The Risks, They Just Keep On Coming

(Impacts of Environmental Bills in Congress)

GAMS Anniversary Seminar
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HAPPY BIRTHDAY, ALEX

Order of Presentation

1. How Our Models Work

2. Results of Modeling Current Bills In Congress

3. Discussion of the Risk Implications

4. Conclusions

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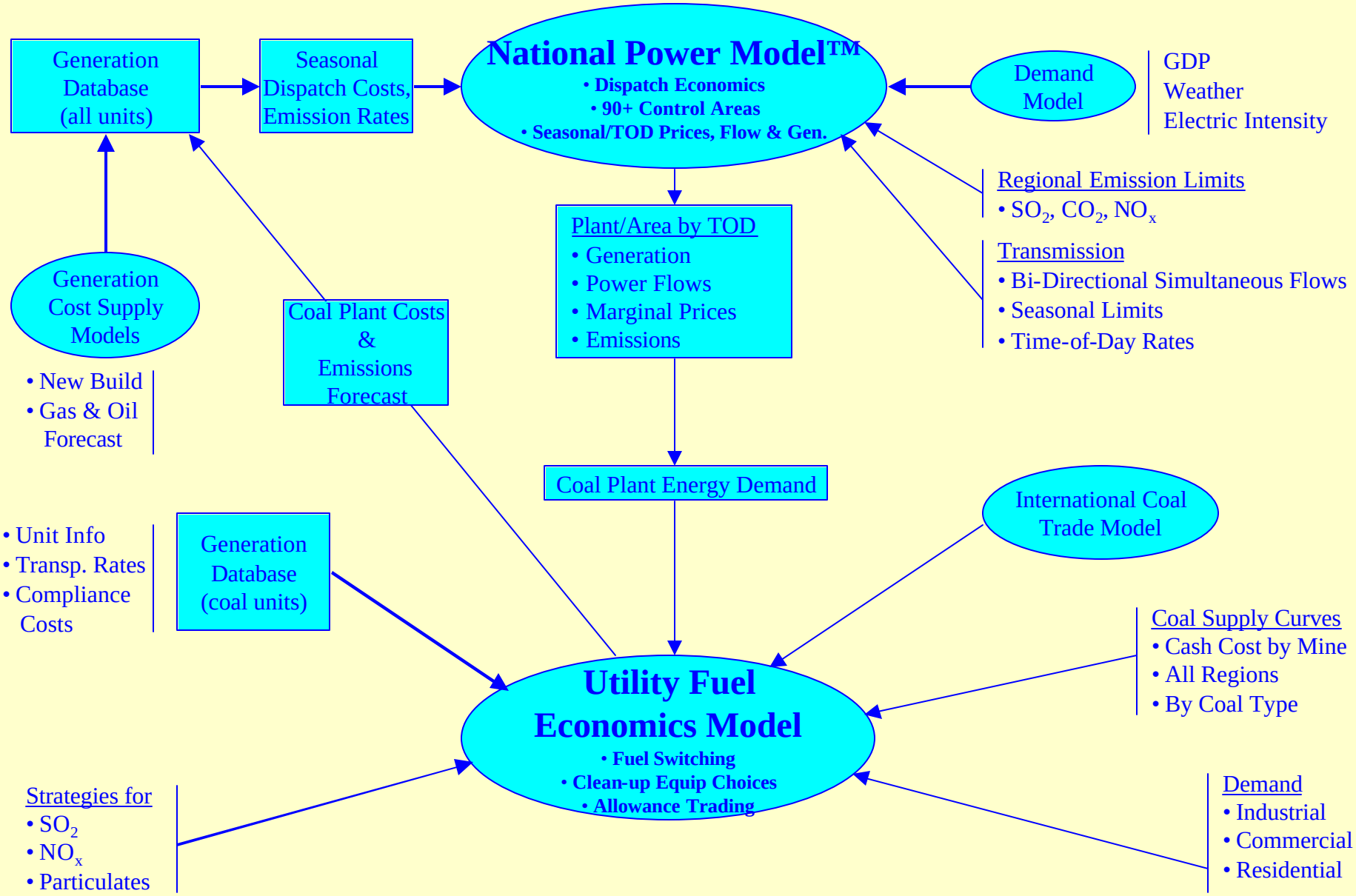
Electric Generation, Coal and Emissions Forecasting System



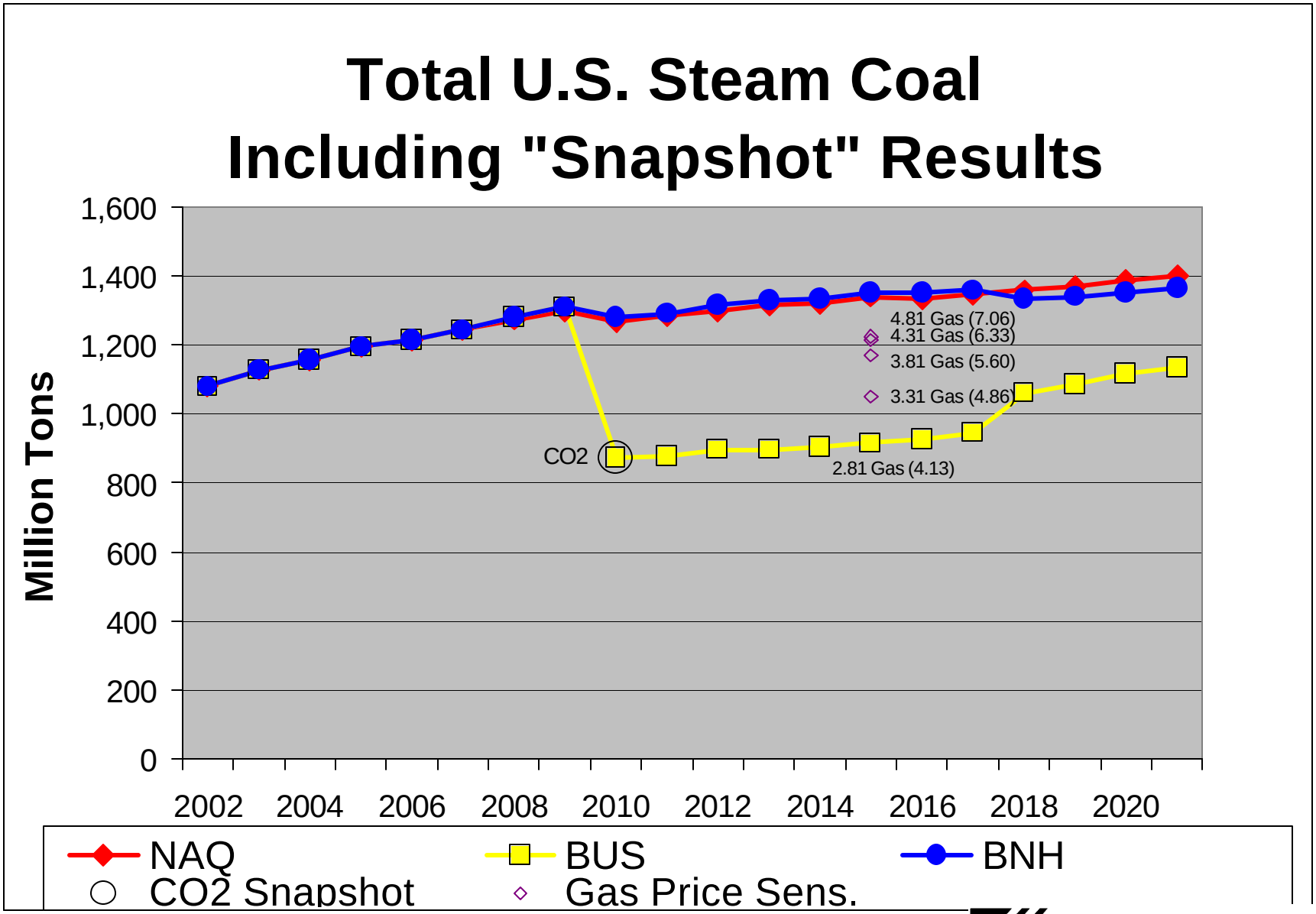
Three Factors Differentiate Us

- Our Coal Mining Cost Curves By Detailed Type of Coal
- The Feedback Loop With Dispatch, Coal Choice and Equipment Decisions Co-Dependent
- Simultaneous Interplay of Pollutant Limits

Multi-Emission Limits

Emission	Actual 1999	NAAQS	Clear Skies Initiative As Introduced in Congress	Sen. Carper's "CAP 2002"
SO2	12.0 million tons	4.35 mm in '10	4.5 mm in '10 3.0 mm in '18	4.5 mm in '08 3.5 mm in '12 2.25 mm in '15
NOx	7.1 million tons	OTC Stepdown '03 21-State SIP Call '05	2.1 mm in '08 (1.582 mm East/0.538 mm West) 1.7 mm in '18 (1.162 mm East/0.538 mm West)	1.7 mm in '12
Mercury	48.6 tons	None	26 tons in '10 15 tons in '18	24 tons in '08 5-16 tons in '12 (EPA set cap) 10 tons (H&A)
CO2	2.19 billion tons	None	None	~2.6 billion in '08 (2005 levels) ~2.3 billion in '12 (2001 levels)

Last Year's Outlook



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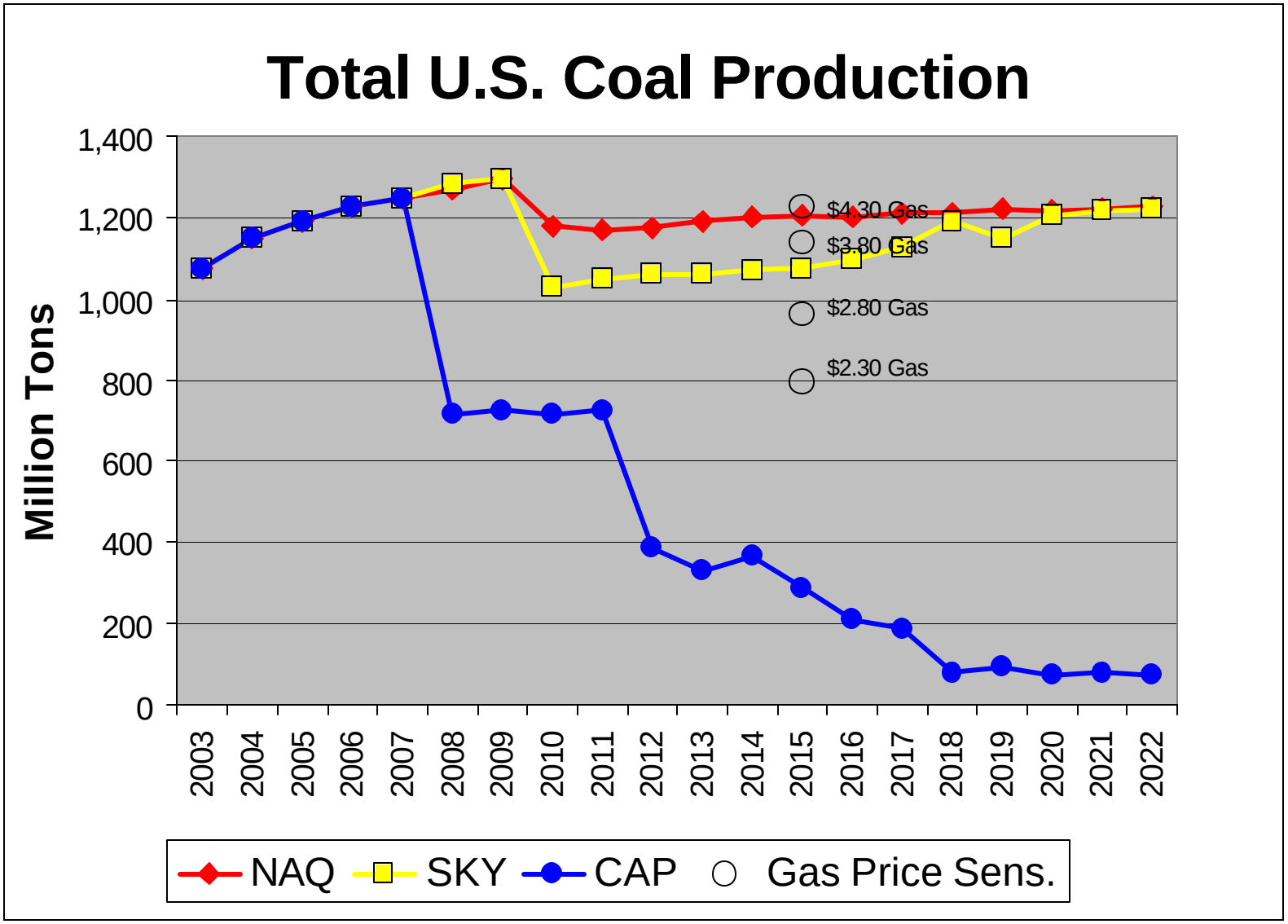
This Year's Study



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Different Types of Risk for Coal

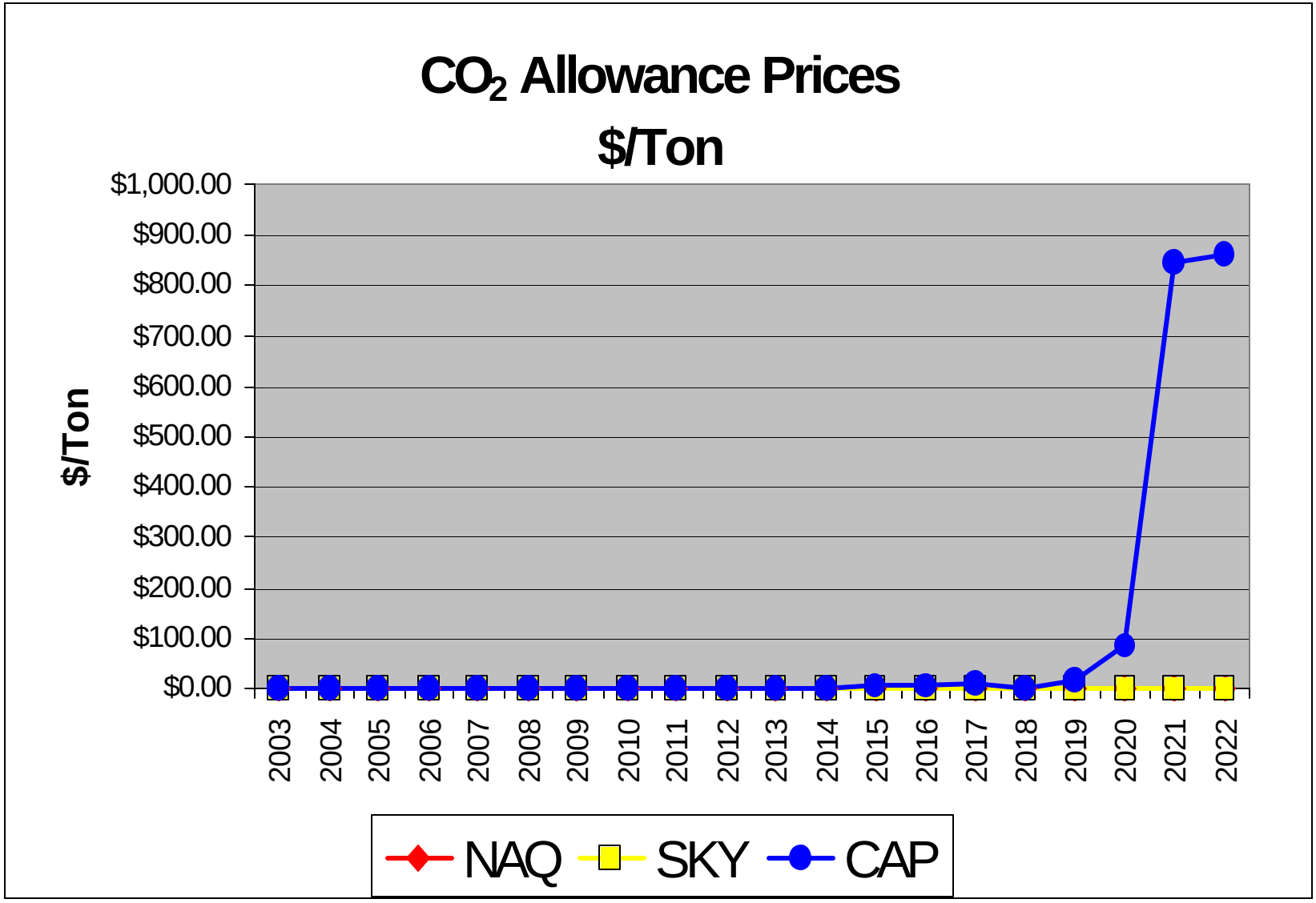
- The Risk of the Carper Bill Being Passed (Or Any Other Form of Fixed CO2 Limits)

- The (Mercury + Gas Price) Risk
  - More Insidious (Looks OK from One Angle)
  - Coal Tonnage Alone Doesn't Tell Whole Story

- Risks Not Reflected In Our Modeling

CO_2 Impact: It Ain't Rocket Science

- Starting Point: 3.904 Billion MWH
- If Grows 2.5%/yr for 25 Years = 7.238 Bln
- Assume 20% Is Hydro, Relicensed Nuc.s, etc (Remaining 80% Is Fossil-Fired = 5.790 Bln)
- Even If **ALL** Fossil-Fired Is Natural Gas, Result is CO_2 Emission of 2.29 Billion Tons (vs Carper Bill Limit of 2.3 Bln – No Coal!)



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Current Global Mercury Emissions

- Total of Natural, Anthropogenic & Oceanic = 5500 tons
- U.S. Anthropogenic = 158 tons (2-3%)
- U.S. Power Plants = 48.6 tons (<1%)
- Geologists' Anecdote: 1 Volcano Erupting…

Measurement of Hg Emissions

- Dispute Over Whether They Can Be (And Are Being) Measured Accurately
- SO_2 and NO_x Range 2-12 ***million*** tons/year
- Hg : 50 tons/yr (<1mm, <1k, <100)
- SO_2 and NO_x in Coal: lb./million Btu
- Hg in Coal: lb./trillion Btu
  (i.e., ***one-millionth*** the level of other pollutants)

But Isn't Mercury Poisoning Especially Bad?

- State of Hawaii – Continuous Simmering Volcanic Emissions + Occasional Eruptions … Why don't we hear about a lot of mercury deaths there ?

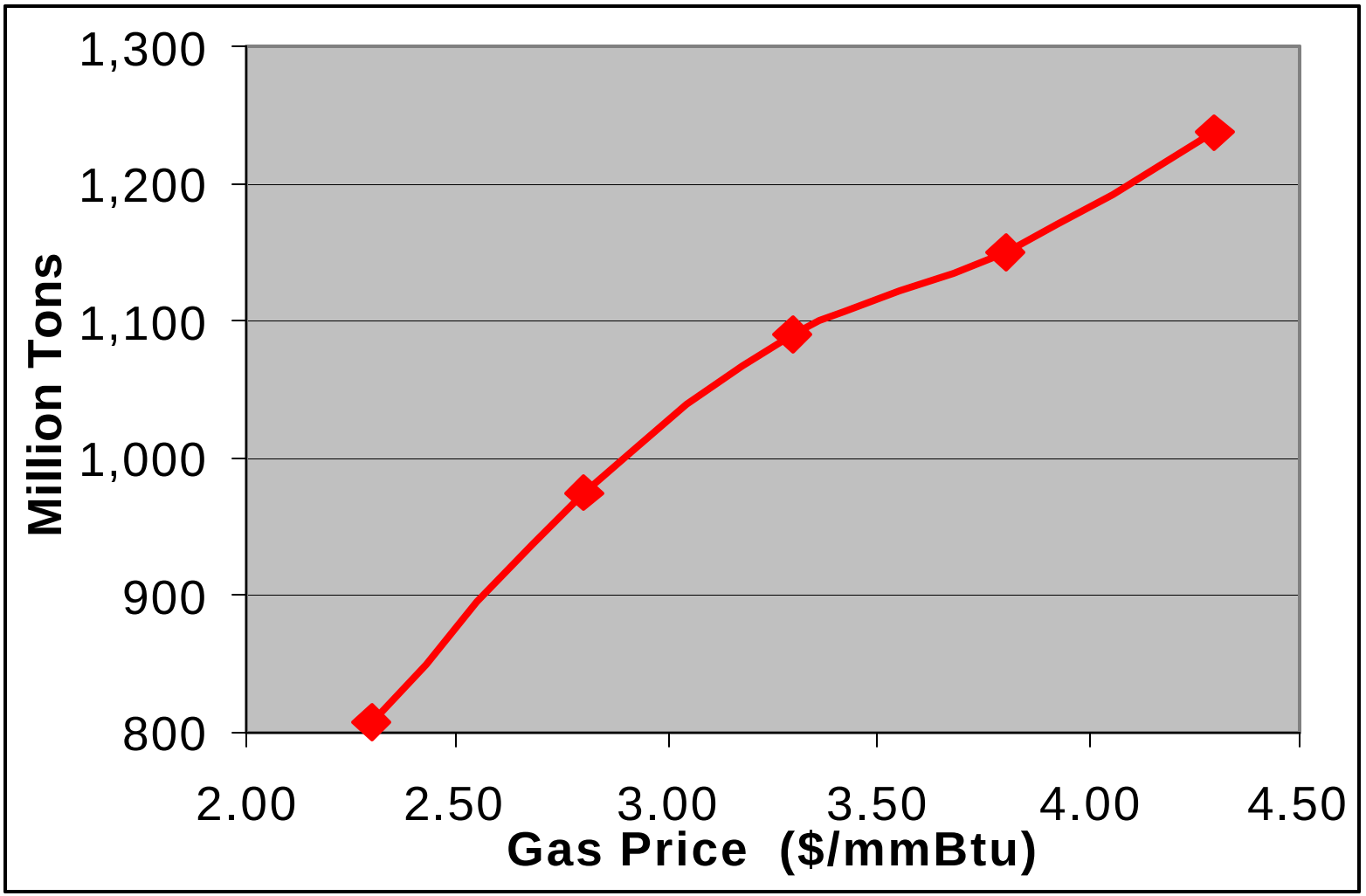
- EPA Administrator Browner's Official Basis:

"There is a ***'plausible link'*** between man-caused emissions of mercury and the ***possible*** bioaccumulation in the food chain and the ***possibility*** that the level could become high enough to adversely affect the health of women of childbearing age and young children."

Mercury Impact: Highly Volatile w/ Gas Prices

- Unlike CO_2 This Is Economic Trade-Off
  - A Brand-New Gas-Fired Combined Cycle Plant Simply Wins The Dispatch Competition vs Many Coal-Fired Plants
  - The Balance Point Changes, Obviously, With Natural Gas Price

Hg-Surviving Coal vs Gas Price



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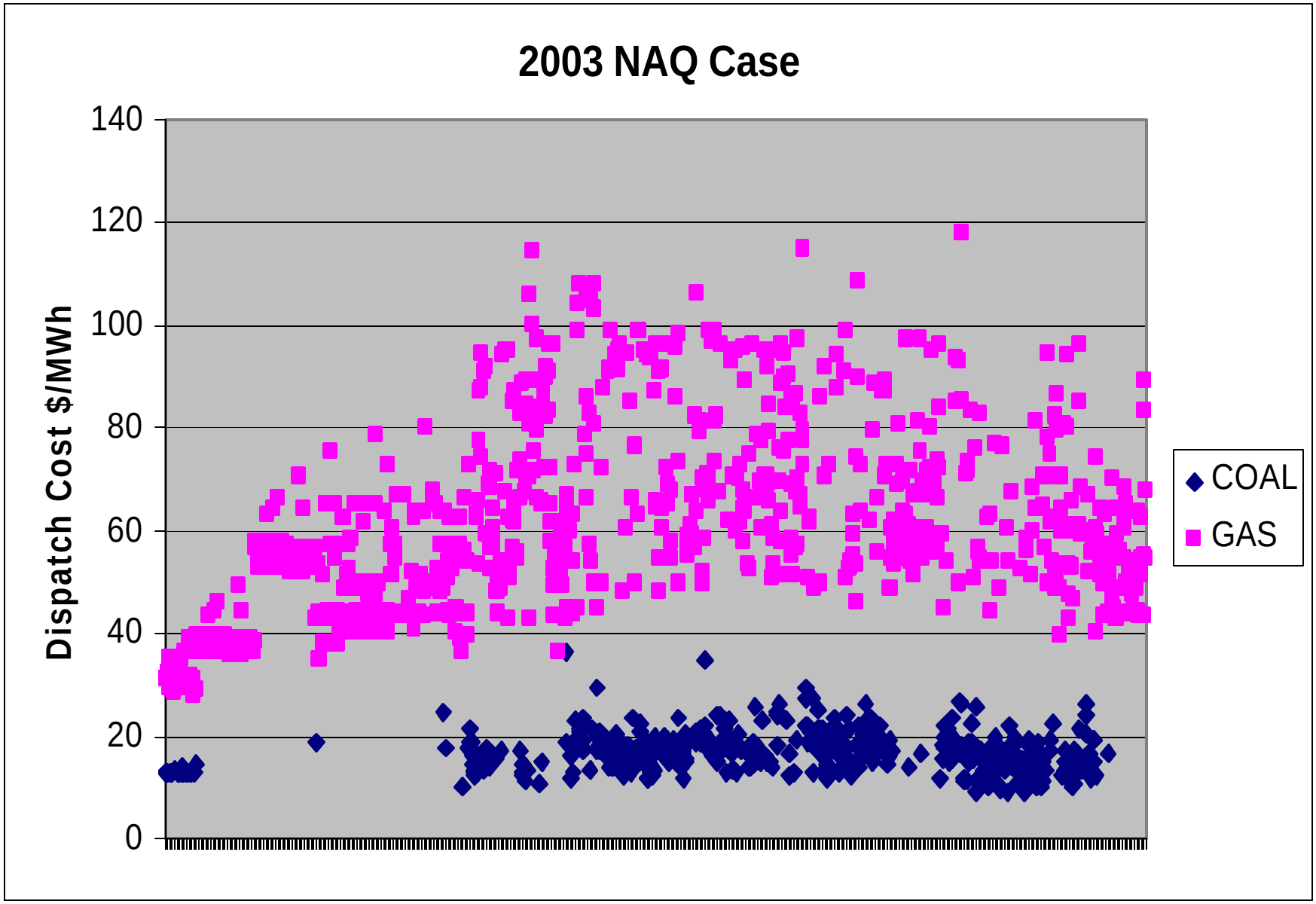
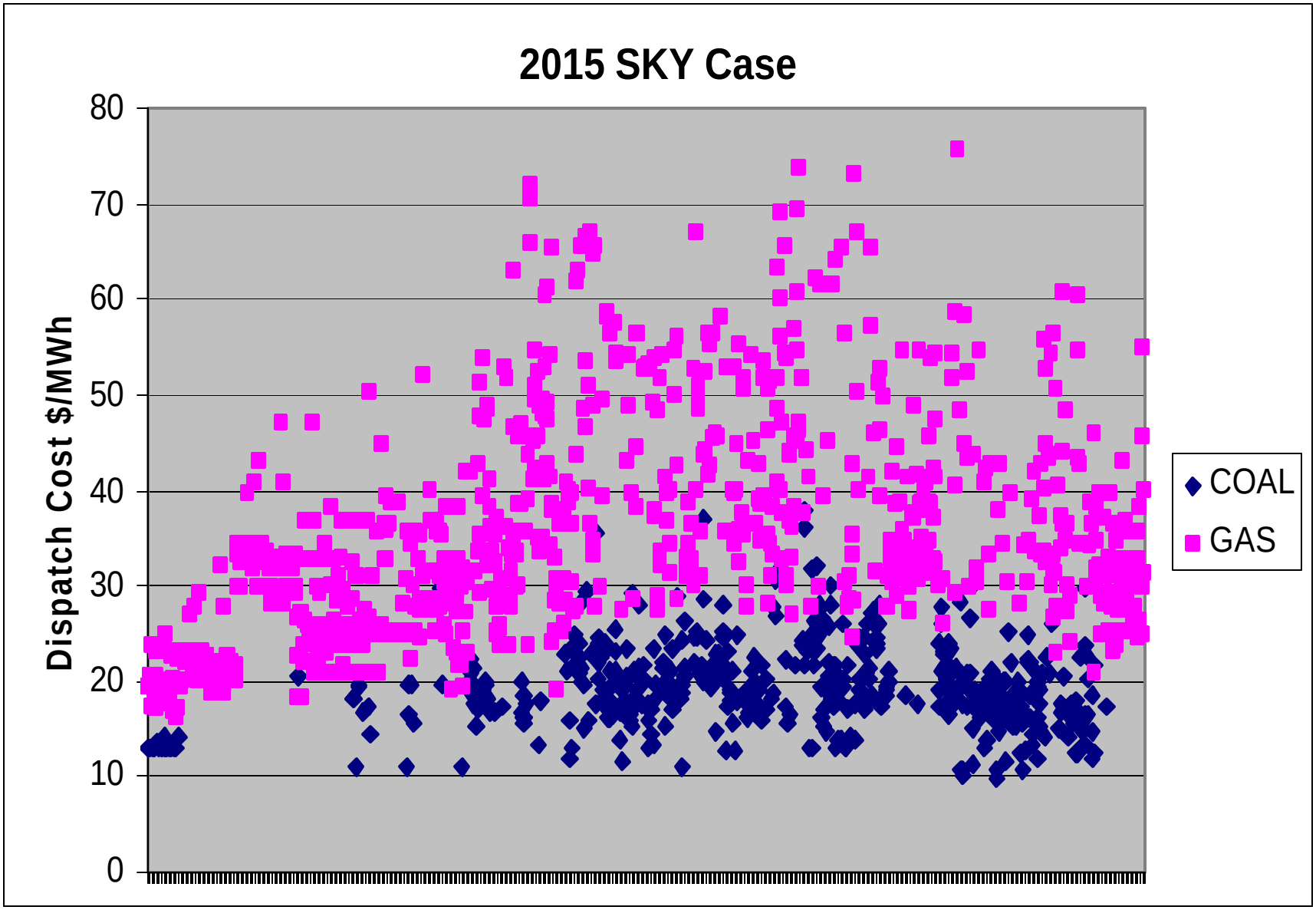
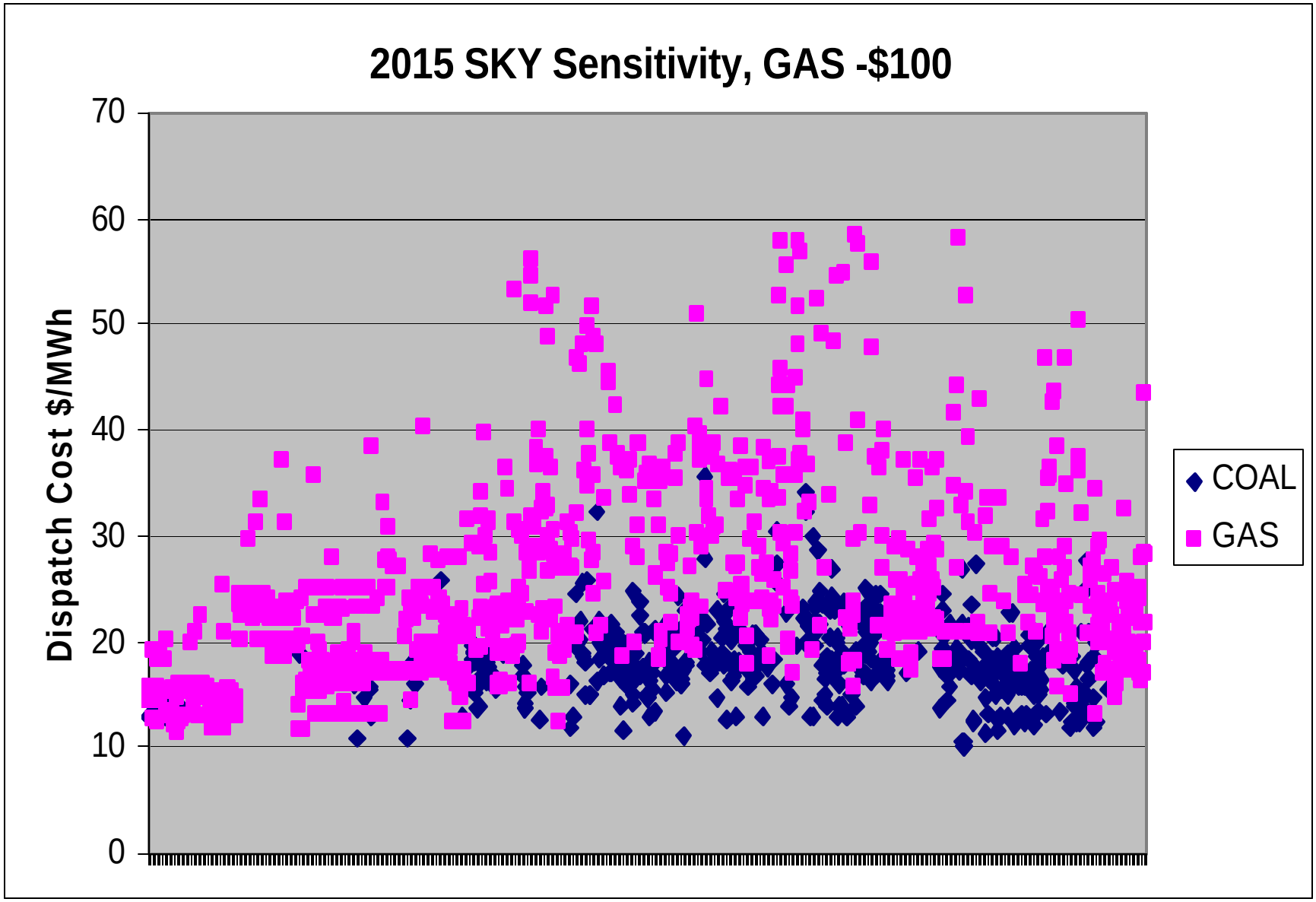

2003 NAQ Case
Dispatch Cost $/MWh
140
120
100
80
60
40
20
0
COAL
GAS


2015 SKY Case
Dispatch Cost $/MWh
80
70
60
50
40
30
20
10
0
COAL
GAS


2015 SKY Sensitivity, GAS -$100
Dispatch Cost $/MWh
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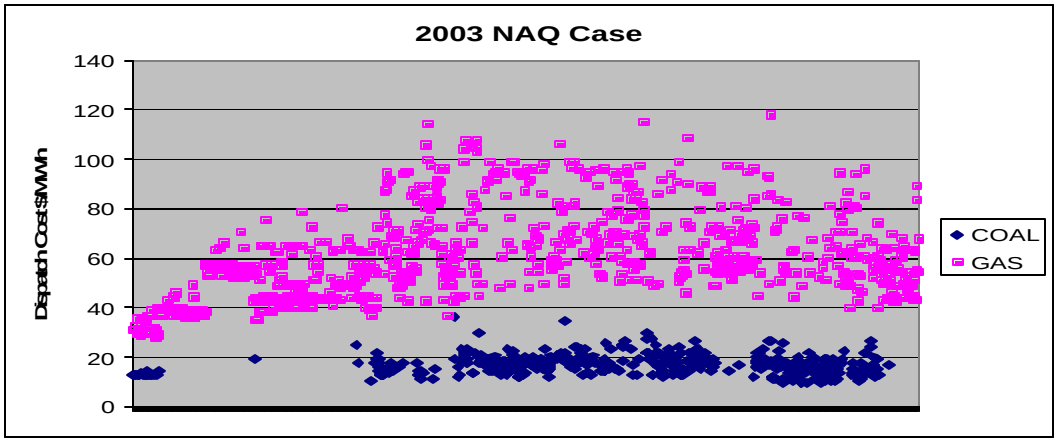
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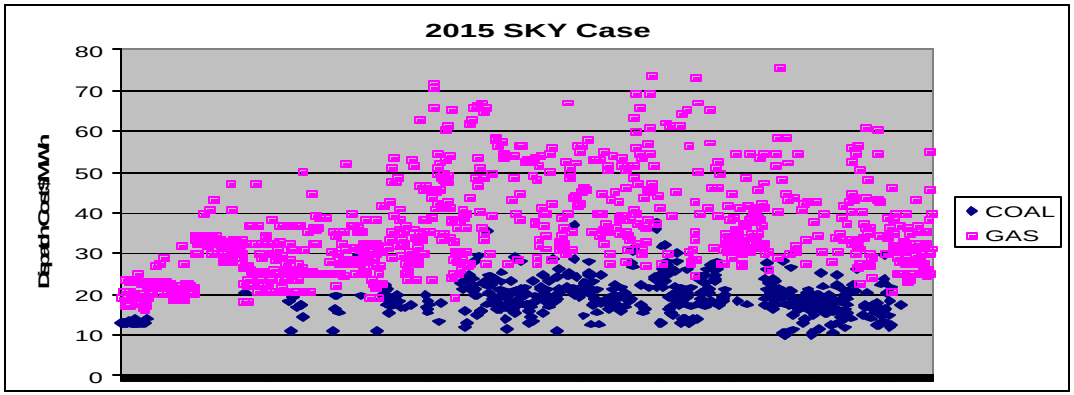
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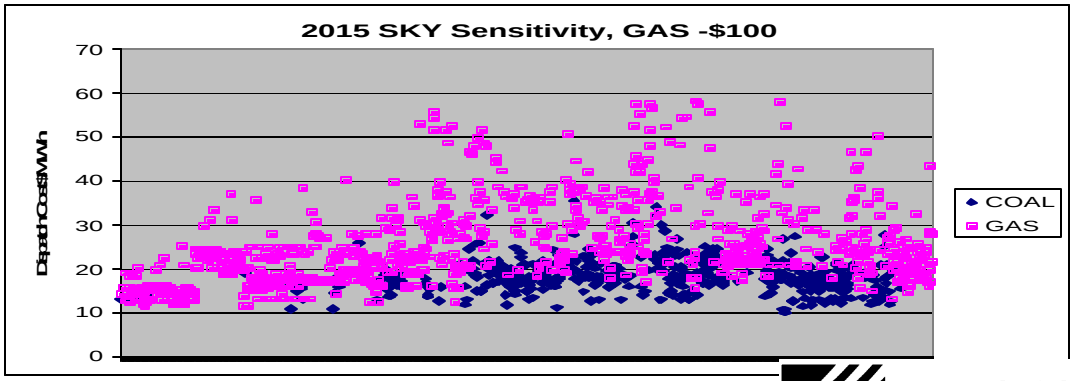
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30
20
10
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COAL
GAS

What's The Point Here On Mercury?

- Don't Focus As Much On The Single "Correct" Answer As On The RISK!
  - If Supply/Demand Balance For Natural Gas Shifts (Drilling, LNG, Trans-AK and/or Trans-Canada Pipeline, etc), Then Much Of Coal Industry Gets **Killed** Under Hg Limits
  - Remember, U.S. Utilities' Hg Is Less Than 1% Of The Global Atmospheric Load !!!

But Coal Tonnage Alone Doesn't Tell The Whole Story

- Mercury Allowance Price of About $150,000 per lb. X 52,000 lb = $7.8 bln

- In Fact, For 2010:
  - NAQ Sum (Mwh * Disp_Cost) = $92 bln
  - SKY Sum (Mwh * Disp_Cost) = $78 bln

($14 billion per year extra cost to generate)

Other Risks Not Shown By Our Modeling

- We Traditionally Choose To Use Identical Electric Demand Across Scenarios (i.e., No Price Elasticity of Electric Demand)
  - Utility Generation Would Suffer At These Levels
  - U.S. Economy Would Get A Huge "Hit"

- Our Models Are Currently Set Up To Assume Any Gas Infrastructure Needed Would Arrive
  - But Carper Case (w/ CO_2Lim.) Goes To 42 TCF !

CONCLUSIONS

- Our Models Aren't Perfect, But We Are Probably Getting Closer Than Many Others (especially Government analyses)

- The Threat Is Real! (and Risk Affects Capital Availability)

- Key Decision-Makers Are Starting To Realize This May Be An Unacceptable Risk

BACKUP SLIDES

Some Mercury Technology

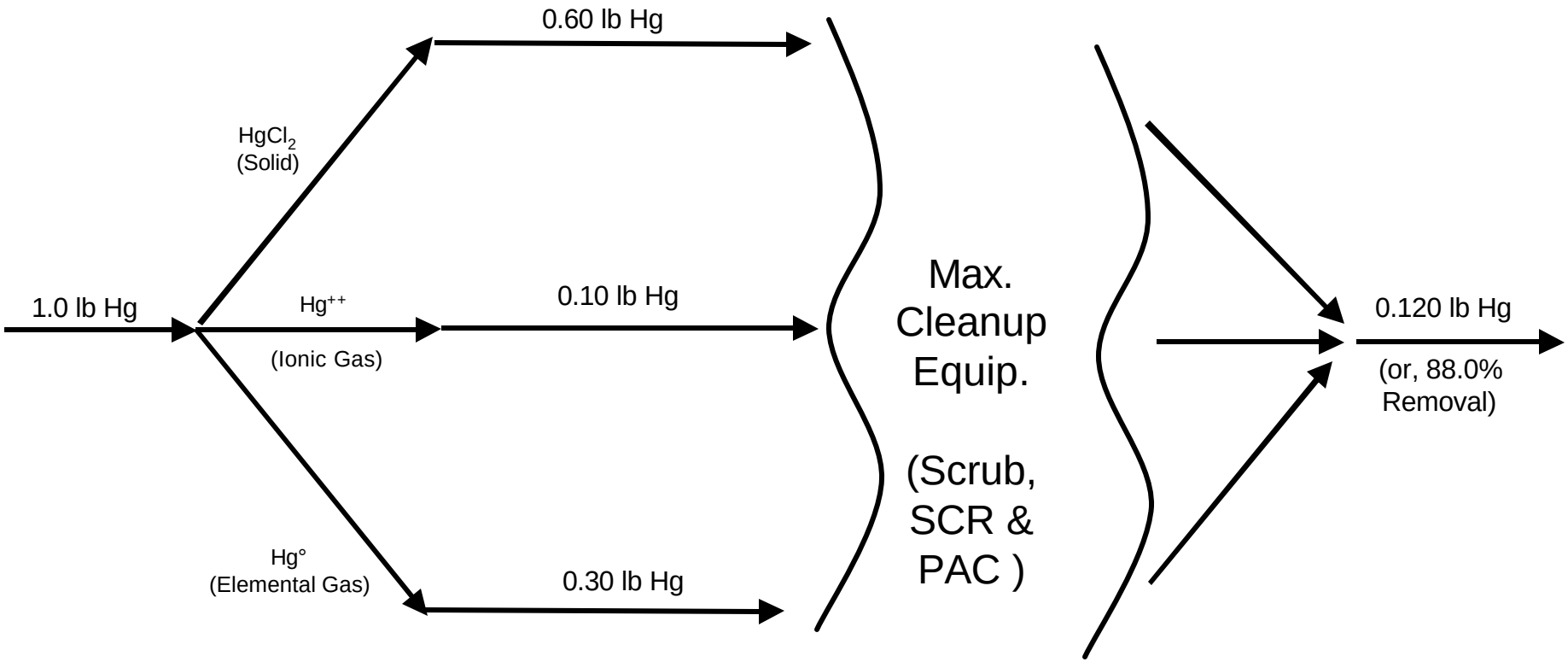
- 3 Forms of Mercury (Hg)
  - Elemental (gas at boiler temperatures) – Hg^{o}
  - Ionic (gas) – Hg^{++}
  - Solid Particles (Predominantly $HgCl_2$)

- 2 Forms of Capture
  - Gaseous Hg adsorbed onto porous particles (PAC), then collected with ESP's or Bag Houses (PM collection)
  - The predominant Hg solid compounds are soluble in wet scrubber solutions & captured by wet FGD

- Elemental Hg is hardest to capture, but can be oxidized to Ionic (belief that SCR promotes this)
  - PRB coal high in elemental form

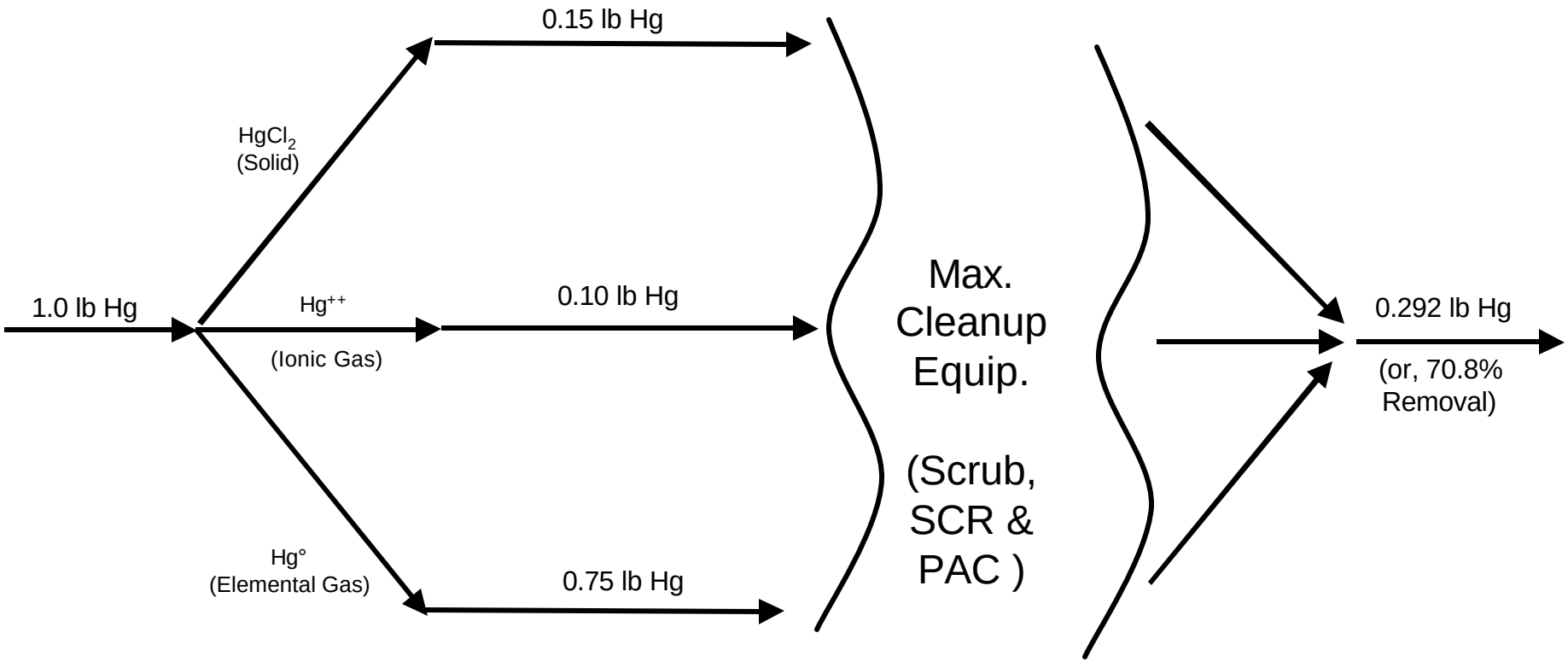
Eastern Bituminous Coal – Mercury Modeling

(1.0 lb Hg Basis)

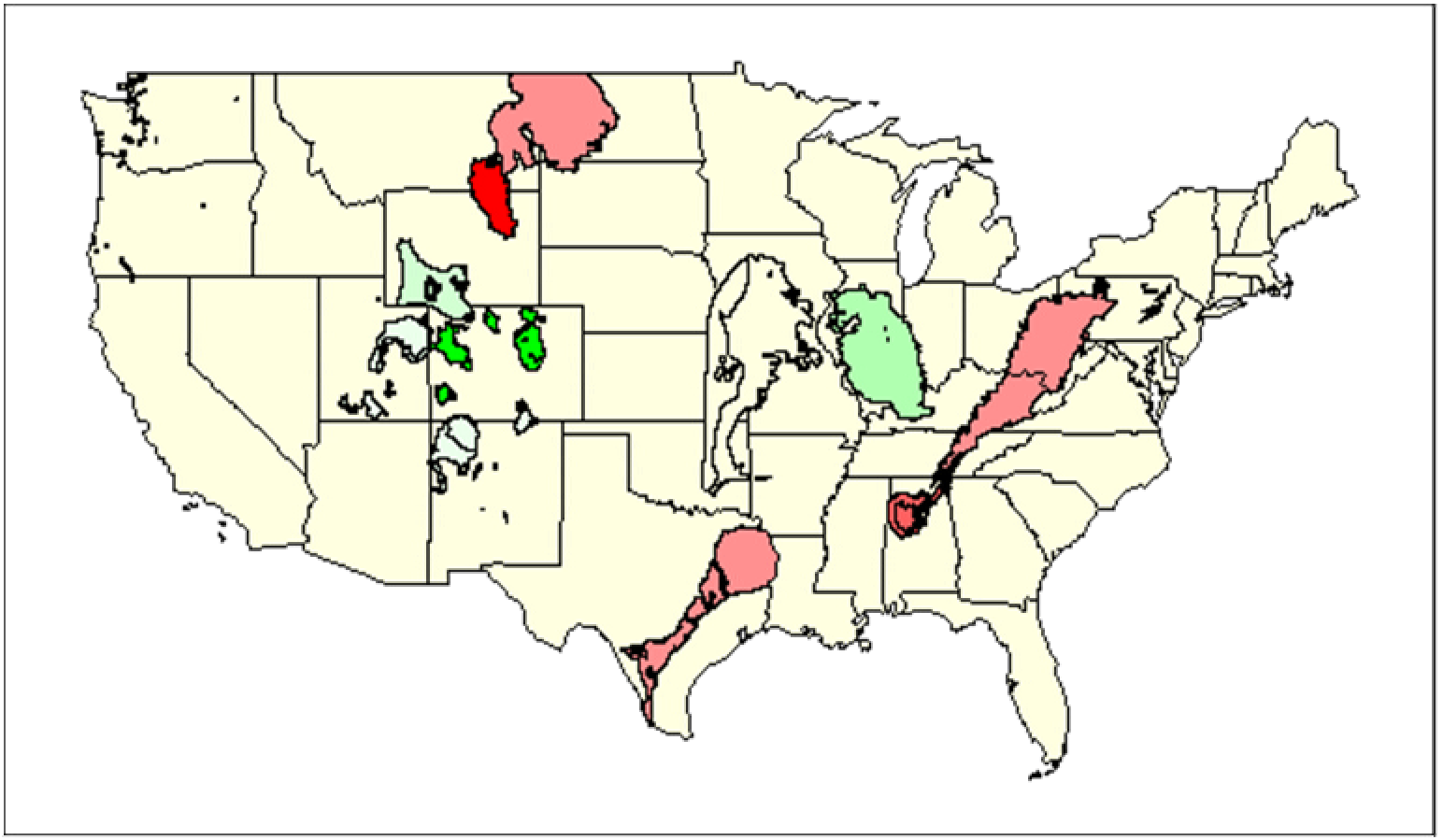


PRB Coal – Mercury Modeling

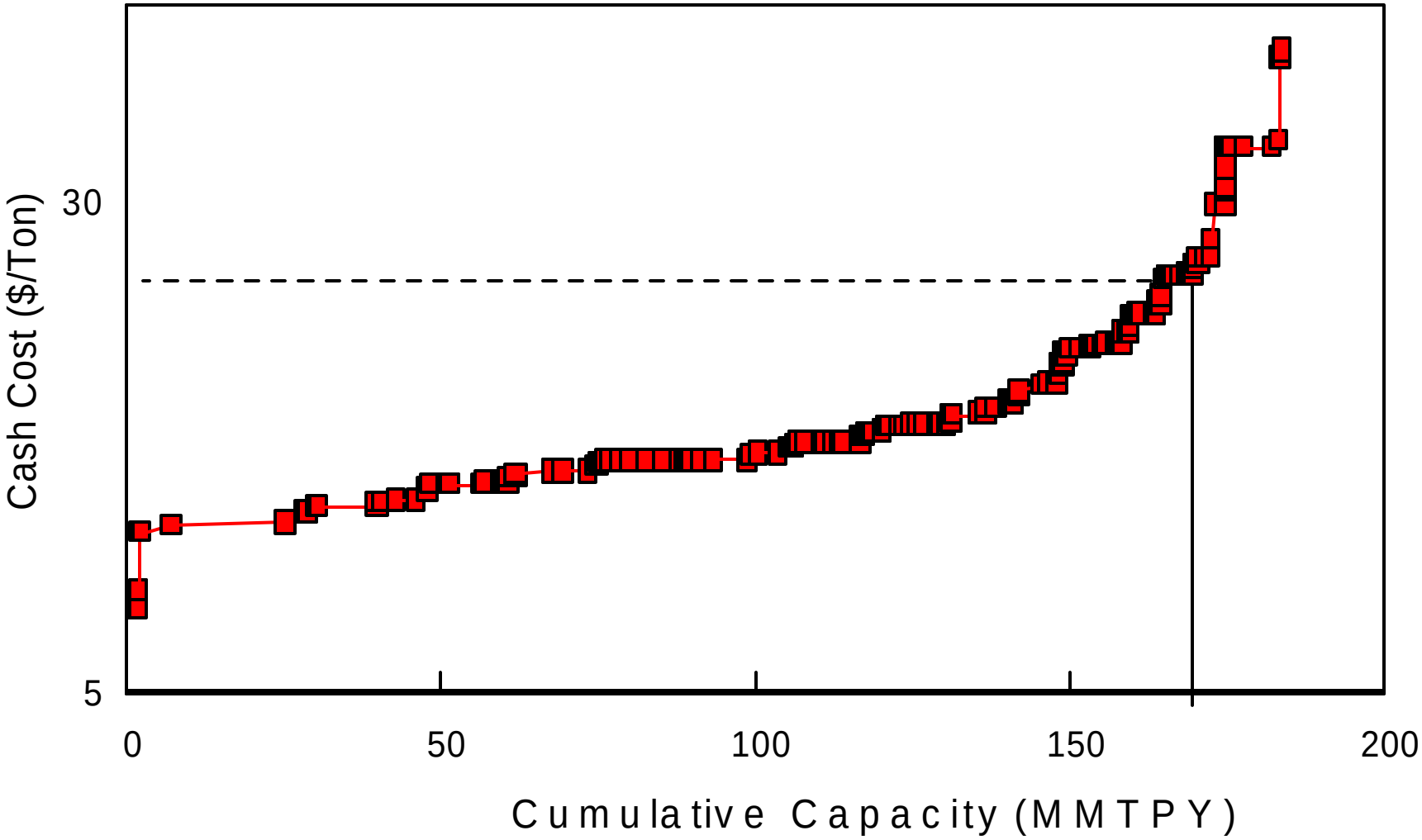
(1.0 lb Hg Basis)



Coal Basins Losing/Gaining Tonnage via Mercury Limits



Generic WV All Mines Cost Curve



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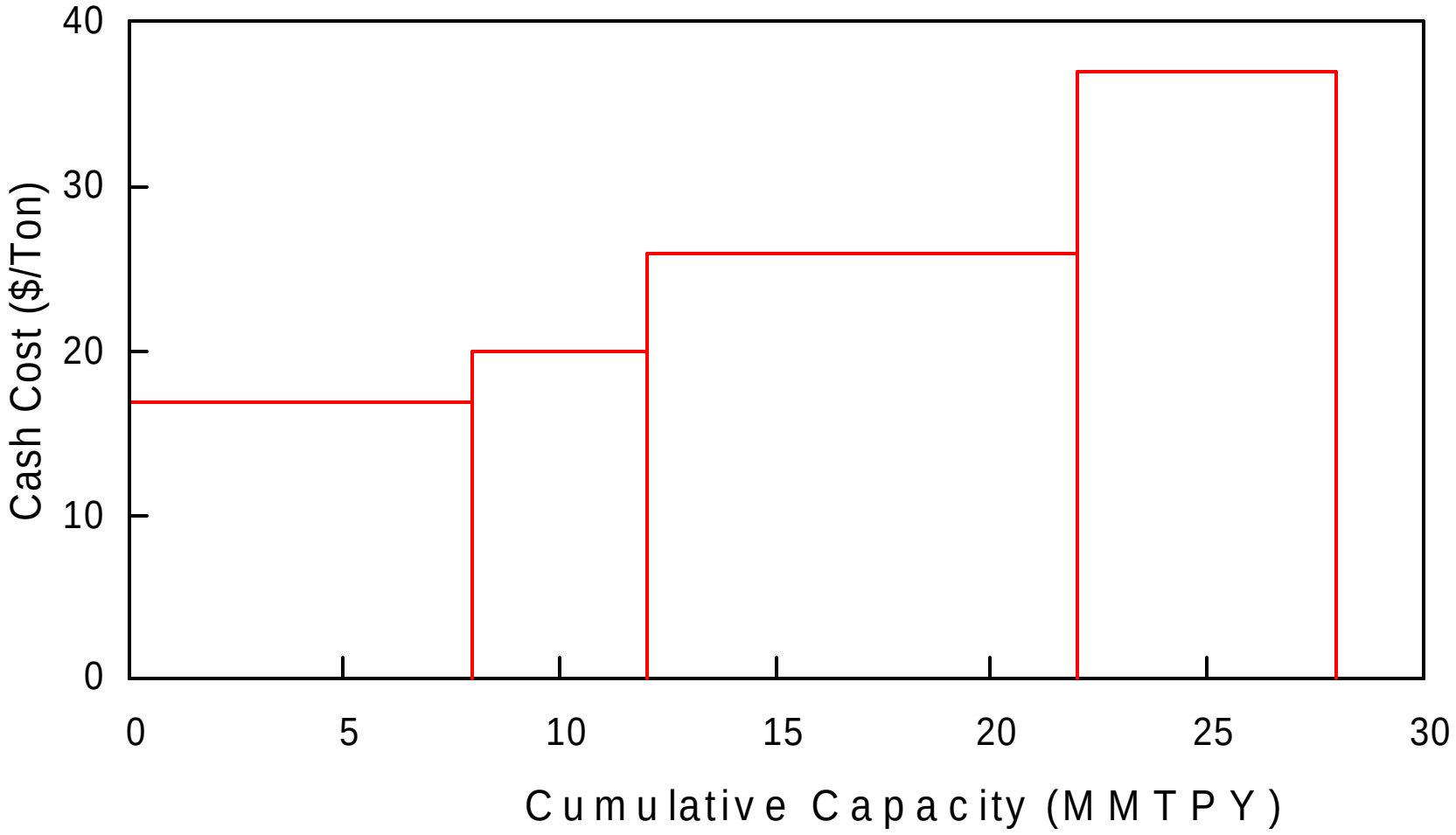
Simplified Generic Cost Curve



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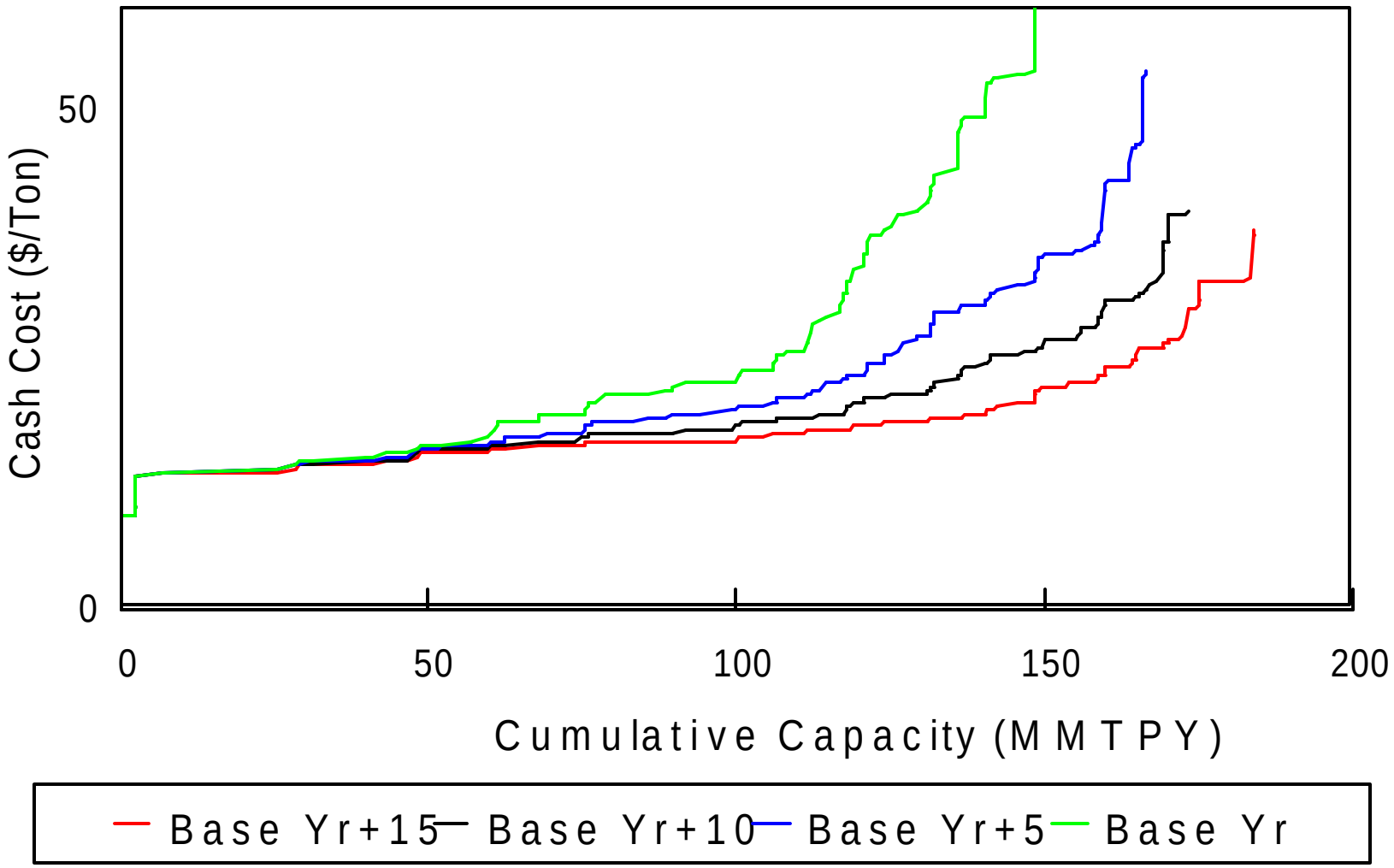
Cost Curve Movement Over Time



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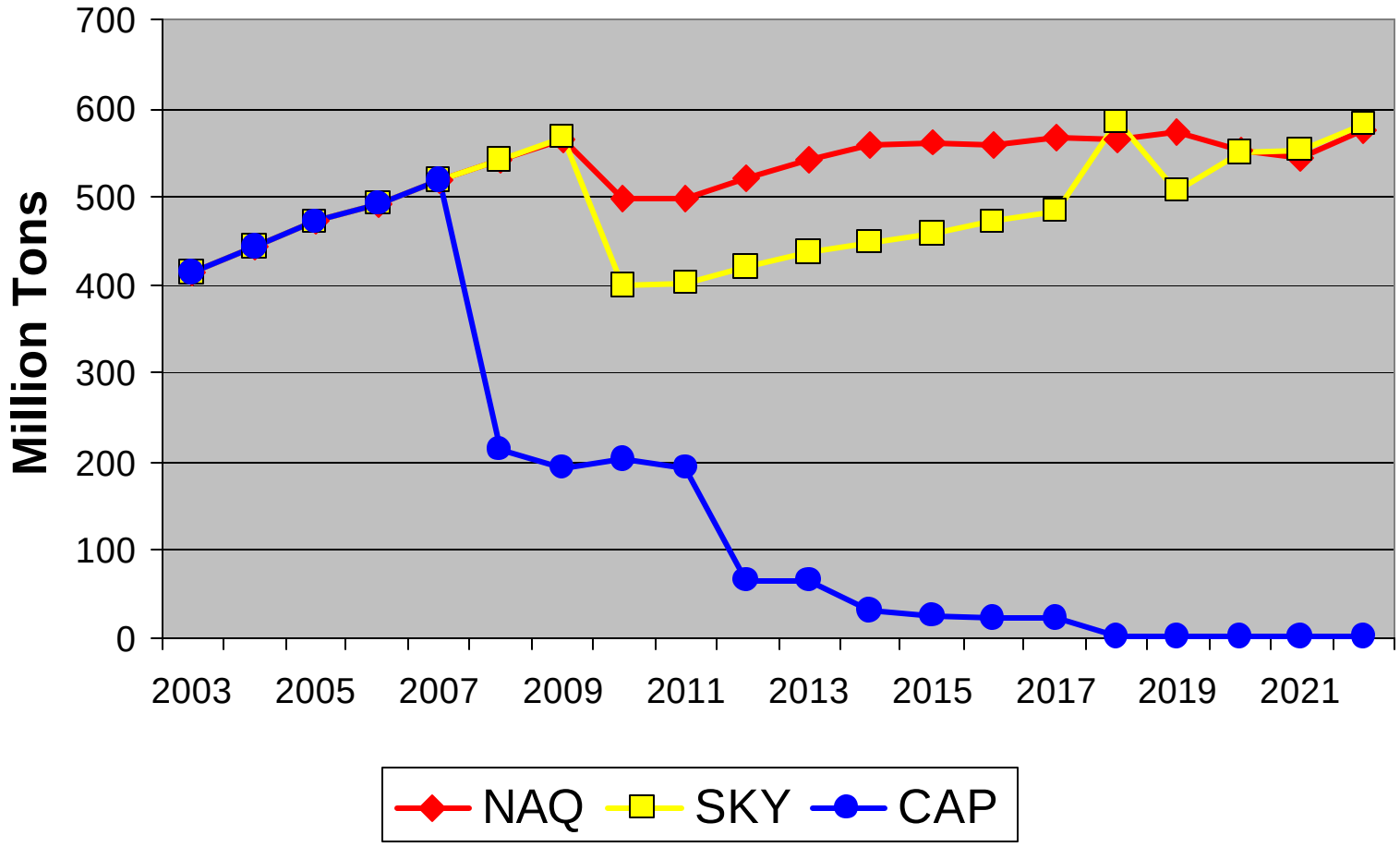
Powder River Basin
Coal Production



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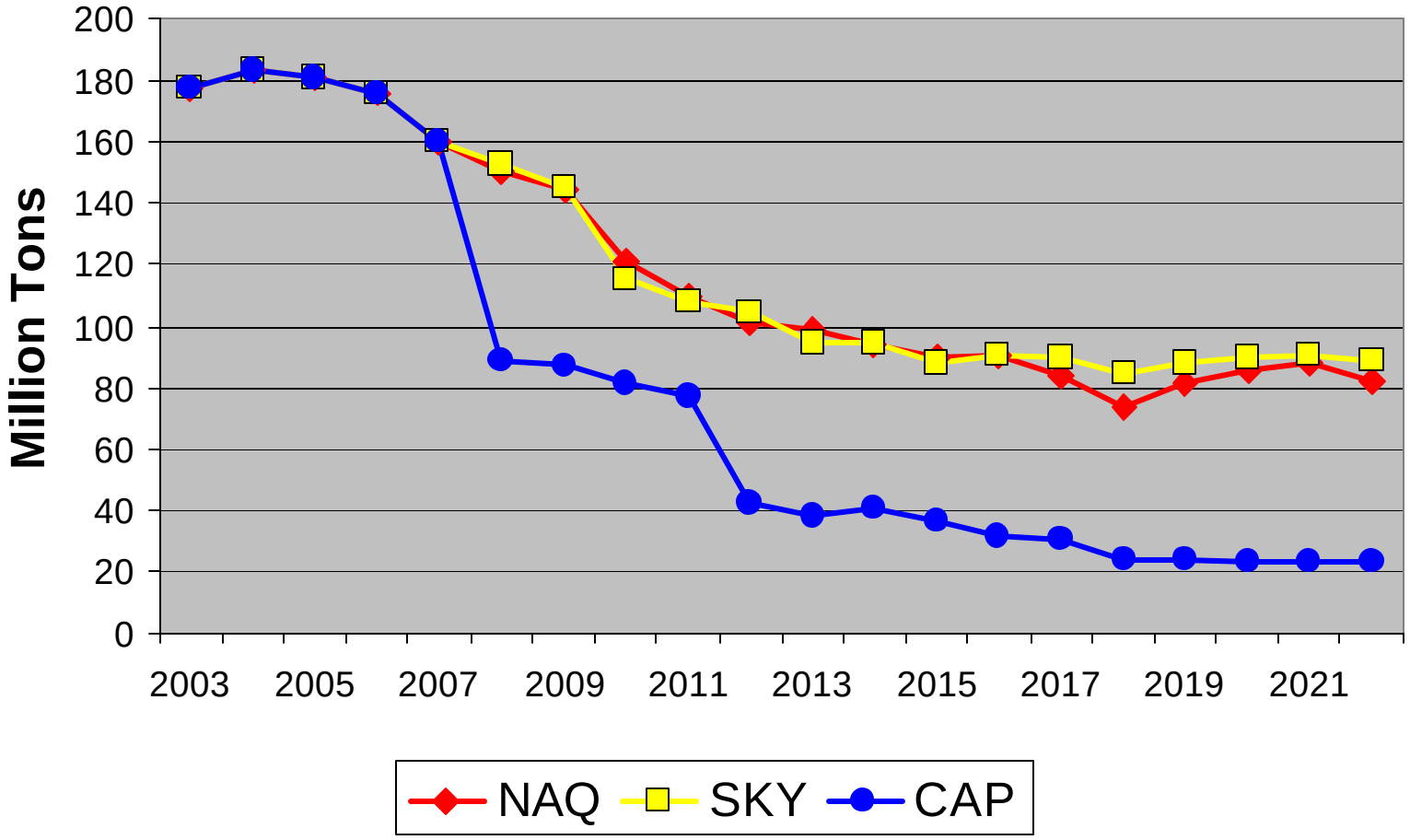
Central Appalachia Coal Production



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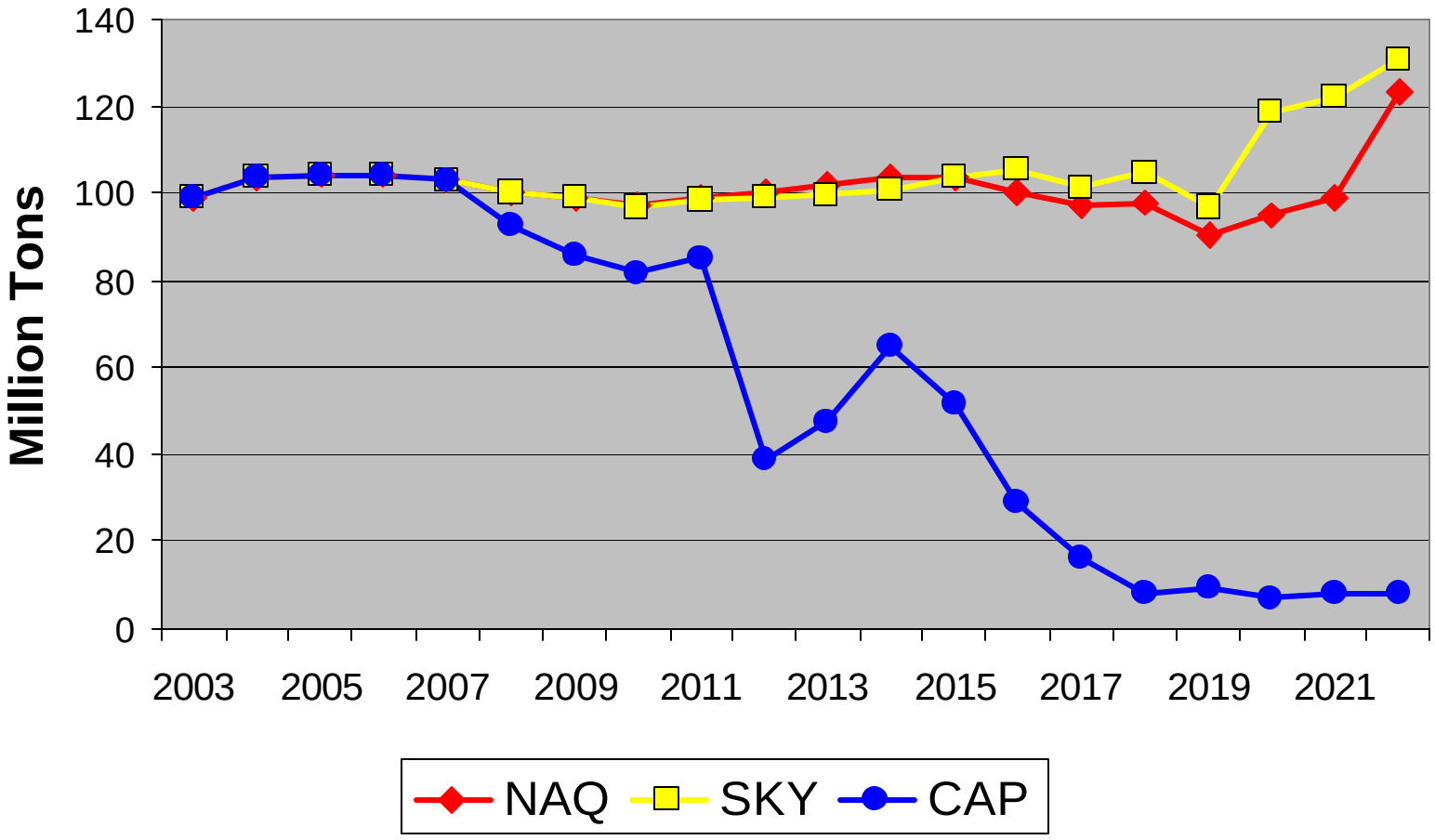
Illinois Basin
Coal Production



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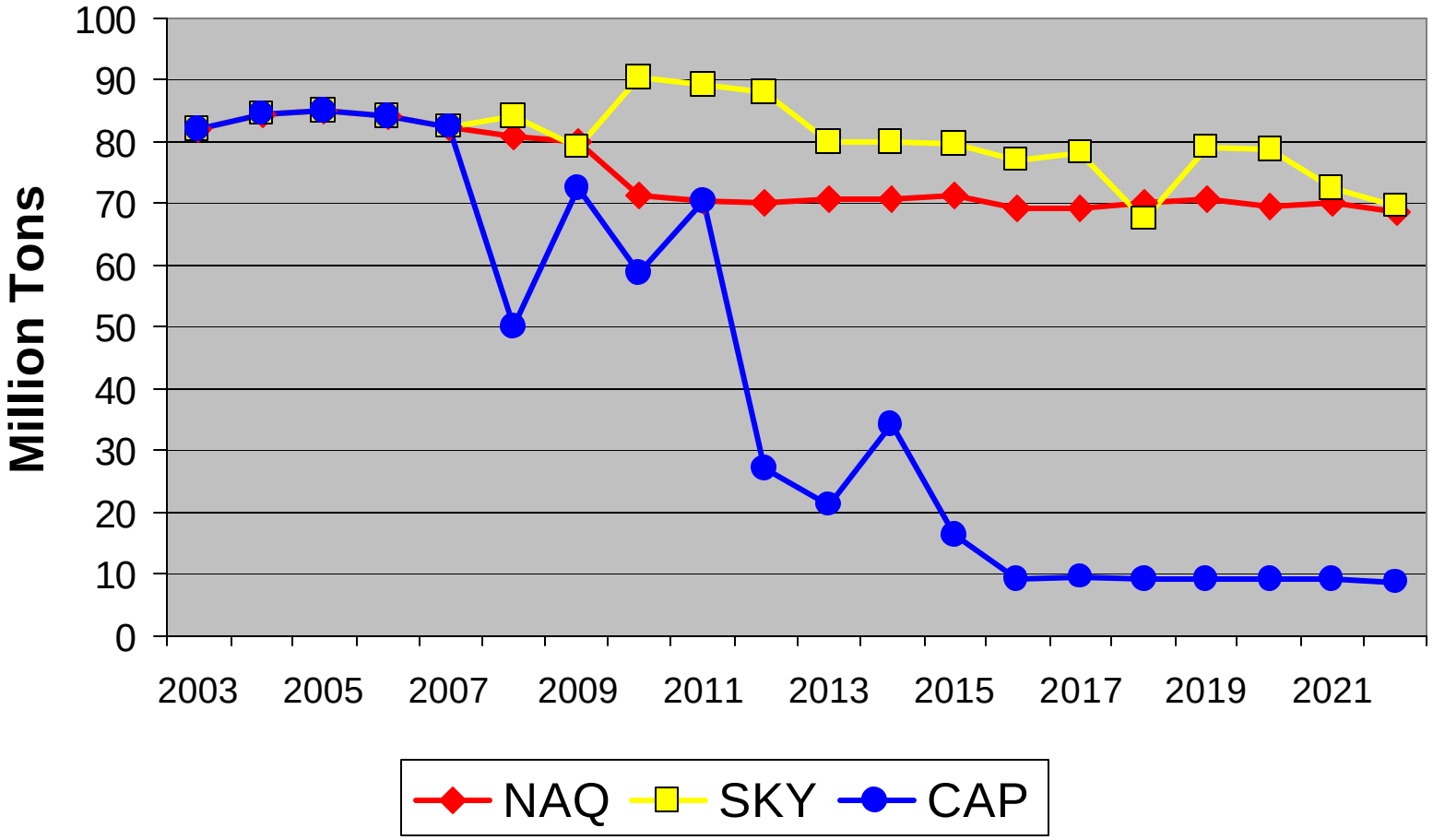
Colorado, Utah, New Mexico Coal Production



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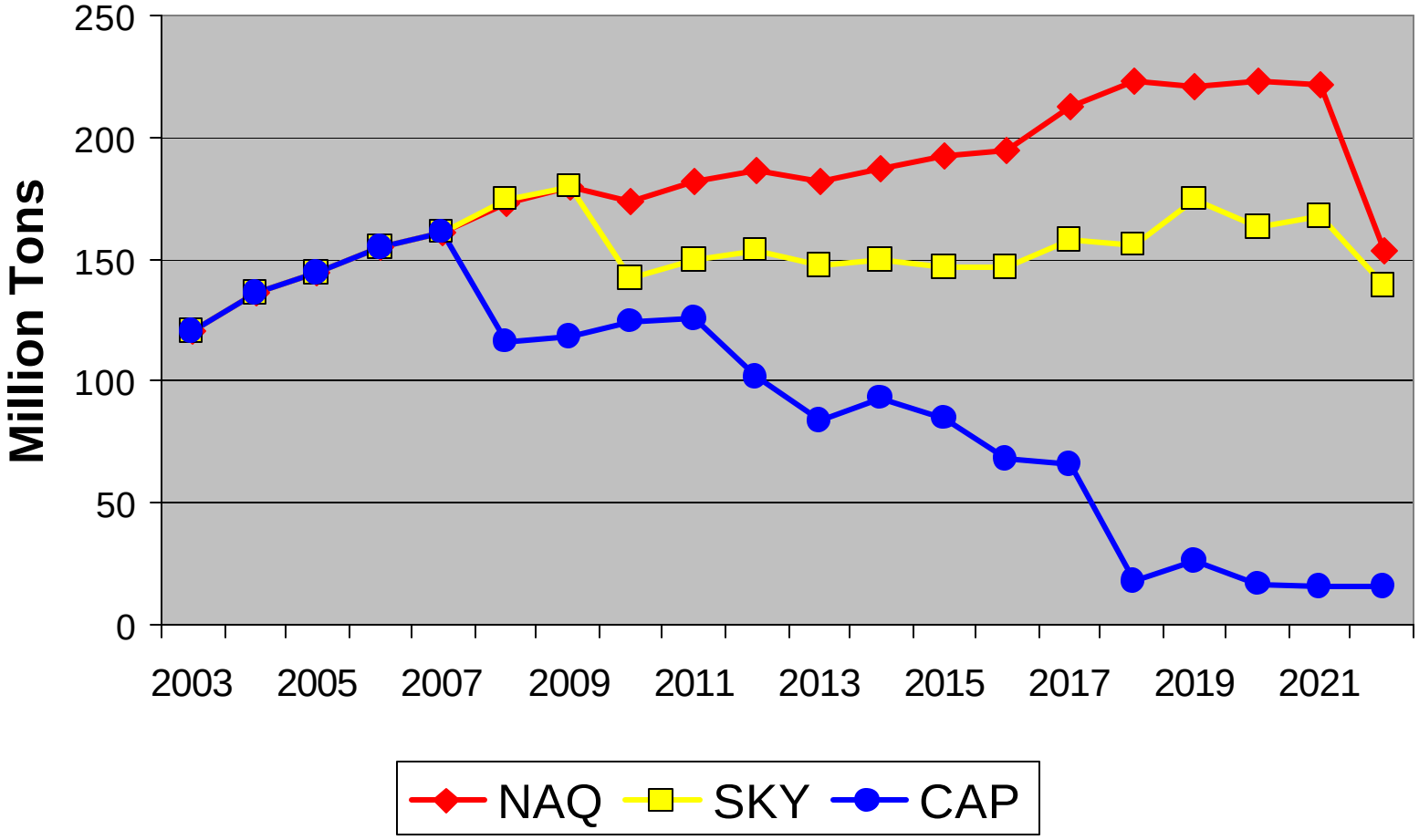
Northern Appalachia Coal Production



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