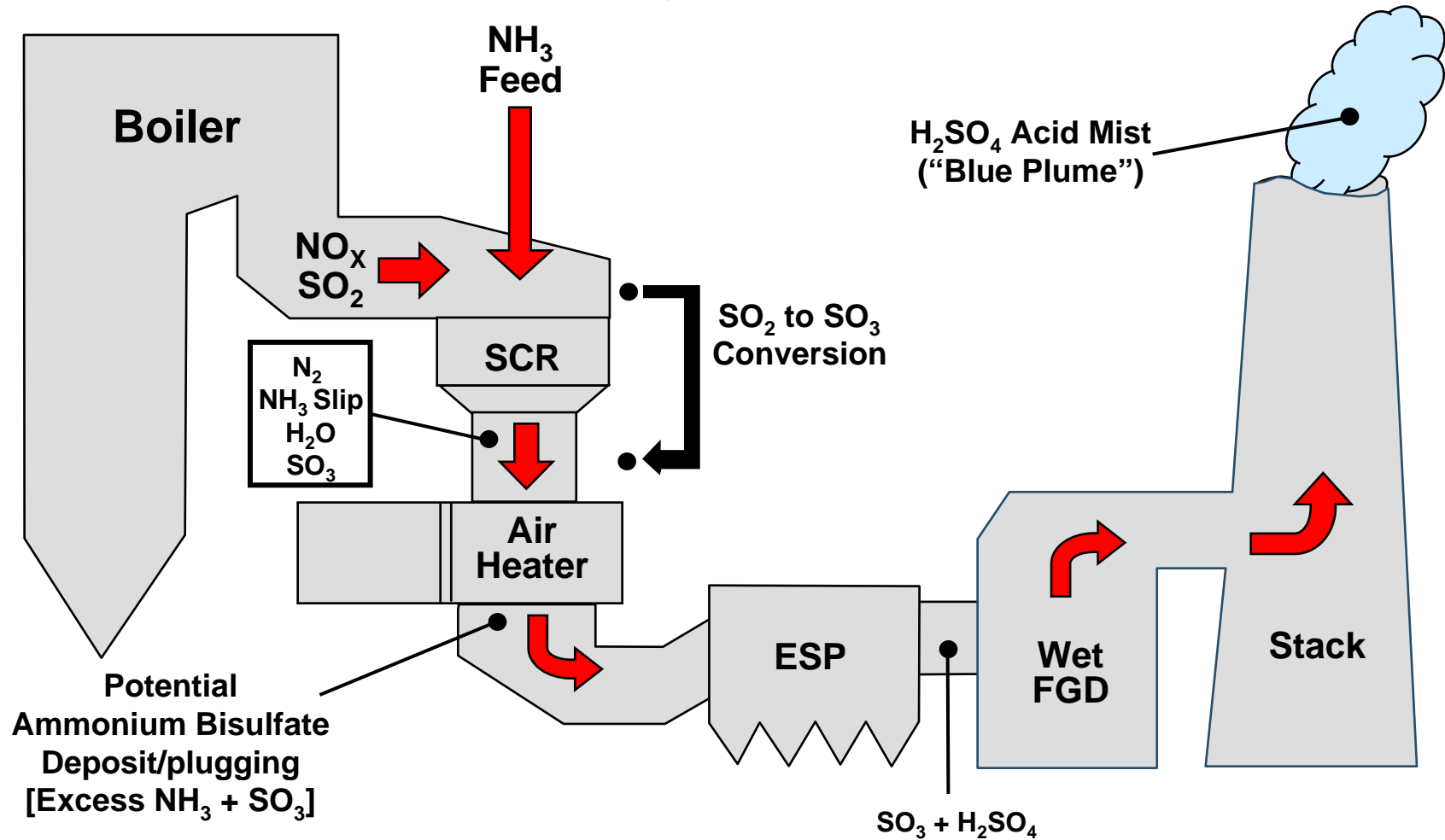
Mercury Control through ACI

- ***Powdered activated carbon increases particulate loading into the ESP***
- ***Type of carbon and degree of mercury control determines solids injection rate for a given coal***
- ***Low chlorine PRB coals may not require much higher injection rates than Eastern bituminous coals!***
 - ***SCR enhances mercury oxidation and control on PRB coals***
- ***SO₃ affects mercury capture by ACI***
 - ***Some eastern coals generate high levels of SO₃***
 - ***Additional increases in SO₃ due to SCR***



SCR Impacts

Increased SO_2 to SO_3 Conversion



Sulfur Trioxide Issues

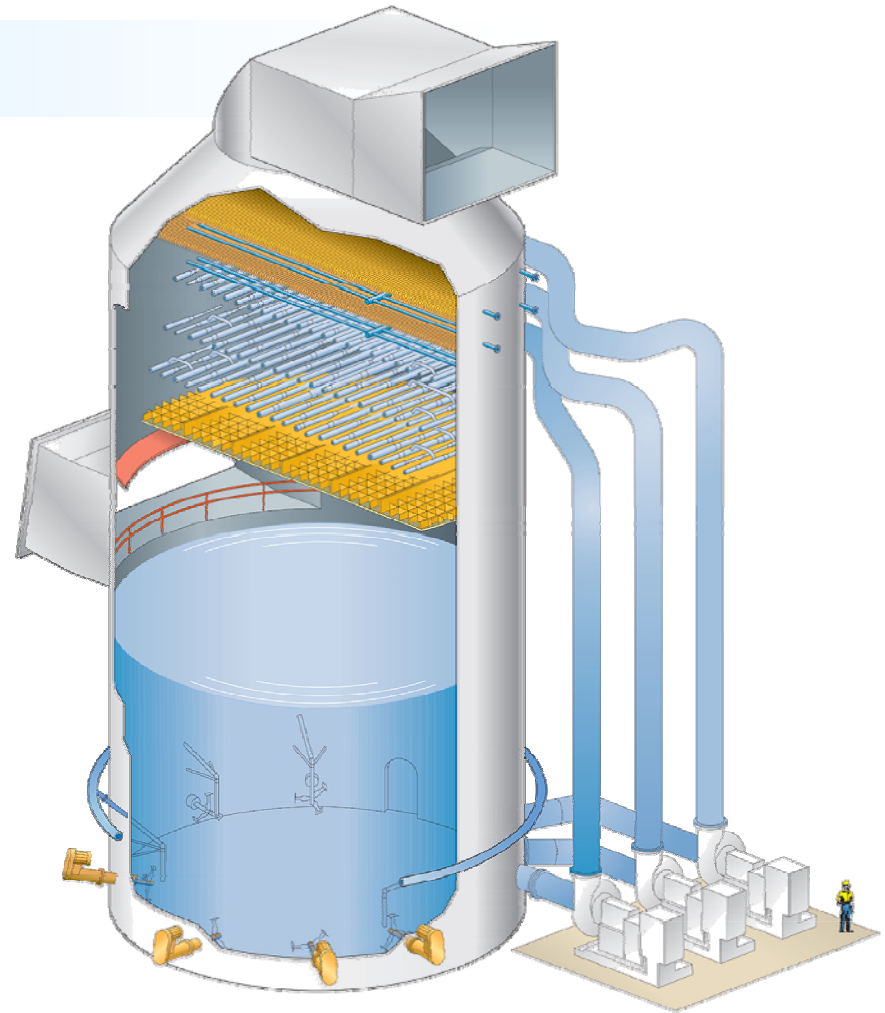
- *Sulfur trioxide (SO₃ or acid mist) corrodes flues, air heaters and other equipment*
- *SO₃ forms sulfuric acid mist aerosol in a wet scrubber which contributes to a visible, trailing plume*
- *Wet FGDs collect very little acid mist: 10 to 30%*
- *There can be more acid mist than dry particulate in many wet scrubber stacks*
- *Acid mist is PM_{2.5}*
- *SO₃ affects mercury capture by ACI*



Wet FGD Stack Particulate Emissions

Includes:

- Flyash
- Gypsum carryover
- H_2SO_4
- Permitted emission and opacity limits will drive technology



SO₃ Control

Injection Options:

- Sorbent injection (calcium, magnesium, or sodium compounds), typically in furnace, after the SCR, or upstream of the particulate collection device
- Ammonia injection upstream of the Dry ESP



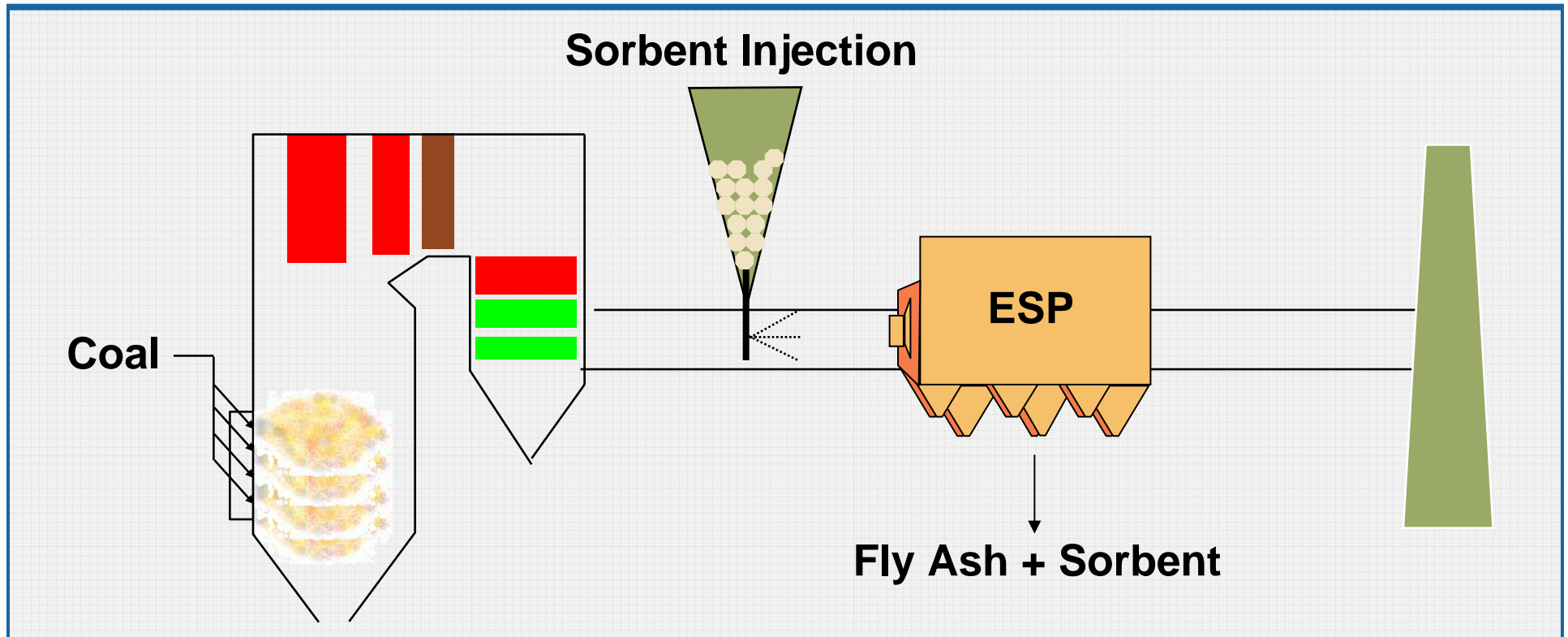
VS.

Hardware Solution:

- Wet ESP



Sorbent Injection for SO_x Control



- Sorbent is injected upstream of the ESP
- Trona, lime magnesium and ammonia known to remove SO_3
- Sorbents affect ESP ash and performance
- Dry sorbent injection with trona used for SO_2 control



Key Factors Affecting ESP Performance

ESP Inlet Loading & Flyash Size Distribution

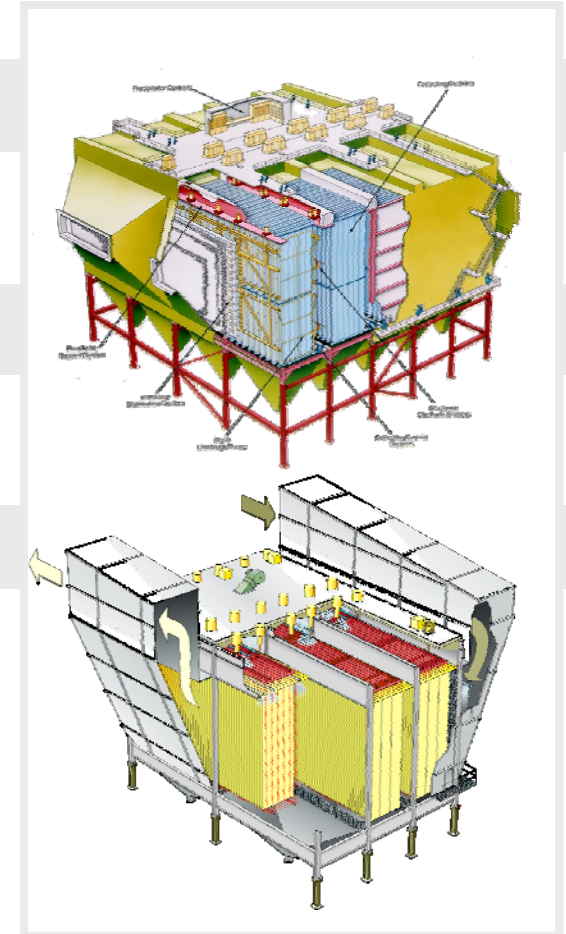
- Increase in fines and loading can impair performance

Flyash Resistivity

- Increase in resistivity can critically hurt performance

Flyash Cohesivity

- Increase in ash cohesivity is beneficial to controlling re-entrainment
- Needs management to prevent performance damaging build-ups



Implications on Sorbent Injection with Dry ESPs

Sodium Based Sorbent for SO_x Control

- Decrease in flyash resistivity from 10*12 to 10*11 ohm.cm
- Increased ESP Performance / Decreased PM emissions up to 30% SO₂ control in several plants
- Sorbent loading and fines increase – and may impose performance limits
- Hotside ESP experience is more promising: no loading effects up to 80% SO₂ control
- Higher SO₂ removals may contribute to NO₂ plume



Implications on Sorbent Injection with Dry ESPs

Ammonia Based Sorbent for SO₃ Control

- No resistivity impact seen on several high S applications
- Increased fines
- Ash may get too sticky
- Hopper evacuation issues
- Electrode design is important to preserve emissions performance

Lime/ MgO for SO_x Control

- Increased resistivity.
- Decreased ESP Performance / Increased PM Emissions
- ESP performance enhancement may be necessary



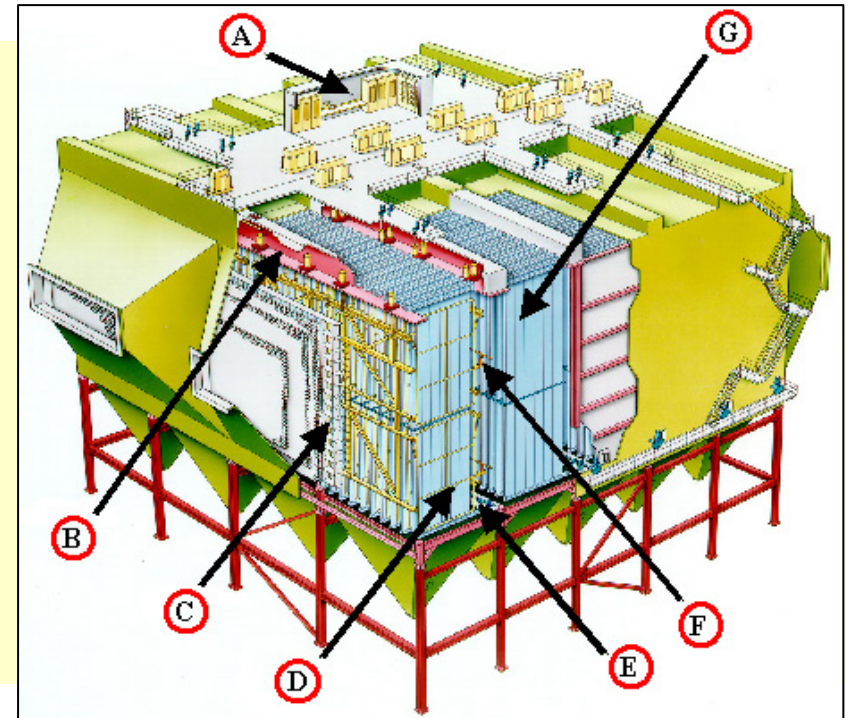
Dry ESPs on more than 70% of boilers in US

Principle

- Ash particles charged, collected to plates then rapped off into hoppers

Features

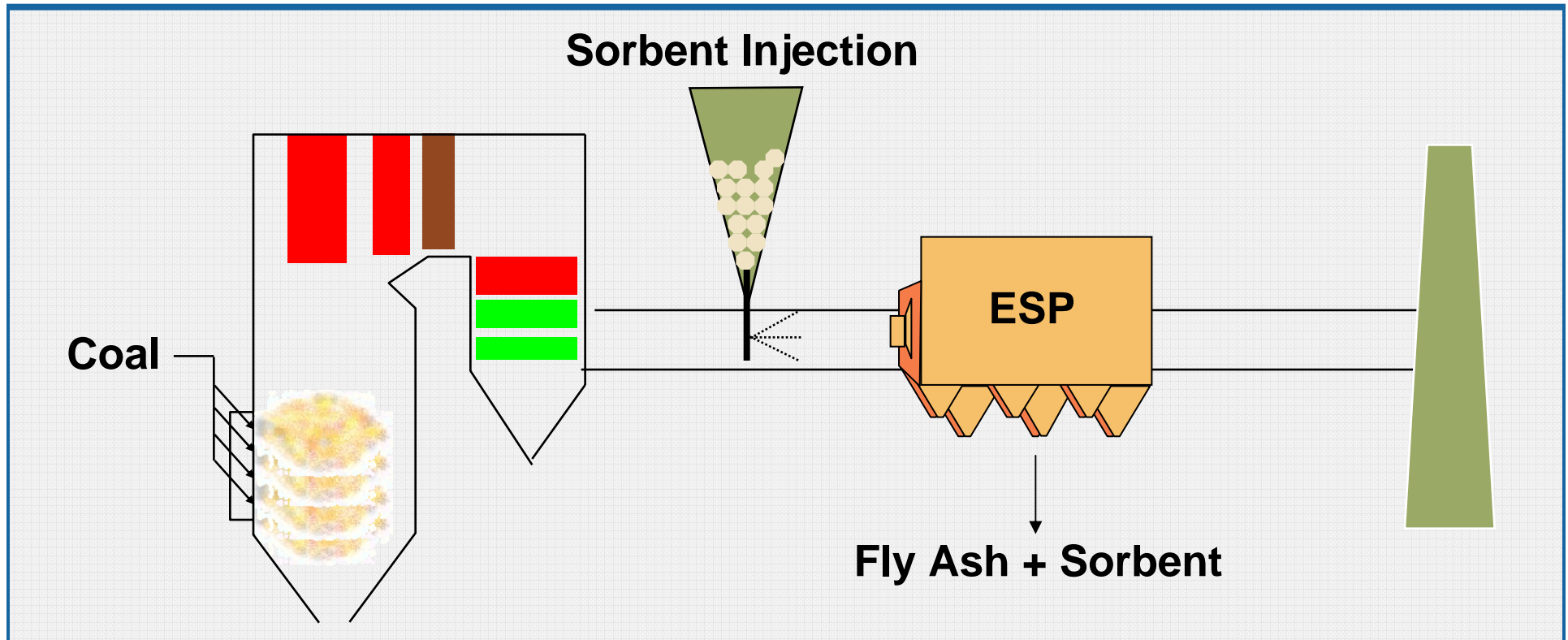
- Top rapped or tumbling hammer
- Wires, Rigid DEs or rigid frame
- Variable CP spacing to 400 mm (15.75 in)



- A. Precipitator Controls
- B. High Voltage Support System
- C. Inlet Flow Distribution Devices
- D. High Voltage Discharge Electrodes
- E. Collecting Plate Rappers
- F. Discharge Electrode Rappers
- G. Collecting Plates



Sorbent Injection for Mercury Control

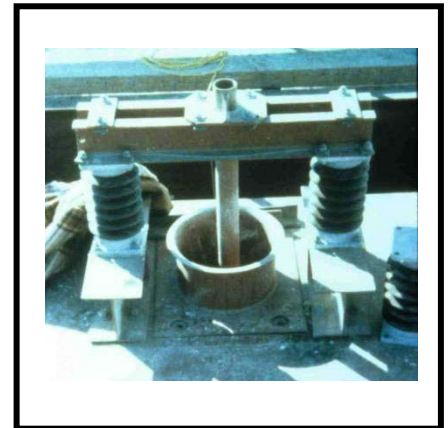
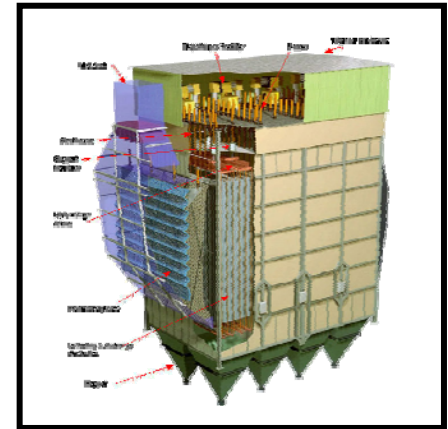


- ACI is injected upstream of the ESP
- In some plants, heavy ESP sparking noticed: Insulators getting coated?
- Some indications of heightened peak opacity while average opacity is preserved: re-entrainment and electrical effects
- There will be upper limits to injection rate before opacity shows increase
- ESP enhancement techniques may be needed



Upgrades/Enhancements can restore ESP Performance

- **Replace worn out, corroded internals**
- **Increase electrical sectionalization**
- **Improve flow quality**
- **Install optimal rigid discharge electrodes**
- **Upgrade HV power supplies**
- **Increase treatment time**
 - **Raise roof to put in taller electrodes**
 - **Add a field**



Thank You.



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