Indiana's Stake in the CO2 Control Debate

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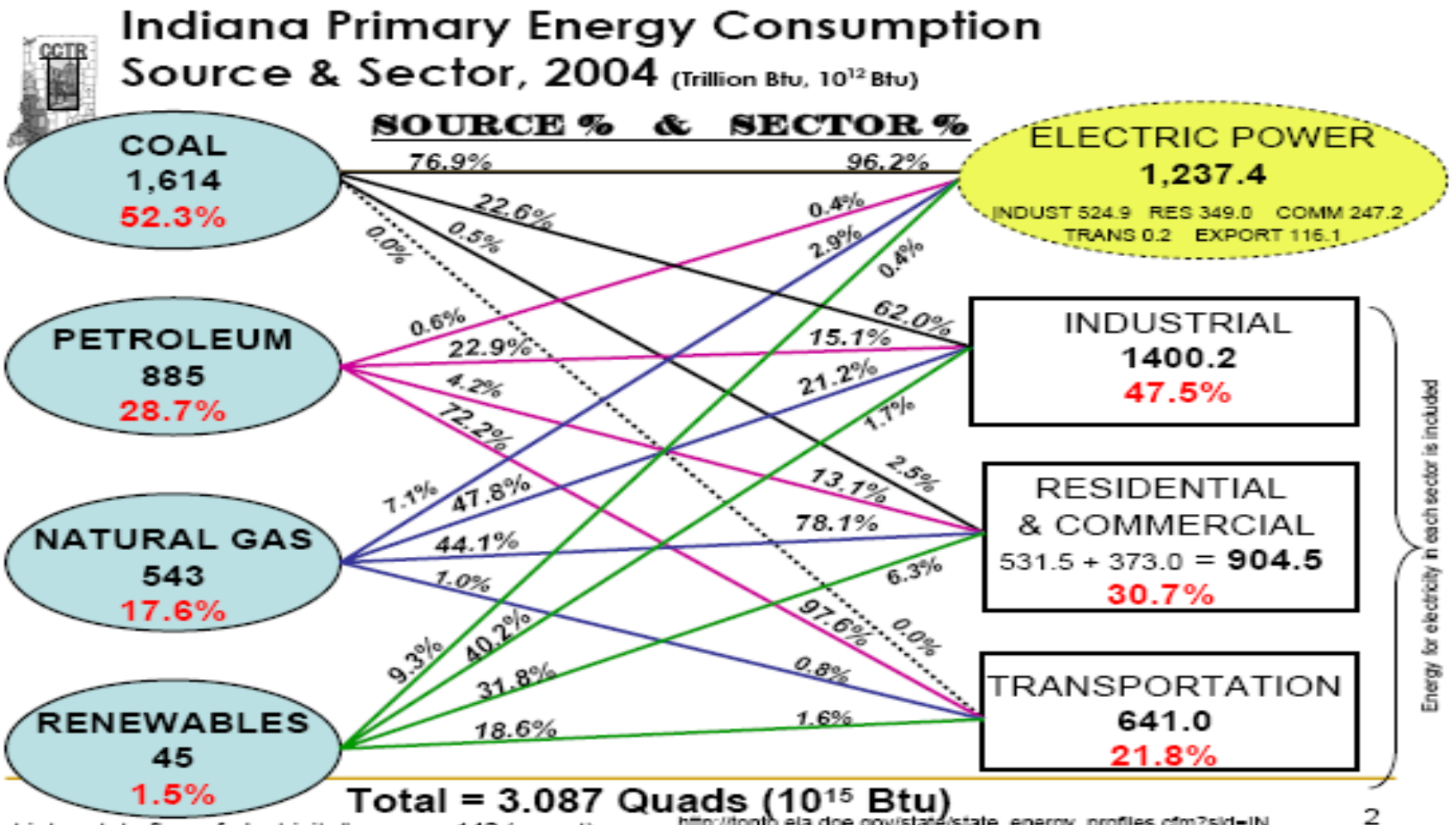
Indiana Primary Energy Consumption Source & Sector, 2004 (Trillion Btu, 10^{12} Btu)



Net inter-state flow of electricity/losses = -142 (export)

http://www.eia.doe.gov/emeu/states/sep_sum/html/sum_btu_tot.html

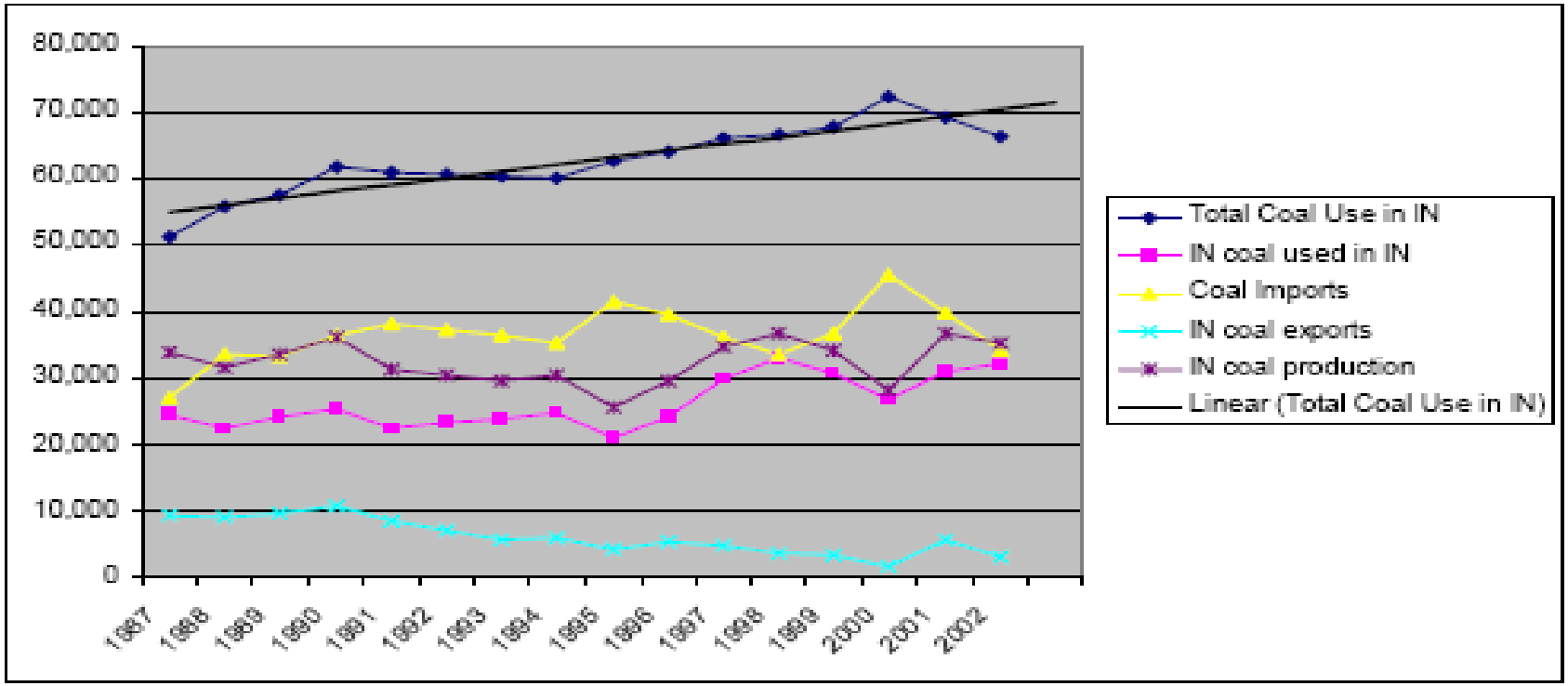
http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=IN

http://www.eia.doe.gov/emeu/states/state.html?q_state_a=in&q_state=INDIANA

Coal use Up

Coal Use Trend

Indiana coal consumption growing much faster than Indiana coal production



Coal Answer to the Emissions problem?

Increasing the use of electricity focuses the emissions issue back to the Utility, rent pollution control when you buy electricity.

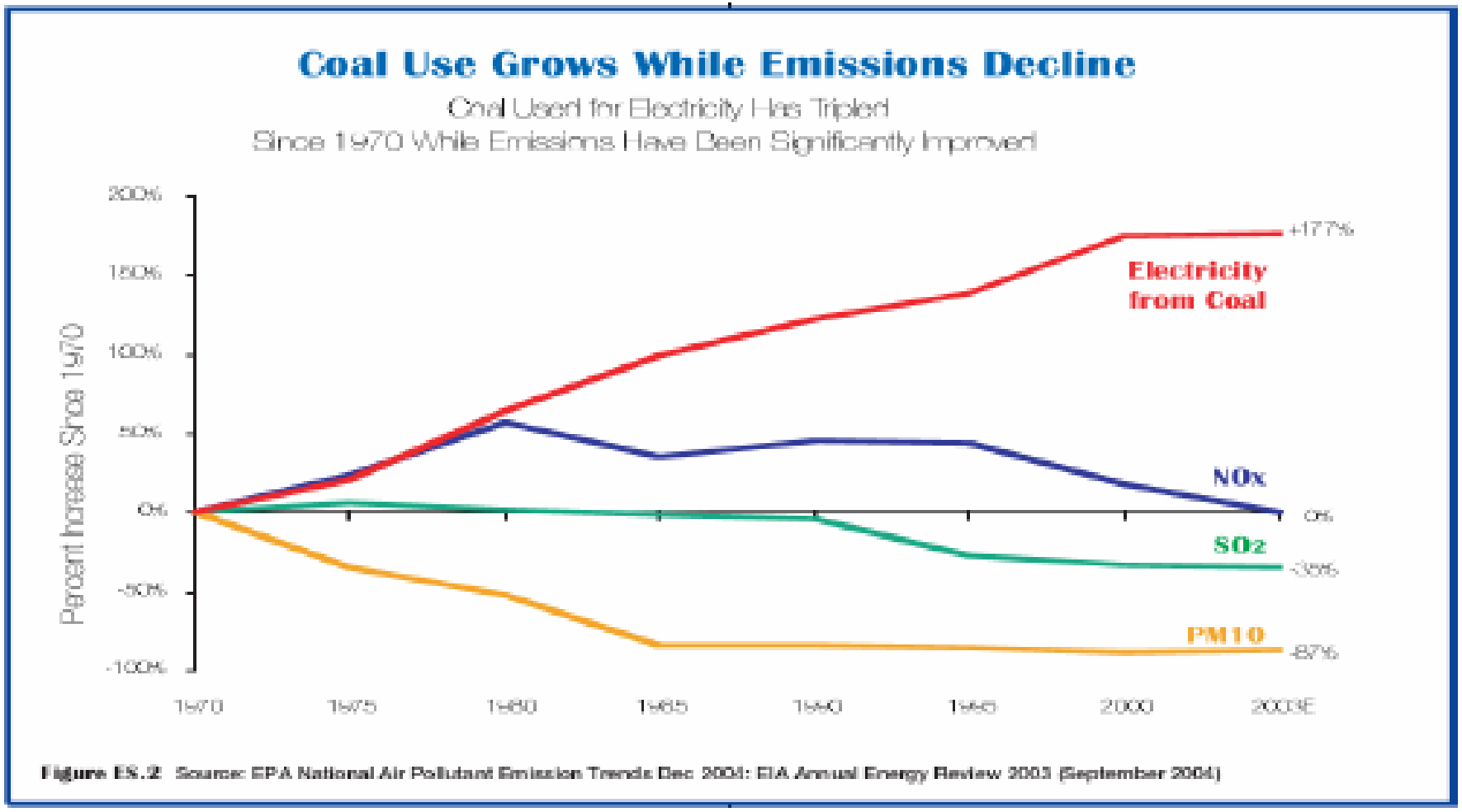
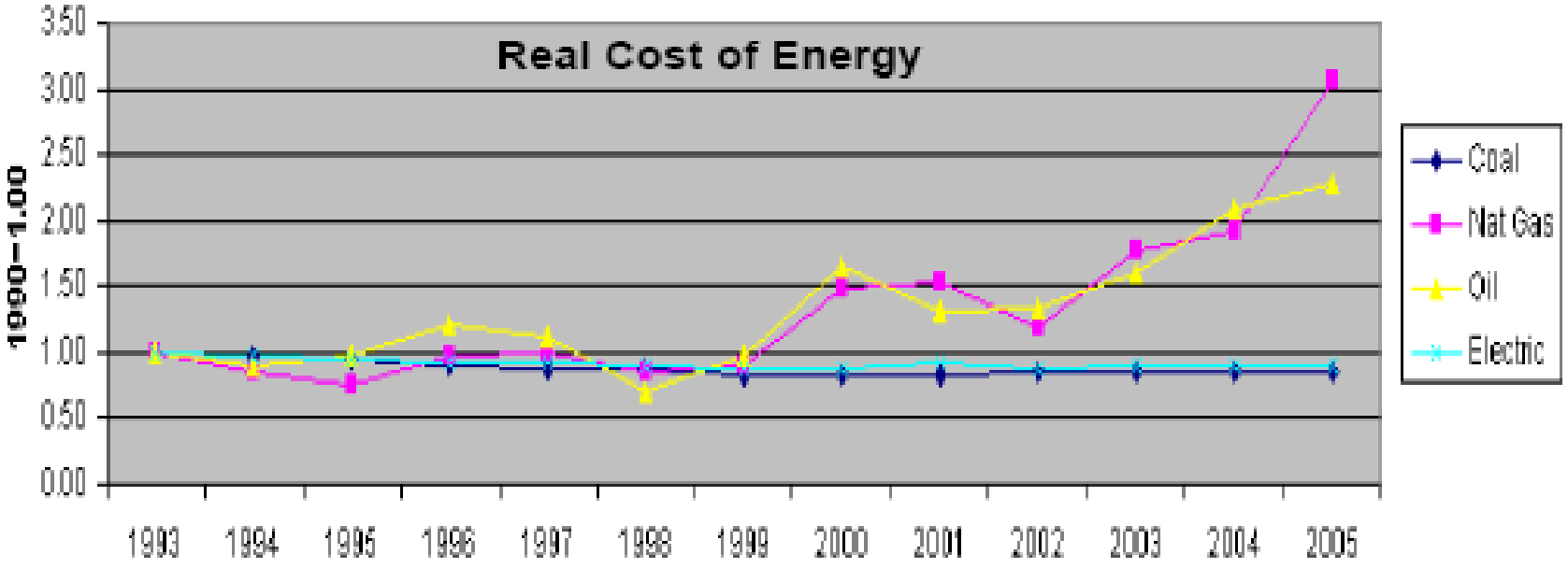


Figure ES.2 Source: EPA National Air Pollutant Emission Trends Dec 2004; EIA Annual Energy Review 2003 (September 2004)

Coal prices are relatively stable in real terms while other forms continue to rise. In Indiana coal = electricity

Low energy price helps the economy of the state.
If we have a least cost option, use it.



Price of Energy

Demand increases even as Price Increases

- From 1995to 2006 :
- Coal price per MMBTU increased **21.1%**

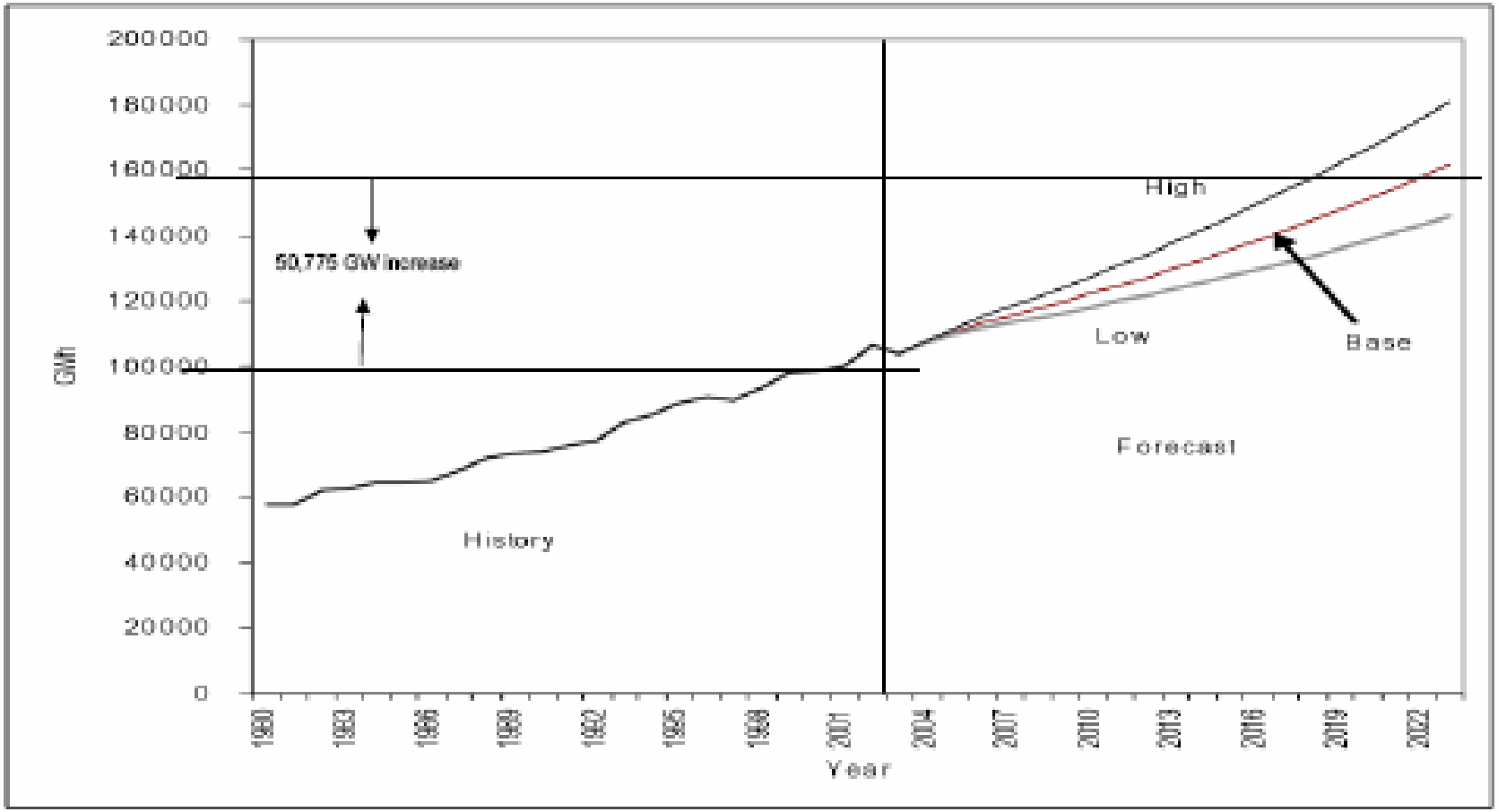
  Demand increased 14.0%
- N G price per MMBTU increased **250.5%**

  Demand increased 26.7%
- Petroleum price per gallon **107.5%**

  Demand increased 14.9%
- Electricity in Indiana price increased **23.5%**

  Demand increased 21.3%

Indiana electric requirement by scenario 45.9% increase in electric demand in next 17 years, SUFG



The Real Problem

We are not ready

The Energy Workforce of the Future

- **All energy industries face issues**
  - Coal miners are retiring; average age 51
  - Technologies are changing
  - Boilermakers are offshore
  - Nuclear welders do not exist
  - Stigma of a vocational technical education
  - Power generation industry – average age 50
    - Employs 1 million nationwide
    - ½ workforce retirement in 5-10 years
    - 62% of managers are 50 and older
    - 61% of line superintendents are 50 and older
    - 43% of foremen are 50 and older

southern states energy board

What Will Work to Meet the Demand?

Don't confuse Energy Efficiency with Government Control

Global Energy Forms Face Limits in Supply & Price

All Energy Forms Needed for Diversity of Supply

ENERGY EFFICIENCY/DEMAND-SIDE MANAGEMENT/CONSERVATION

An important resource but insufficient to power the future

OIL

Consistently above $50/barrel; declining reserves; risky sources

NUCLEAR

Valuable but constrained due to safety and waste disposal concerns

HYDRO

No growth in supply

WIND

Limited availability; grid disruptions; erratic supply

ETHANOL

Clean but energy inefficient; strains food supplies; cellulosic key

NATURAL GAS

Consistently above $6/mcf; declining reserves; risky sources

Courtesy: Peabody Energy, 2007

Evolution of the Coal Power Plant

Yet the electricity per ton of coal input stays level

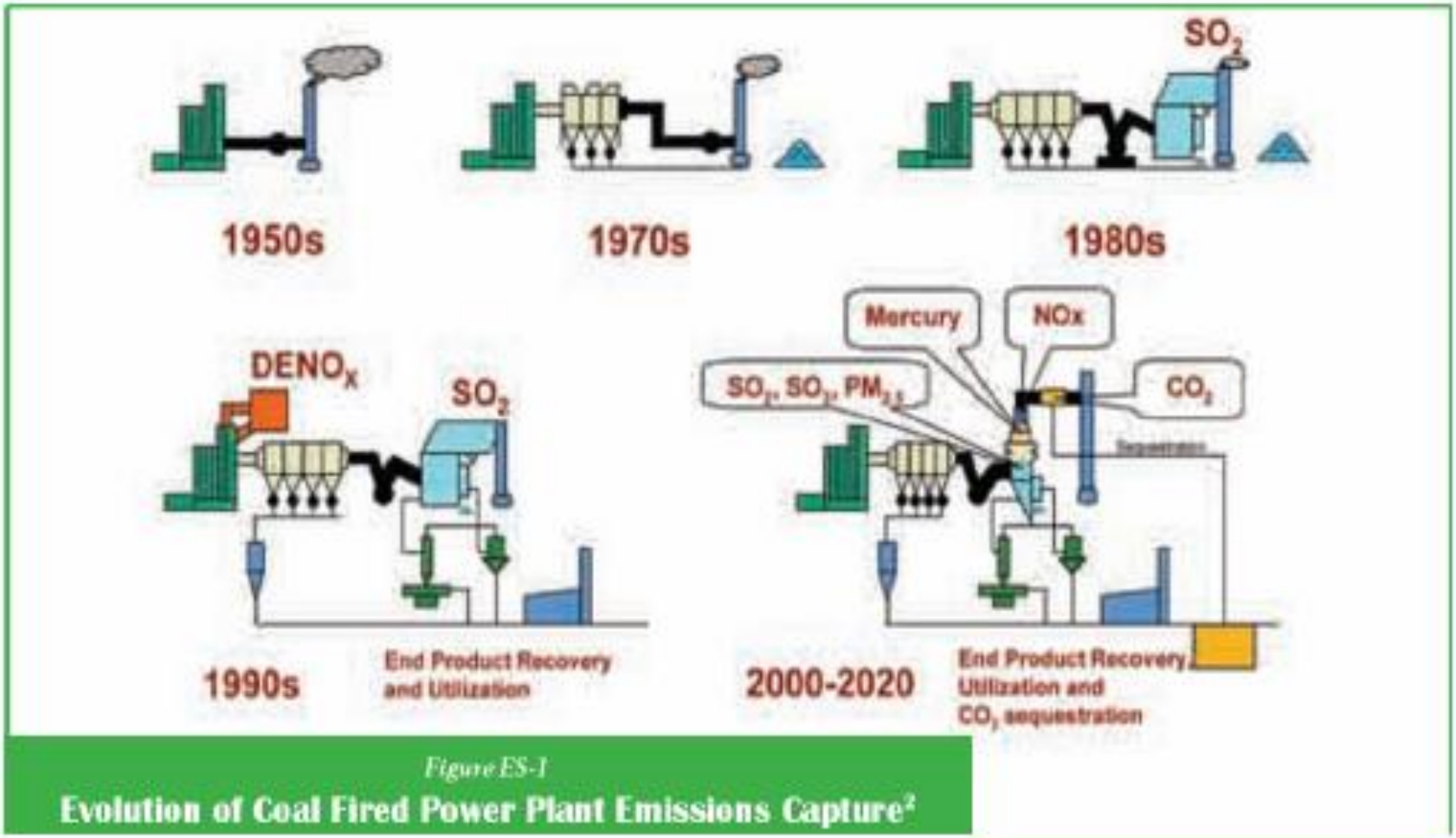


Figure ES-1

Evolution of Coal Fired Power Plant Emissions Capture[2]

It takes power to make power

Size comparison of original PC to new technology

IGCC Project Layout

Estimates of cost Impact of CO2 Controls

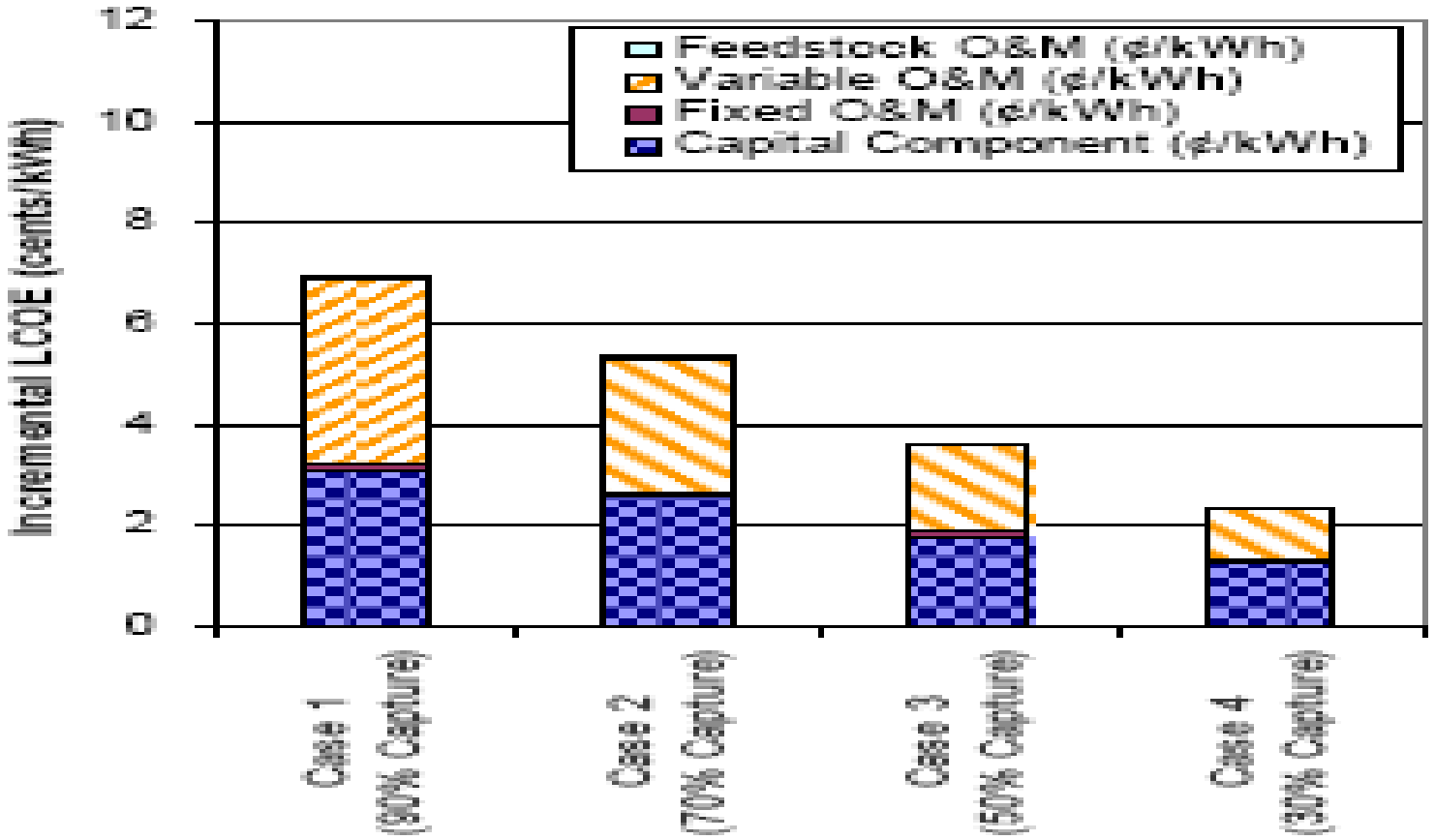
Type Coal	size	Plant efficiency	CO2 lb/mmbtu	Water GPM	Cost of Electricity	Plant Cost $/Kw
IGCC	630mw	39.53%	198.7	3850.6	77.9 mils	$1,841
IGCC	630mw	32.07%	20.6	4425.7	106.3 mils	$2,496
with CCS 90% reduction						
Difference		**-18.9%**	**-89.6%**	**+14.9%**	**+36.4%**	**+35.5%**
PC	550mw	37.95%	203.0	5826.5	63.65 mils	$1,562
PC	550mw	26.05%	20.3	13128.5	116.80 mils	$2,882
with ccs 90% reduction						
Difference		**-31.4%**	**-90%**	**+125.3%**	**+83.5%**	**+84.5%**

DOE/NETL-2007/1282, May 2007

How much water does your cell phone consume?

2.8 gallons a day if you charge it at home, 0 if you charge it with your car.

Retrofit cost by level of capture



Power production Losses Associated with CO2 Capture

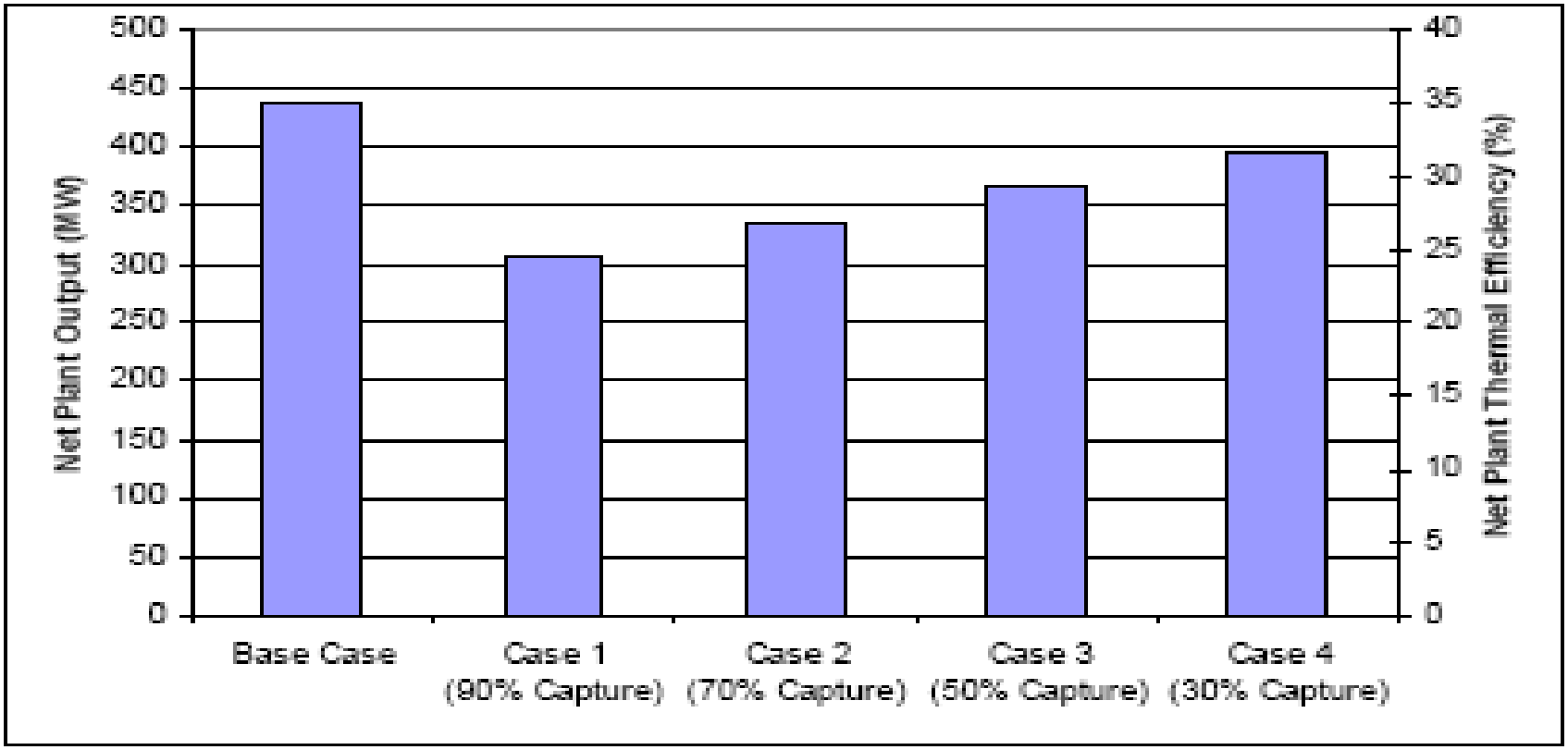
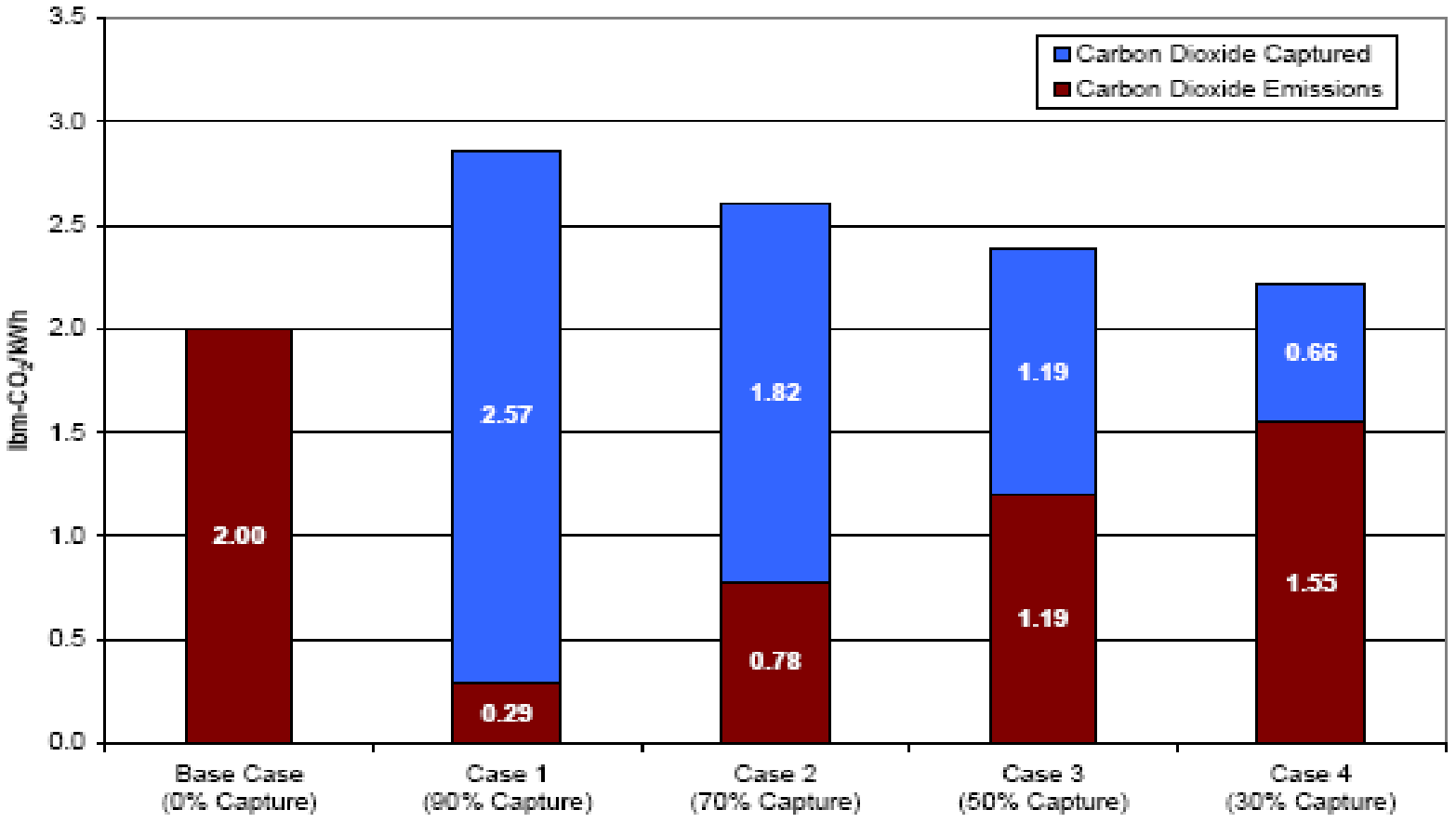
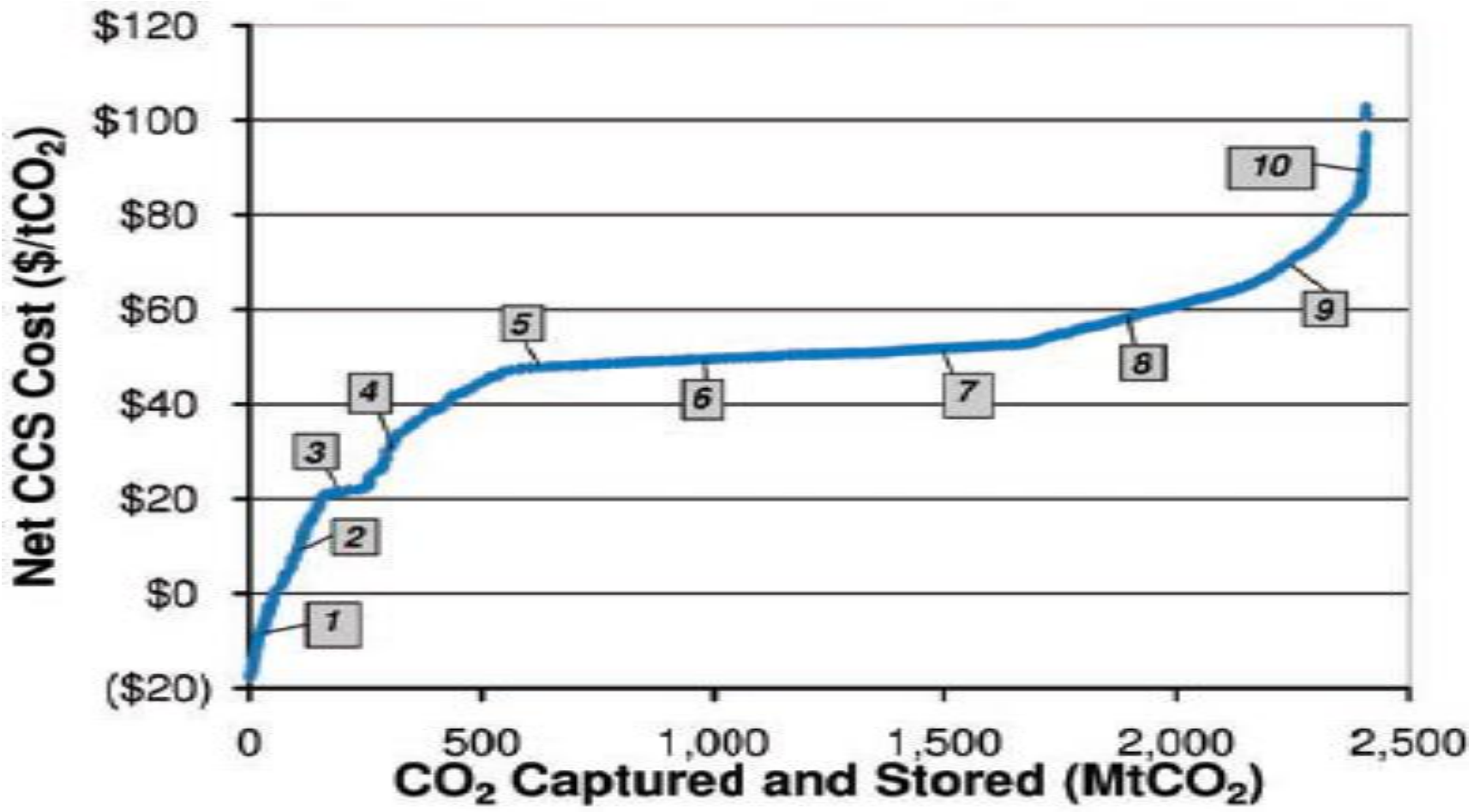


Figure ES-3: Plant Performance Impact of Retrofitting a Pulverized Coal-Fired Plant at Various Levels of Carbon Capture

CO2 capture Scenarios
as Mw capacity falls CO2 per Mw increases



Estimated Cost of CO2 Capture Differs by Situation



Best to Worse Scenarios

- Range from -$10/ton to $90/ton
- 1) High purity ammonia plant / nearby (<10 miles) EOR opportunity
- 2) High purity natural gas processing facility / moderately distant (~50 miles) EOR opportunity
- **3) Large, coal-fired power plant / nearby (<10 miles) ECBM opportunity**

  $20/ton
- 4) High purity hydrogen production facility / nearby (<25 miles) depleted gas field
- **5) Large, coal-fired power plant / nearby (<25 miles) deep saline formation**

  $45/ton
- 6) Coal-fired power plant / moderately distant (<50 miles) depleted gas field
- 7) Iron & steel plant / nearby (<10 miles) deep saline formation
- 8) Smaller coal-fired power plant / nearby (<25 miles) deep saline basalt formation
- 9) Cement plant / distant (>50 miles) deep saline formation
- 10) Gas-fired power plant / distant (>50 miles) deep saline formation

Source: Global Energy Technology Strategy Program, Battelle & PNNL, May 2007

What can Indiana do NOW?

- **Wabash**:
- Started in 1994, it was the most visited DOE research site outside of the national labs for over 10 years.
- The longest continuously operating coal (and pet coke) gasifier in the US.
- Now it is a full gasification production site supplying syngas to Duke's Wabash River power station using pet coke as a fuel source.
- CCTR and Purdue University want to put 1 or 2 graduate engineering students at the Wabash site for the purpose of determining the training and education needs of future gasifier workers.
- **This facility is ready today to work on CO2 capture, it is already built and functioning, and designed for research activity.**
- **The best short term site for CCS testing**.

Edwardsport

- Edwardsport:
- The only IGCC that has both air permitted and has regulatory authority to be built.
- Edwardsport has a market in place for its electrical production adding to the Duke Indiana capacity, a capacity that is sorely in need of new generation.
- The IURC ordered Duke to perform a study of how to reduce CO2 emissions by 20%.
- The study of how to add a CO2 system onto an existing IGCC is very important. Other future IGCC facilities will use Edwardsport as a model not only of how to build an IGCC ,but also how to accommodate CO2 capture.

Crane Naval

- SAIC/Crane:
- This CCTR sponsored project started as a proposal to put a small scale IGCC inside Crane Military base to make it energy self sufficient.
- Early study indicates that this is not practical: BUT
  - a 25mw system could supply Crane with its power needs,
  - maintain enough excess gas to supply a fertilizer plant or,
  - produce FT fuels for military use is doable

  if the facility is moved a few miles off base. (closer to a water source).
- The key to the system will be the capture of CO2 for sale to industry. At this size facility CO2 could be captured is technologically viable.
- This would prove to be a very good test case for how to scale up CO2 technology.

Indiana Gasification and the CO2 Pipeline

- Indiana Gasification Inc.:
- This large scale coal gasifier will convert coal to usable natural gas for distribution through the existing gas pipeline system.
- The location of this facility would also make it idea as a source of CO2 for the proposed CO2 pipeline that Indiana Illinois and Ohio have discussed.
- The gasification plant will be sized similar to that of an IGCC, but will have the flexibility of being able to move its gas production to where the market needs it.
- It also will be a perfect test case for large scale CO2 technology development, In that the testing will not interfere with the gas production