Reinhold Environmental Ltd.

2008 NOx-Combustion Round Table & Expo Presentation

February 4-5, 2008 in Richmond, VA

Advancing Towards Cleaner Coal

Perspectives of a Technology Developer

Sharon Sjostrom
ADA-ES, Inc.

Reinhold NOx – Combustion Round Table
February 4, 2008

Coal: a Key Energy Resource

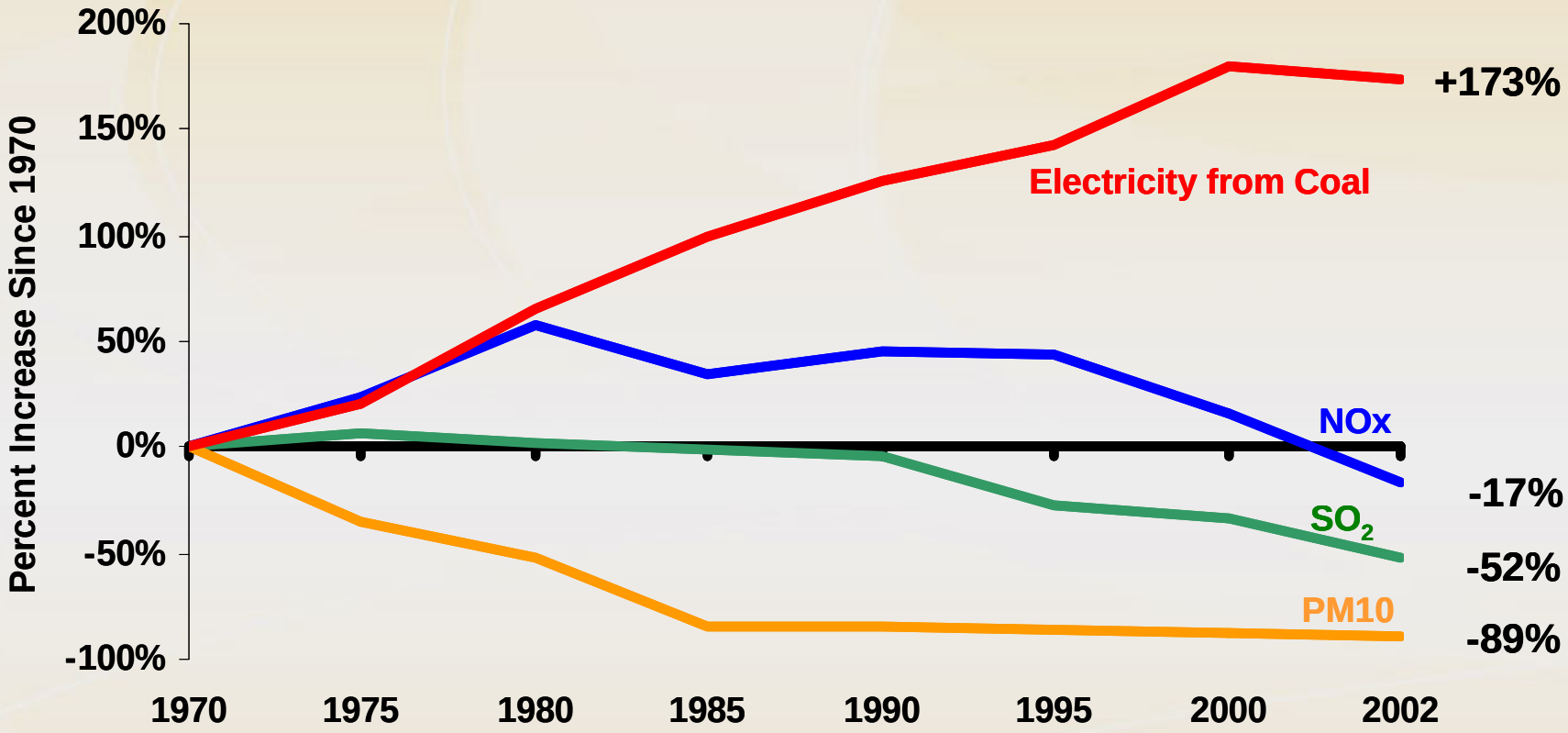
- Coal powers 50%+ of electricity generated in the U.S.
  - 1.1 billion tons of coal consumed in U.S. in 2007
  - 1.7 billion tons estimated in 2030
    U.S. Department of Energy's (DOE) Energy Information Administration
- 1,100+ coal-fueled boilers (~320 GW)
- Low cost energy source
- Secure energy source – 250-year U.S. reserve
- Making coal cleaner is critical to long-term viability

What Do We Know about Developing Emissions Control Technologies?

- Solutions come in different shapes and sizes
- Collaboration → Accelerated Development
- Regulations create market certainty driving R&D and commercial competition for lower cost solutions
- Great track record for improving emissions control performance at lower costs

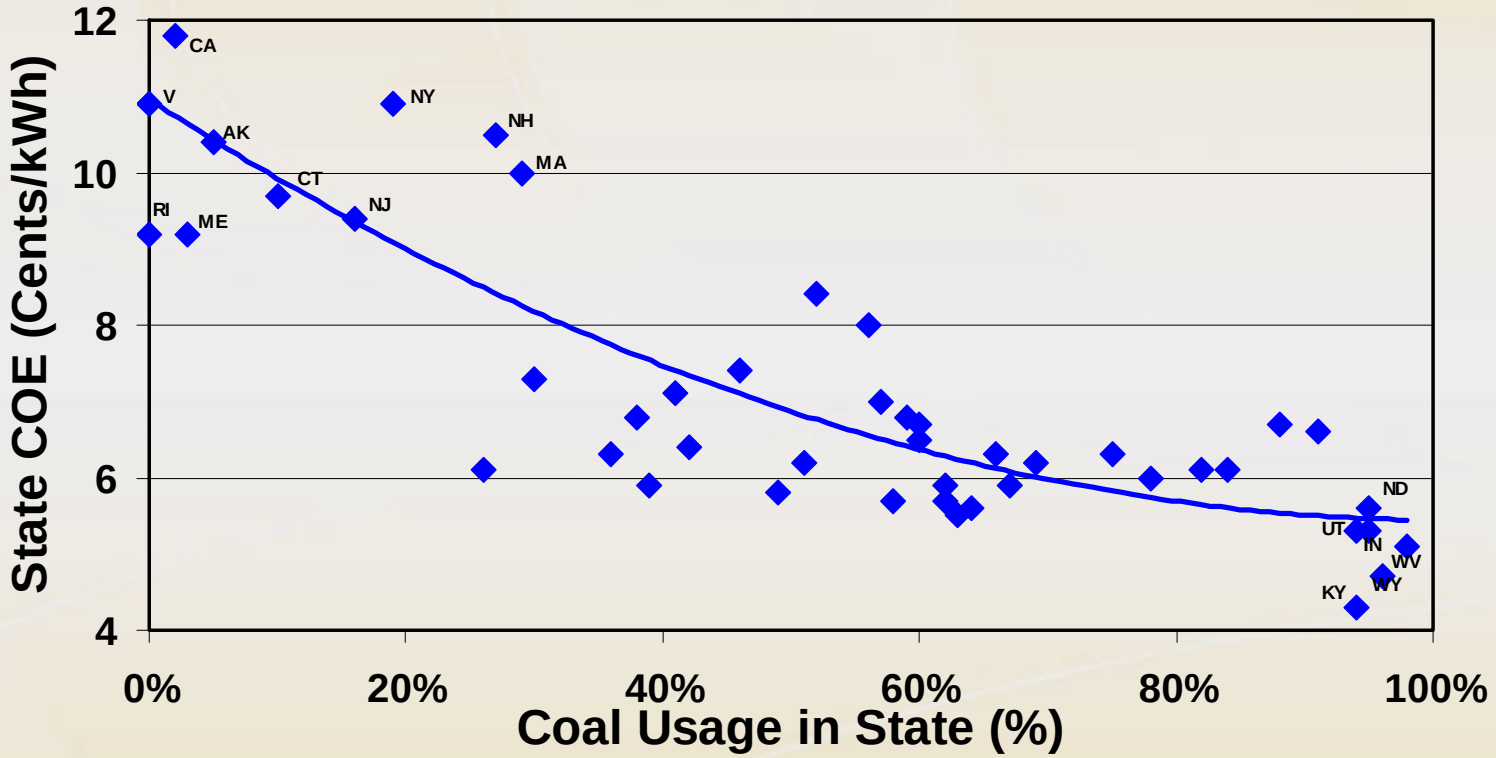
Reducing Emissions is Essential to Coal's Future

Emissions decrease even as coal usage increases

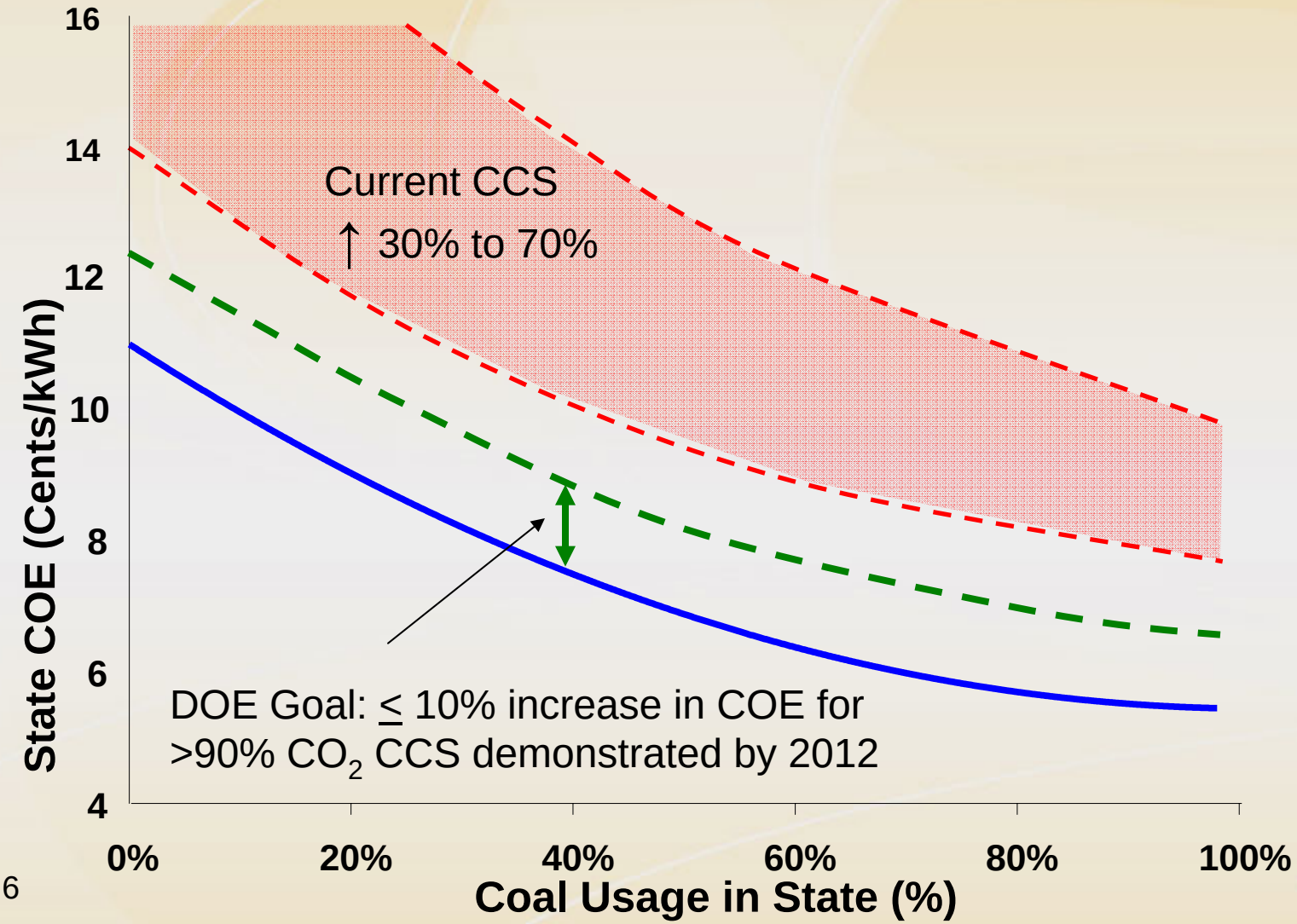


ADA-ES

The Cost of CO_2 Control



The Cost of CO_2 Control



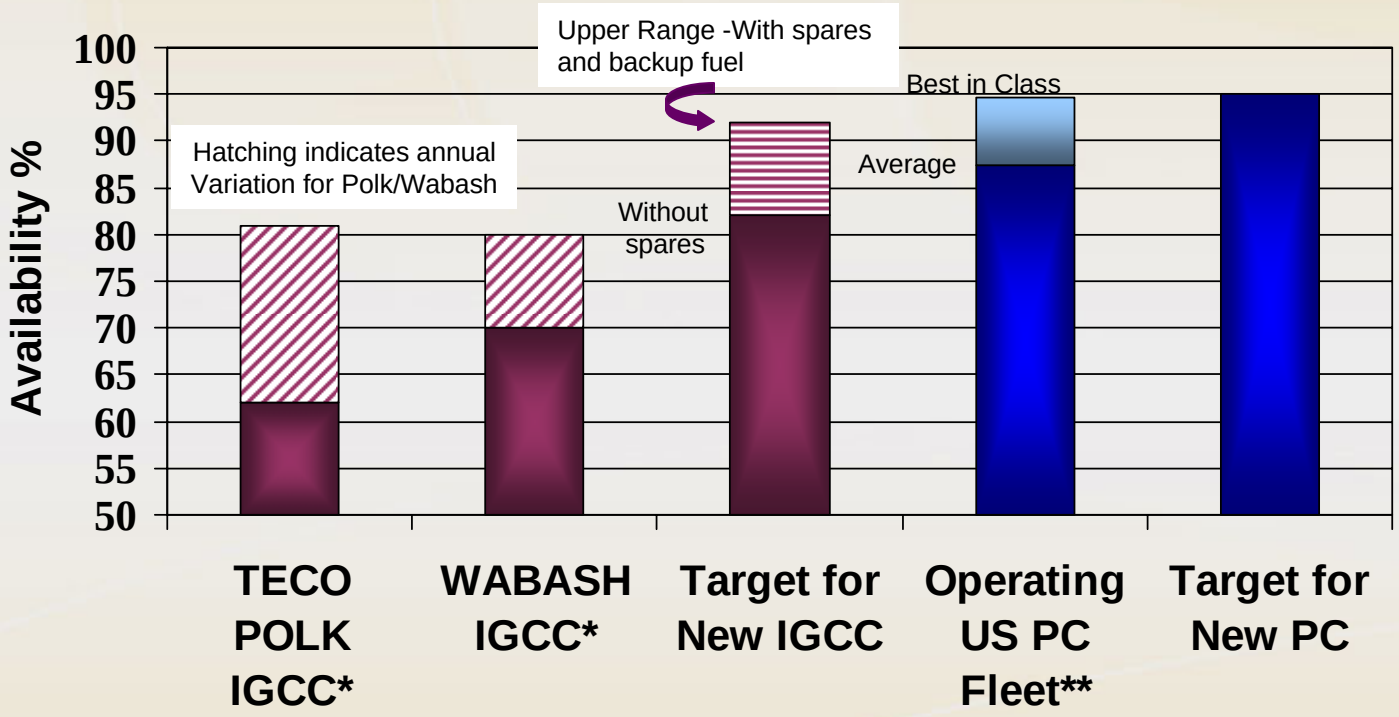
Meeting the Carbon Challenge

- Choosing a technology winner too early will slow development of lower-cost options
- All generation technologies produce same CO_2/Mwhr for same efficiency
  - Efficiency is typically the lowest-cost option to reduce CO_2 (demand-side and generation-side)
- CO_2 can be captured from all coal-based generation technologies
  - Costs differ due to factors such as CO_2 concentration in gas stream and pressure
  - Trade-offs: higher initial capital cost for IGCC vs. higher cost/ton of CO_2 capture for post combustion
- Suite of solutions will be neede to maximize cost-effectiveness

ADA-ES

Meeting the Goals for Coal Based Power - Reliability

- Actual reliability for operating IGCC << Operating (old) PC
- Project reliability of next generation projected to match average of operating PC fleet with spares and NG backup
- New PC/CFB reliability increasing under commercial pressure



* Availability of IGCC plant firing syngas

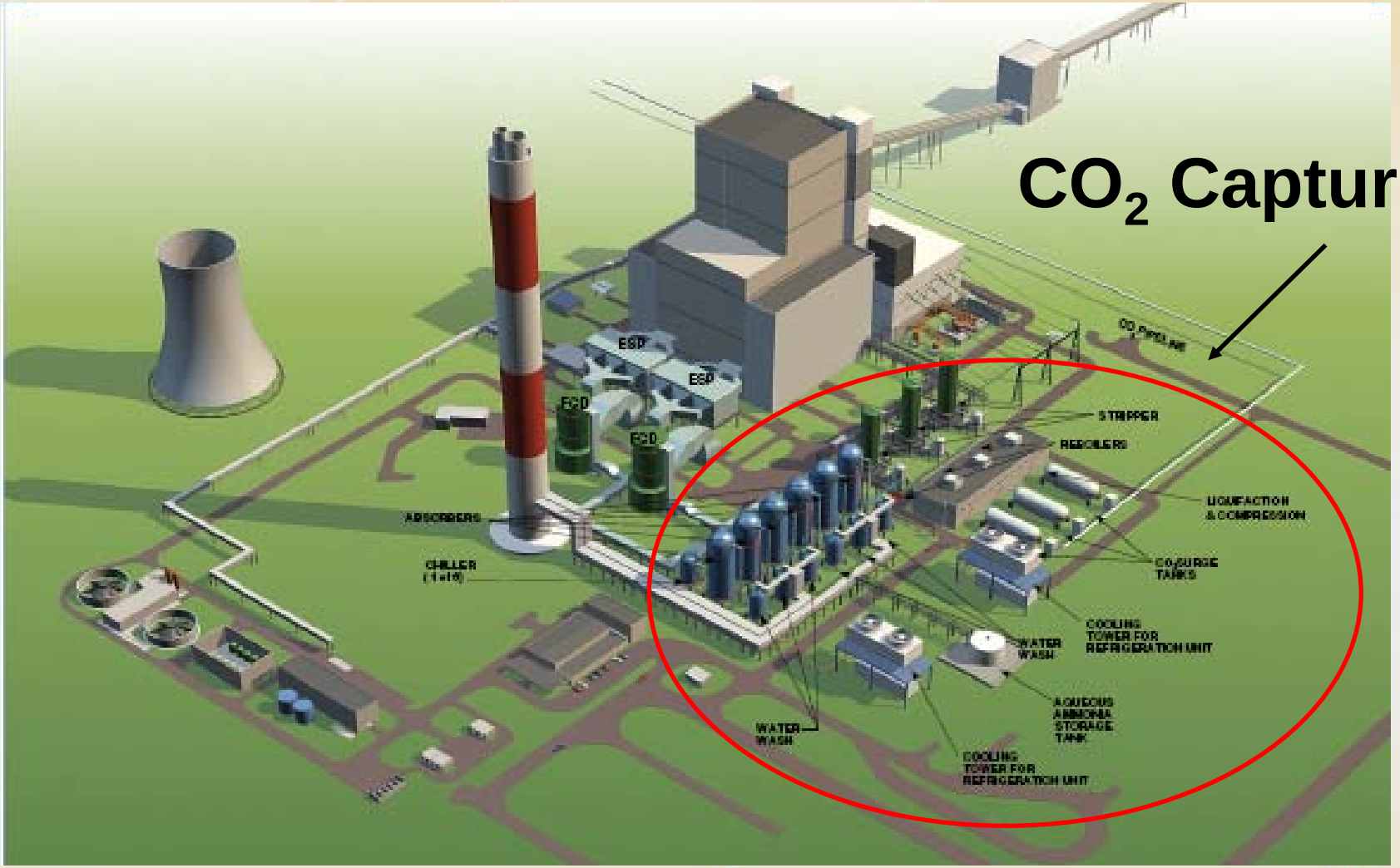
** Source: NERC Avg availability of coal units 100 MW and larger =87.4%; best in class (top 10%) = 94.6%

ADA-ES

The Scale of CO_2 Capture

"the value chain is technically feasible, it is not commercially viable"
Statoil and Shell in a joint statement. Reuters, June 29, 2007

Chilled Ammonia Footprint



Morris, AEP, 2007

ADA-ES

Developing New Control Technologies

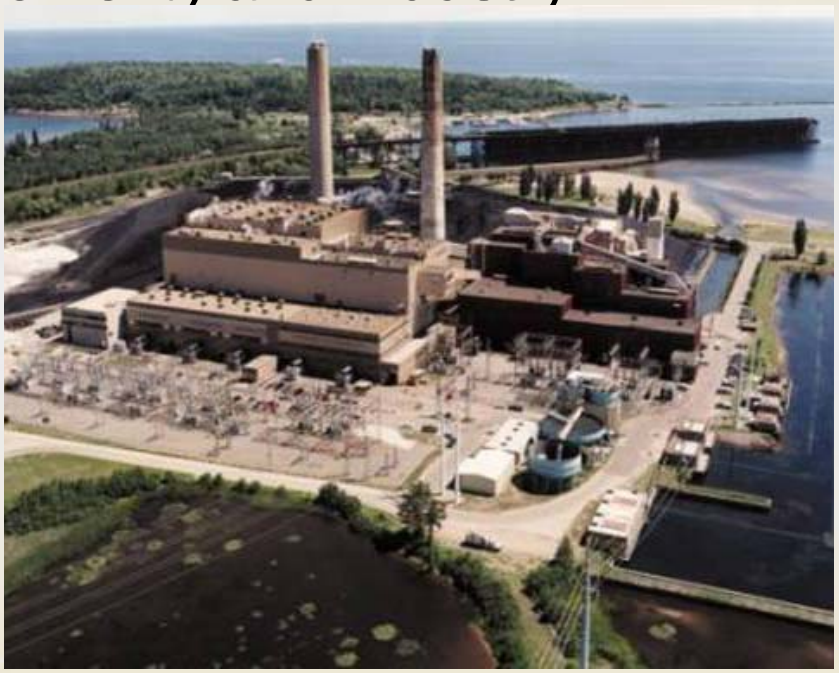
- Timing is everything
  - Can't impose a regulation if there is no control technology
  - Without a regulation there is no market for the control technology to justify investment
- Developing new technology for the power industry is very expensive and requires years
- There is no assurance of that R&D investments can be recovered
  - There may never be a regulation (market driver)
  - Being the first to prove a technology does not guarantee a position in the commercial market
  - A "cleaner coal" plant is more expensive than existing plants but must compete on the open market with exactly the same product

Case Study: Mercury Control Technology Development

- 30+ Full-scale demonstrations of sorbent-based mercury control conducted on coal-fired boilers in U.S. from 2001 through 2007

  Funding from DOE NETL (50 to 75%) and industry
  ~ $500k to $2M per site

- Clean Coal Power Initiative TOXECON™
  $24.9M DOE
  $28.5M We Energies



We Energies Presque Isle

ADA-ES

Funding for CCS Development

- DOE 2009 budget request

  $648 million for the DOE Office of Fossil Energy's advanced coal technology research.

  Largest request in 25 years

- 5 MW chilled ammonia pilot at Pleasant Prairie funded by EPRI, WE Energies and 19 other utilities ($10M). Est. COE increase 15% to 30% for capture
- 20 to 30 MW chilled ammonia pilot at AEP Mountaineer (~ $50 to 80M est) *"The company will seek federal grants and will ask state regulators to let it charge customers."*

  NY Times, March 2007

ADA-ES

Creating a Future with Cleaner Coal

- Coal is critical to the security of the Nation
  - Keeps the lights on
  - Assures low-cost power
  - Reduces reliance on foreign fuels
- Reducing emissions from burning coal is a priority
- Choosing a “winner” technology too early can stifle the development process
- There is tremendous risk at each stage in technology development
  - R&D
  - Demonstrations
  - Early commercialization
- Federal investment required for rapid advancement of control technologies
- Industry collaboration is essential

We Can Do This - Together

ADA-ES