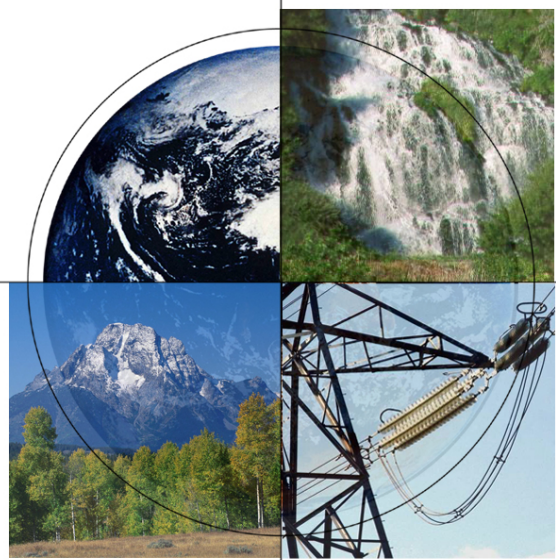
to Pittsburgh

NETL

Overview of DOE/NETL's Mercury and CUB R&D Program



DOE/NETL's Mercury Control Technology R&D Program Review

July 12-14, 2005
Pittsburgh, PA

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National Energy Technology Laboratory

Presentation Outline

- Who is NETL
- Mercury control R&D
- Preliminary mercury control cost analysis
- Coal utilization by-products R&D
- Summary
- Questions?

National Energy Technology Laboratory

- **One of DOE's 17 national labs**
- **Government owned / operated**
- **Sites in:**
  - Pennsylvania
  - West Virginia
  - Oklahoma
  - Alaska
- **More than 1,100 federal and support contractor employees**

What We Do

- **Shape, fund, and manage extramural R&D**
- **Conduct onsite research**
- **Support energy policy development**

NETL Plays Key Role in Fossil Energy Supply, Delivery, and Use Technologies

Electric Power Using Coal

Coal Production

Environmental Control

V21 Next Generation

Carbon Sequestration

Clean Liquid Fuels

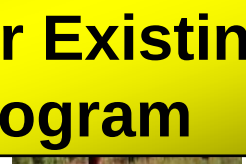
Exploration & Production

Alternative Fuels

Future Fuels

Natural Gas

Exploration & Production



lines & age

Fuel Cells

Combustion Turbines

Innovations for Existing Plants Program

Photo of hydrogen fueled car: Warren Gretz, NREL

Innovations for Existing Plants
Program Components

- **R&D Activities**
  - **Mercury control**
  - NO_x control
  - Particulate matter control
  - Air quality research
  - **Coal utilization by-products**
  - Water management

2005 Hg Control Technology Program Review

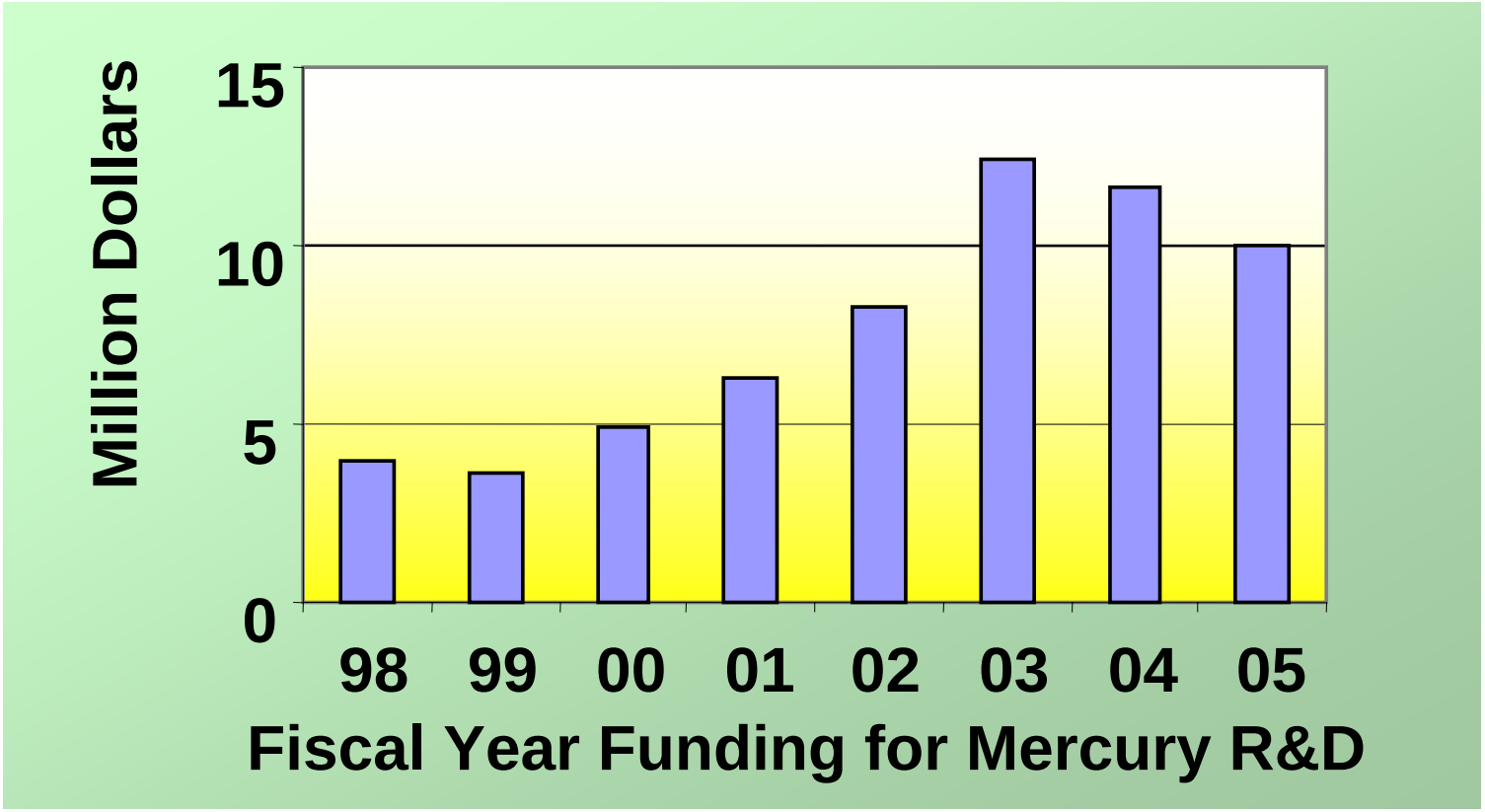
- Cinergy
- Exelon Power
- Great River Energy
- Constellation Energy
- Public Service of New Hampshire
- TVA
- Reliant Energy
- Nebraska Public Power District
- Mirant Corporation
- Dynergy
- Dominion
- Duke Power
- DTE Energy Co.
- Florida Power & Light
- Xcel Energy
- Basin Electric Power Cooperative
- American Electric Power
- We Energies
- Allegheny Energy
- Progress Energy
- Arizona Public Service
- Southern Company
- Texas Municipal Power Agency
- Lansing Board of Power & Light
- American Public Power Association
- Consumers Energy
- TXU Power

Mercury Control Technology R&D

Preliminary Findings

DOE/NETL Mercury Research Funding

Over $60 Million Funding for Mercury R&D During Past Eight Years

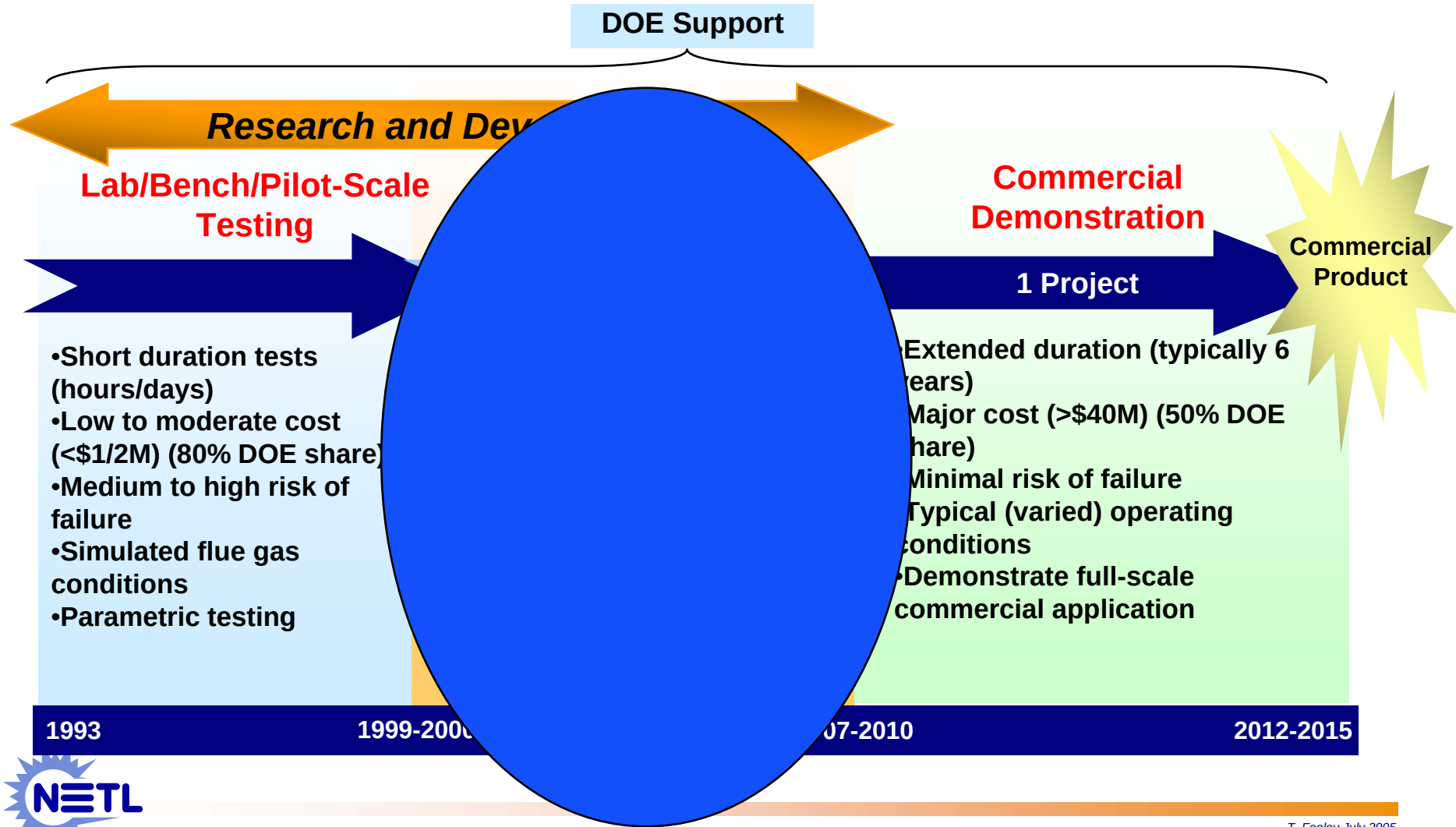


Private sector providing over $15 million during this time frame.

Stages of Mercury Control Technology Development

DOE RD&D Model

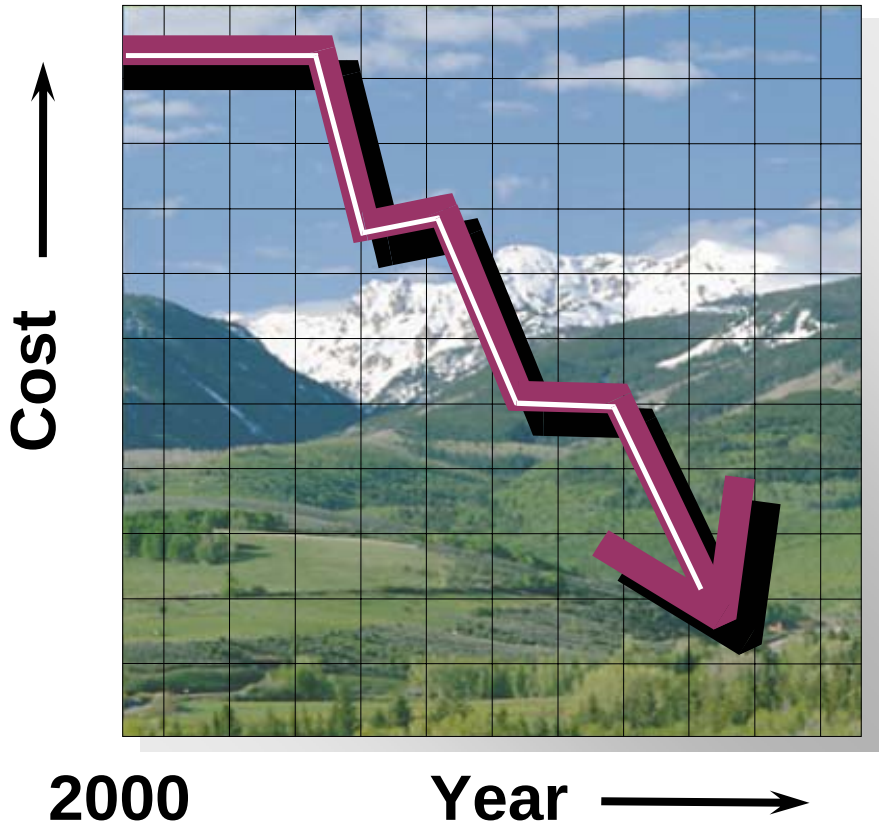
Progress over time



Mercury Control Technology Field Testing Program

Performance/Cost Objectives

- Have technologies ready for <u>commercial demonstration</u> by 2007 for all coals
- Reduce “uncontrolled” Hg emissions by 50-70%
- Reduce cost by 25-50% compared to baseline cost estimates



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

Phase II Mercury Control Field Test Projects

- Fourteen projects; 28 test sites
- 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

DOE/NETL Phase II Mercury Control Field Testing Technology Matrix

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	
		Lee 3	Buck	Gavin	Yates 1	
	Yates 1&2	Portland			Conesville	
		Monroe			Conesville	
Subbituminous	Crawford	Meramec	Council Bluffs			Holcomb
		Dave Johnston	Louisa			Laramie River
		Stanton 1	Will County			
Lignite (North Dakota)		Leland Olds 1			Milton Young	Antelope Valley 1
		Leland Olds 1				Stanton 10
						Stanton 10
Lignite (Texas)					Monticello	
					Monticello	
					Monticello	
Blends		St. Clair		Big Brown		

- Sorbent Injection
- Sorbent Injection & Oxidation Additive
- Oxidation Additive
- Oxidation Catalyst
- Chemically-treated sorbent
- Other – MERCAP, FGD Additive, Combustion

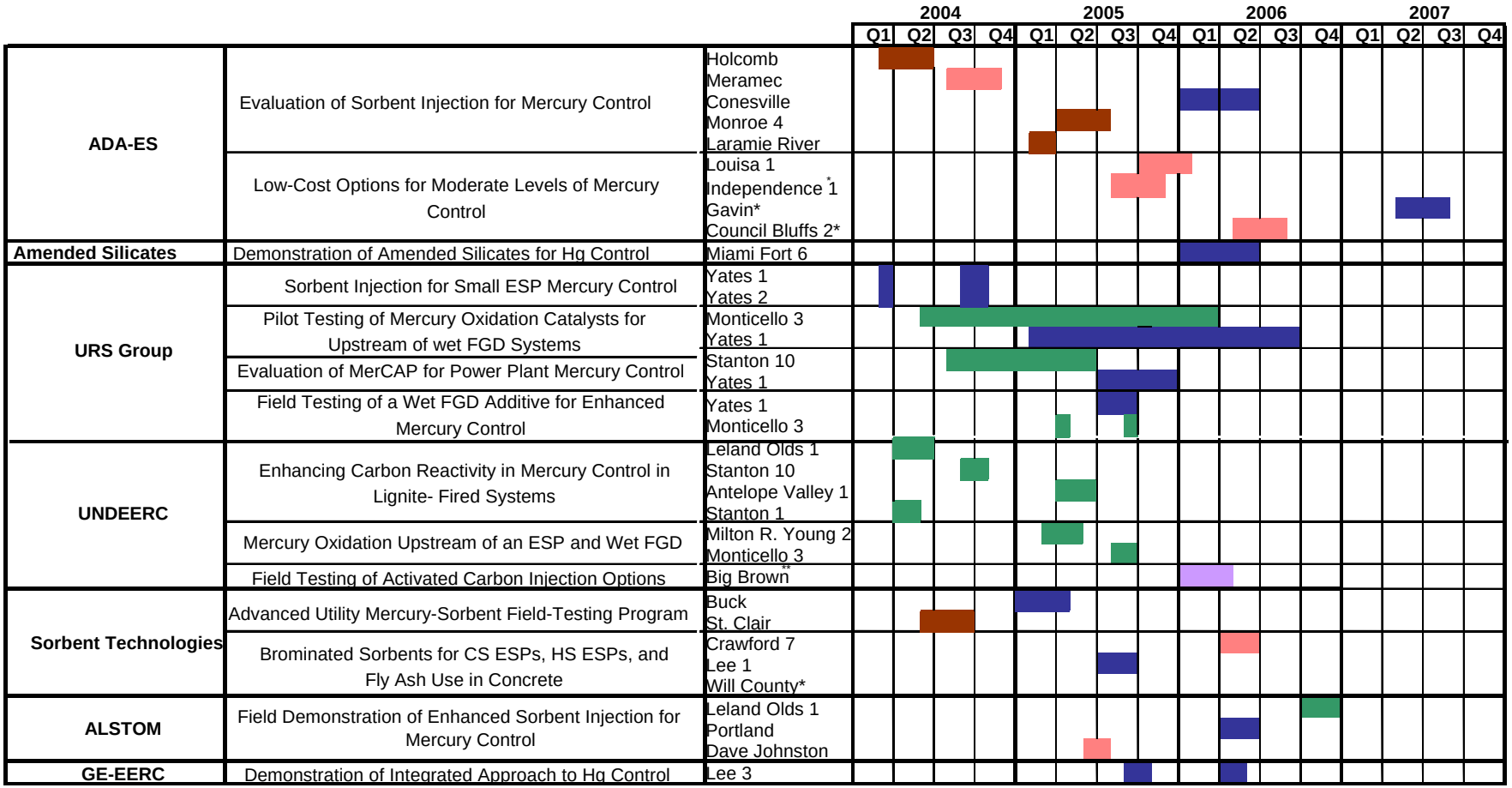
NETL Phase I and II Mercury Field Testing by Coal Rank and Air Pollution Control Device

	Bituminous		Subbituminous		Lignite		Blends		% Units NETL is Testing
	NETL	U.S.	NETL	U.S.	NETL	U.S.	NETL	U.S.	
CS ESP	7	492	6	103	1	7	2	38	3
CS ESP+ FGD	6	97	0	17	2	10	0	5	6
CS ESP+ SDA	0	0	0	3	0	0	1	1	25
HS ESP	1	71	3	38	0	0	0	7	3
HS + FGD	0	11	0	8	0	0	0	0	0
HS + SDA	0	1	0	0	0	0	0	0	0
ESP + FF	1	1	0	0	0	0	1	1	100
FF	0	36	0	21	0	1	0	0	0
FF + FGD	0	7	0	7	0	0	0	1	0
FF + SDA	0	20	0	12	2	4	1	1	8

Notes:
1. Total control device installation information is based on the UDI database.
2. NETL control device information is based on project specific configurations and may differ from UDI data.

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

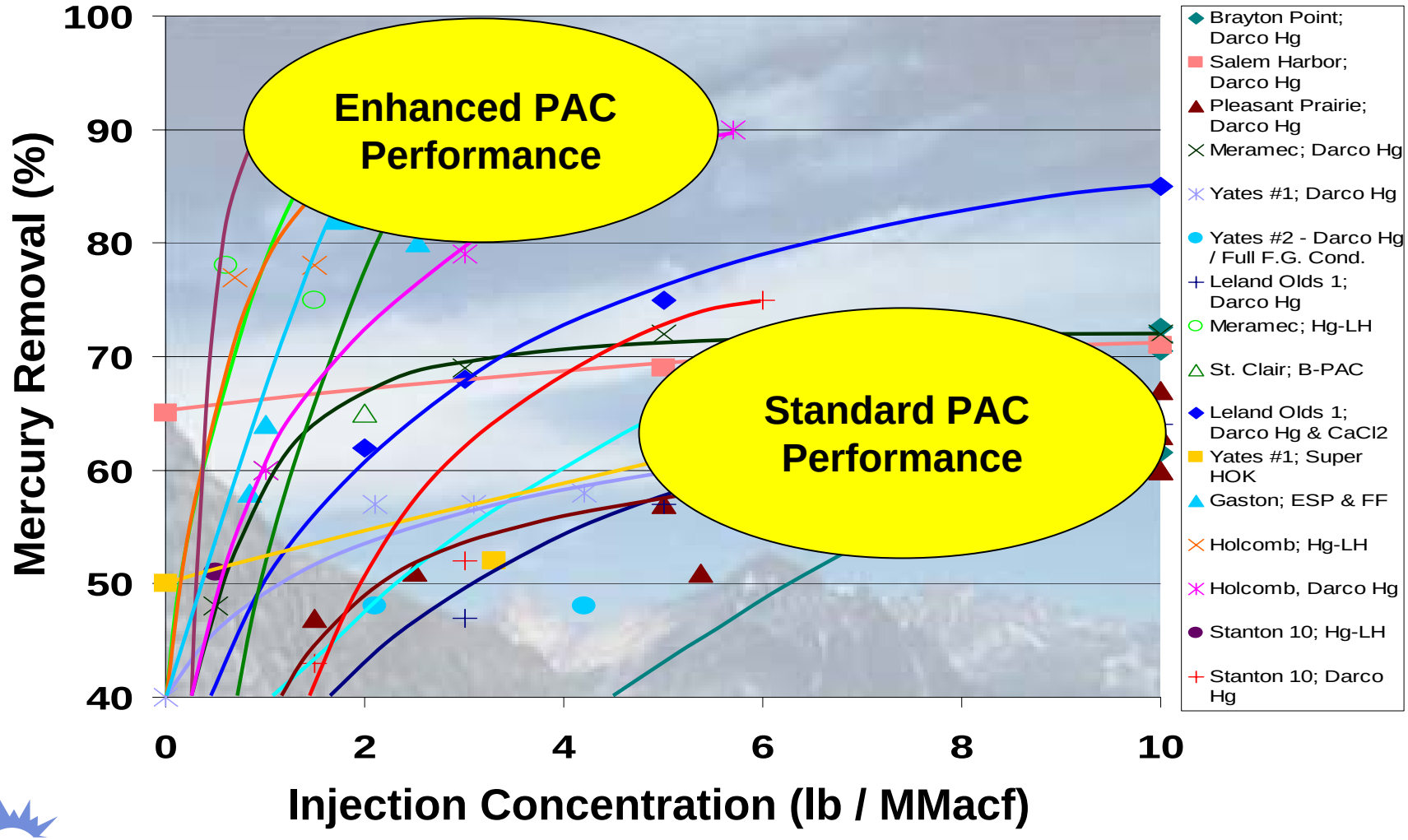
Phase II Mercury Field Testing Schedule



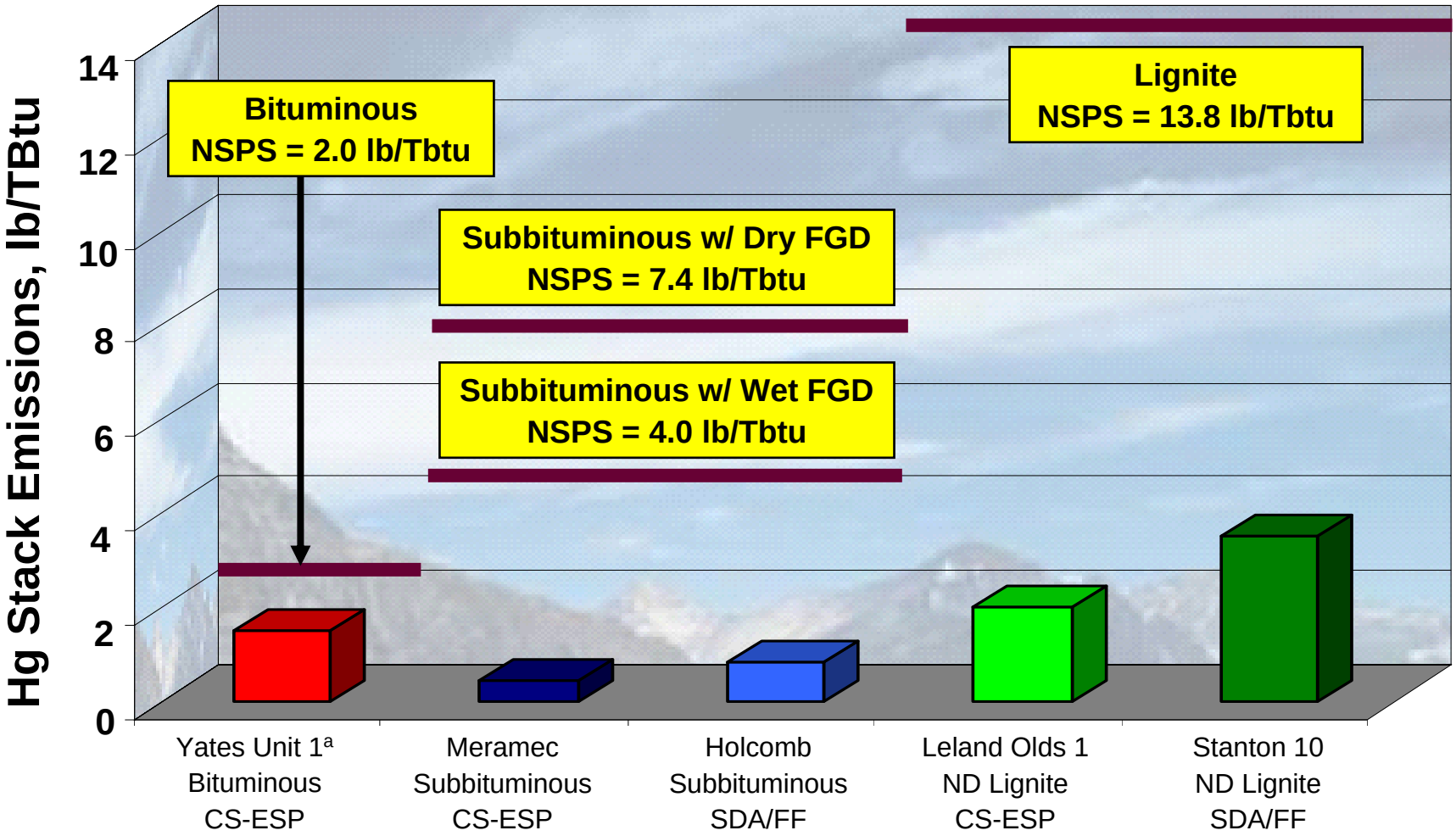
*Testing dates to be determined
**Tests will be performed at Big Brown using either a TX Lignite or a TX Lignite/Sub Blend

Field Testing Results 2001 – 2004

Comparison of Standard & Enhanced PAC



DOE/NETL Control Technology Field Testing Performance vs. CAMR NSPS

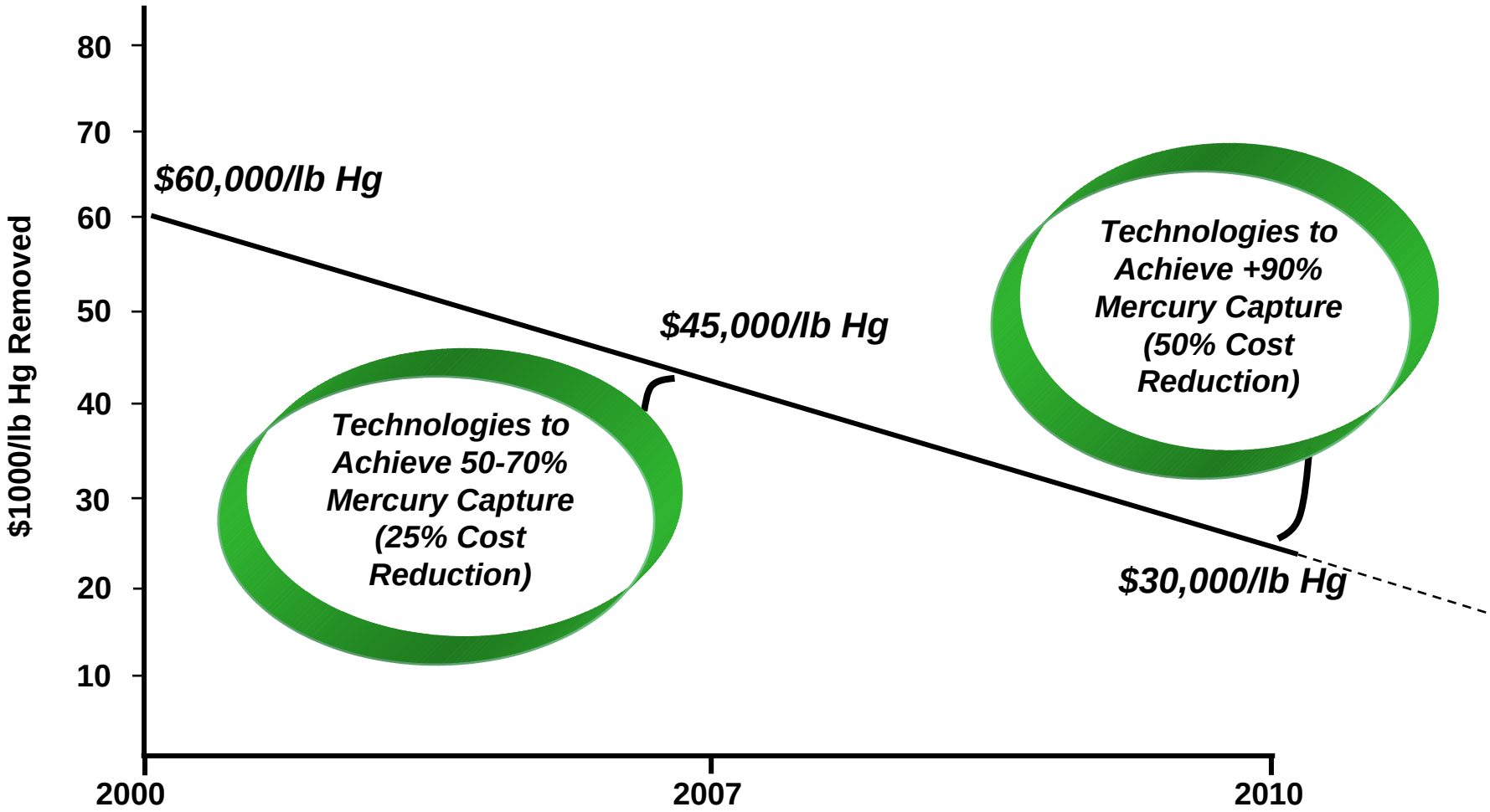


[a] Mercury measurement taken at CS-ESP outlet.

Economic Analysis

Preliminary Findings

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

DOE/NETL Economic Analysis of Mercury Control via Sorbent Injection for Coal-Fired Power Plants – 2005 Update

Prepared for

U.S. Department of Energy
National Energy Technology Laboratory
Innovations for Existing Plants Program

Prepared by

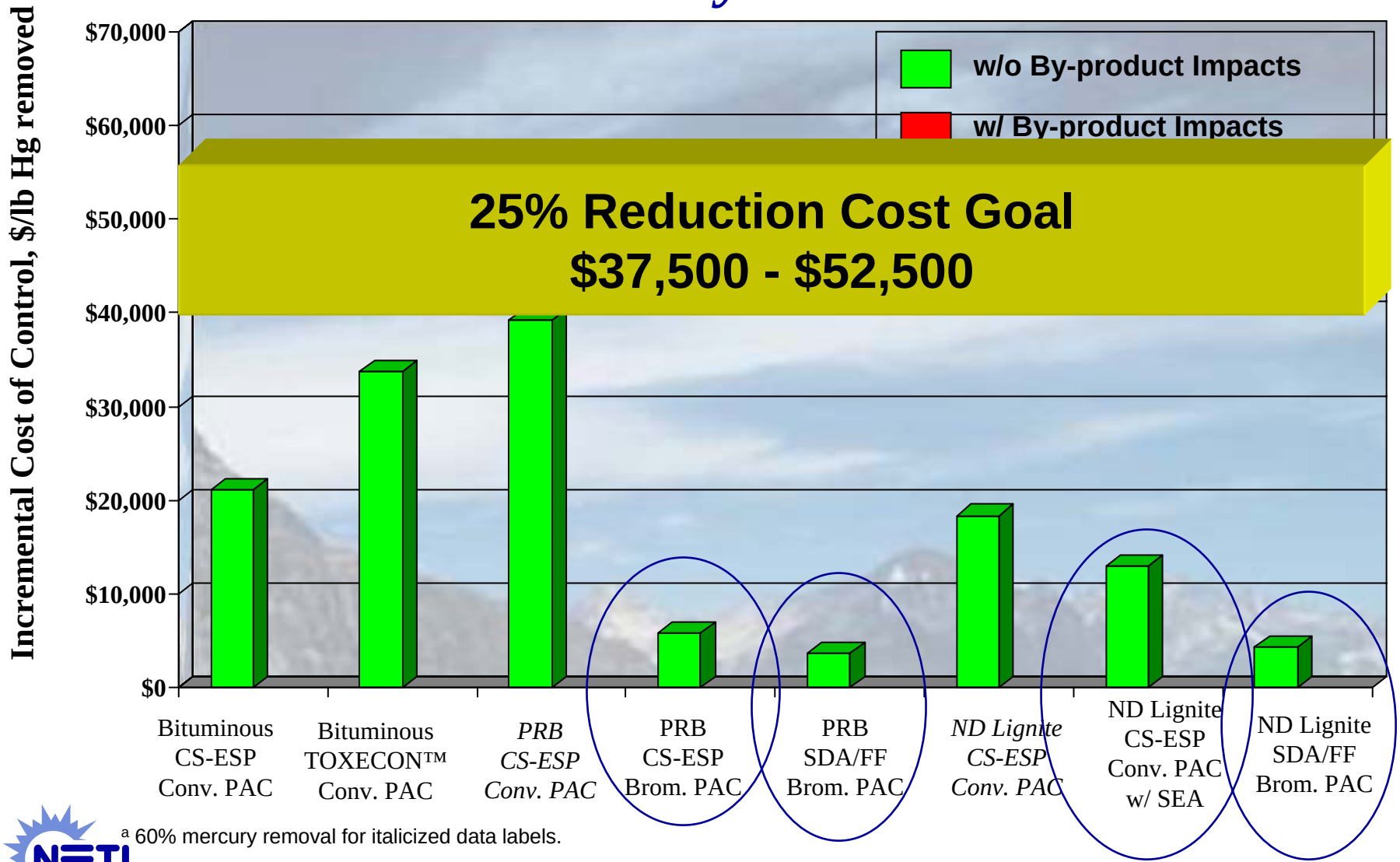
Andrew P. Jones[1], Jeffrey W. Hoffmann[2], Thomas J. Feeley, III[2], James T. Murphy[1]

[1] Research and Development Solutions, LLC
[2] U.S. Department of Energy, National Energy Technology Laboratory

June 2005

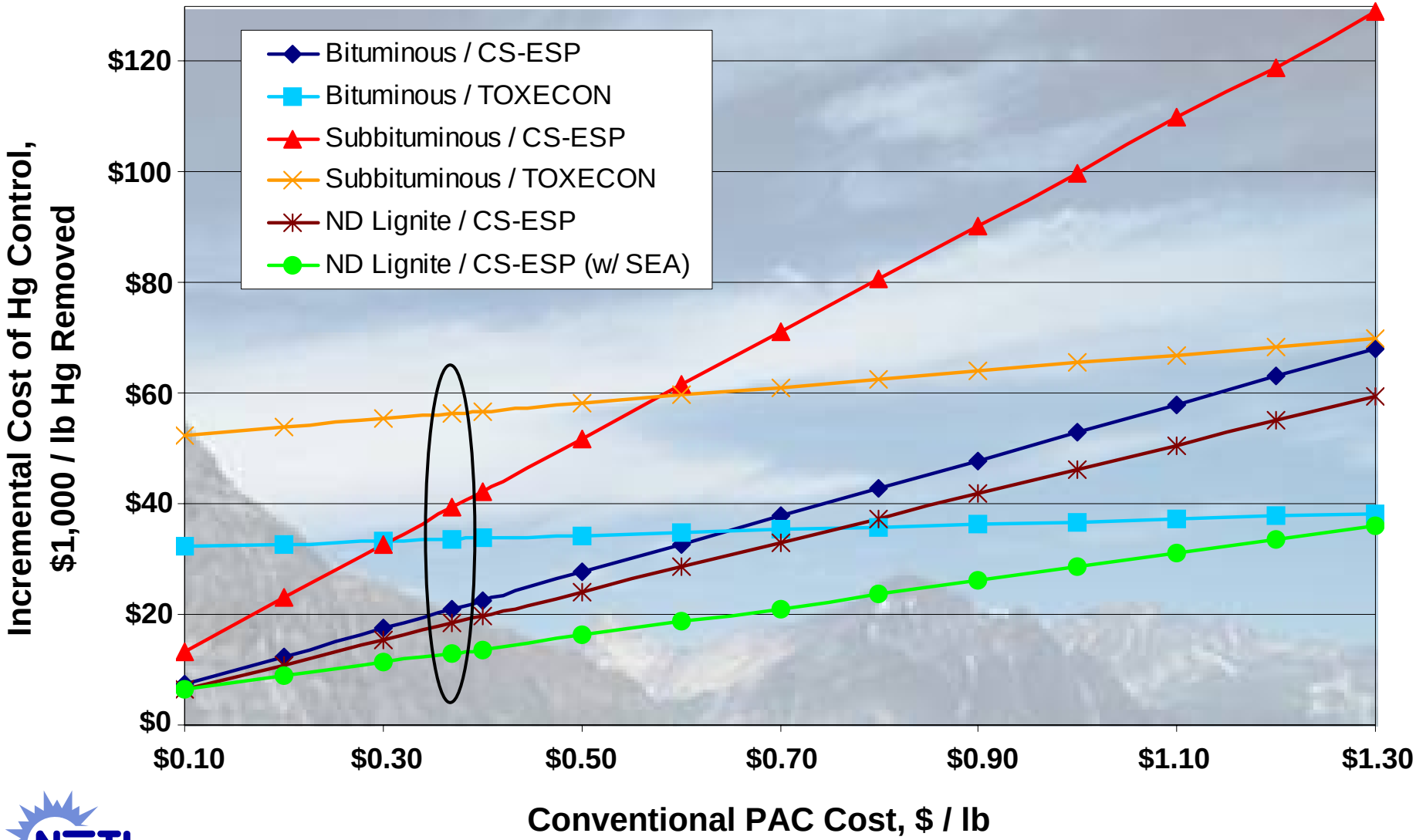
Incremental Cost of 70% Mercury Control[a]

Preliminary Results



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

Sensitivity of the Incremental Cost of 70% Mercury Control to Variations in Conventional PAC Cost

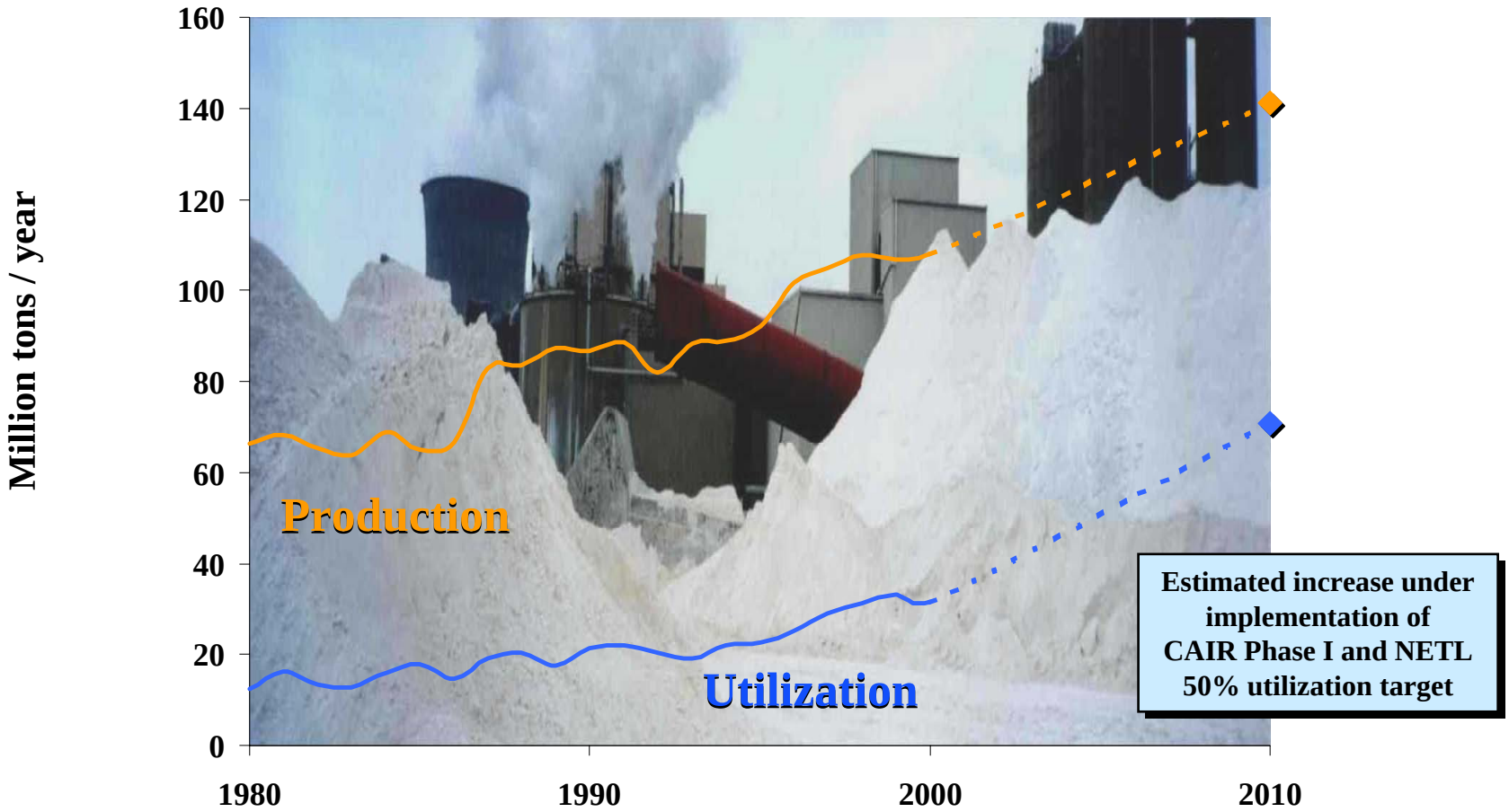


Future Plans

- **Issued competitive solicitation in June 2005**
- **Four areas of interest:**
  - Phase III Field Testing of Advanced Post-Combustion Mercury Control Technologies Capable of Achieving 90+% Mercury Removal
  - Phase II Round III Field Testing of Advanced Post-Combustion Mercury Control Technologies Capable of Achieving 50-70% Mercury Removal
  - Novel Combustion and Post-Combustion Mercury Control Technologies Capable of Achieving 70+% Mercury Removal
  - Novel Pre-Combustion Mercury Control Technologies Capable of Achieving 50+% Increase in Mercury Removal
- **Proposals are due by August 15, 2005**

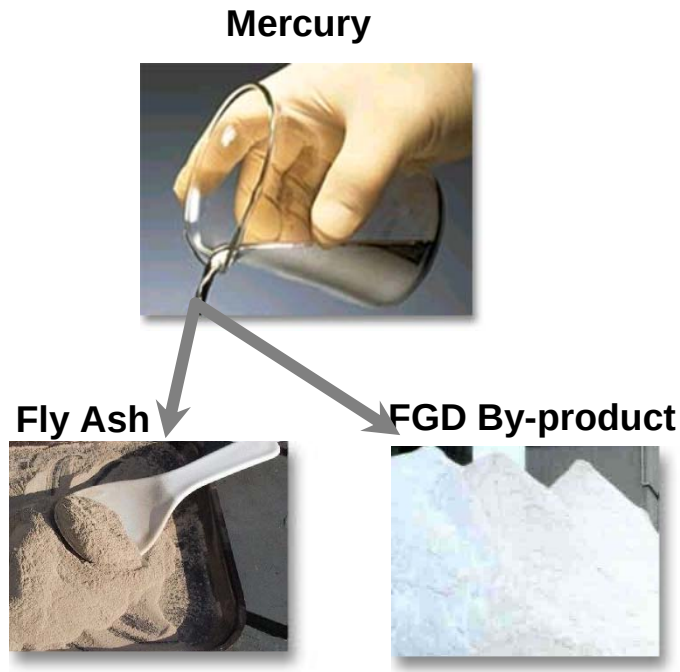
CUB Mercury Research

DOE/NETL Goal: Increase CUB Utilization to 50% by 2010



4 Key Challenges to Increased CUB Use

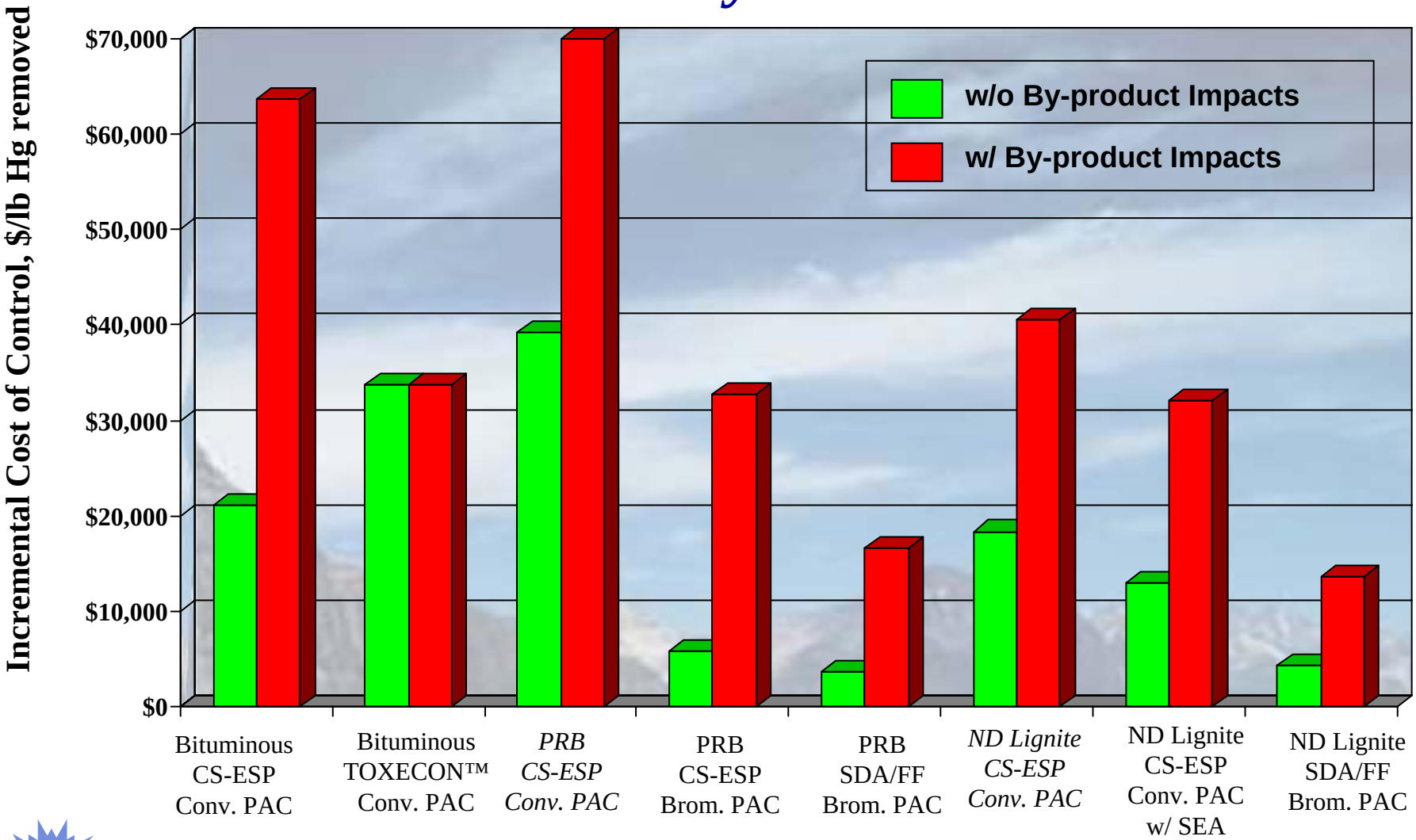
- Installation of additional FGD to meet CAIR will increase volume of scrubber solids
- Installation of additional advanced combustion technology and SCR to meet CAIR could increase UBC and NH_3 in fly ash
- Use of PAC injection for Hg control could impact fly ash utilization due to increased carbon content



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

Incremental Cost of 70% Mercury Control[a]

Preliminary Results



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

DOE/NETL CUB Research Program
Responding to Challenge

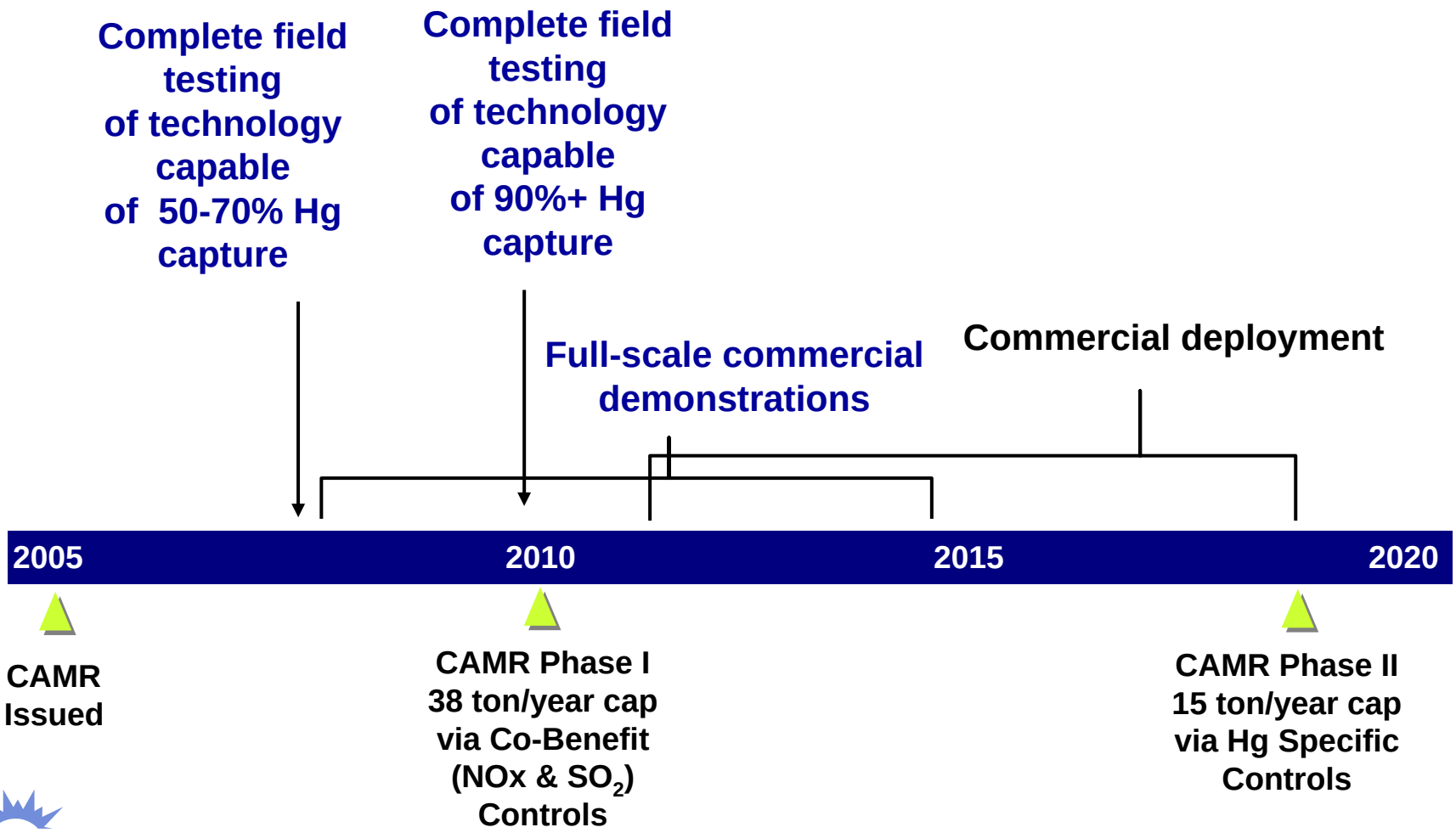
- **Comprehensive extramural and in-house CUB research program**
- **Directed at characterization (leaching, volatilization, and microbial release) of mercury and other trace metals from CUB (e.g., fly ash, scrubber solids, etc.) generated during field testing program**
- **Particularly focused on potential release of mercury from synthetic gypsum during wallboard manufacturing process**

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)

NETL Mercury Control RD&D Program Timeline



Key Takeaways

- **Significant strides have been made in developing mercury control technology over the past several years, both in terms of performance and cost, but more R&D is needed particularly related to BOP and byproducts**
- **Activated carbon/sorbent injection and oxidation systems (i.e., catalysts, chemical additives) are most promising Hg control technologies**
- **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**

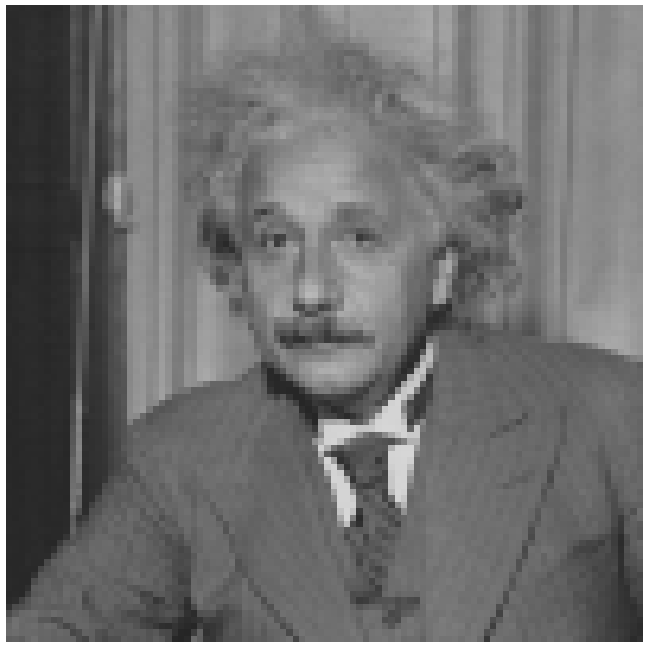
Partnering for Success

- EPRI
- EPA
- Electric utility industry
- Technology developers

Thank You!

"The important thing is not to stop questioning"

~ *Albert Einstein*



Questions?

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

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