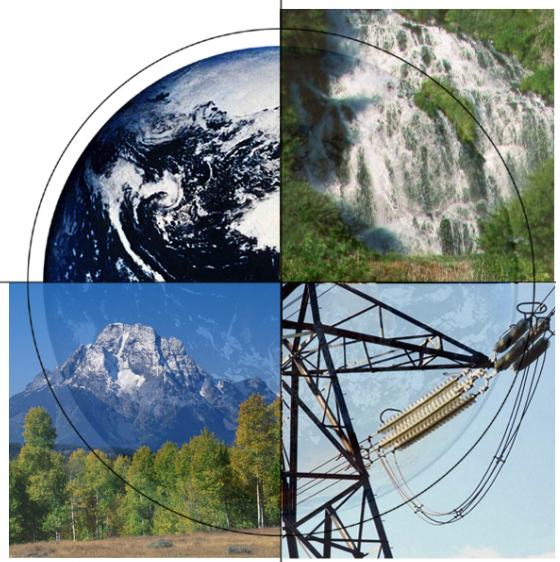
Status of U.S. Department of Energy's Mercury Control Technology Field Testing Program



Navigating the Mercury Issue

October 19-20, 2005
Arlington, Virginia

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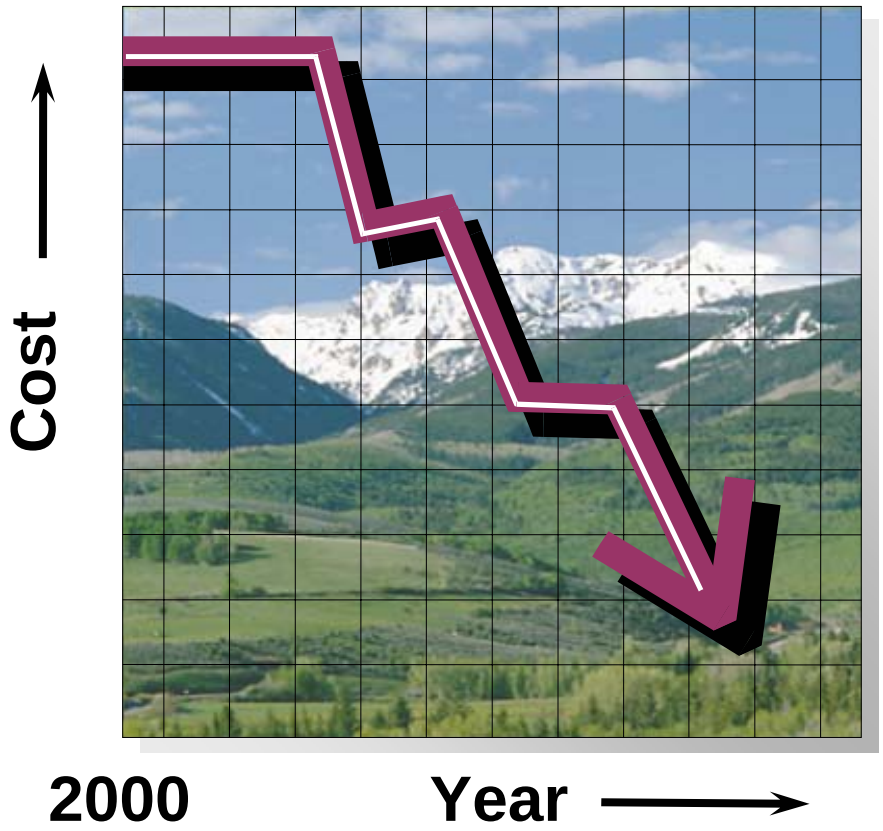
National Energy Technology Laboratory

Mercury Control Technology Program
Performance/Cost Objectives

- **Have technologies ready for <u>commercial demonstration</u> by:**
  - **2007 that can reduce "uncontrolled" Hg emissions by 50-70%**
  - **2010 for all coals that can reduce "uncontrolled" Hg emissions by +90%**
- **Reduce cost by 25-50% compared to baseline cost estimates**

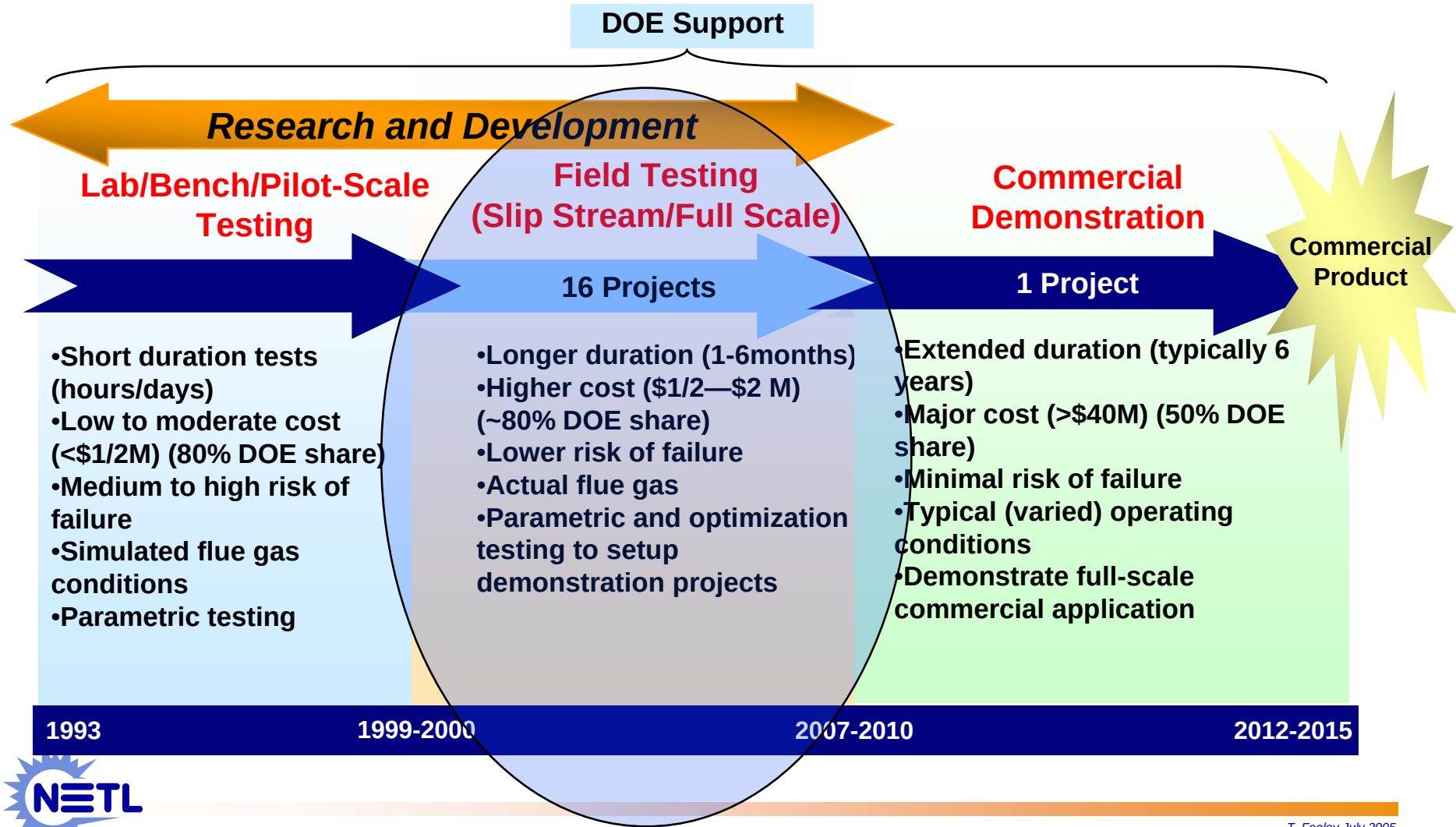


Baseline Costs: $50,000 - $70,000 / lb Hg Removed

Stages of Mercury Control Technology Development

DOE RD&D Model

Progress over time



Phase II Mercury Control Field Test Projects

- Fourteen projects
- Long-term (30 days or more @ optimum conditions), large-scale field testing
- Broad range of coal-rank and air pollution control device configurations; focus on low-rank coals
- Sorbent injection & mercury oxidation control technologies

Field testing at 28 different coal-fired units --representing approximately 2.3% of 1,165 existing coal-fired generating units.

NETL/DOE Mercury R&D Field Testing Phase II Projects

Evaluation of Sorbent Injection for Mercury Control	ADA-ES
Low-Cost Options for Moderate Levels of Mercury Control	ADA-ES
Field Demonstration of Enhanced Sorbent Injection for Mercury Control	ALSTOM
Demonstration of Amended Silicates for Mercury Control	Amended Silicates
Demonstration of Integrated Approach to Mercury Control	GE-EERC
Enhancing Carbon Reactivity in Mercury Control in Lignite-Fired Systems	UNDEERC
Mercury Oxidation Upstream of an ESP and Wet FGD	UNDEERC
Field Testing of Activated Carbon Injection Options for Mercury Control	UNDEERC
Sorbent Injection for Small ESP Mercury Control	URS Group
Pilot Testing of Mercury Oxidation Catalysts for Upstream of Wet FGD Systems	URS Group
Evaluation of MerCAP for Power Plant Mercury Control	URS Group
Field Testing of a Wet FGD Additive for Enhanced Mercury Control	URS Group
Advanced Utility Mercury-Sorbent Field-Testing Program	Sorbent Technologies
Brominated Sorbents for Cold-Side ESPs, Hot-Side ESPs, and Fly Ash Use in Concrete	Sorbent Technologies

DOE is providing over $32 million in funding for 14 Phase II projects

DOE/NETL Phase II Mercury Control Field Testing Technology Matrix[a]

Coal Rank	Cold-side ESP (low SCA)	Cold-side ESP (medium or high SCA)	Hot-side ESP	TOXECON	ESP/FGD	SDA/FF or SDA/ESP
Bituminous	Miami Fort 6	Lee 1	Cliffside	Independence	Yates 1	
	Yates 1&2	Lee 3	Buck		Yates 1	
		Portland		Gavin	Conesville	
Subbituminous	Crawford	Meramec	Council Bluffs			Holcomb
		Dave Johnston	Louisa			
		Stanton 1	Will County			Laramie River[b]
Lignite (North Dakota)		Leland Olds 1			Milton Young	Antelope Valley 1
		Leland Olds 1				Stanton 10
						Stanton 10
Lignite (Texas)						
PRB / Bit Blend		St. Clair				
		Monroe				
TX Lignite / PRB Blend				Big Brown	Monticello	
					Monticello	
					Monticello	

Sorbent Injection

Sorbent Injection & Oxidation Additive

Oxidation Additive

Oxidation Catalyst

Chemically-treated sorbent

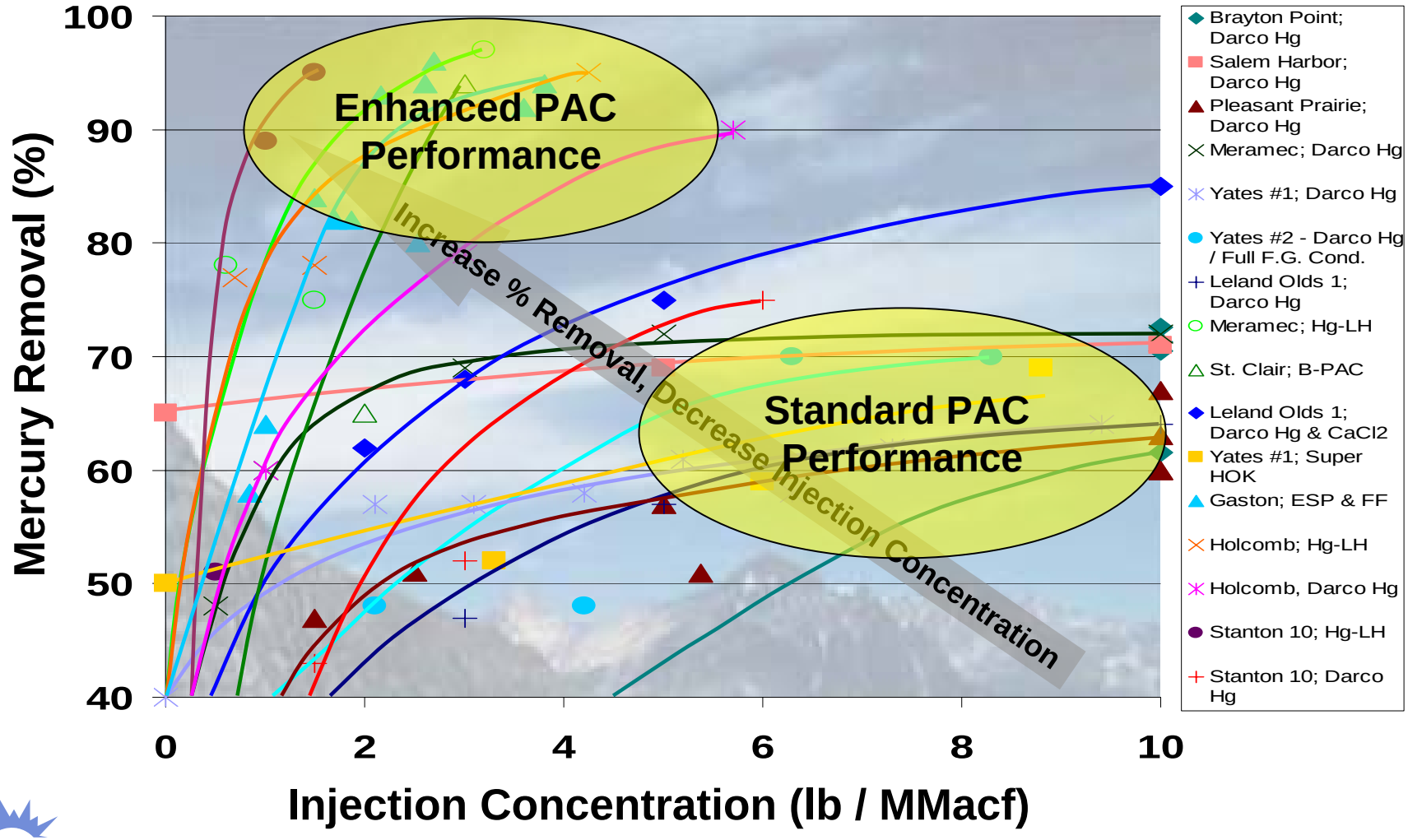
Other – MERCAP, FGD Additive, Combustion

[a] Matrix based on mercury control technology used during long-term testing.

[b] At Laramie River, parametric tests included: (1) sorbent injection; (2) oxidation additives; (3) sorbent injection with oxidation additives; and (4) chemically-treated sorbent injection.

Field Testing Results 2001 – 2005

Comparison of Standard & Enhanced PAC



Evaluation of Sorbent Injection for Mercury Control -- *ADA-ES*

Evaluate full-scale sorbent injection with existing pollution-control equipment at five sites:

- ***Sunflower Electric's Holcomb Station Unit 1***
  - burns PRB coal and equipped with SDA/FF
- ***AmerenUE's Meramec Plant Unit 2***
  - burns PRB and equipped with ESP
- ***Missouri Basin Power Project's Laramie River Station Unit 3***
  - burns PRB and equipped with SDA and ESP
- ***DTE Energy's Monroe Station Unit 4***
  - burns PRB/bituminous coal blend and equipped with SCR and ESP
  - long-term test completed July 1, 2005
- ***AEP's Conesville Station Unit 6***
  - burns bituminous coal and equipped with ESP and wet FGD
  - testing scheduled to begin March 2006

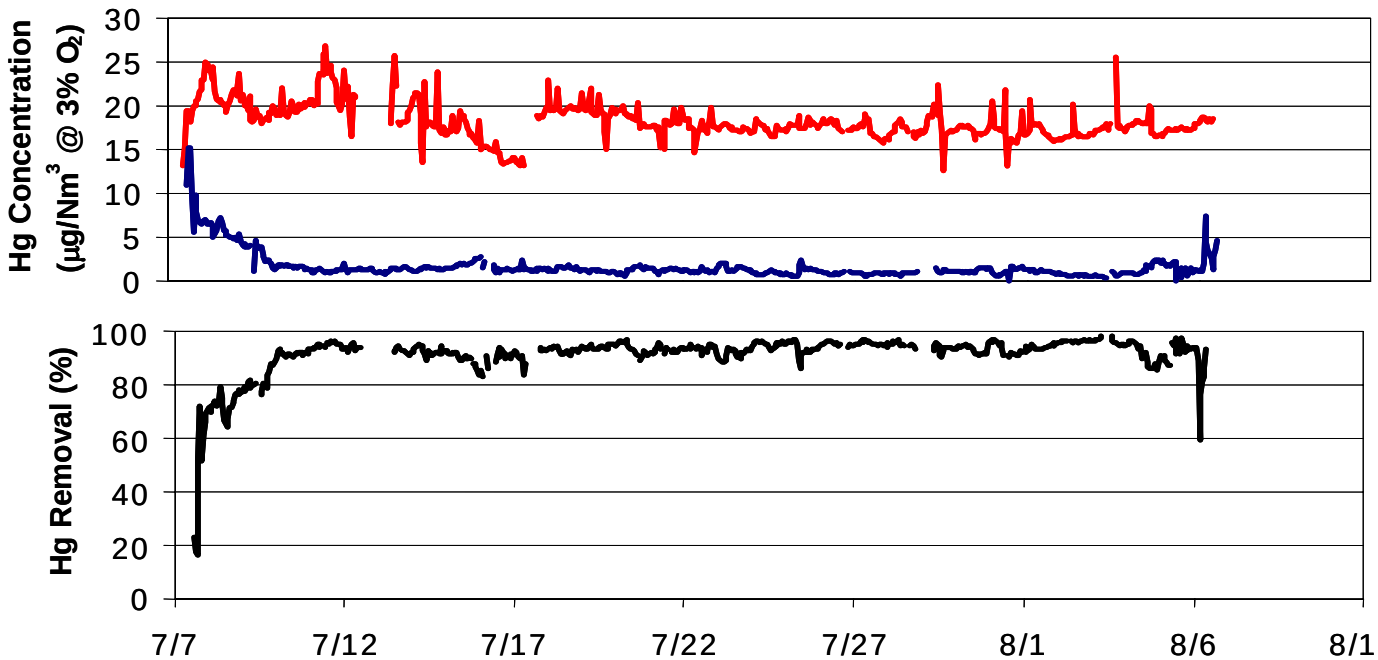
AC Storage Vessel

Evaluation of Sorbent Injection for Mercury Control – ADA-ES

Preliminary Results

Sunflower Electric's Holcomb Station Unit 1

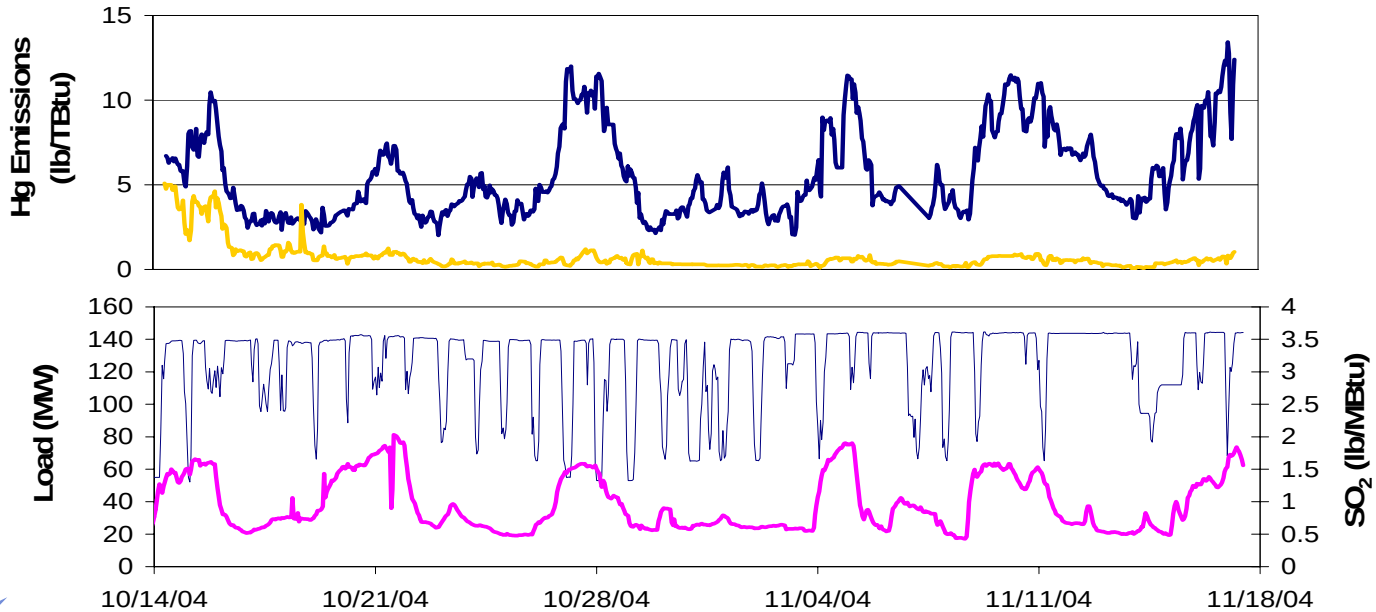
- Baseline mercury removal < 20%
- 30-day long-term test using Norit's DARCO® Hg-LH
- **Average mercury removal 93% with 1.2 lb/MMacf**



Evaluation of Sorbent Injection for Mercury Control – ADA-ES
Preliminary Results

AmerenUE's Meramec Station Unit 2

- Baseline mercury removal 15-18%
- 30-day long-term test using DARCO® Hg-LH
- **Average mercury removal 93% at 3.3 lb/MMacf**



Advanced Utility Mercury Sorbent Field-Testing Program -- *Sorbent Technologies*

- Evaluate the performance of Sorb-Tech's brominated B-PAC™ and H-PAC™ sorbents

Full-scale testing at two sites:

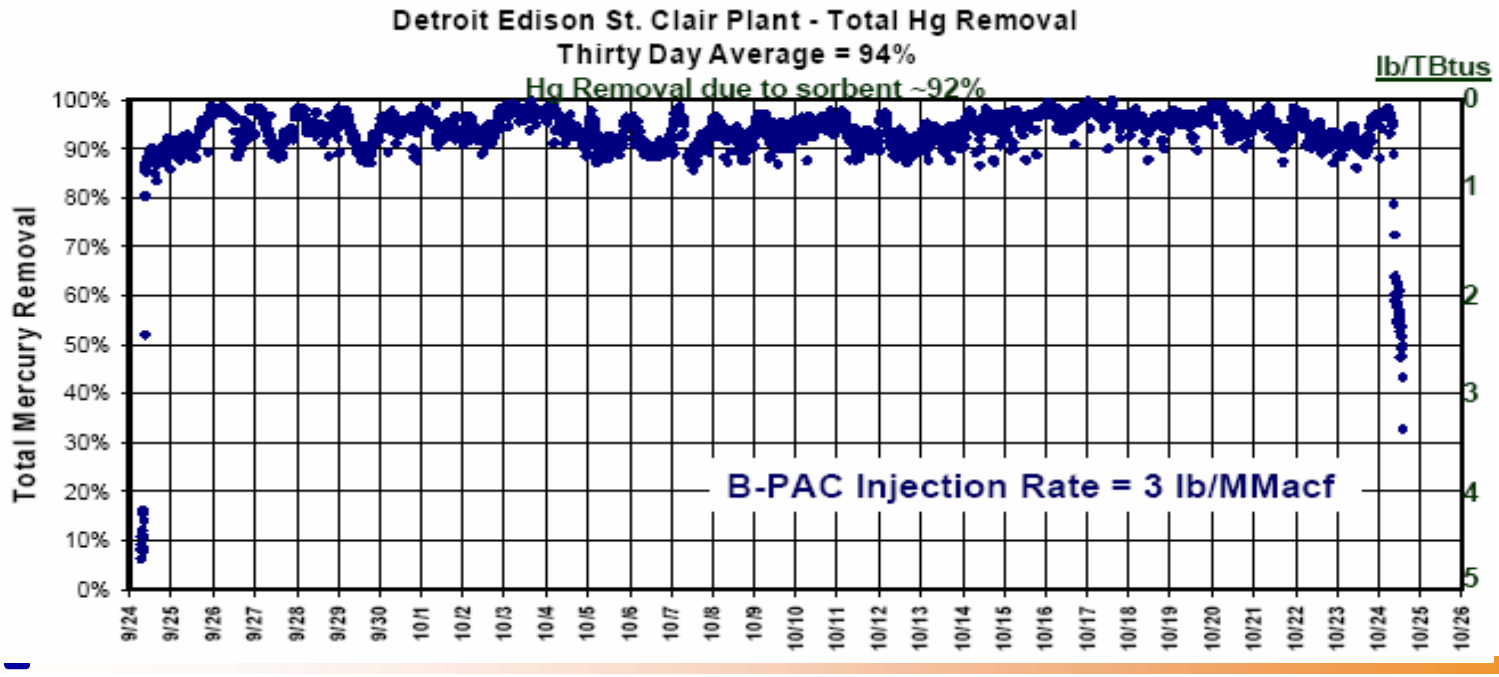
- ***Detroit Edison's St. Clair Station Unit 1***
  - burns PRB/bituminous coal blend and equipped with ESP
- ***Duke Energy's Buck Plant***
  - burns bituminous coal and equipped with hot-side ESP

Detroit Edison's St. Clair Station

Advanced Utility Mercury Sorbent Field-Testing Program -- Sorbent Technologies *Preliminary Results*

Detroit Edison's St. Clair Station Unit 1

- Baseline mercury removal across ESP varied from 0% to 40%
- One month long-term test with B-PAC™ sorbent injection
- **Average mercury removal 94% at 3 lb/MMacf**

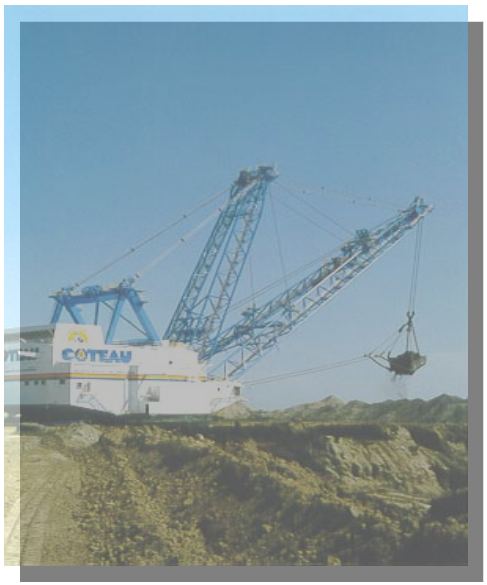


Enhancing Carbon Reactivity in Mercury Control in Lignite-Fired Systems

UNDEERC

Evaluate two approaches for introducing halogens to the flue gas at sites burning ND lignite coal:

1. Coal treatment with chemical additives in conjunction with conventional ACI
2. Injection of chemically-treated sorbents



Full-scale testing at four sites:

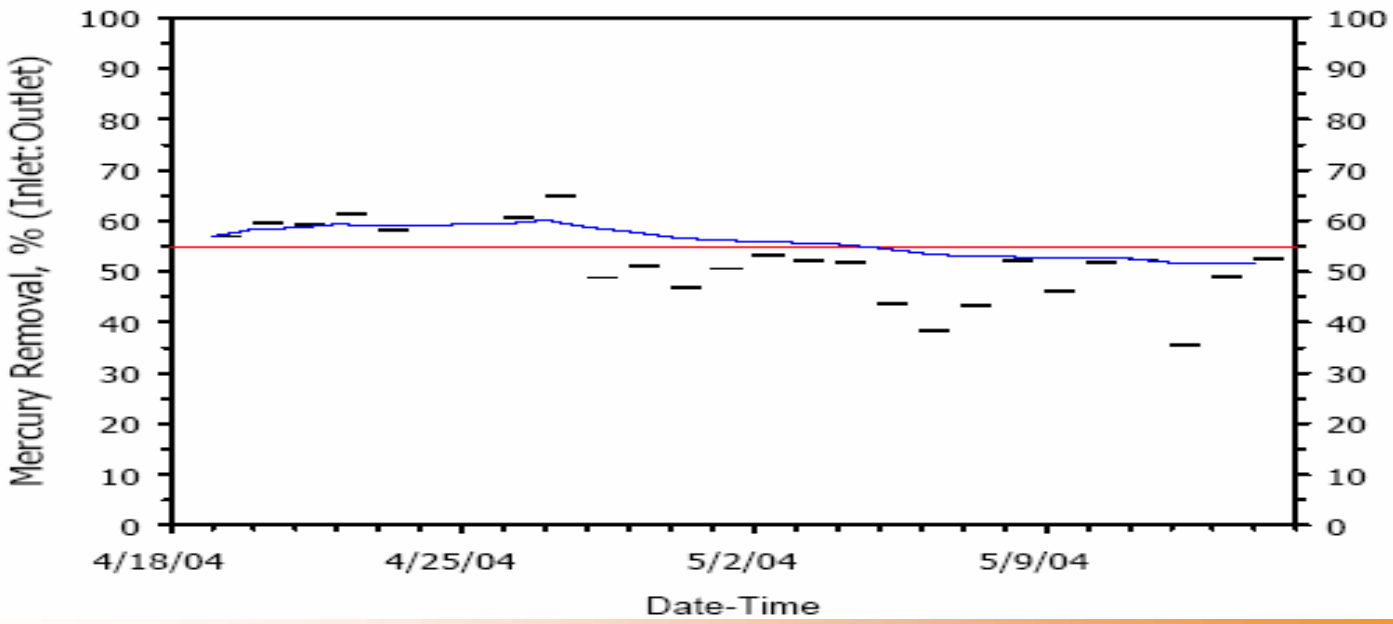
- ***Basin Electric's Leland Olds Station Unit 1***
  - equipped with ESP
- ***Great River Energy's Stanton Station Unit 10***
  - equipped with SDA/FF
- ***Basin Electric's Antelope Valley Station Unit 1***
  - equipped with SDA/FF
- ***Great River Energy's Stanton Station Unit 1***
  - equipped with ESP (burning PRB coal)
  - long-term test scheduled to begin October 2005

Enhancing Carbon Reactivity in Mercury Control in Lignite-Fired Systems

Preliminary Results

Basin Electric's Leland Olds Station Unit 1

- Baseline mercury removal ~15% across ESP
- 30-day long-term test using DARCO® Hg and $CaCl_2$ coal additive
- Average mercury removal ~63% with coal additive equivalent to 500 ppm chlorine in coal and 3 lb/MMacf sorbent injection

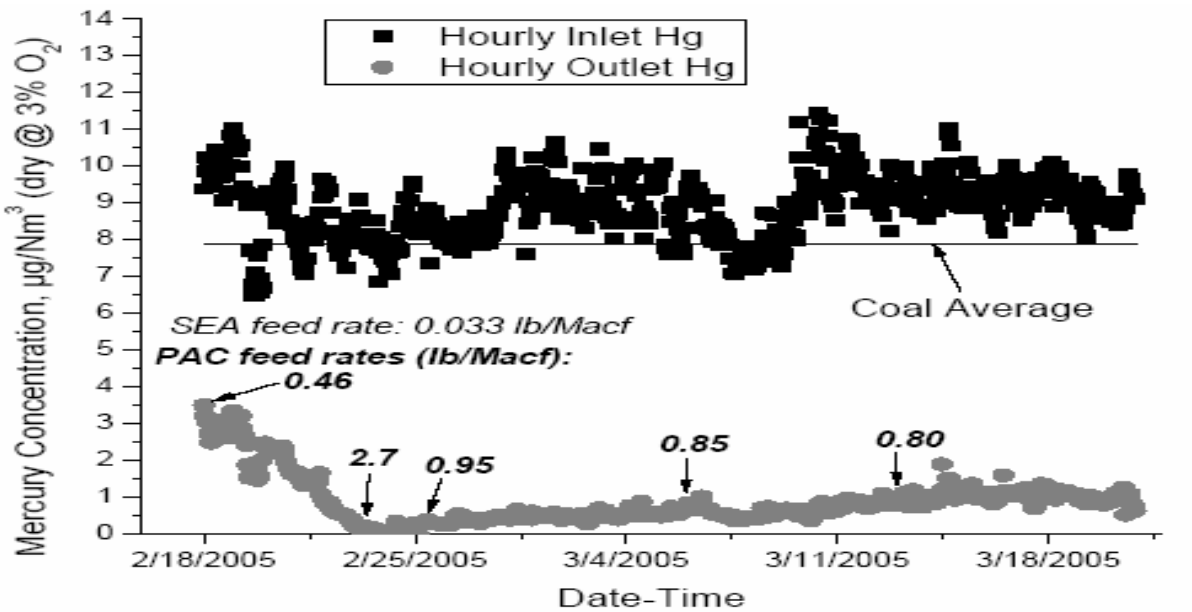


Enhancing Carbon Reactivity in Mercury Control in Lignite-Fired Systems

Preliminary Results

Basin Electric's Antelope Valley Station Unit 1

- Baseline mercury removal less than 10% across SDA/FF
- 30-day long-term test using DARCO® Hg and SEA-2
- Average mercury removal was approximately 90% with an SEA-2 feed rate of 0.033 lb/MMacf and an average DARCO® Hg injection concentration of 1 lb/MMacf



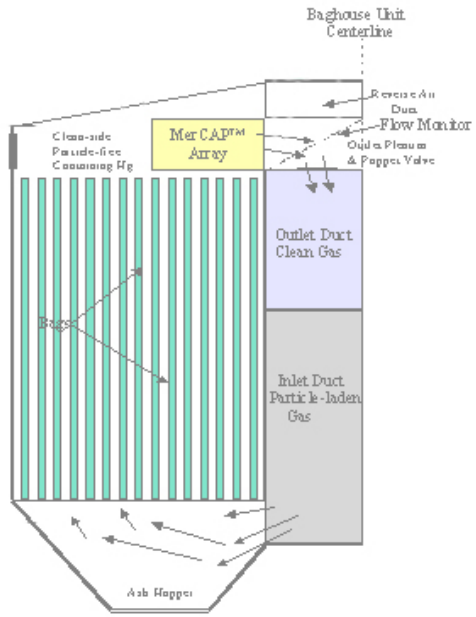
Evaluation of MerCAP™ for Power Plant Mercury Control

URS Group

- Evaluate EPRI's Mercury Control via Adsorption Process (MerCAP*TM*) technology
- Regenerable, gold-coated fixed-structure sorbent
- Mercury not contained in combustion by-products

Testing at two sites over a six month period:

- ***Great River Energy's Stanton Station Unit 10***
  - fuel switch from ND lignite to PRB coal
  - unit equipped with SDA/FF
- ***Southern Company's Plant Yates Unit 1***
  - burns bituminous coal and equipped with ESP and wet FGD
  - testing scheduled to begin November 2005



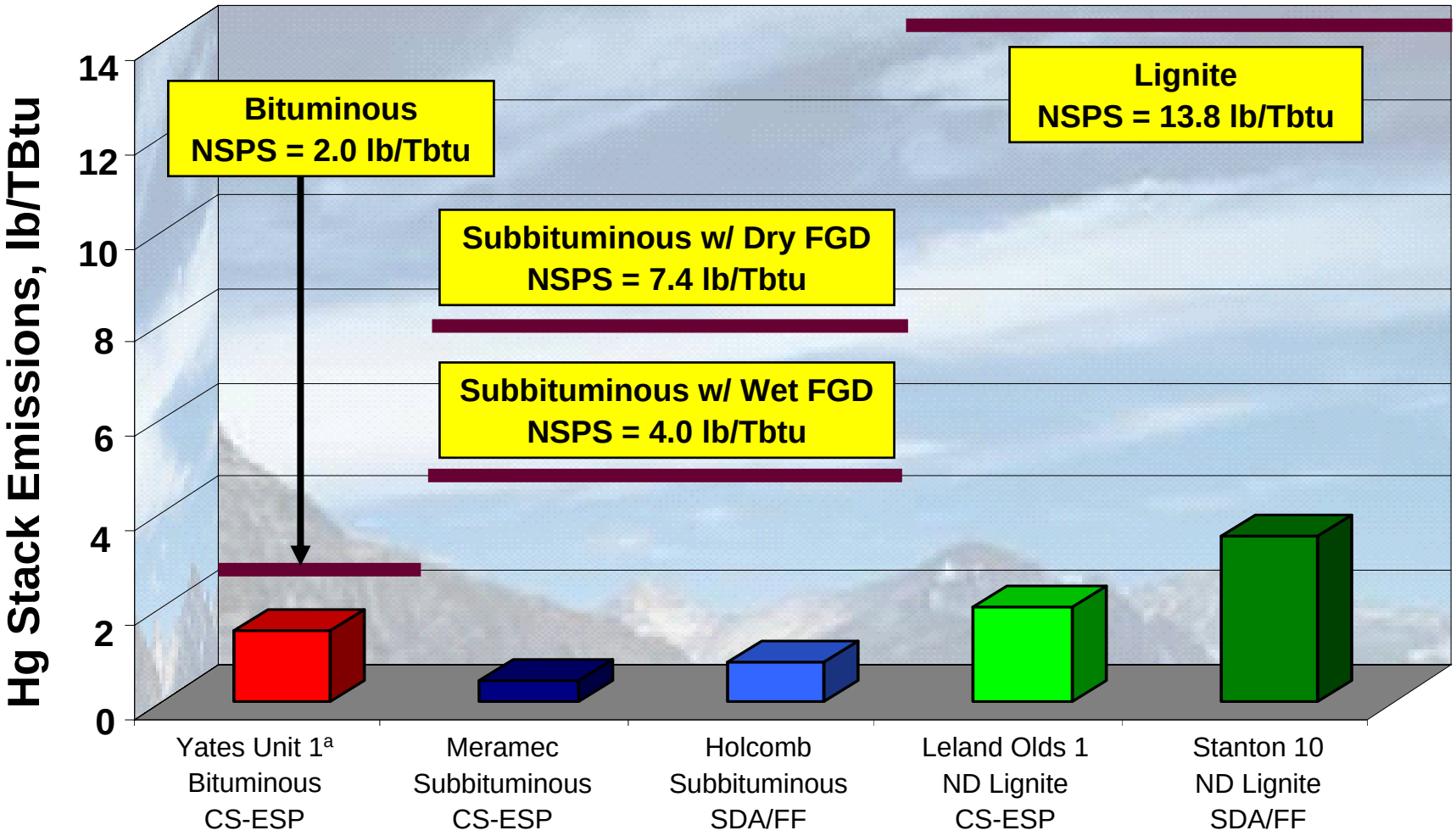
Evaluation of MerCAP™ for Power Plant Mercury Control
Preliminary Results

Great River Energy's Stanton Unit 10

- Baseline mercury capture <10% across SDA/FF
- Unit switched to PRB coal after over 1700 hours of operation
- In January 2005, untreated MerCAP™ substrates removed and treated with acid
- Mercury removal increased from 10-12% to 52-58% following acid treatment

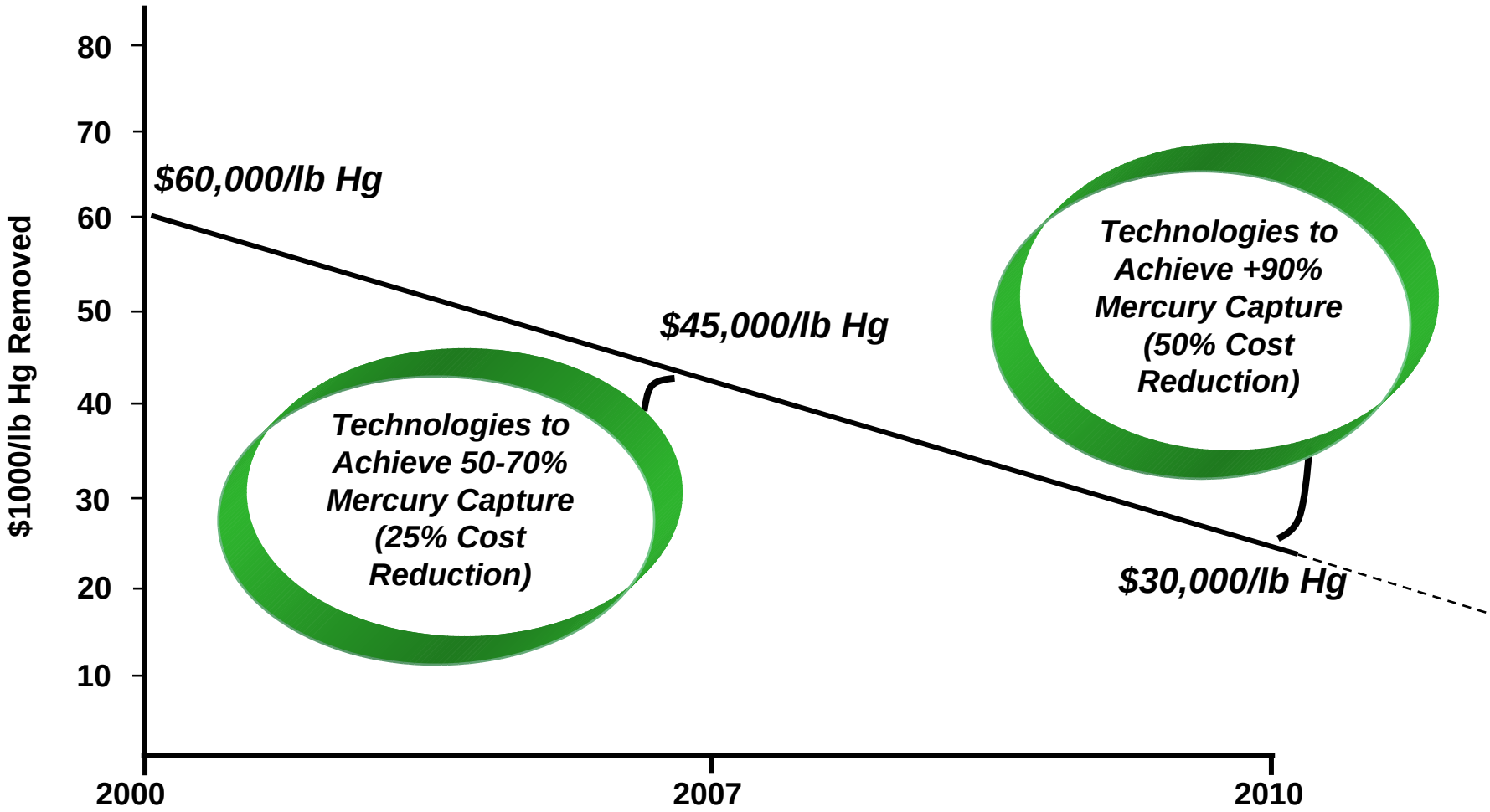
Duct Section	Substrate	Plate Spacing	Installation Date	Average Mercury Removal
Duct 1	Acid-treated	1”	8/22/04	30-35%
Duct 2	Untreated	1”	11/18/04	10-18%
Duct 2	Acid-treated	1”	1/25/05	52%
Duct 3	Untreated	½”	11/18/04	12-30%
Duct 3	Acid-treated	½”	1/25/05	58%
Duct 4	Baseline	N/A	N/A	0%

DOE/NETL Long-Term Field Testing Performance vs. CAMR NSPS



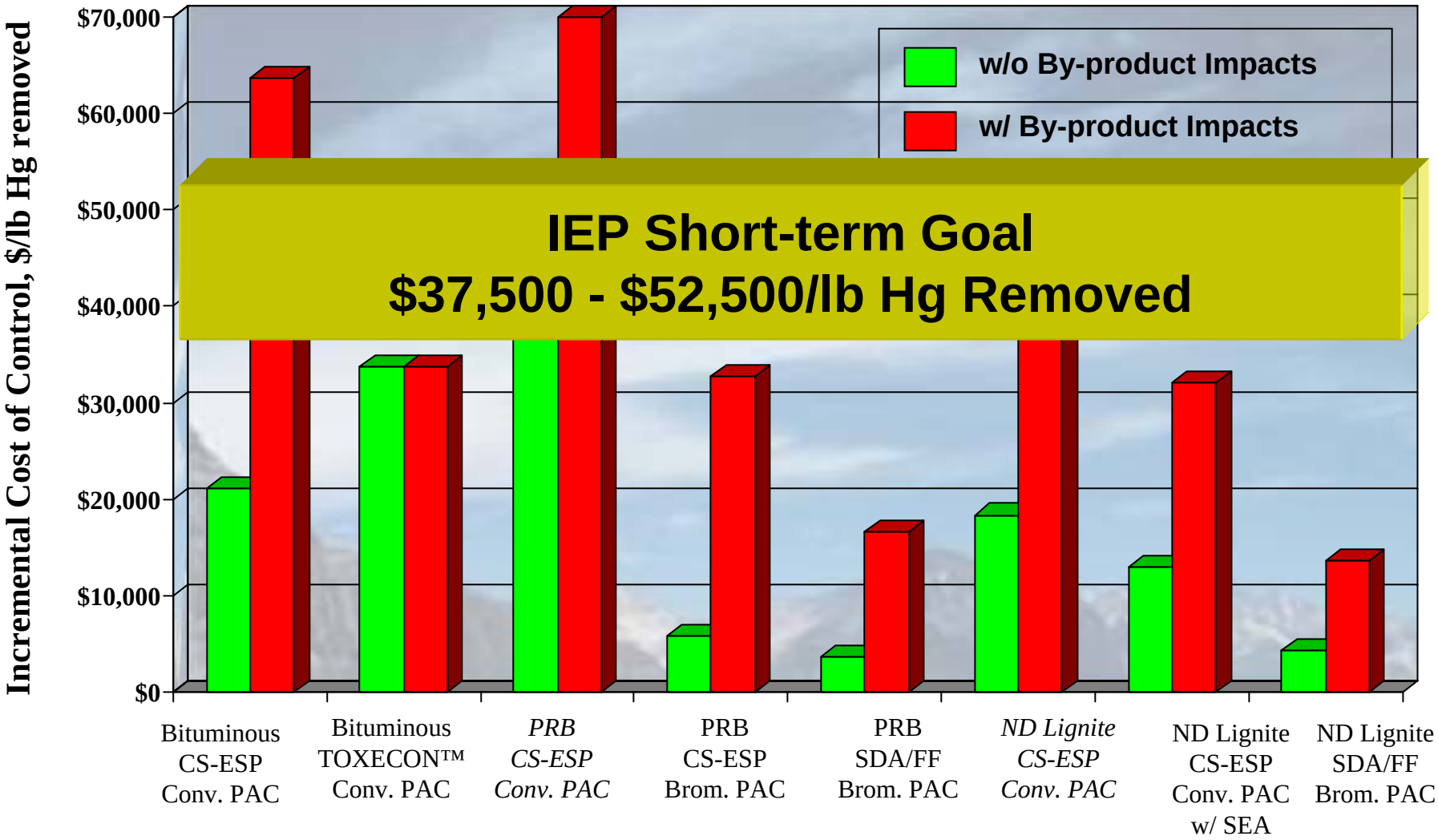
[a] Mercury measurement taken at CS-ESP outlet.

Driving Down Cost of Mercury Control(1)



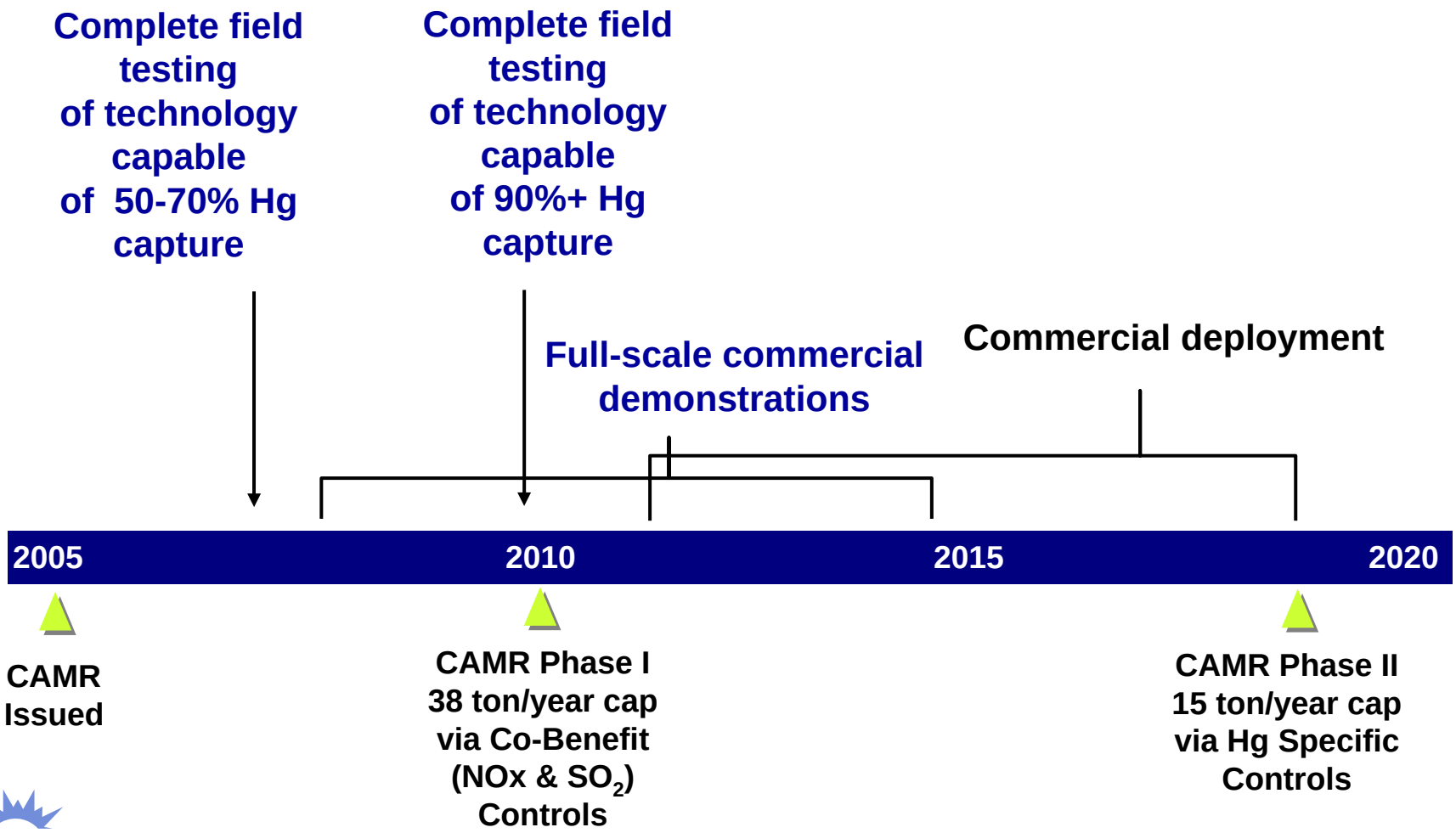
(1) The 2007 and 2010 milestone dates represent when technologies will be ready for commercial demonstration scale of testing prior to broad commercial availability

Incremental Cost of 70% Mercury Control[a]



[a] 60% mercury removal for italicized data labels.

NETL Mercury Control RD&D Program Timeline



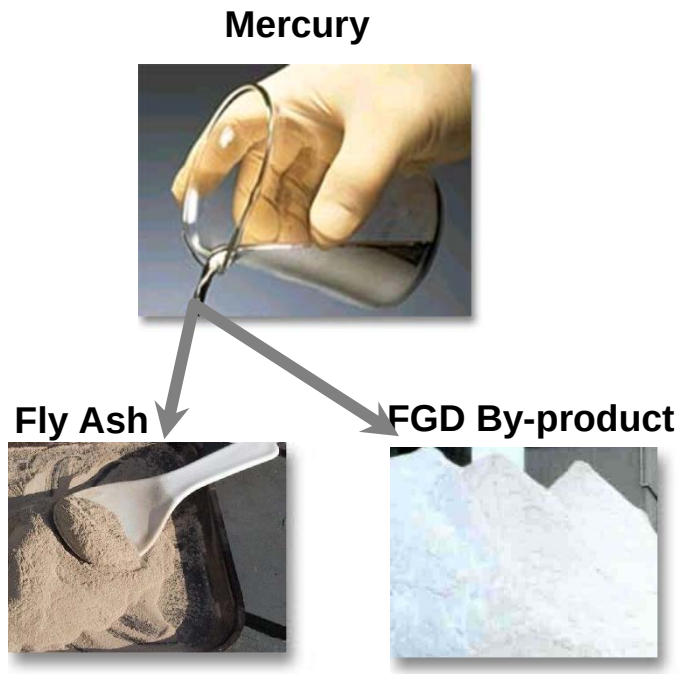
CAMR Identifies Need for Further RD&D

…The Phase II cap is timed such that these technologies can be installed and operational on a nationwide basis, i.e., until the technology becomes generally available.... To that end, the **Phase II cap serves as a driver for continued research and development of Hg-specific control technologies**, while providing a global market for the application of such equipment, which ultimately may serve to significantly reduce the global pool of Hg emissions. **The timing of the Phase II cap is such that new technologies can be developed, installed, demonstrated and commercially deployed** with little impact to the stability of the power grid."

Source: May 18, 2005 Federal Register, pages 28620-28621 (underline and bold added)

Coal Byproducts and Mercury

- Installation of additional FGD to meet CAIR would increase volume of scrubber solids
- Installation of additional advanced combustion technology and SCR to meet CAIR could increase UBC and NH3 in fly ash
- Use of PAC injection for Hg control could negatively impact fly ash utilization due to increased carbon content



- Increased scrutiny of CUBs due to transfer of Hg from flue gas to fly ash and scrubber solids

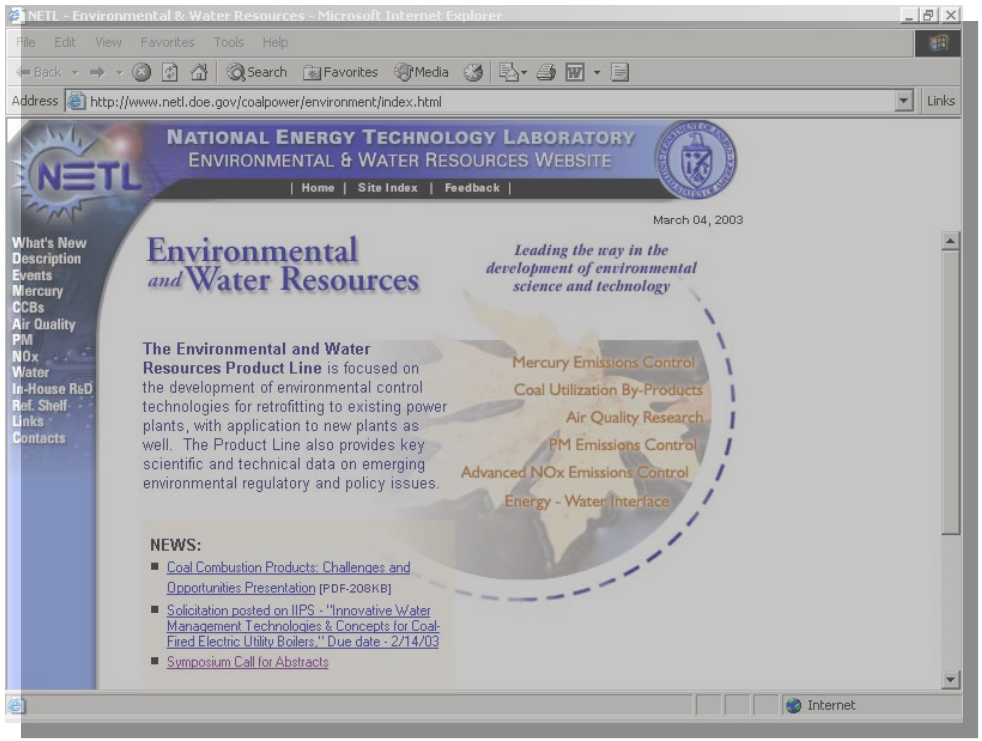
Key Takeaways

- **Significant strides have been made in developing effective mercury control technology over the past several years particularly for low-rank coals – fate of mercury in byproducts remains an issue**
- **Activated carbon/sorbent injection and oxidation systems (i.e., catalysts, chemical additives) are most promising Hg control technologies**
- **Estimated cost of mercury control on a $/lb removed basis have been reduced**
- **DOE's current field testing activity is an R&D program**
- **Further long-term field testing is needed to bring technology to commercial-demonstration readiness**
- **DOE's RD&D model projects broad commercial availability in 2012-2015**

Future Plans

- **NETL closed a competitive solicitation entitled "Phase III Mercury Control Technology Field Testing and Related R&D" on September 15, 2005.**
  - Topic Area I – Field testing of mercury control technology capable of 90% or greater mercury capture
  - Topic Area II – Field testing of mercury control technology capable of 50%-70% mercury capture
  - Topic Area III – Laboratory through bench-scale testing of novel mercury control technologies
  - Topic Area IV – Laboratory through bench-scale testing of novel pre-combustion mercury control technologies
- **Anticipate $30 - $35 million in funding over next 3 years**

Innovations for Existing Plants Program



To find out more about DOE-NETL's Mercury R&D activities visit us at:

http://www.netl.doe.gov/coal/E&WR/index.html