Mercury Control Technology – A Review

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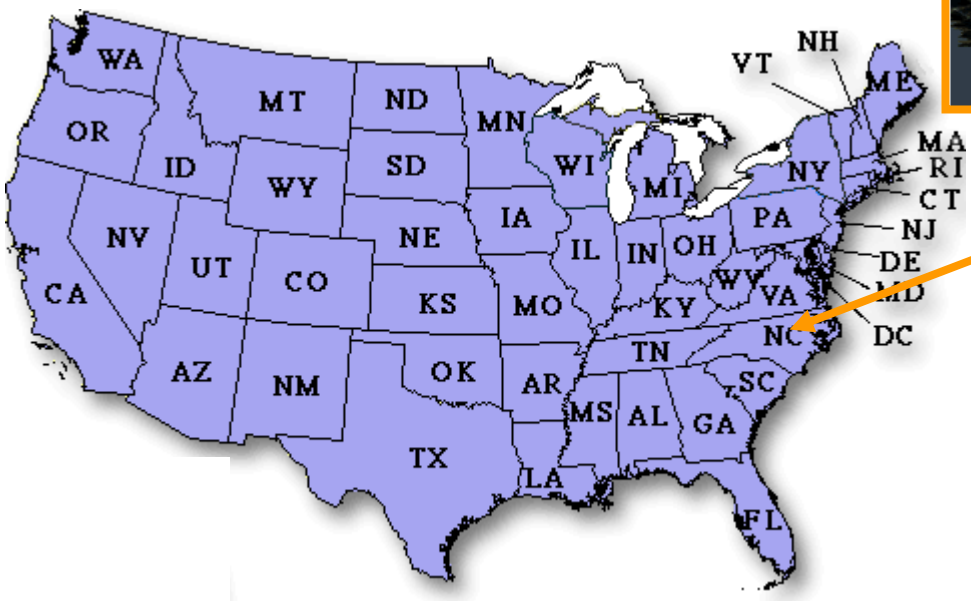
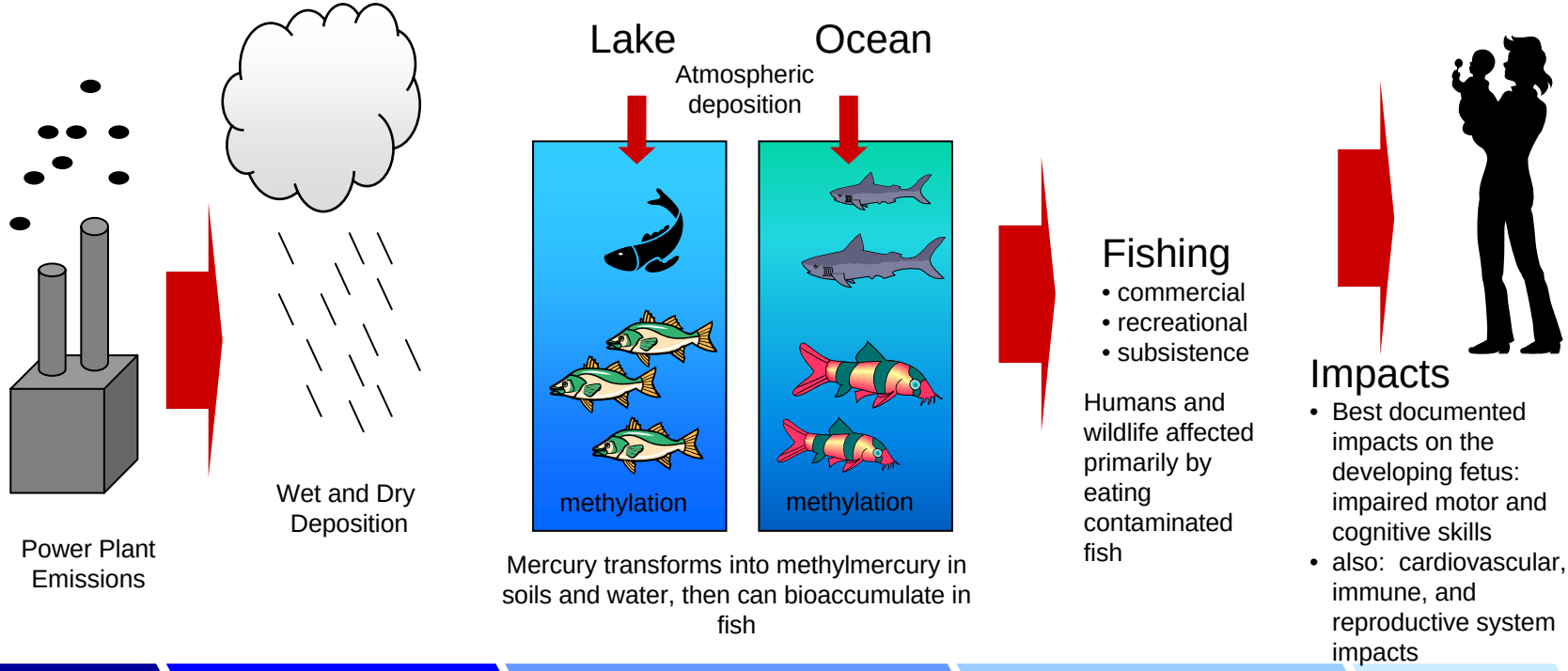
Research Triangle Park Campus
North Carolina



Mercury Emissions from Power Plants Cause Human Exposure to Mercury

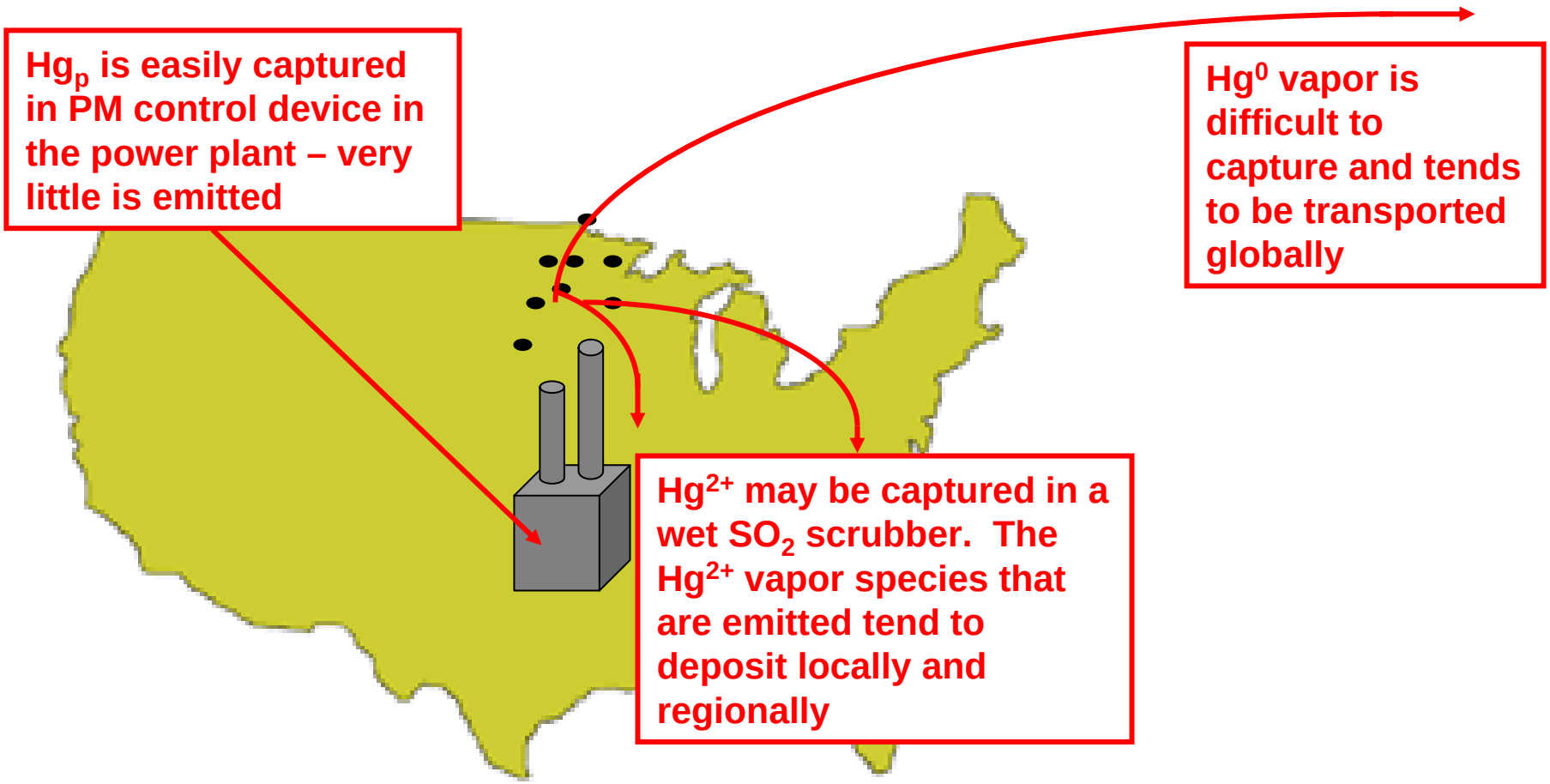


Emissions Reductions → **Reduce Atmospheric Transport and Deposition** → **Reduce Ecosystem Transport and Methylation** → **Reduce Human and Wildlife Exposure** → **Reduce Health Impacts**

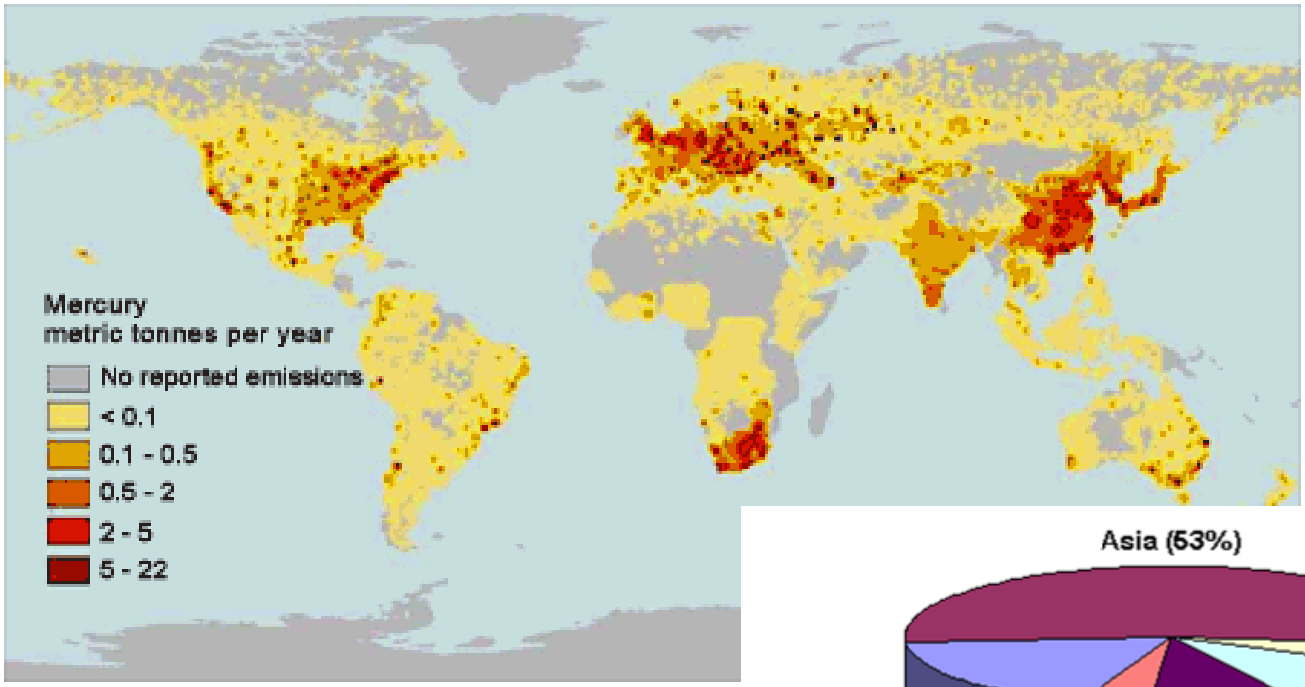
Health Impacts

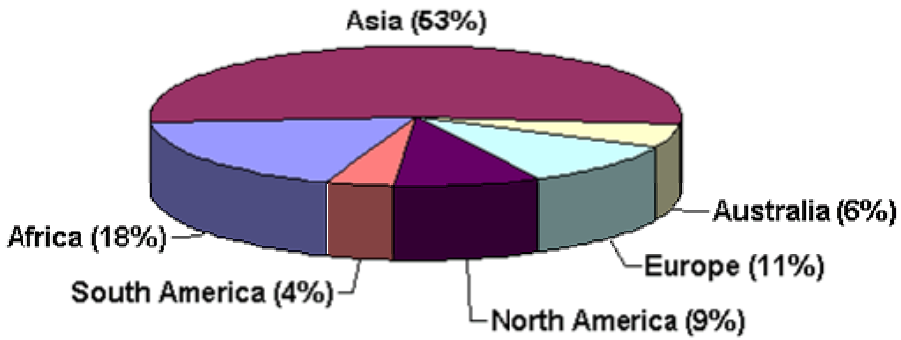
- Known to bioaccumulate in fish and animal tissue in its most toxic form, methylmercury.
- Human exposure to methylmercury associated with serious neurological and developmental effects.
- Adverse effects on fish, birds, and mammals include reduced reproductive success, impaired growth, behavioral abnormalities, and even death.

Regional and Global Transport of Mercury



Worldwide Distribution of Hg Emissions (total)

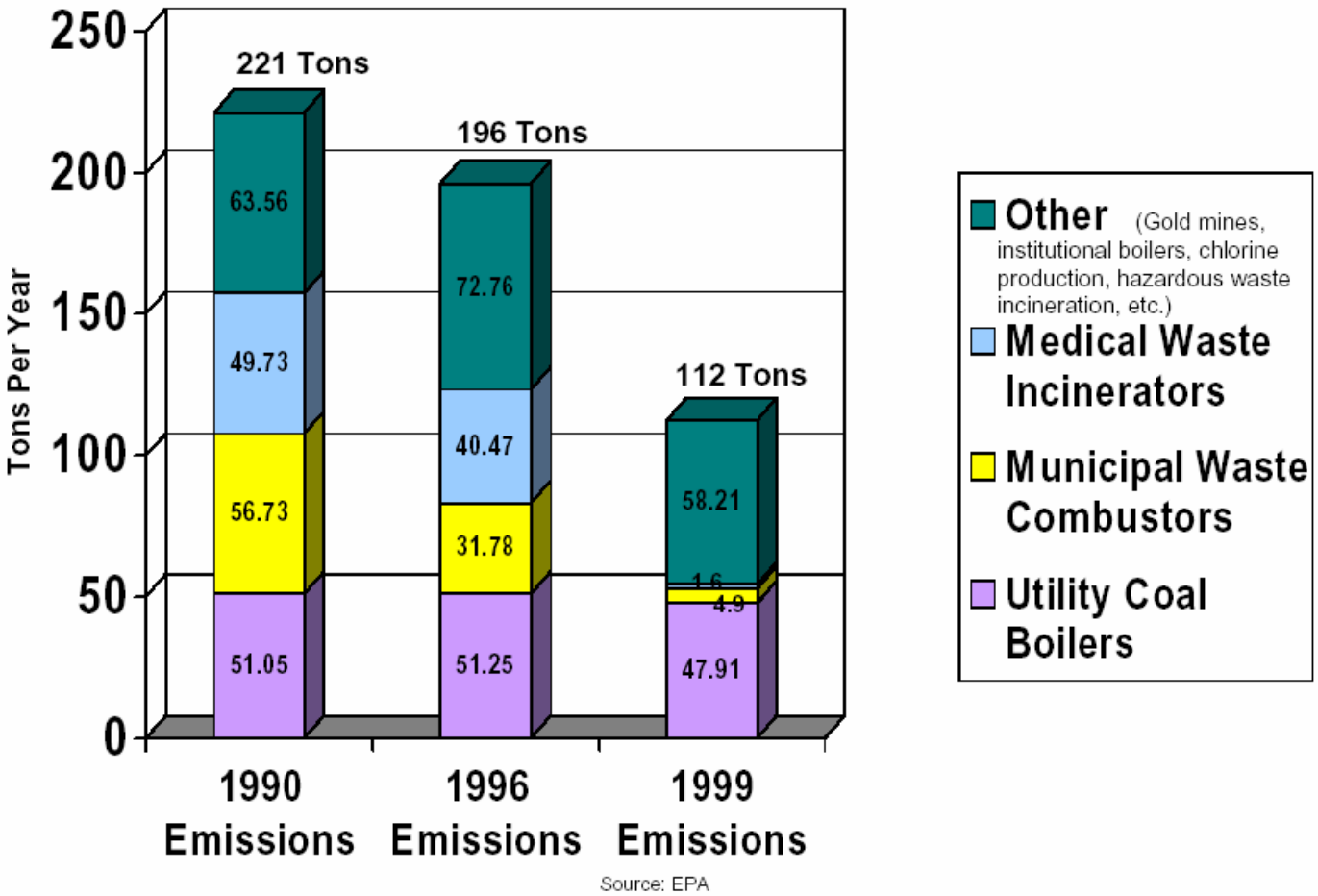




U.S. anthropogenic mercury emissions are estimated to account for roughly **three percent of the global total**, and emissions from the **U.S. power sector** are estimated to account for about **one percent of total global emissions**.

(United Nations Environment Programme (UNEP). Chemicals, Global Mercury Assessment, Geneva, 2002.).

U.S. Anthropogenic Mercury Emissions



Source: EPA

Two Recently Promulgated EPA Rules (March 2005)

- **Clean Air Interstate Rule (CAIR) - http://www.epa.gov/cleanairinterstaterule/**

- Creates a **two-phase program** with declining emission caps
  - for NOx (for PM-2.5 and ozone control) in 2009 and 2015, and
  - for SO_2 (for PM-2.5 control) in 2010 and 2015
  - based on application of highly cost effective controls to large EGUs.

- **Clean Air Mercury Rule (CAMR) – http://www.epa.gov/oar/mercuryrule/**

- Establishes limits on mercury emissions from new and existing coal-fired power plants and creates a market-based cap-and-trade program that will reduce nationwide utility emissions of mercury in two distinct phases
  - **Phase I (2010):** Cap is 38 tons; most mercury reductions resulting from "co-benefit" (reductions from SO_2/NO_X/PM control technologies)
  - **Phase II (2018):** Cap is 15 tons; additional mercury-specific control technologies will likely be necessary for deeper mercury reductions.

Clean Air Mercury Rule (CAMR)

- On January 30, 2004 EPA proposed regulations for power plant Hg control
- Clean Air Mercury Rule was promulgated on March 15, 2005
- CAMR establishes limits on mercury emissions from new and existing coal-fired power plants and creates a market-based cap-and-trade program that will reduce nationwide utility emissions of mercury in two distinct phases
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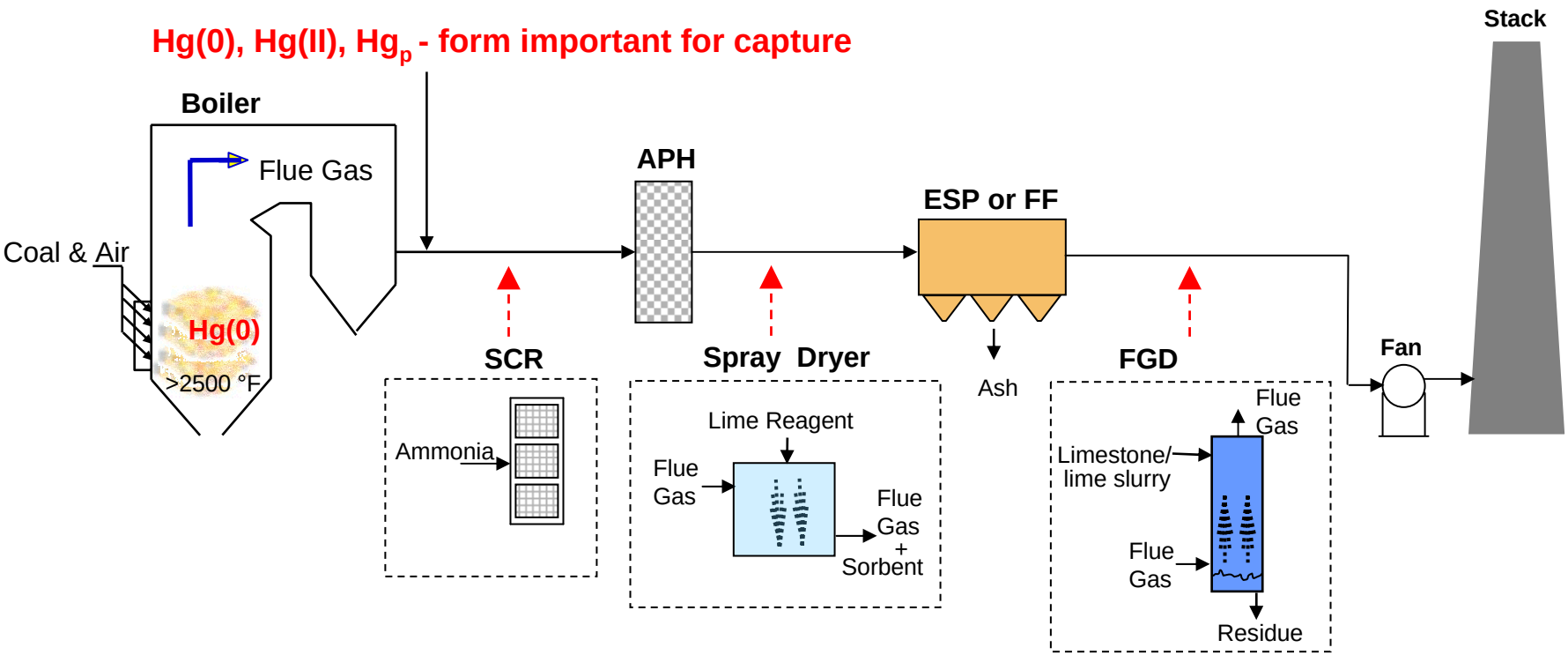
Power Plant Equipment and Mercury



Hg Removal in PM Controls

Hg adsorbed in fly ash is captured; FF more effective than ESP in Hg removal.

Hg Capture in Scrubbers/Spray Dryers

FGD effective in removing Hg(II), but not Hg(0); SCR can enhance capture in wet scrubber via Hg oxidation. SDA-FF/subituminous coal combination removes Hg very effectively;

Mercury Capture in Wet Flue Gas Desulfurization (FGD) Scrubbers

- Hg^{2+} capture depends on solubility of each compound
- Hg^{0} is insoluble and cannot be easily captured.
- Removals in 80% to 90% range achievable
- Removal can be enhanced by using oxidizers and/or oxidizing catalysts (e.g., upstream SCR catalysts)
- In some cases Hg^{2+} is reduced to Hg^{0} in the scrubber solution
  - results in re-emission and lowering of overall Hg removal
  - chemical additives can prevent such reduction
- Research underway to better understand fate of Hg in FGD waste and FGD gypsum

Sorbent Injection for Hg Control

- Injection of powdered sorbent materials is the most widely studied Hg-specific control technology.

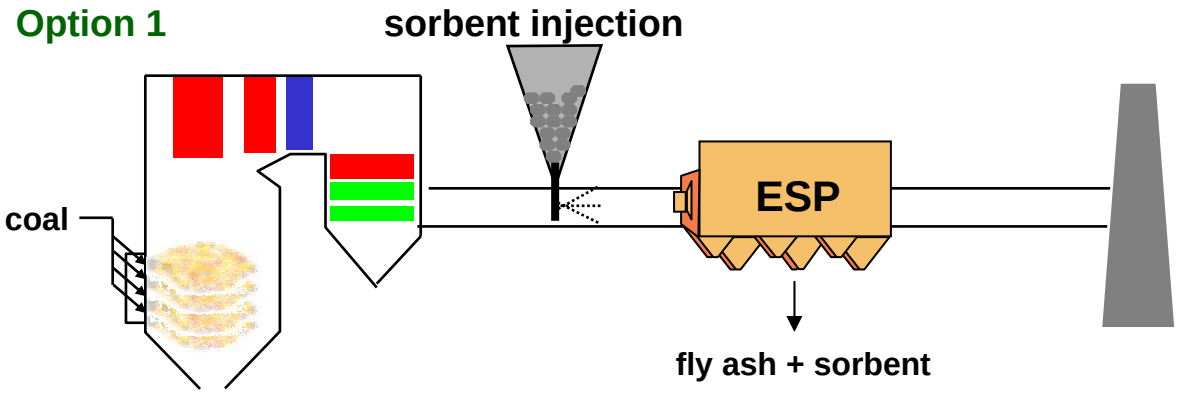
- Most testing has used coal-based powdered activated carbon (PAC)
  - But other inorganic sorbents have been tested and are still being developed

- Standard powdered activated carbon (PAC)
  - Relies on in-duct surface halogenation (by flue gas Cl_2 or HCl)
  - Effective for bituminous coals with adequate Cl content

- Pre-halogenated powdered activated carbons (Hal-PAC)
  - Pre-loaded with halogens (e.g., Cl, Br)
  - Effective for subbituminous coals with low Cl content

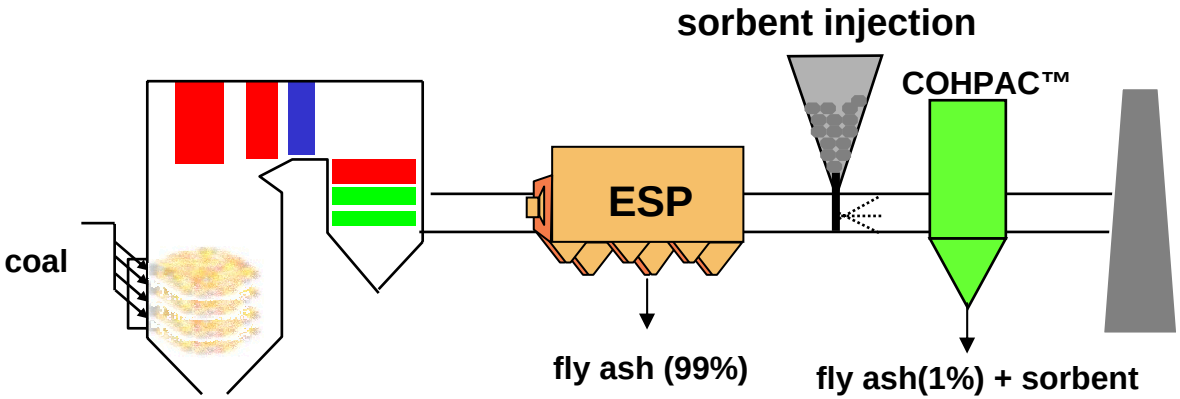
Sorbent Injection

Option 1



- Sorbent is injected upstream of the PM control device (ESP or FF)
- Collected fly ash and sorbent are mixed

Option 2: Electric Power Research Institute's TOXECON™ System



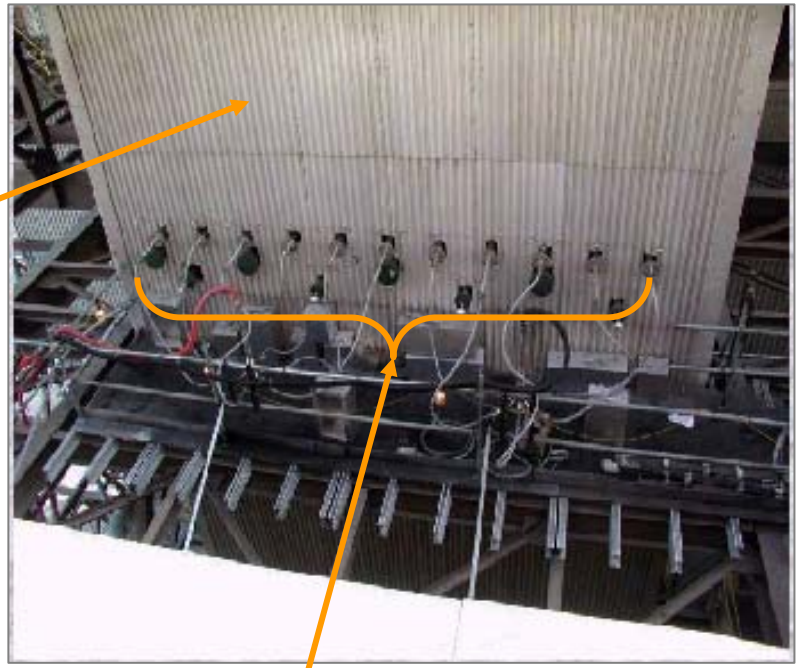
- Sorbent injection + Compact Hybrid Particulate Collector (COHPAC™)
- Potential solution to ash reuse problems

The extent of capture depends on:

- Sorbent characteristics (particle size, porosity, capacity at different gas temperatures)
- Residence time in the flue gas
- Type of PM control (FF vs. ESP)
- Concentrations of SO_3 and other contaminants

Activated Carbon Injection (ACI)

Activated carbon injection system



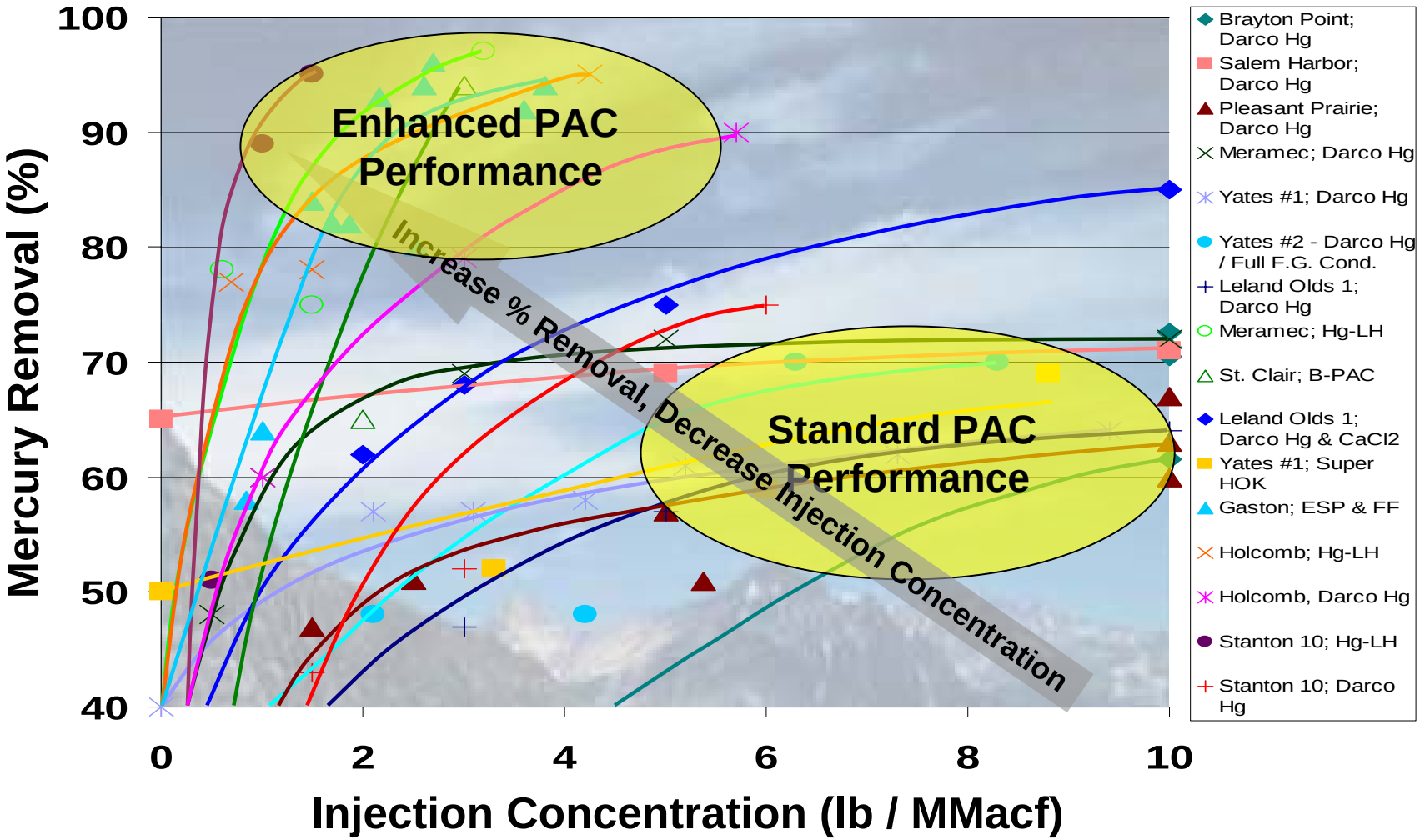
Injection lances

Flue gas duct

Activated carbon storage and feed system

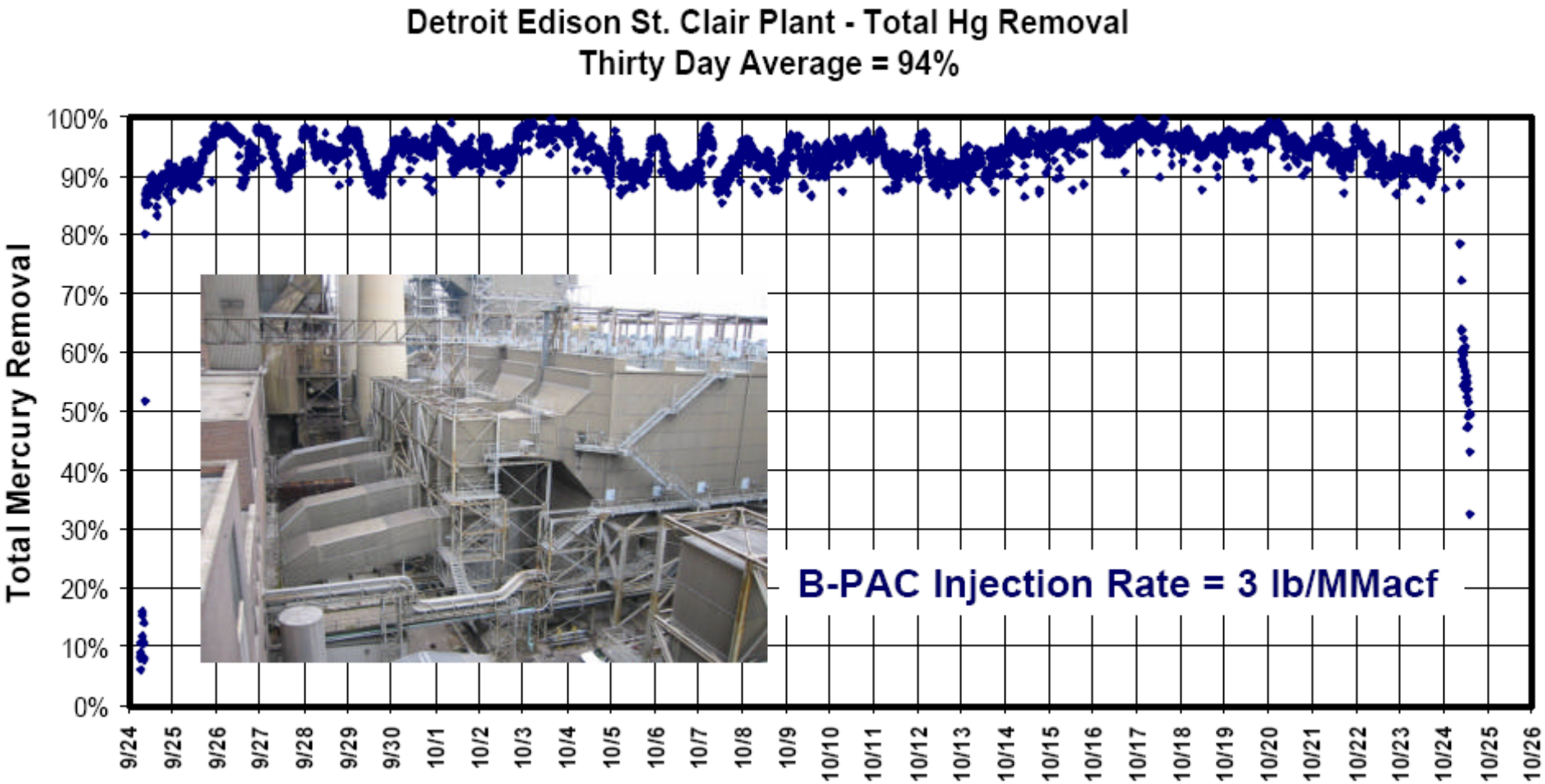
Storage silo

Field Testing Results 2001 – 2005
Comparison of Standard & Halogenated PAC



Source: DOE/NETL, 2005

Example of Full Scale Testing of Br-PAC



Source: Sid Nelson, Sorbent Technologies Corporation

For additional information

http://www.epa.gov/mercury