Status of Mercury Control Technologies, Measurement Methods, and Emerging State Regulations for U.S. Coal-Fired Utility Sector

Praveen Amar, Ph.D., P.E.

Director, Science and Policy, NESCAUM

IJC and CEC: Consultation on Emissions from Coal-Fired Electric Utilities

Montreal, Quebec

July 20 and 21, 2004

What is NESCAUM?

- Northeast States for Coordinated Air Use Management
- Association of air quality divisions of state departments of environmental protection
- Provides scientific, technical and policy support to member-states governments
- Assists states in complying with federal regulations and in developing regionally consistent regulations and strategies

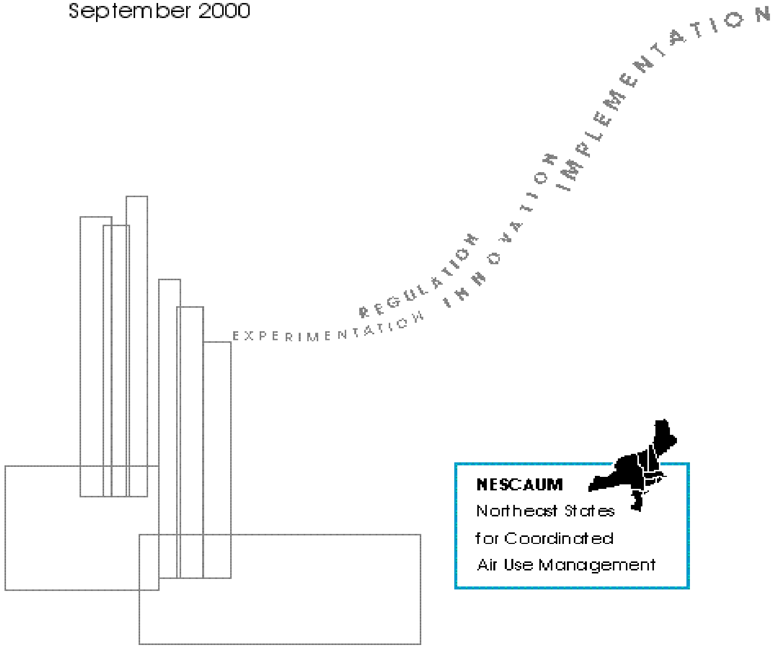
Overview

- Existing and emerging emission control technologies for mercury
  - Related "co-benefits," type of control equipment currently in use, projected future use
- Status of continuous emission measurement systems (CEMS) for mercury
  - Implications for control strategies (especially market-based approaches)
- Cost of controls
- Emerging states regulations in the U.S./federal landscape

Environmental Regulation and Technology Innovation:

Controlling Mercury Emissions from Coal-Fired Boilers

September 2000



NESCAUM
Northeast States
for Coordinated
Air Use Management

NESCAUM Report:
Environmental Regulation & Technology Innovation

- Evaluated historical relationships over 50 years between environmental regulatory drivers and innovation in control technologies
- Three case studies: SO_2 from power plants; NOx from power plants; & Automobiles (controls/fuels/engines)

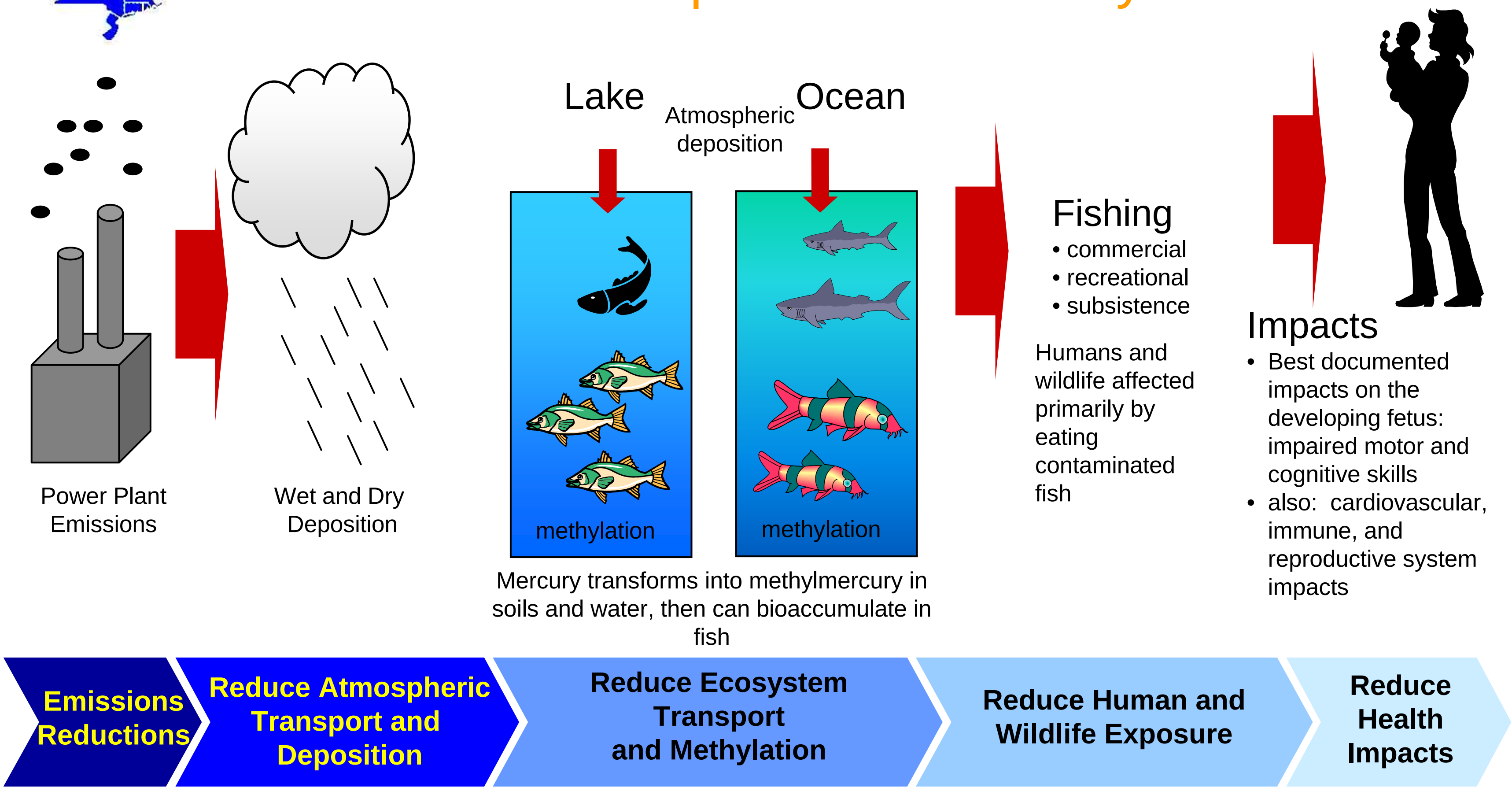
NESCAUM Report: Key Findings

- “Where strong regulatory drivers exist, substantial technological improvements & steady reductions in control costs follow.”
- “Dynamic occurs even when control options were limited or untested at the time regulations were introduced.”

Mercury Policy Context in the Northeast

- New England Governors/Eastern Canadian Premiers' Regional Mercury Action Plan
  - 50% reduction by 2003
  - 75% reduction by 2010
  - Virtual elimination of anthropogenic discharges of mercury is long-term goal
- Example : Mass "Zero Mercury" Strategy
  - 75% reduction by 2010
  - Virtual elimination of anthropogenic discharges and use of mercury is long-term goal

Mercury Emissions from Power Plants Cause Human Exposure to Mercury

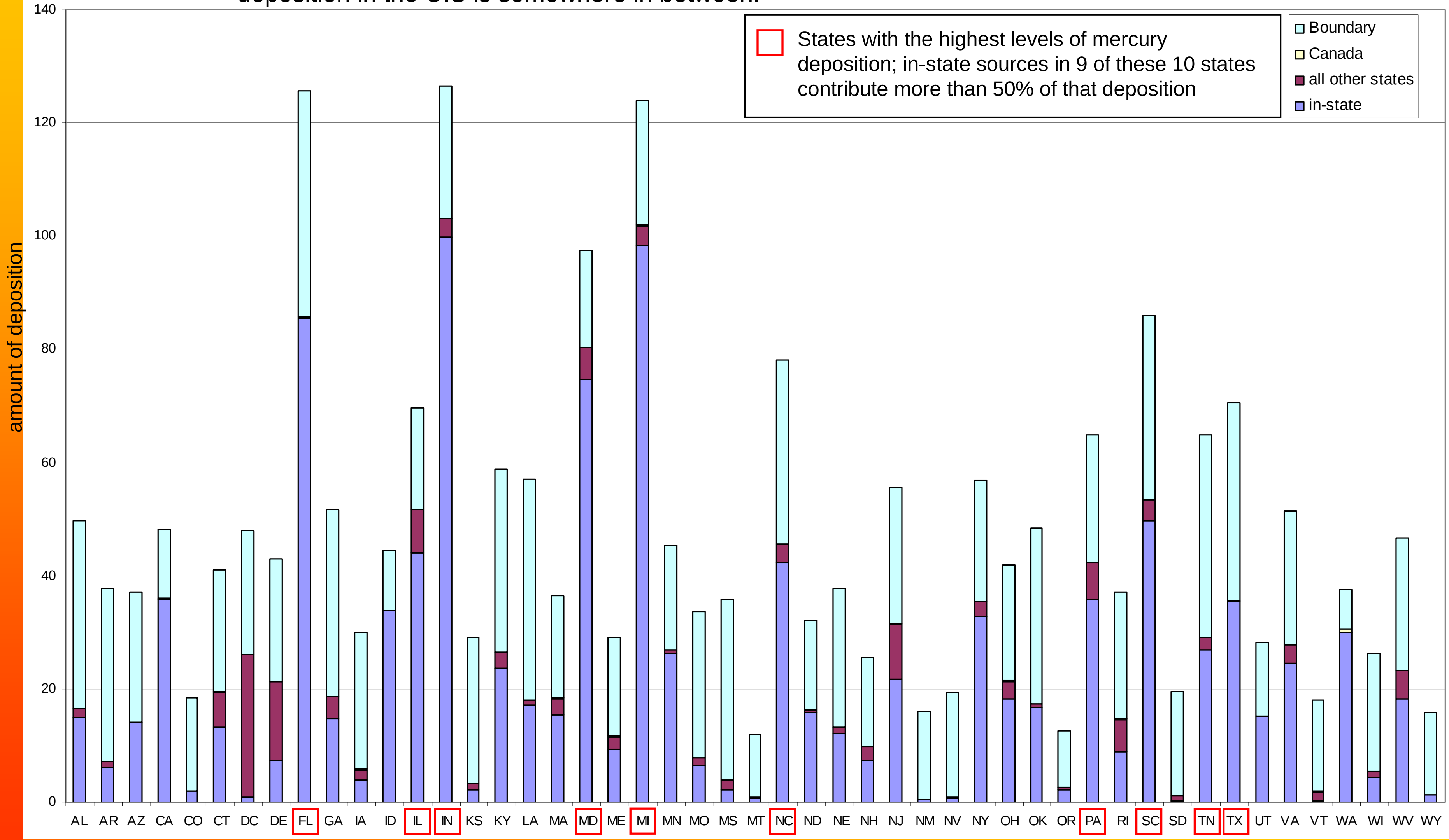


Atmospheric Transport

- Mercury is emitted from sources in one of three forms: elemental, ionic (also called reactive or divalent), and particulate
- Elemental mercury is slowly converted to ionic mercury in the atmosphere
- Elemental mercury can travel quite far before it deposits, so it tends to enter the "global pool" and deposit far from its initial source
- Ionic mercury deposits quickly, especially in rain, and so tends to deposit relatively near to its initial source
- Estimates vary, but current U.S. emissions are thought to account for over half of the atmospheric deposition in the U.S. (on average)
    - near sources the percentage is even higher

Atmospheric Transport of Mercury

At the point where modeled deposition is the highest, in-state sources are responsible for more than 50% of the deposition in many states. In most places the contribution of U.S. sources to mercury deposition in the U.S is somewhere in between.



NESCAUM
Northeast States for Coordinated Air Use Management

Atmospheric Deposition

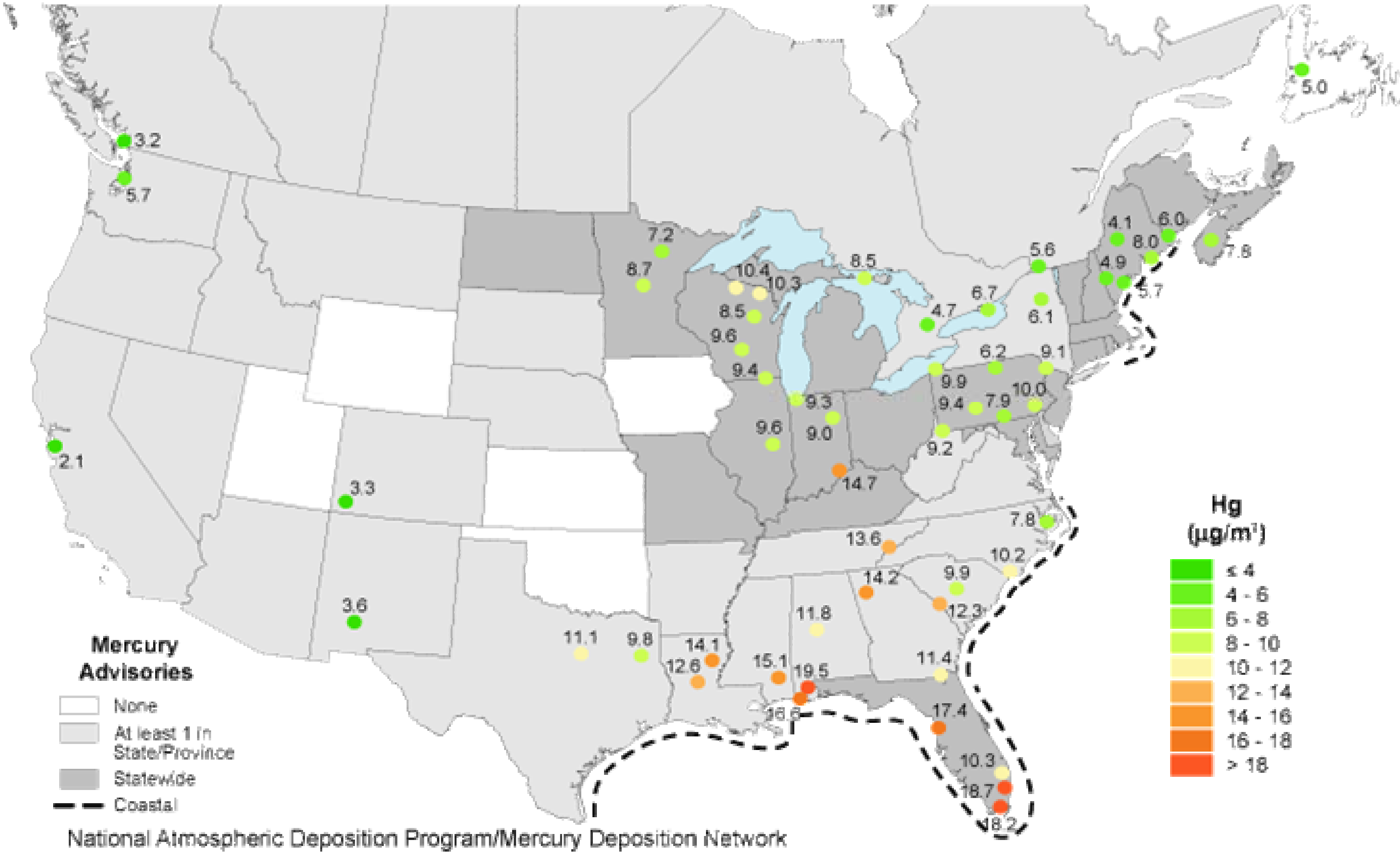
- Mercury is deposited in rain (wet deposition), dry deposition (including throughfall and litterfall), and fog
  - throughfall is mercury “washed off” leaves by rain
  - litterfall is mercury from the atmosphere taken up by plant leaves and deposited to the ground when the leaves fall from the tree

- Mercury deposition is monitored by a single national deposition monitoring network-- the Mercury Deposition Network (MDN)
  - measures wet deposition weekly at approximately 80 locations

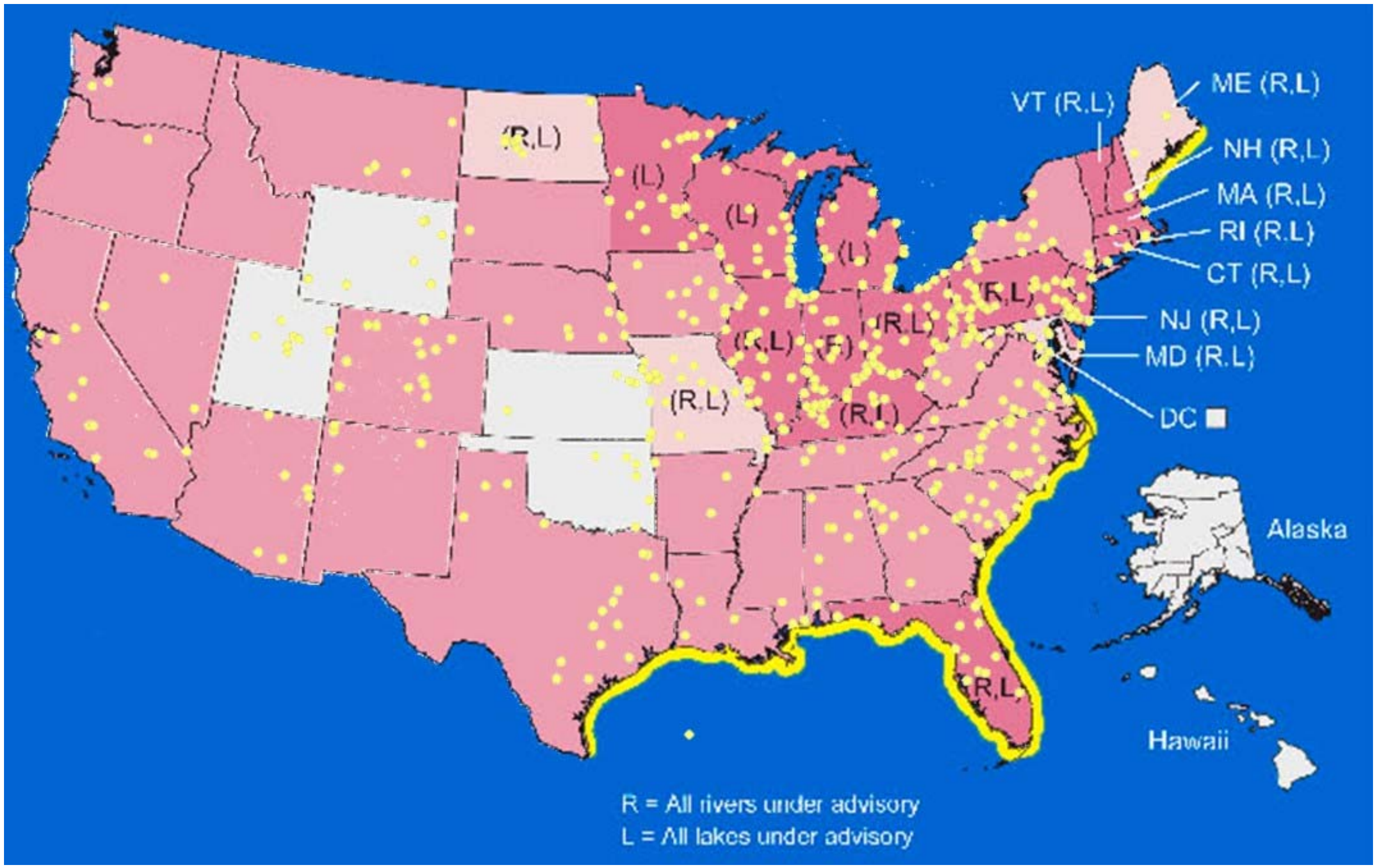
- Some intensive dry deposition monitoring at research sites and by ORD, but there are no dry or fog mercury monitoring networks in the U.S.

NESCAUM
Northeast States for Coordinated Air Use Management

Total Wet Mercury Deposition (2002)



Coal-Fired Power Plants

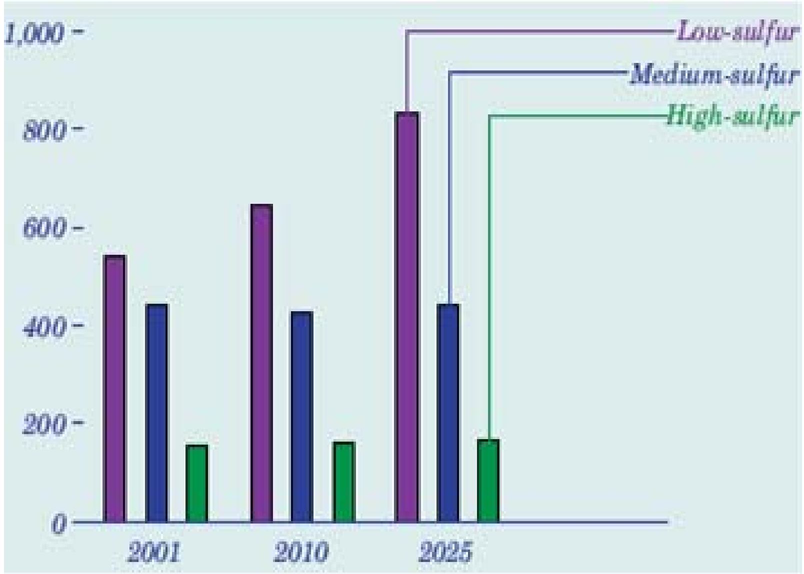


- **There are about 530 power plants with 305 gigawatt of capacity that consist of about 1,300 units, 1,150 of which are >25 megawatt.**
- **Coal plants generate the vast majority of power sector emissions:**
  - **100% of Hg**
  - **95% of SO_2**
  - **90% of NO_X**

Looking Ahead - Coal Use

Consumption
(million short tons)

Production
(million short tons)



Consumption of low-sulfur coals in the power generation sector is expected to increase in the future.

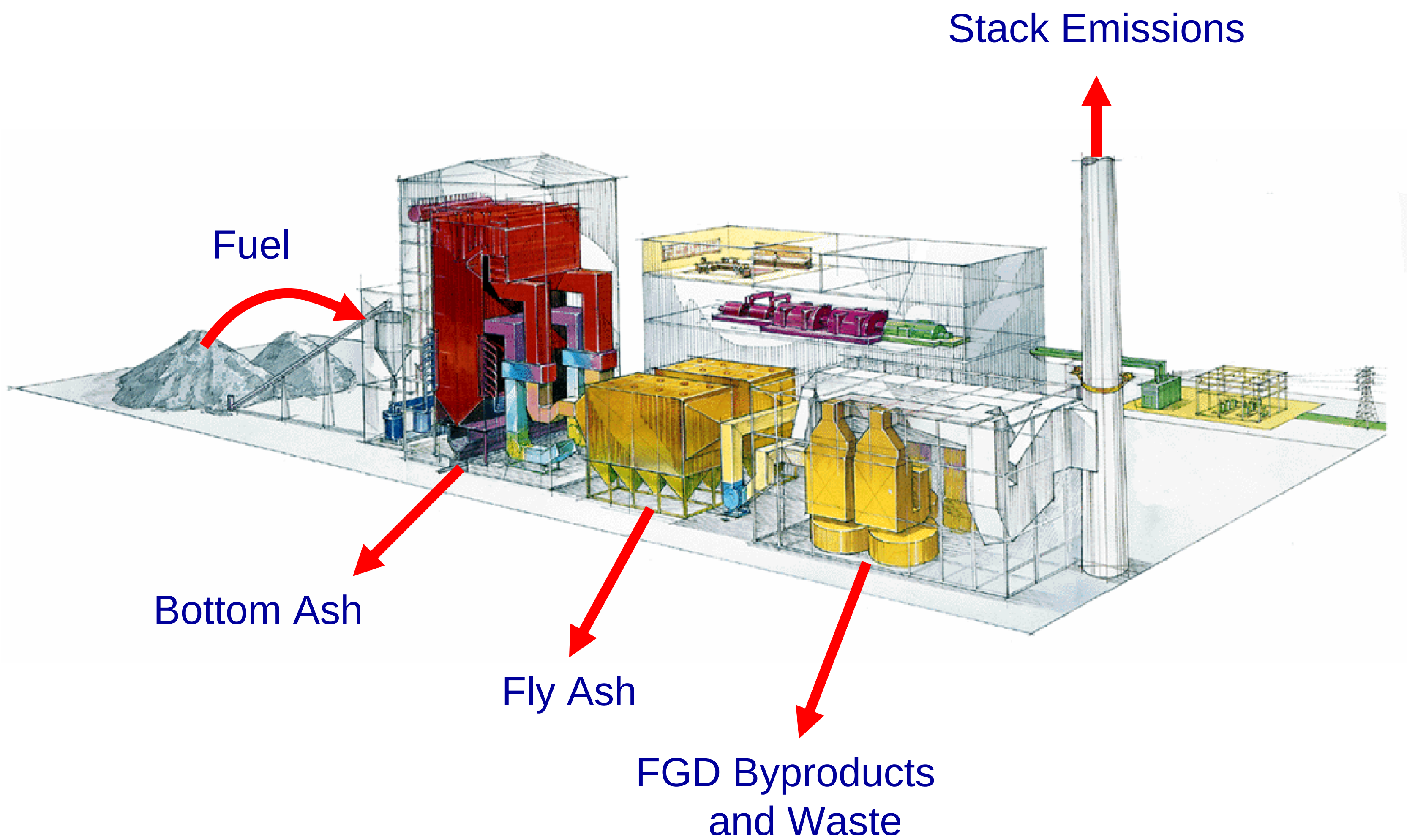
Source: Annual Energy Outlook 2003 with Projections to 2025, DOE/EIA-0383(2003)

NESCAUM Northeast States for Coordinated Air Use Management

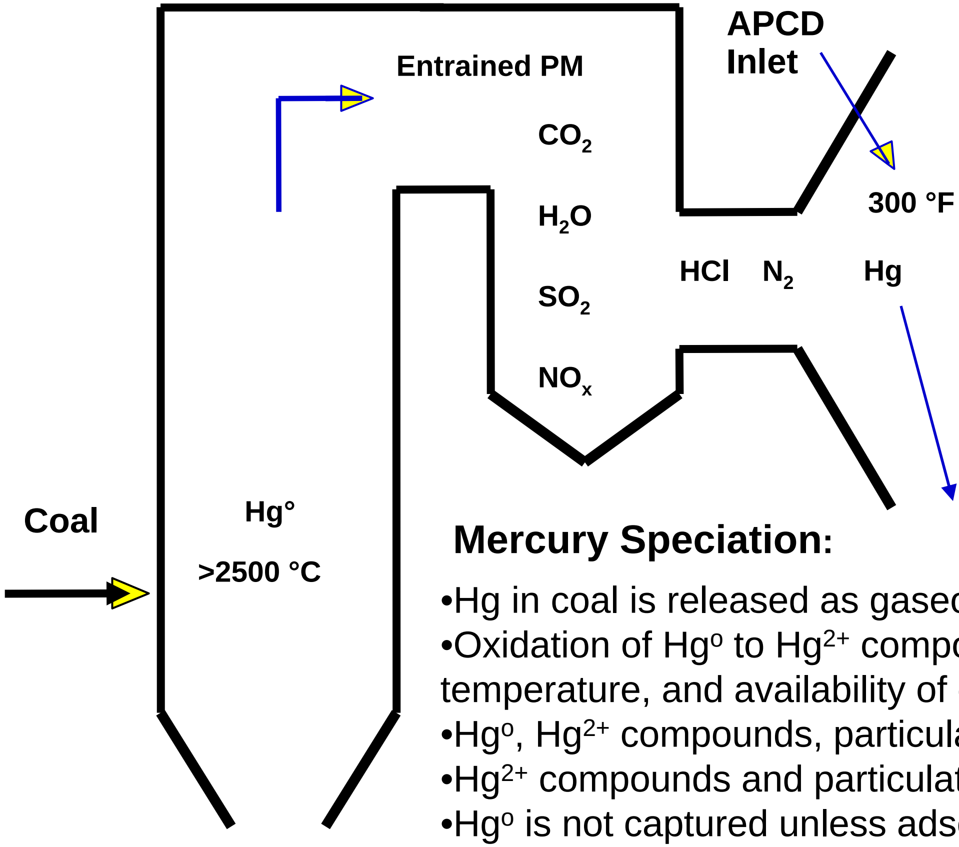
Status of Issue in the U.S.: Mercury (Hg) Control From Power Plants

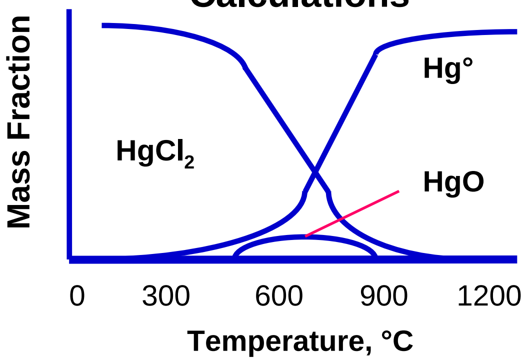
- U.S. EPA and many states regulated municipal waste combustors (MWCs) and medical waste incinerators in 1990s; controlled more than 40 tons (up to 98 % control)
- Coal-fired power plants now major source; 48 tons (1999)
- On January 30, 2004, EPA proposed regulations for power plant Hg control; presently in comment/review phase
- A number of U.S. states have already proposed mercury regulations

Power Plant Emissions



Mercury in Coal-fired Boilers





Senior, Boole, Morency, et. al., PSI Final Report, 1997

Mercury Speciation:

- Hg in coal is released as gaseous Hg^o
- Oxidation of Hg^o to Hg^{2+} compounds is driven by cooling exhaust gas temperature, and availability of chlorine and unburnt carbon
- Hg^o, Hg^{2+} compounds, particulate mercury Hg(p) exist at inlet to APCD
- Hg^{2+} compounds and particulate mercury Hg(p) may be removed by APCD
- Hg^o is not captured unless adsorbed onto particulate. Hg^o, uncaptured Hg^{2+} compounds and uncaptured Hg(p) are released to atmosphere.

Factors That Influence Mercury Control from Coal-fired Boilers

- Coal type
- Time/temperature profile
- Flue gas composition and fly ash characteristics (carbon, calcium, iron, porosity)
- Air pollution controls installed

Mercury Capture in Existing Equipment

Removal in PM Controls

- Mercury can be adsorbed onto fly ash surfaces; Hg^{2+} is more readily adsorbed than Hg^0
- Mercury can be physically adsorbed at relatively lower temperatures (hot-side ESP vs. cold-side ESP)

Capture in Wet Scrubbers

- Hg^{2+} capture depends on solubility of each compound; Hg^0 is insoluble and cannot be captured
- Capture enhanced by SCR

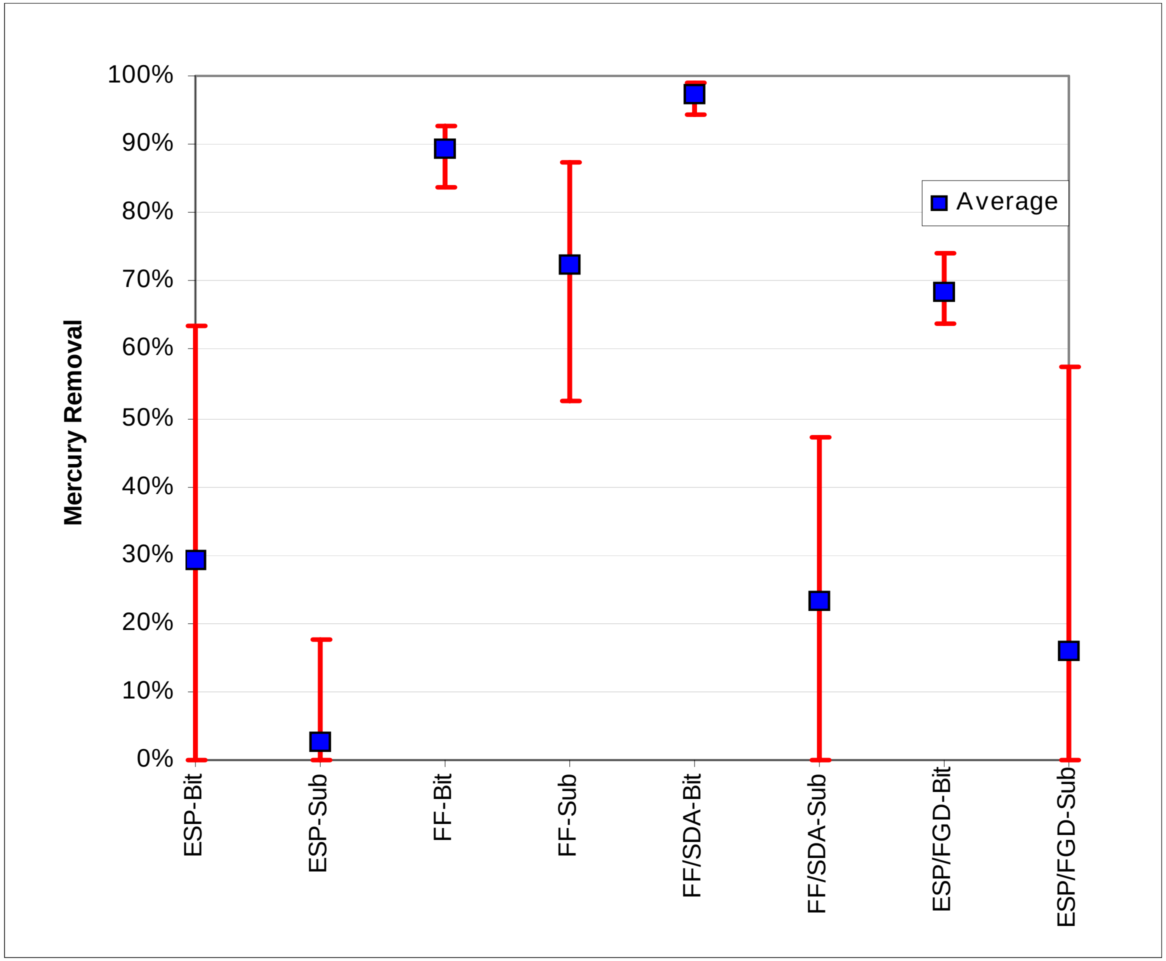
ICR Data – Capture in Existing Equipment

- Higher levels of Hg capture for bituminous coal-fired plants compared to low-rank coal-fired plants
- Large ranges of Hg capture observed
- Compared to electrostatic precipitators (ESPs), fabric filters (FF) capture higher levels of Hg
- Limited data suggested that scrubbers could potentially capture oxidized Hg effectively

Hg Removal with Existing Equipment

Controls	Bituminous	Subbituminous
PM Only		
CS-ESP	46%	16%
HS-ESP	12%	13%
FF	83%	72%
PM Scrubber	14%	0%
Dry FGD		
SDA + ESP		38%
SDA + FF	98%	25%
Wet FGD		
CS-ESP+Wet FGD	81%	35%
HS-ESP+Wet FGD	55%	33%
FF+Wet FGD	96%	

ICR Data – Capture in Existing Equipment



- Bituminous vs. subbituminous
- Hg capture for different coal-control technology combinations correlate with coal chlorine content
- Unburnt carbon content of fly ash plays a role in Hg capture

Wide variation in ICR Hg Capture Data

NESCAUM
Northeast States for Coordinated Air Use Management

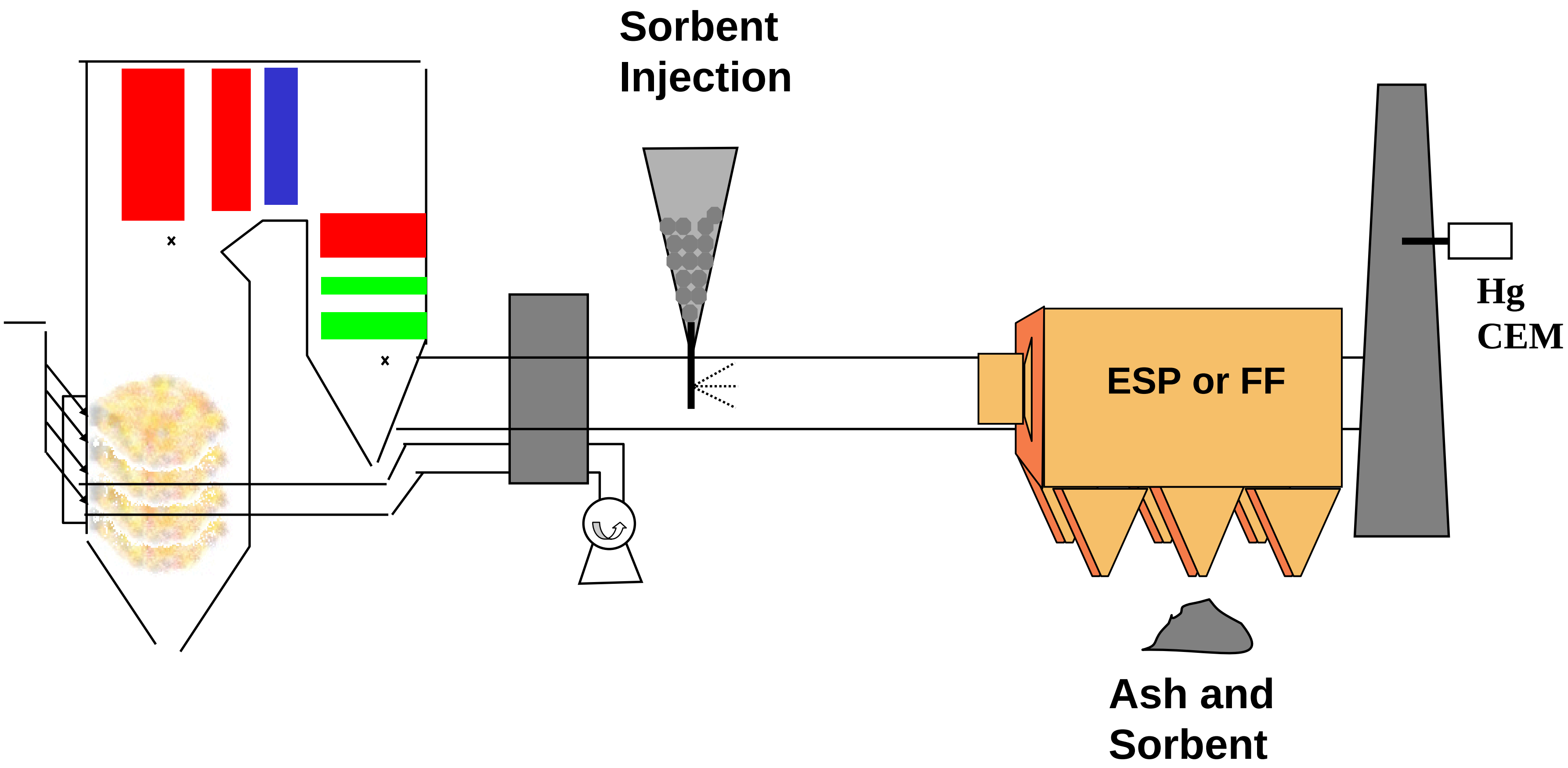
Potential Mercury-Specific Control

- Emerging add-on Hg controls
  - Activated carbon injection
  - Other sorbents
- Modified (optimized) NO_X, SO_2, and PM controls (SCRs, FGDs (wet and dry), ESPs and Fabric Filters (baghouses)

NESCAUM
Northeast States for Coordinated Air Use Management

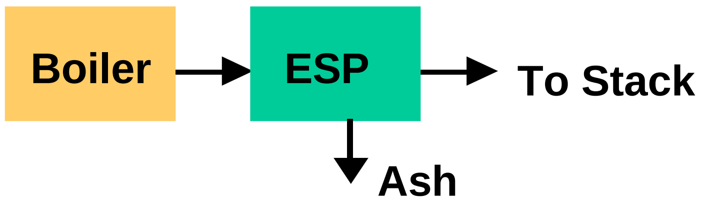
Sorbent Injection Mercury Control Technology

Coal-Fired Boiler with Sorbent Injection

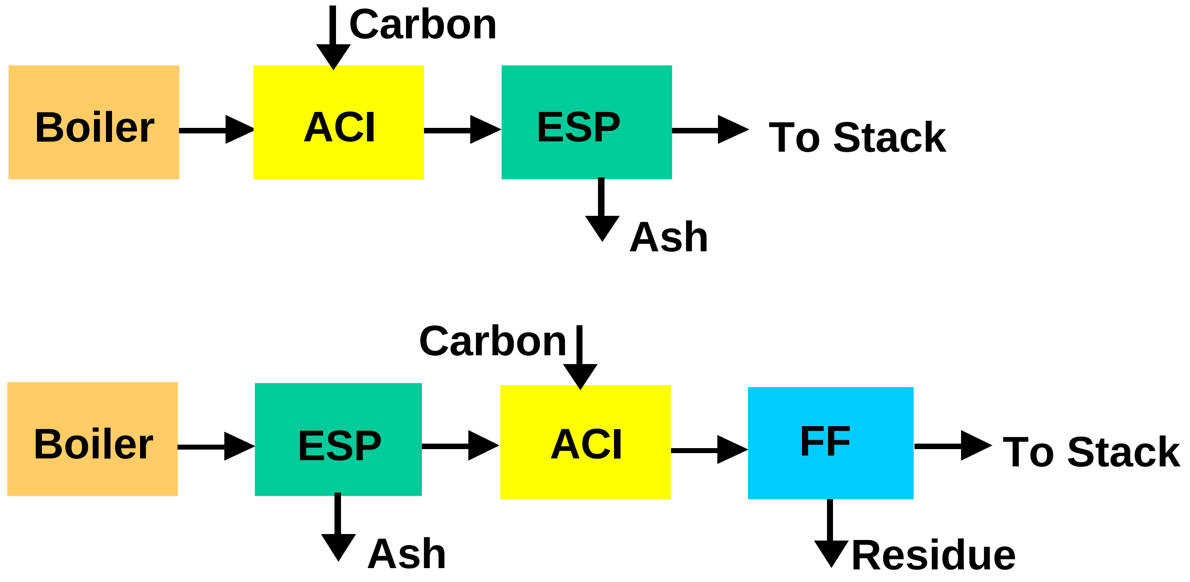


Hg Control for Key Configurations

Typical Eastern No Control Configuration (> 65%, 1999)

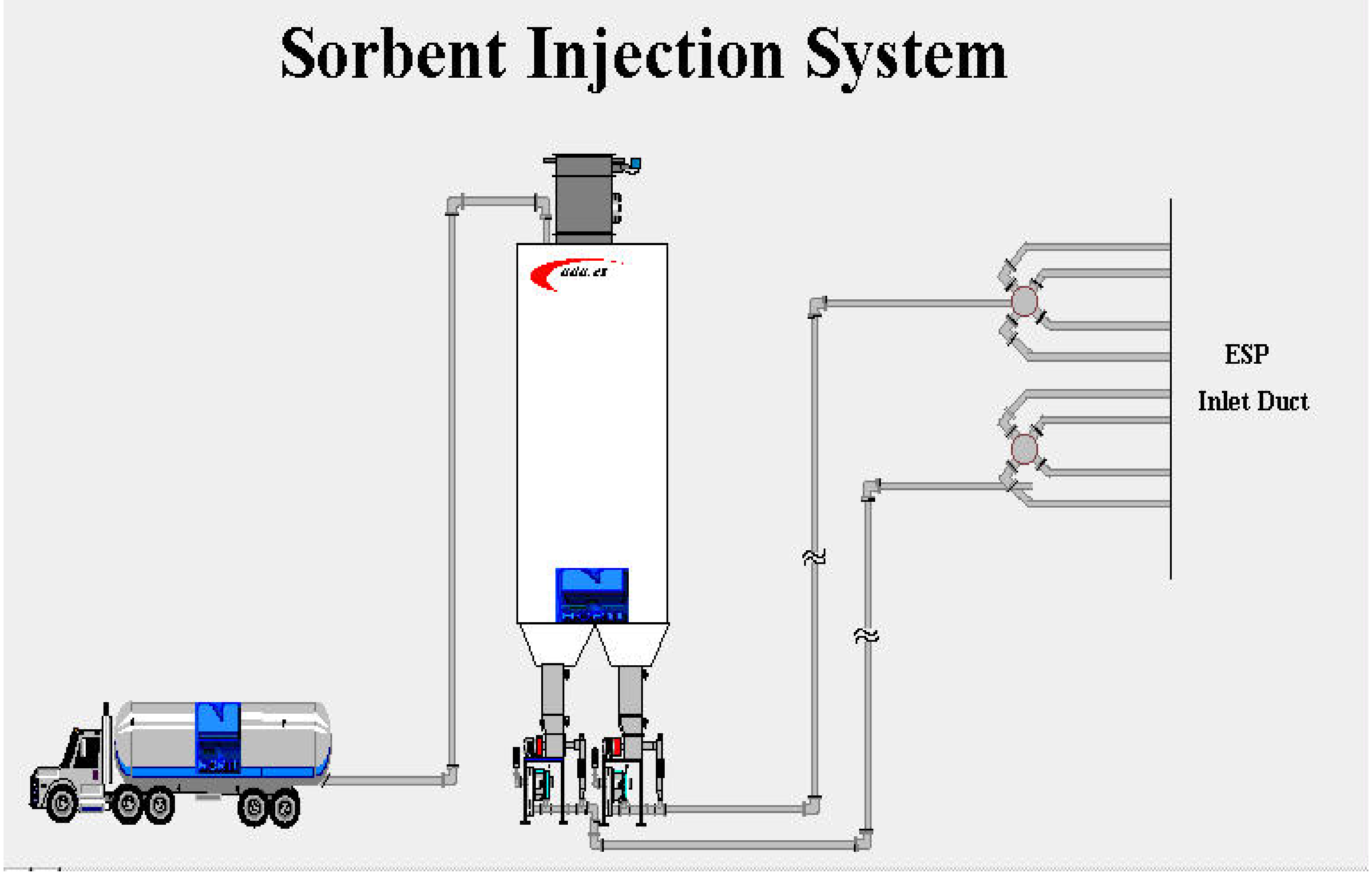


ACI-Based Hg Control Modifications



Activated Carbon

Activated Carbon Storage and Feed System



Powdered Activated Carbon Delivery System

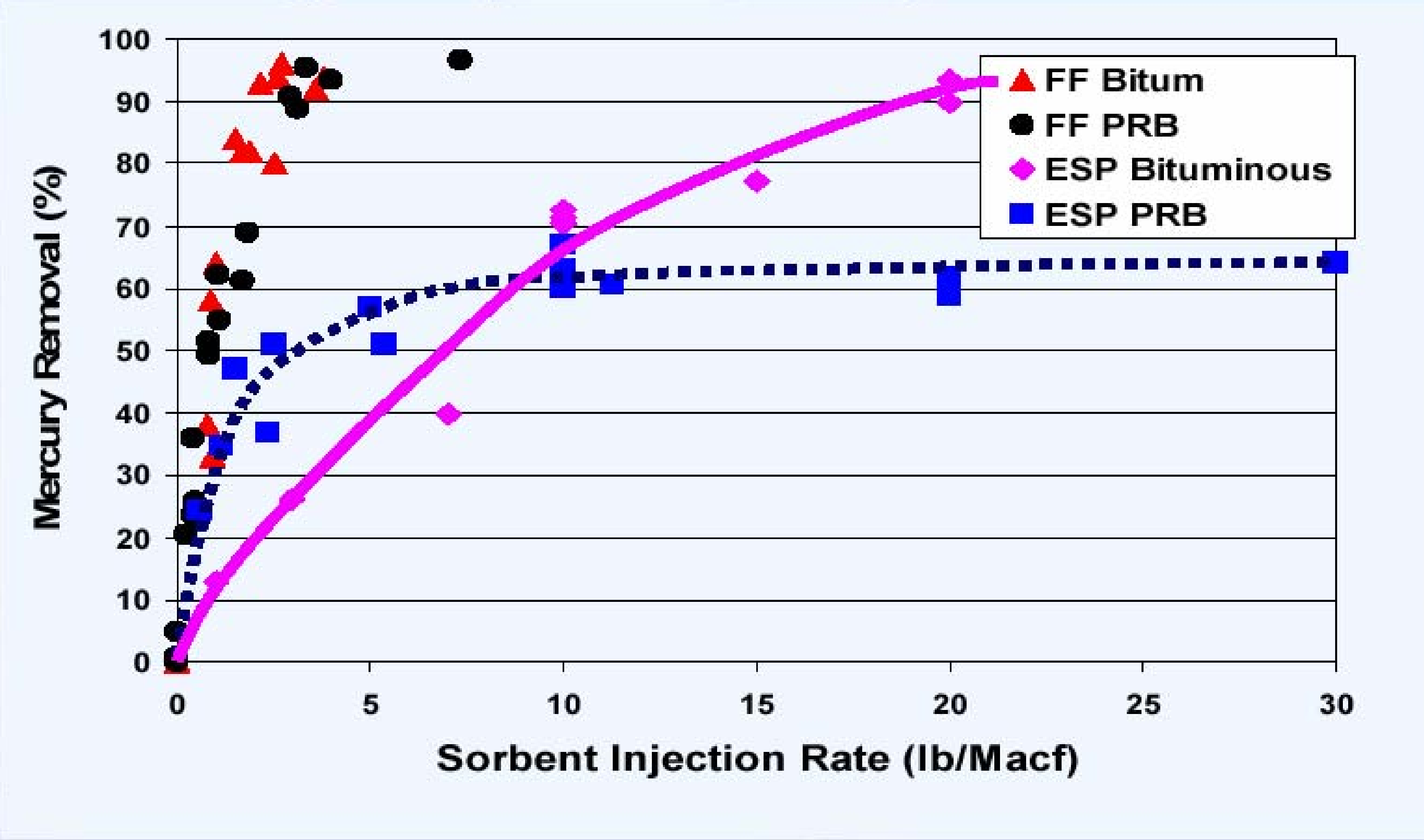
Activated Carbon Injection

ACI system includes a sorbent storage silo and a sorbent injection system. It may also include an added fabric filter to capture the carbon.


Activated carbon injection system

Activated carbon storage and feed system

Mercury Removal with Activated Carbon on Fabric Filters and ESPs



ada.es

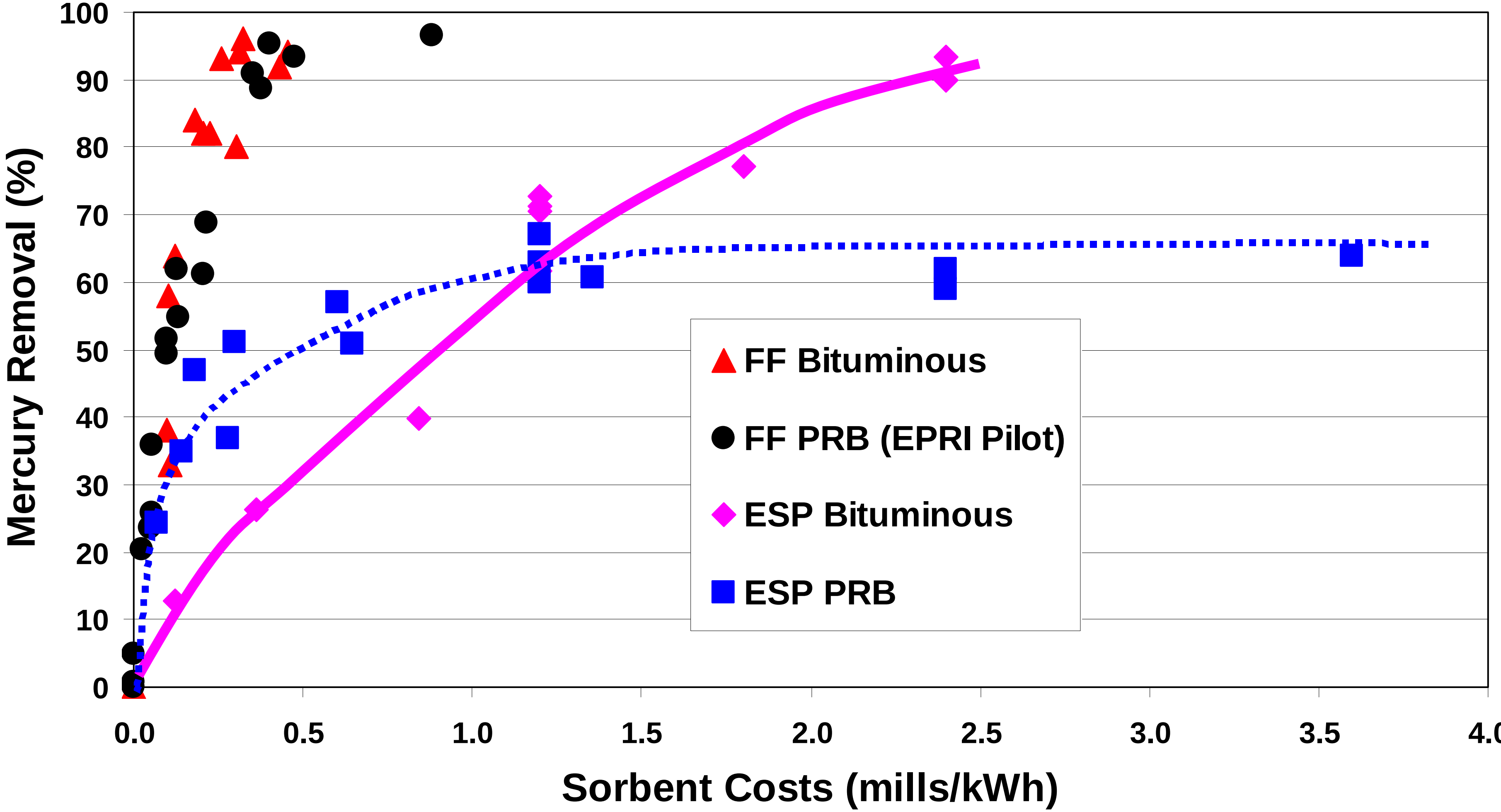
Carbon Injection Field Test Projects

Test Site Information			Mercury Capture, %		
Test Site	**Coal**	**Particulate Control**	**Baseline**	**ACI Test Results**	**Test Duration**
PG&E Brayton Point, Unit 1	Low-sulfur Bituminous	Two CS-ESPs in Series	90.8	94.5	ACI for two 5-day periods
PG&E Salem Harbor, Unit 1	Low-sulfur Bituminous	CS-ESP	90	94	ACI for one 4-day period
Wisconsin Electric Pleasant Prairie, Unit 2	Subbituminous	CS-ESP	5	65	ACI for one 5-day period
Alabama Power Gaston, Unit 3	Low-sulfur Bituminous	HS-ESP + COHPAC	0	90	ACI for one 9-day period

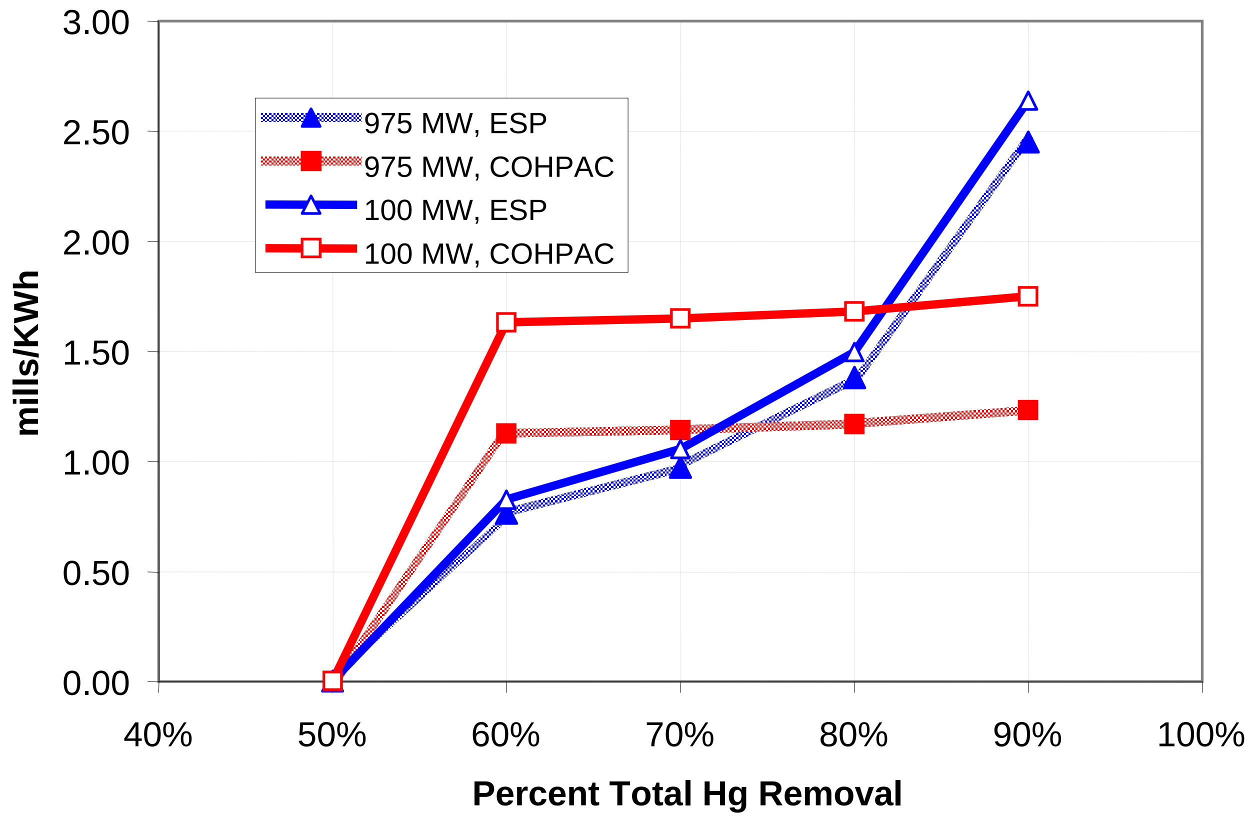
Limitations: Short-term tests, variability in Hg emissions, impacts on plant operation, unique test conditions, limited capture of Hg for low-rank coal.

NESCAUM
Northeast States for Coordinated Air Use Management

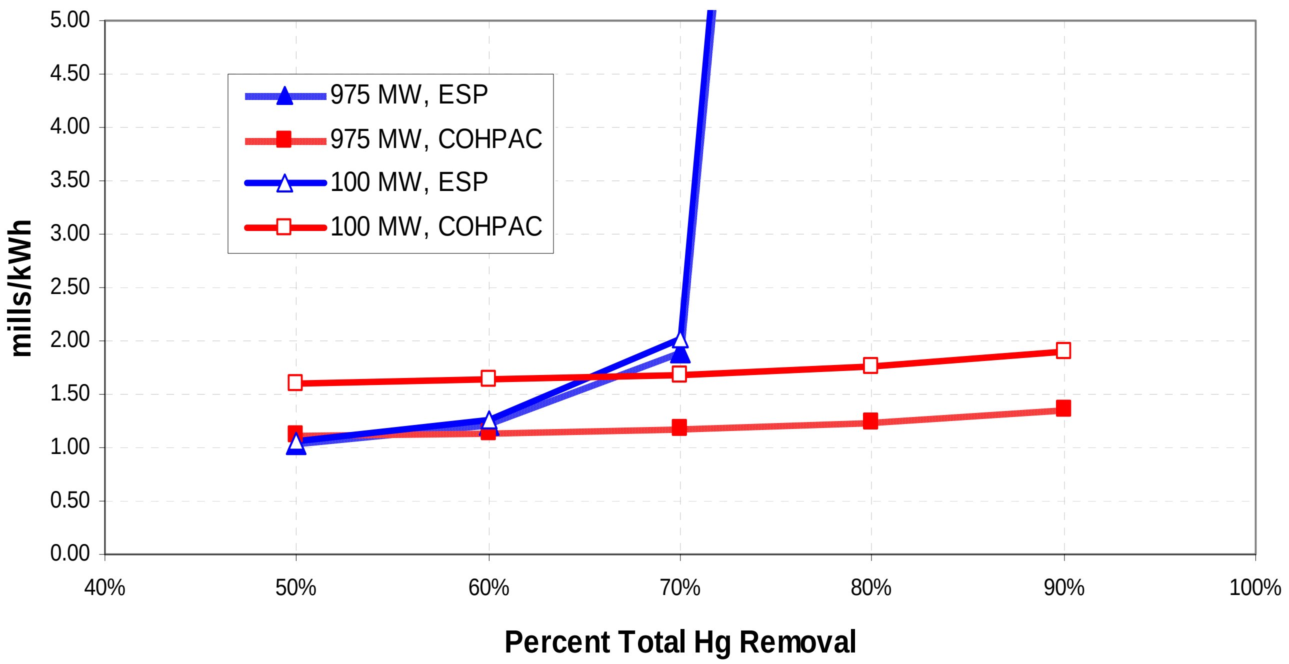
Cost and Performance of Sorbent-Based Mercury Control



Preliminary Cost of Control with Carbon Injection (Low-sulfur Bituminous Coal)



Preliminary Cost of Control with Carbon Injection (Subbituminous Coal)



ACI Cost Estimates for Bituminous Coals

- Assumptions:
  - 250 MW Plant; 80% Capacity Factor
- Capital and Operating Costs for ESP:
  - 70% Mercury Removal: PAC Injection @ 10 lb/Macf
  - PAC Injection: $790,000
  - Carbon costs: $2,562,000/yr
- Capital and Operating Costs for FF:
  - Add COHPAC Fabric Filter at $50/kW: $12,500,000
  - 90% Mercury Removal: PAC Injection @ 3 lb/Macf
  - PAC Injection: $790,000
  - Carbon costs: $769,000/yr

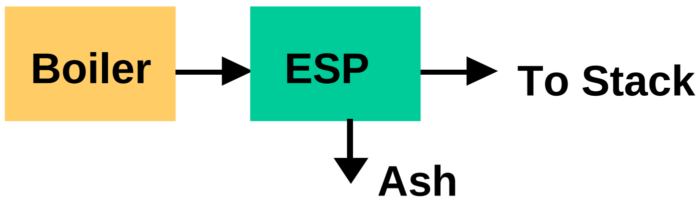
Ash Issues

- The mercury captured by PAC, LOI, and ash appears to be very stable and unlikely to reenter the environment.
- The presence of PAC will most likely prevent the sale of ash for use in concrete.
- Several developing technologies to address the problem:
  - Separation
  - Combustion
  - Chemical treatment
  - Non-carbon sorbents
  - Configuration solutions such as EPRI TOXECON™

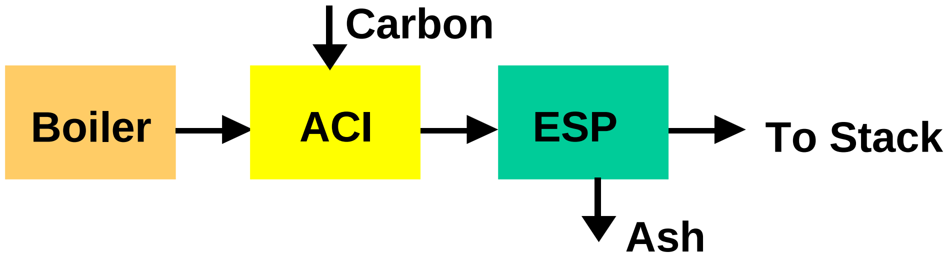
NESCAUM
Northeast States for Coordinated Air Use Management

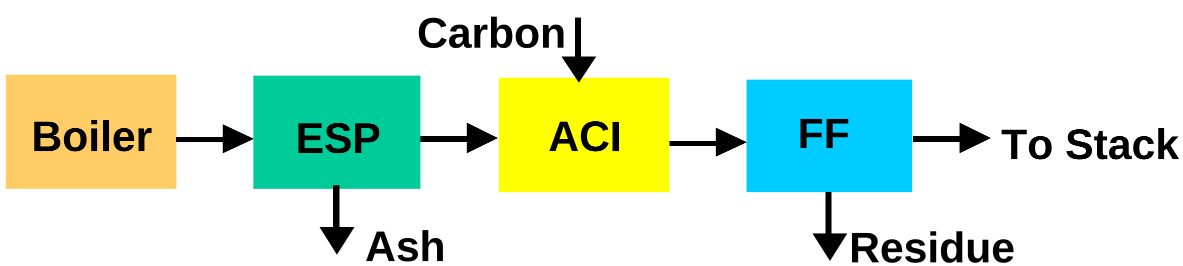
Hg Control for Key Configurations

Typical Eastern No Control Configuration (> 65%, 1999)

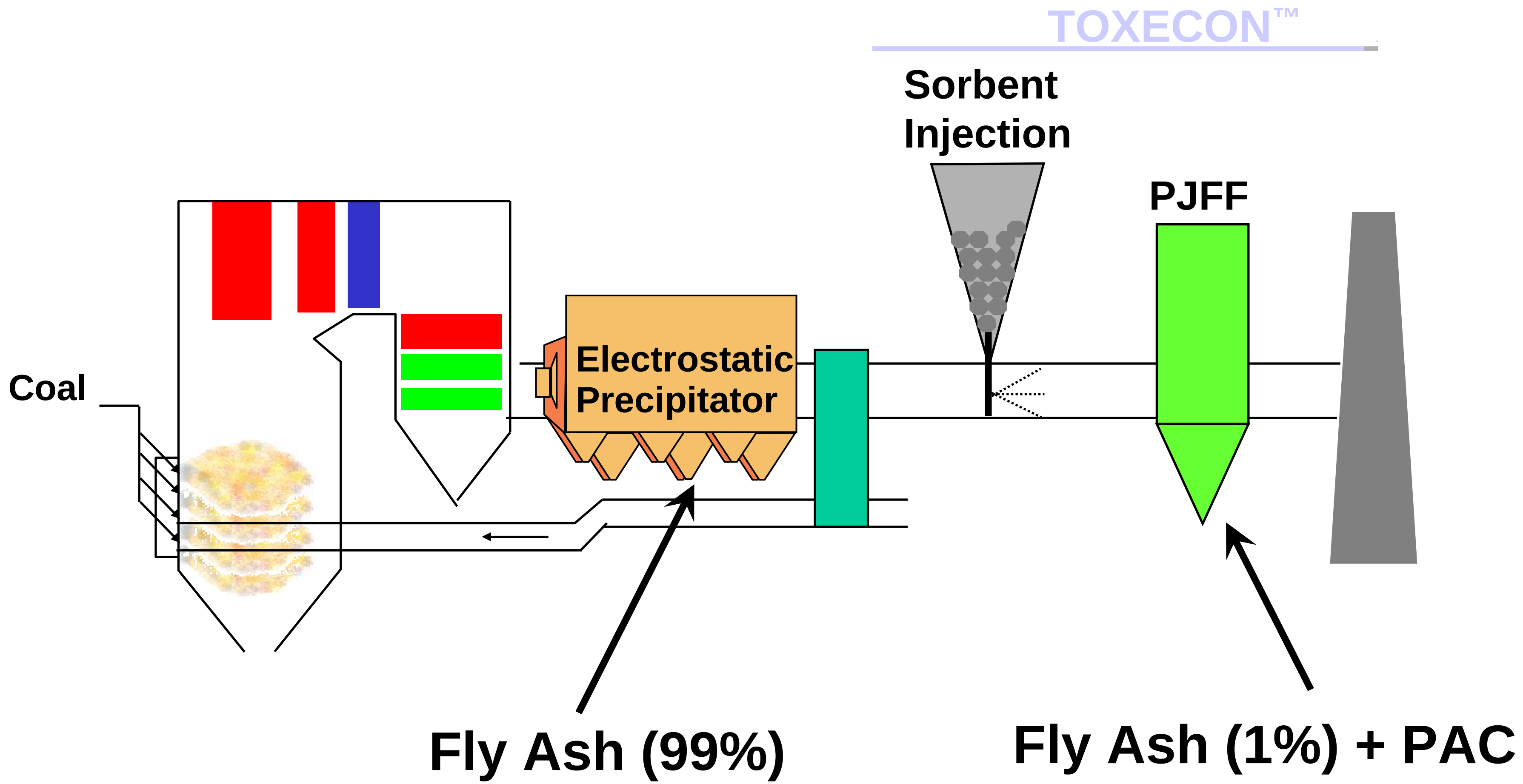


ACI-Based Hg Control Modifications





TOXECON™ Configuration

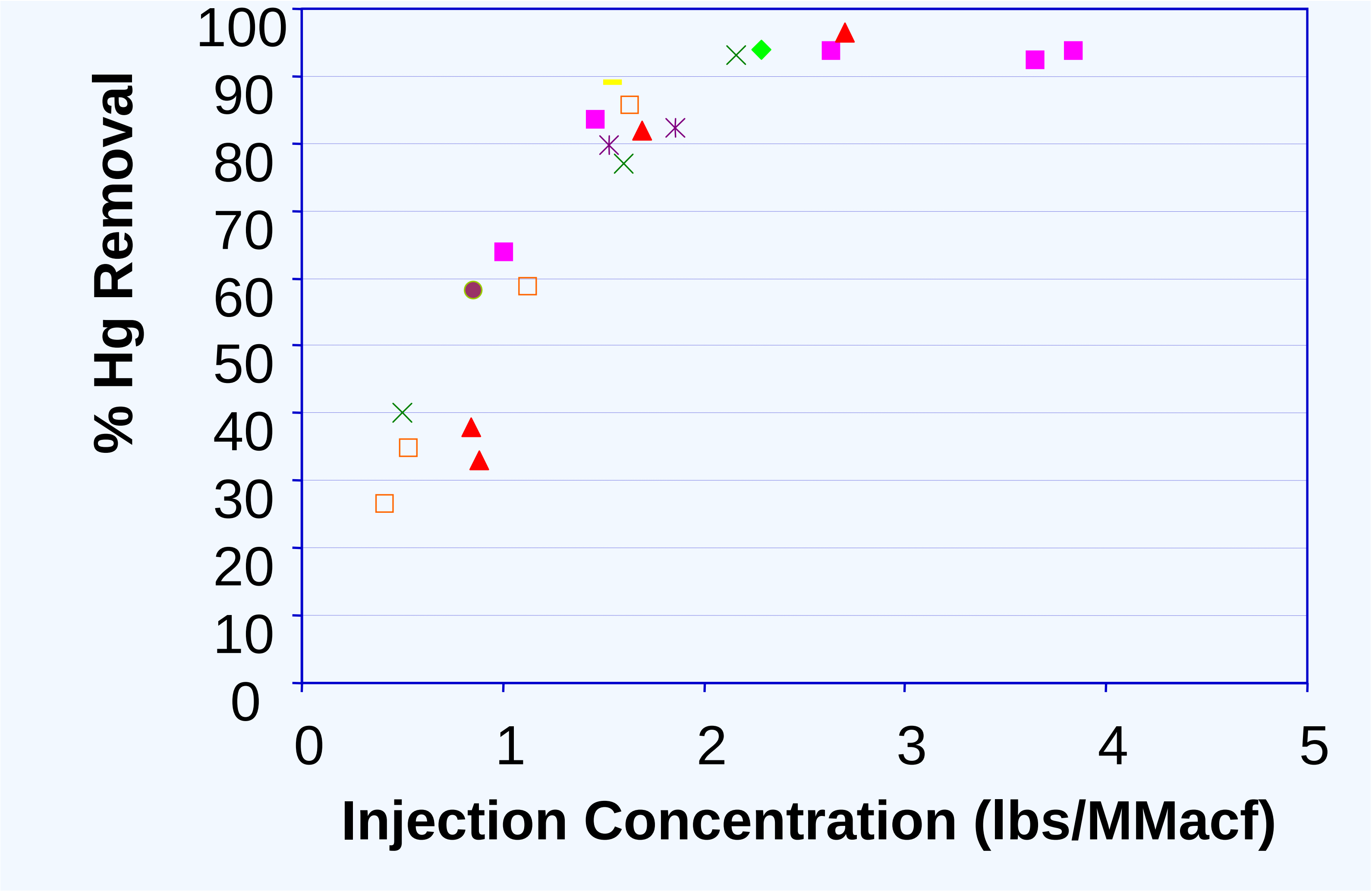


Alabama Power E. C. Gaston Unit 3

- 270 MW firing a variety of low-sulfur, washed eastern bituminous coals.
- Particulate Collection:
  - Hot-side ESP; SCA = 274 ft²/kacfm
  - COHPAC™ baghouse
- Wet ash disposal to pond.
- Primary funding from DOE/NETL with co funding provided by:
  - Southern Company
  - Duke Energy
  - Ontario Power Generation
  - TVA
  - Kennecott Energy
  - We Energies

– EPRI
– First Energy
– Hamon Research-Cottrell
– Arch Coal

Phase I Test Results



Removal of Mercury Species with PAC on Bituminous Coal

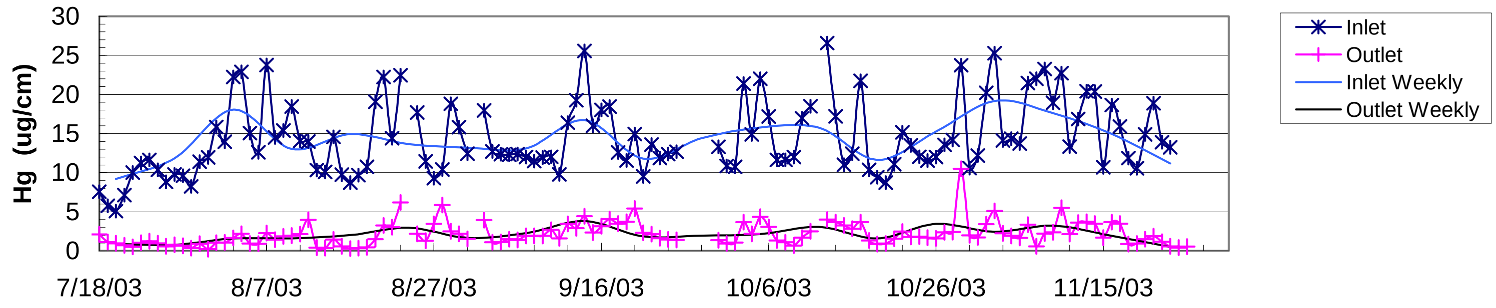
Bituminous with FF

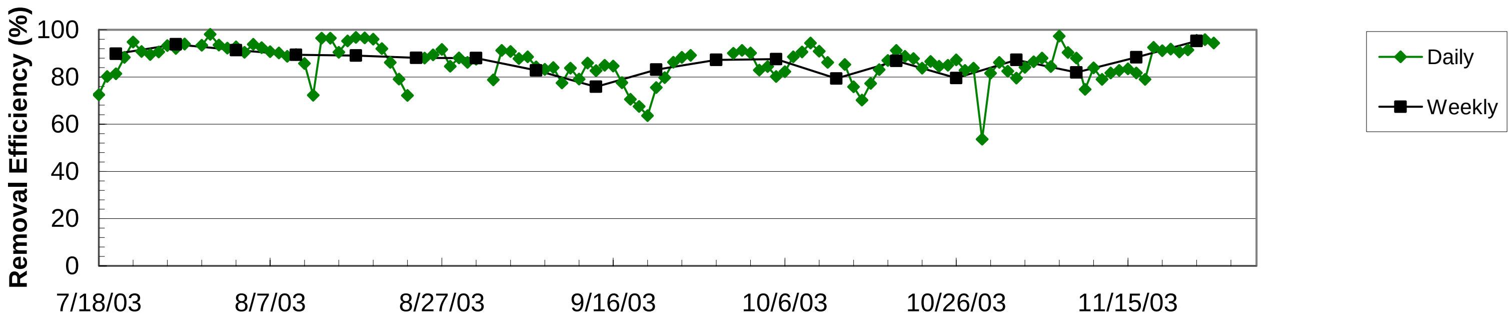
	PARTICULATE	OXIDIZED	ELEMENTAL	TOTAL
PAC Injection	µg/m^3	µg/m^3	µg/m^3	µg/m^3
COHPAC™ Inlet	0.23	6.37	4.59	11.19
COHPAC™ Outlet	0.12	0.91	0.03	1.05
Removal Efficiency	45.6%	85.7%	99.3%	90.6%

Year-long TOXECON^{TM} Test

- Conduct ~ 1 year demonstration of TOXECON^{TM} (sorbent injection into COHPAC) for power plant mercury control
- Determine design criteria and costs for new TOXECON^{TM} systems
- Determine balance-of-plant impacts

Daily and Weekly Average Mercury





Weekly, Average Mercury

Week Starting	Inlet Mercury ($\mu g/m^3$)	Outlet Mercury ($\mu g/m^3$)	Mercury Removal (%)	Standard Deviation Hg Removal
7/20/03	9.2	0.8	91	6.5
7/27/03	11.8	0.8	93	3.6
8/3/03	18.1	1.6	91	4.5
8/10/03	13.0	1.6	87	10.7
8/17/03	14.9	2.0	86	12.0
8/24/03	13.9	2.9	79	6.3
8/31/03	13.2	1.7	87	5.7
9/7/03	13.1	2.3	82	6.3
9/14/03	16.7	3.8	77	10.6
9/21/03	11.8	1.9	83	7.3
9/28/03	11.3	1.1	90	1.6
10/5/03	15.8	2.1	86	6.3
10/12/03	15.8	3.1	80	8.7
10/19/03	11.6	1.6	86	6.2
10/26/03	15.2	3.5	77	14.6
11/2/03	19.2	2.4	87	6.6
11/9/03	17.6	3.2	82	6.5
11/16/03	14.9	1.9	87	7.1
Overall Average	14.3	2.1	**85.6%**	

Commercial Status of Technology

1. Equipment
   - Similar equipment has been used successfully in the waste industry to inject AC into flue gas
   - It has successfully been scaled up for full-scale utility applications
   - Operating continuously for nearly a year at Gaston
   - Three AC injections systems currently operating
2. Supply of Activated Carbon and Other Sorbents
   - Sufficient supply available to meet several State regulations
   - Additional production needed to meet Federal regulations
   - Tremendous progress being made with improved sorbents
3. Performance
   - Will vary with type of equipment (FF vs. ESP)
   - Will vary from site to site due to flue gas characteristics (temperature, acid gases)

Availability of Activated Carbons

	Current excess capacity of AC production in Tons/year
NORIT Americas:	22,500
Other US Suppliers:	40,000
Total US Excess Capacity	62,500
Donau (Germany)	130,000
CarboChem (China)	60,000
Total Import Excess Capacity	190,000
Total US and Import Excess Capacity	252,500

Number of 250 MW Plants that Can Be Treated by Currently Available AC (out of 1100 in US)

	Excess Capacity Tons/yr	ESPs (50-70%)	FF (70-90%)
US AC	62,000	30	99
Total US Plus Imports	252,000	120	400

- Manufacturers plan to increase production to meet market demand, but only upon regulatory certainty

Other Mercury Sorbents

- Sodium Tetrasulfide
  - Commercially used in Europe on waste incinerators
  - Avoids ash disposal issues
- Amended Silicates
  - Similar cost/performance as PAC is projected
  - Avoids ash disposal issues
  - To be tested by Cinergy at Miami Fort 6 under DOE program
- Enhanced PAC
  - PAC-based sorbent with higher efficacy due to added chemicals
  - May avoid ash disposal issues
  - To be tested by Duke Power and DTE Energy under DOE program
- Mercury Control Absorption Process (MerCAP)
  - Sorbent-coated (gold) metal plates suspended in flue gas
  - Slipstream tests at Great River Power, WEPCO and Minnesota Power plants

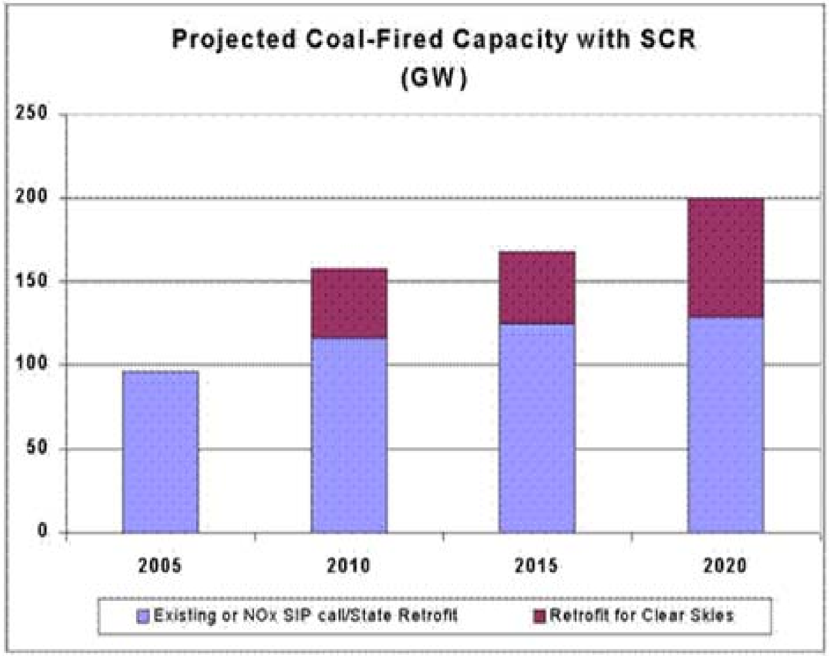
Sources: Babcock Power, Mega Symposium, DOE releases

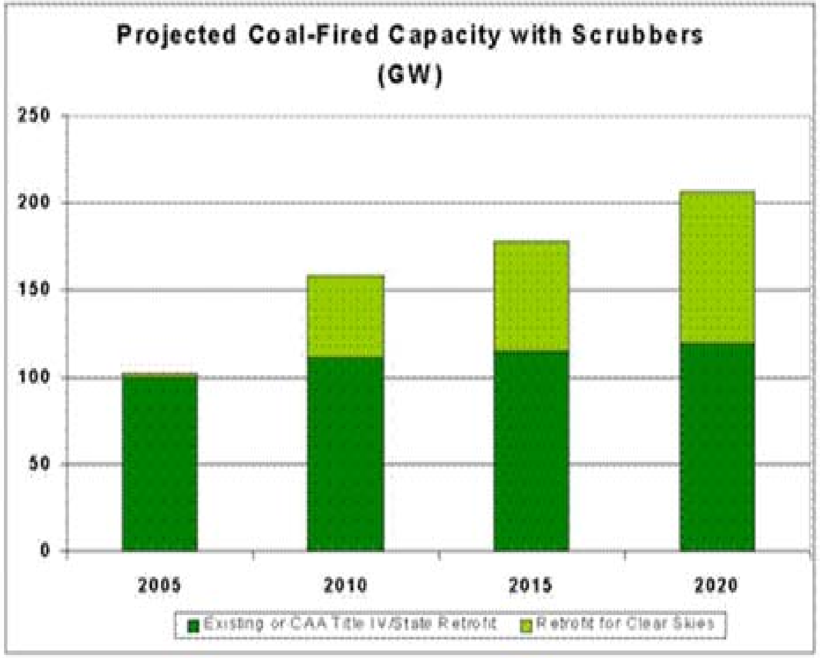
Conclusions on ACI Performance

- AC injection can effectively capture elemental and oxidized mercury from bituminous coals.
- There will be difference in site to site performance of ACI due to differences in coal, equipment, and flue gas characteristics
- Fabric filters provide better contact between the sorbent and mercury than ESPs, resulting in higher removal levels at lower sorbent costs.
- Long-term results are promising showing Hg removal greater than 85%
- New COHPAC™ fabric filters will have to be designed to handle higher loadings of PAC to insure high (>90%) mercury removal.

Mercury Removal with Enhanced Wet (SO_2) Scrubbing, and with SCR (for NOx control) plus Wet Scrubbing

Looking Ahead – SCR and FGD Projections





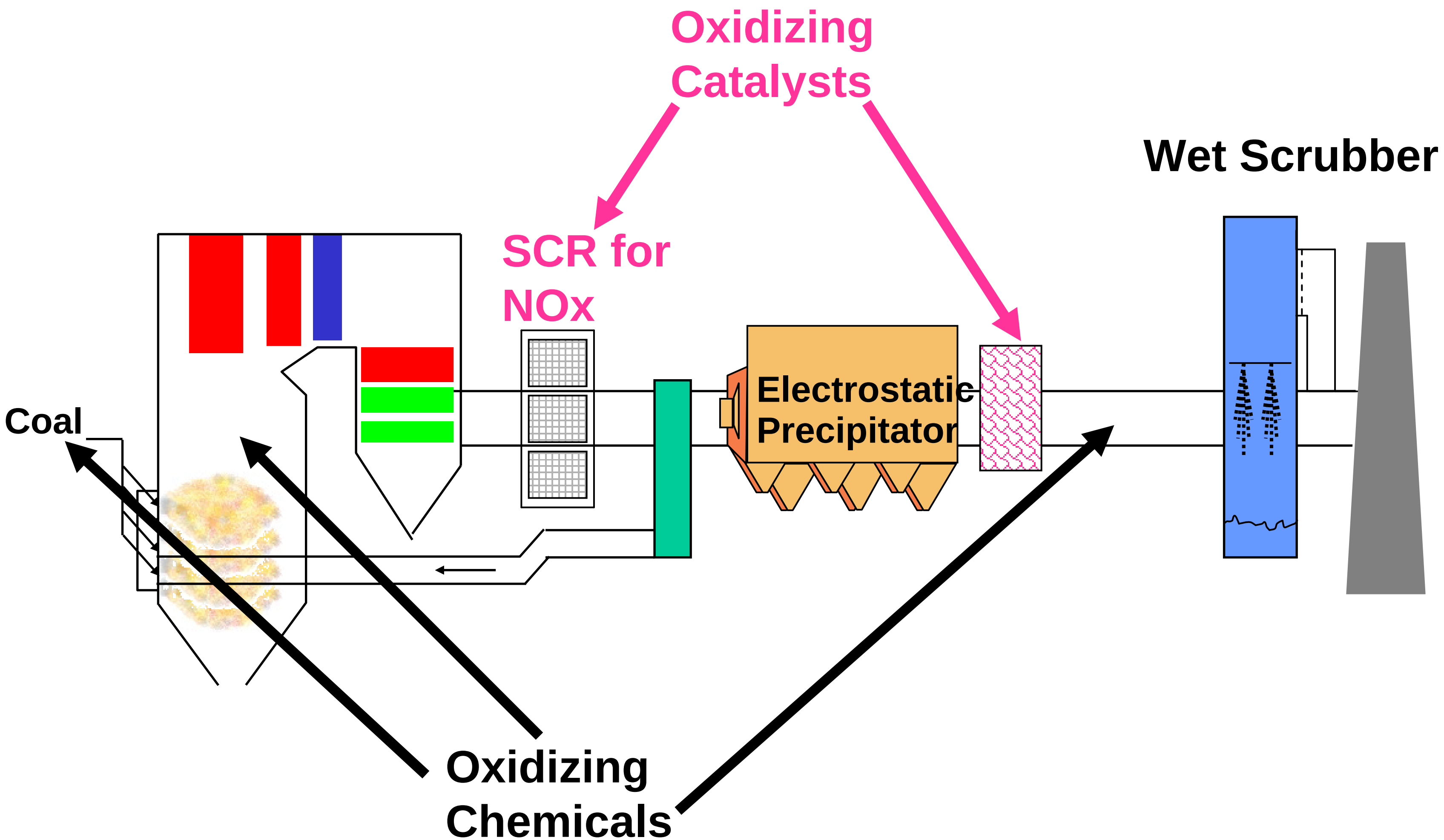
Need to engage in focused RD&D efforts to determine cost-effective means for optimizing/tweaking these controls.

Source: 2003 Technical Support Package for Clear Skies

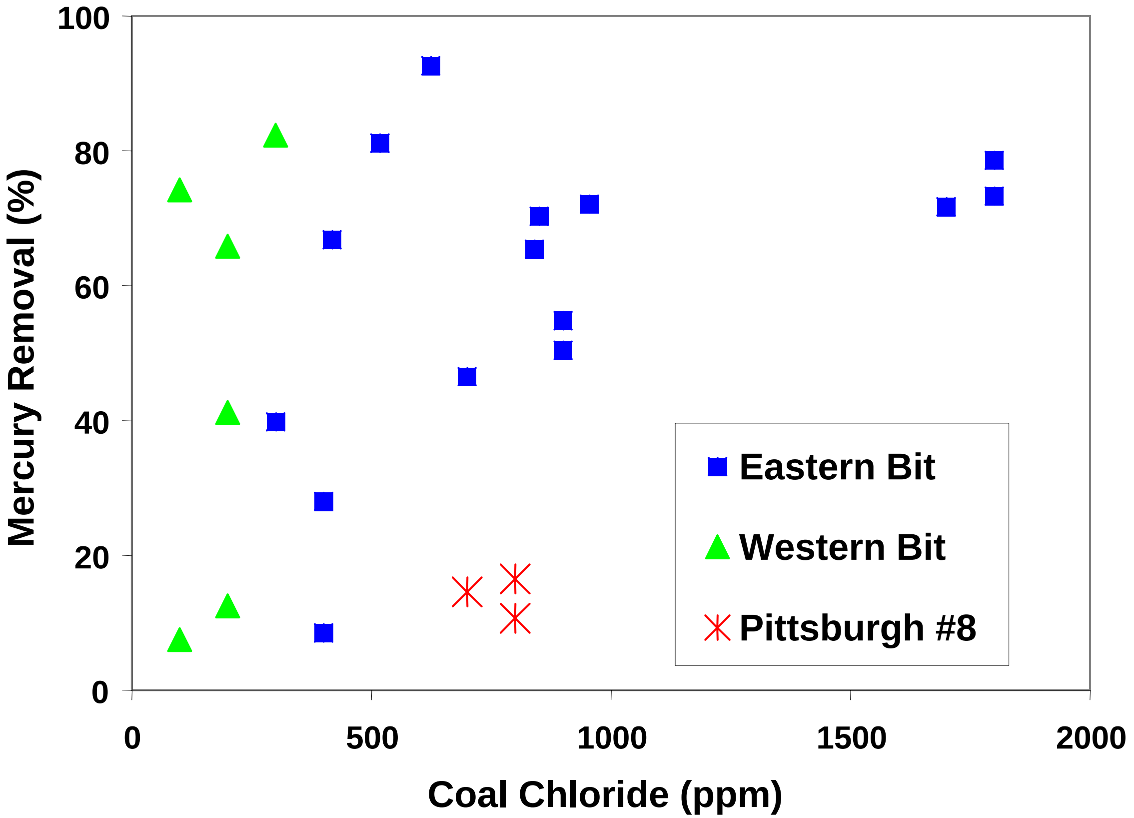
Control of Mercury in Wet FGD Scrubbers

- Oxidized Mercury is water soluble and can be captured in SO_2 wet scrubbers.
  - Some captured mercury gets re-emitted
- Elemental mercury cannot be captured by SO_2 wet scrubbers.

Enhancing Capture of Hg in Wet Scrubbers:



Mercury Removal in Wet Scrubbers for Bituminous Coals



Low correlation of existing data; difficult to predict the mercury removal that will be achieved in a WFGD

Status of Technologies for Oxidizing Mercury

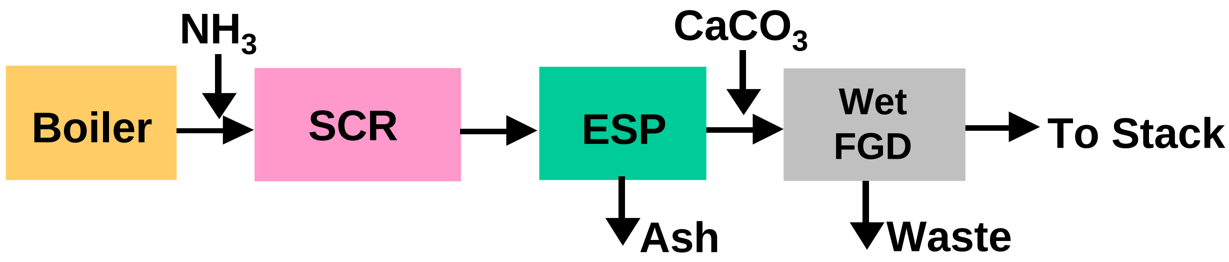
- SCRs:
  - Documenting performance on full-scale installations
  - Better performance on bituminous than subbituminous coals
  - Possibility of aging effects
  - Possibility of interferences from other chemicals
  - Catalysts are being designed to reduce oxidation of SO_3; this may impact oxidation of Hg
- Oxidizing Catalysts:
  - Pilot-scale testing under way
- Oxidizing Chemicals:
  - Some very short-term full-scale tests
  - Concerns with corrosion

Sorbent Injection Upstream of a Wet Scrubber

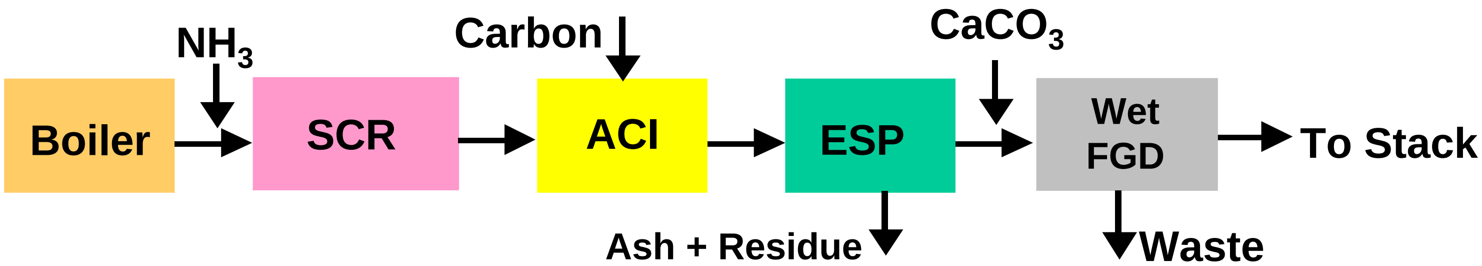
- Injection of AC and capture in ESP will provide an additional mechanism to reduce mercury emissions.
- Oxidation of mercury produced by carbon could enhance capture in FGD.
- Decreased mercury levels in scrubber could reduce potential for reemission of elemental mercury from scrubber.
- Two DOE/Industry full-scale field tests are scheduled
  – Georgia Power Yates; currently on-going, medium-sulfur bituminous coal
  – AEP Conesville; Spring ’05, high-sulfur bituminous

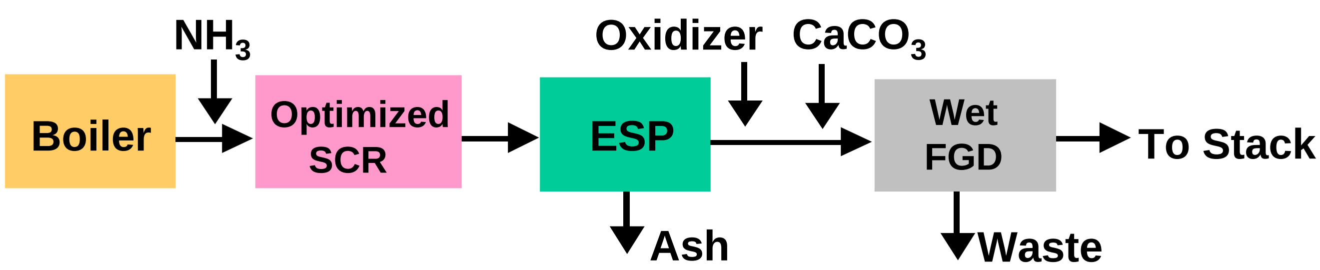
Hg Control for Key Configurations

SO_2 and NO_X Control Configuration



Hg Control Modifications





Emerging Hg and Multi Pollutant Control Technologies

Emerging Technologies

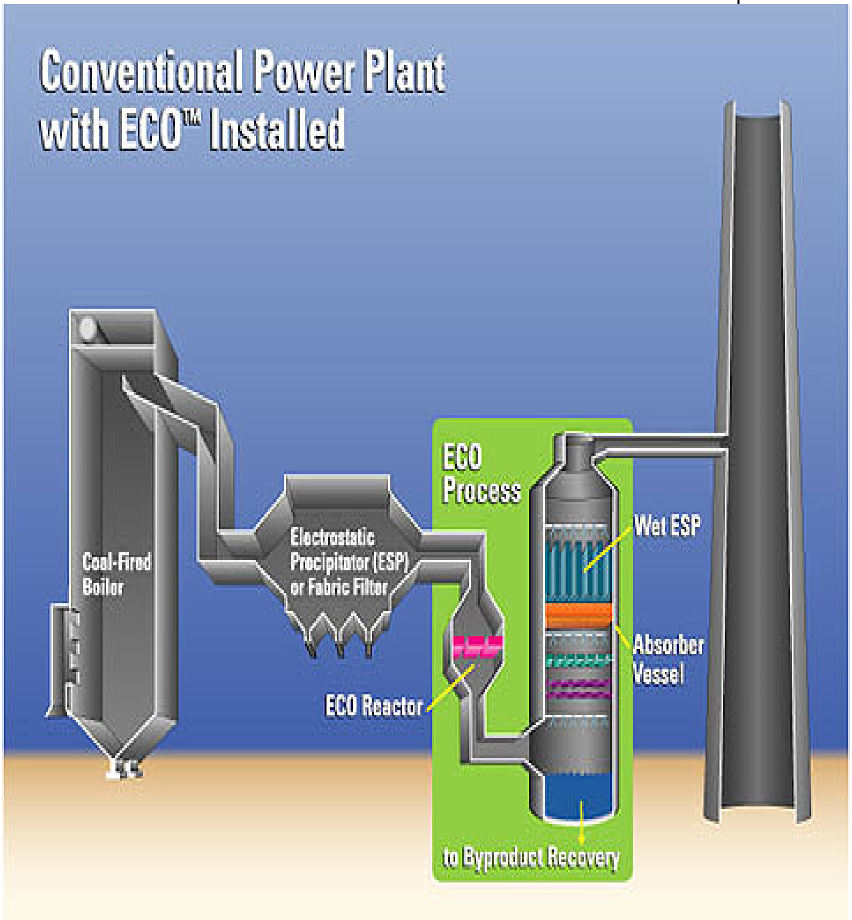
- Reduce costs
- Increase performance
- Increase flexibility

Selected Advanced/Emerging Technologies

WGI-EPRI – AQIV 2003

Technology	Process Description	Commercial status	Controlled pollutants	Removal efficiency	Published costs
ECO **Powespan**	Elecro-Catalytic Oxidation followed by scrubber and wet ESP	Pilot and demonstration tests completed 50MW unit under construction	NOx SO2 Hg metals	55-80 45 >80 >90	$150-200/kw
LoTOx **BOC Gases**	Ozone injection for NO and Hg oxidation and removal by wet scrubber	Completed 25MW demo - NOx only	NOx Hg	90-95 90+	NA
Pahlman Process **Enviroscrub**	Dry injection of Pahlmalite sorbent	Pilot work ongoing NOx-SO2 demonstrated separately	NOx SO2	95+ 99	$150/kw
AIRborne **B&W** **AIRborne Technologies**	Dry sodium injection or wet sodium scrubbing with multiple options for fertlizer products	CCPI project - 525 MW start-up 2007	NOx SO2 HCl metals	40 85-95 90 NA	$170/kw
K-fuel **KFx**	High energy fuel from low quality coal feed stocks	Testy burns completed of K-fuel in WY	NOx SO2 Hg	33 50 70	NA
Mitsui-BF process **Marsulex**	Carbon bed absorption with regeneration NH3 injection for NOx control	Several installation oversees	NOx SO2 Hg PM	60-80 80-99 85-90 <15mg/Nm3	$110-140/kw
GSA **FLSmith/Airtech**	CFB Absorber with lime injection	Commercial largest unit to date is 125MW	SO2 SO3 Hg	>95 >95 50-90	$150/kw

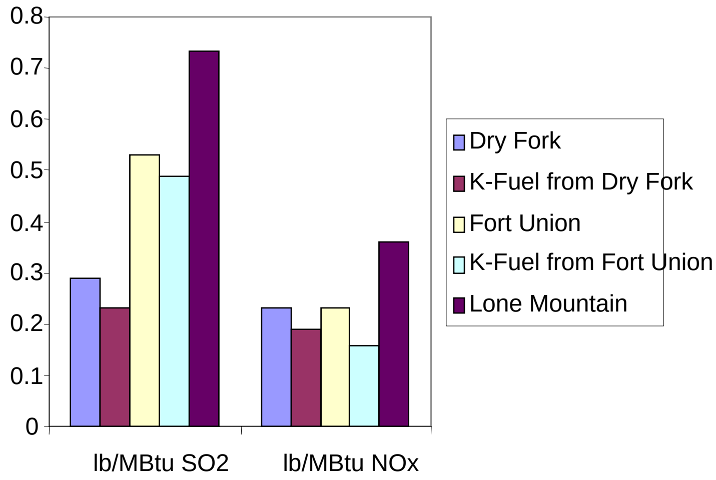
NOx-SO2-Hg Electro-Catalytic Oxidation TM (ECO)

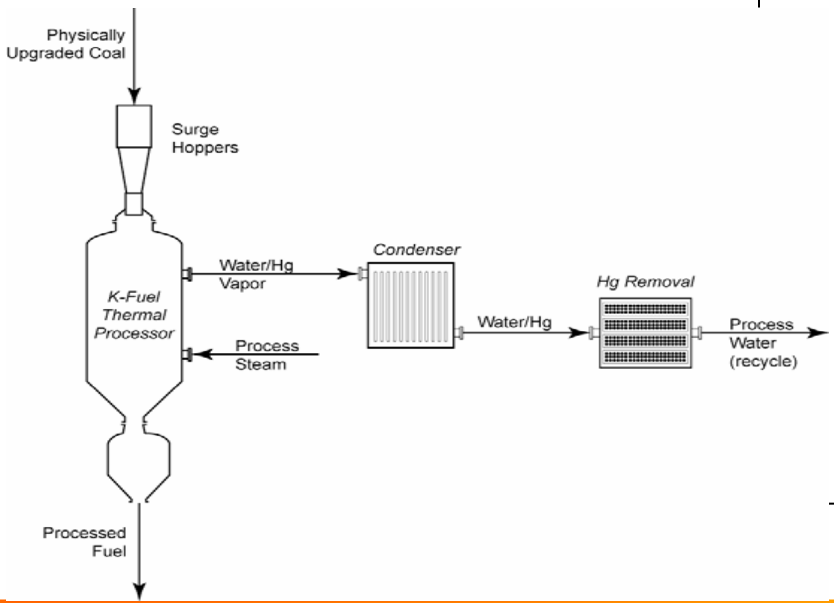


– Process
  - Barrier discharge reactor oxidizes gaseous pollutants
  - Products of the oxidation are captured in ammonia scrubber and wet ESP
  - Ammonium nitrate and sulfate (fertilizers) byproducts

– Status
  - Pilot scale test at approximately 2-4 MW equivalent
  - Projected reductions: 90, 98+, 80-90, and 95% of NO_x, SO_2, Hg, and fine PM
  - DOE-sponsored testing to evaluate mercury removal performance

K-Fuel®





- **K-fuel is a beneficiated coal derived from western subbituminous coals that is lower in ash, higher in BTU value, and produces lower pollutant emissions than parent coals.**
- **Test burns at the SRI - significant reductions in NOx and SO_2**
- **First commercial plant being built at the Black Thunder mine in Wright, Wyoming; completion by 2004; capable of producing more than 700,000 tons per year of K-Fuel**

Status of Mercury CEMS

- U.S. EPA Hg proposal : Method 324 for carbon sorbent tubes (can not provide performance common to CEMS)
- Current availability of CEMs : high state of readiness
- CEMS not a barrier to the deployment of mercury control technology (2004 to 2007)
- Need reliable CEMS especially for market based cap and trade approaches

Status of Hg CEMS (cont.)

- At least half a dozen suppliers of Hg CEMS ; CEMS are accurate, and rapidly advancing toward increased reliability and lower maintenance

Semi-Continuous Mercury Analyzer

Semi-Continuous Mercury Analyzer

- Measures vapor phase mercury (no particle phase)
- Sample time ranges from 10 – 30 minutes depending on mercury concentration
- Research (prototype) analyzer
  - Requires highly experienced engineer to operate

Proposed U.S. Regulatory Alternatives

- Regulatory options outlined in the January 30, 2004 proposal
  - **Section 112**
    - ✓ Command-and-control MACT requirements
    - ✓ Cap-and-trade approach under guidelines of section 112(n)(1)(A)
  - **Section 111**
    - ✓ Market-based, cap-and-trade approach
- Final rule signed on/before March 15, 2005

Regulatory Parameters from a Control Device Perspective

1. Long term averaging
2. Dual Limit
   - Removal Efficiency
   - Emission Limit
3. Flexibility in Achieving Mercury Removal
   - Averaging of units at a site
   - Enhances cost effectiveness
4. Mechanism to Encourage Adoption

EPA Proposed MACT Limits

Subcategory	Hg (lb/TBtu)[1]
Bituminous-fired	2.0
Subbituminous-fired	5.8

NOTE: Output-based standards are referenced to a baseline efficiency (35% for new units; 32% for existing units).

States Initiatives/Legislation/Regulation

- Connecticut:
  - NOx, SO_2 (reg. passed in 2000) and Hg
  - Statewide annual NOx cap (based on 0.15 lbs/MMBtu)
  - Two-phase approach; 0.3% S or 0.33 lbs/MMBtu by 2003 in Phase II
  - June 2003 state leg. to control Hg by 90% by 2008
  - Developing CO_2 plan to meet NEG/ECP goals

States Initiatives/Legislation/Regulation

- **New Jersey**
  - 3 mg/MWhr or 90% control of mercury (equivalent to 0.6 lbs/TBTU)
  - By 12/15/07 if only mercury is controlled
  - Deadlines extended if multipollutant option is chosen by industry (50% of coal capacity by 2007; until 12/15/2012 for full compliance)
  - Multi pollutant : 0.10 (dry bottom) or 0.13 lb/mmBtu (wet bottom) for NOx; 0.15 lb/mmbtu for SO2; 0.030 lb/mmbtu for PM
  - Stack testing (quarterly) or CEMs validated by U.S. EPA

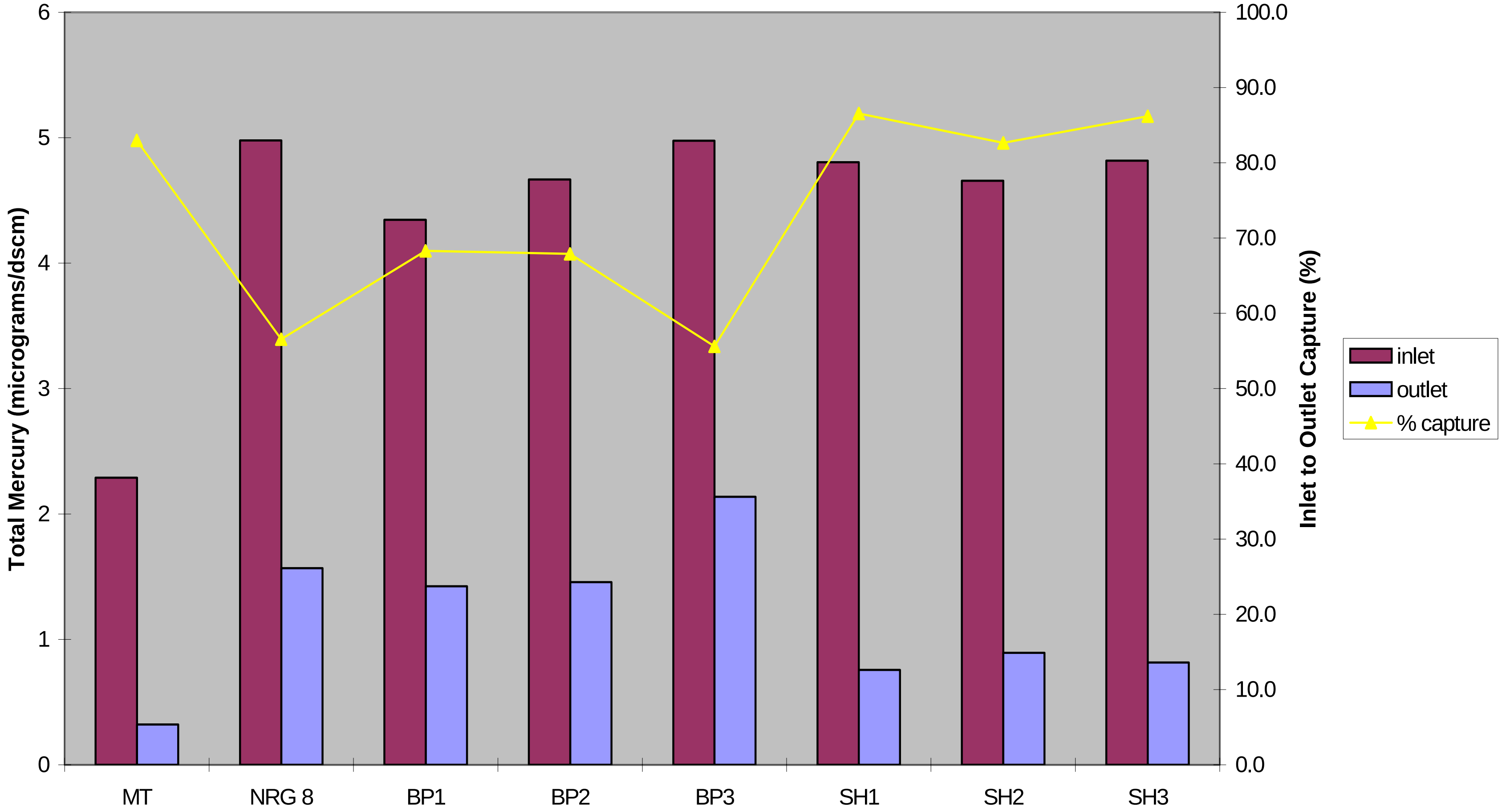
States Initiatives/Legislation/Regulation

- New Hampshire:
  - – NH's Clean Power Act (2002) for NOx, SO_2, CO_2, and "future" Hg
  - – 90% reduction from 1990 emissions for NOx
  - – 87% reductions from 1999 emissions for SO_2
  - – For CO2, return to 1990 levels by 2006 and 25% below 1990 levels by 2011
  - – Statewide cap for Hg proposed 3/31/2004
    - 50 lb/year by 2008 and 24 lb/yr by 2011 from baseline of 120 lb/yr

States Initiatives/Legislation/Regulation

- New York
  - SO_2 and NOx (reg. approved March 2003)
  - SO_2: 50% below Title IV (phase II), statewide cap
  - NOx: Year round statewide cap (based on 0.15 lbs/MMBtu)
  - Governor's Task Force on carbon
  - No action on Hg yet

Mass Average Baseline Mercury Results by Unit



NESCAUM
Northeast States for Coordinated Air Use Management

Mass Control Feasibility Report Economic Conclusions

- Mercury controls are economically feasible
  - Sorbent-based mercury controls costs are LOWER than historically accepted NO_x control costs (mills/kWh) and much lower than SO2 controls (0.7-2.0 mills/kWh for Hg; 2-4 mills/kWh for NOx, 4-5 mills/kWh for SO_2)
  - Multi-pollutant regs (like MA’s) improve cost-effectiveness

Final Mass Mercury Standard

- Form of the standard
  - Output-based and % control efficiency options
- Level of the standard
  - Phase 1: 85% or 0.0075 lb/GWh by 1/1/2008
  - Phase 2: 95 % or 0.0025 lb/GWh by 10/1/2012
- Demonstrating compliance with the standard
  - Quarterly stack tests until 1/1/2008
  - CEMs required beginning 1/1/2008
- Averaging time of the standard
  - Rolling 12-month basis

COMPARISON OF PROPOSED AND FINAL STATE MERCURY EMISSION STANDARDS FOR POWER PLANTS

March 25, 2004

Issue	MA	CT	WI	NJ
Stringency of Standard	Cap emissions at 2001 -2002 emissions levels X 1997-1999 heat input; Phase I -85% control efficiency or 0.0075 lbs/GWh. Phase II -95% control efficiency or 0.0025 lbs/GWh. (equivalent to approx. 0.2 lbs/TBTU)	No caps. 0.6 lbs/TBTU or 90% control efficiency.	Cap on emissions in 2008: current control efficiency x baseline (3 yr. Mercury coal average) Phase I - 40 % reduction Phase II - 80% reduction (both from 2002-2004 levels)	No caps 3.00 mg/MW- hr; **or** 90 percent control of mercury emissions; (equivalent to 0.6 lbs/Tbtu)
Format of Standard	Either/or output-based emissions rate or percent reduction from historic or 2001-2002 input levels	Either/or heat input-based emission rate or percent reduction from input levels	Percent reduction from input levels	Output-based emissions rate or percent reduction from input levels

COMPARISON OF PROPOSED AND FINAL STATE MERCURY EMISSION STANDARDS FOR POWER PLANTS

March 25, 2004

Issue	MA	CT	WI	NJ
Compliance Deadline	Phase I – January 1,2008 Phase II - October 1, 2012	July 2008	Phase I – 2010 Phase II - 2015	December 15, 2007 if only mercury is controlled Multi-pollutant Option Phase I – December 15, 2007 (50%) Phase II – December 15, 2012 (Final compliance)
Compliance Monitoring	CEMs effective January 1, 2008	CEMs when validated by U.S. EPA	Annual (fuel use x Hg content)	Stack testing or CEMs when validated by U.S. EPA

COMPARISON OF PROPOSED AND FINAL STATE MERCURY EMISSION STANDARDS FOR POWER PLANTS

March 25, 2004

Issue	MA	CT	WI	NJ
Frequency of Stack Testing	Every other quarter from 10/06 to 1/08, CEMs required after 1/08	Quarterly with phase-out of stack tests after CEMs are employed.	Annual	Quarterly with phase-out of stack tests after CEMs are employed
Other	Units shutting down can use early or off-site reductions to 2010. Units with less than 5 lb in 2001 can use early or off site red to phase 2	Alternative limit can be developed if technology proven feasible. Stricter standard may also be issued.	Phase I waved if multi-pollutant approach taken. Variances for reliability, technical or economic infeasibility incl. Trading among 4 utilities allowed.	Compliance deadline extended to Dec. 15, 2012 – if an enforceable agreement w/ Dept. by Dec. 15, 2007, to install & operate multi-pollutant control systems by Dec. 15, 2012

Summary: State and Federal Mercury Regulations/Legislation

The proposed federal regulations – uncertain future

Pending federal legislation – passage in an election year questionable

States –A number of state regulations already in place in view of uncertainty at federal level

NESCAUM
Northeast States for Coordinated Air Use Management

Summary & Conclusions

- Control technologies are now commercially available; new technologies are rapidly emerging; 90% and higher control is feasible
- cost effectiveness of Hg control is quite comparable to, and more attractive than the cost effectiveness of SO_2 and NOx controls from power plants (Hg:SO_2:NOx::1 to 3 mills/kwhr :3-5 mills/kwhr:2-3 mills/kwhr)
- CEMS instruments are accurate and rapidly emerging toward increased reliability; should not slow down the application of control technologies
- Many states in the U.S. are moving at a faster and a more certain pace than the federal regulation, based on the assumption that environmental regulation drives technology innovation and implementation