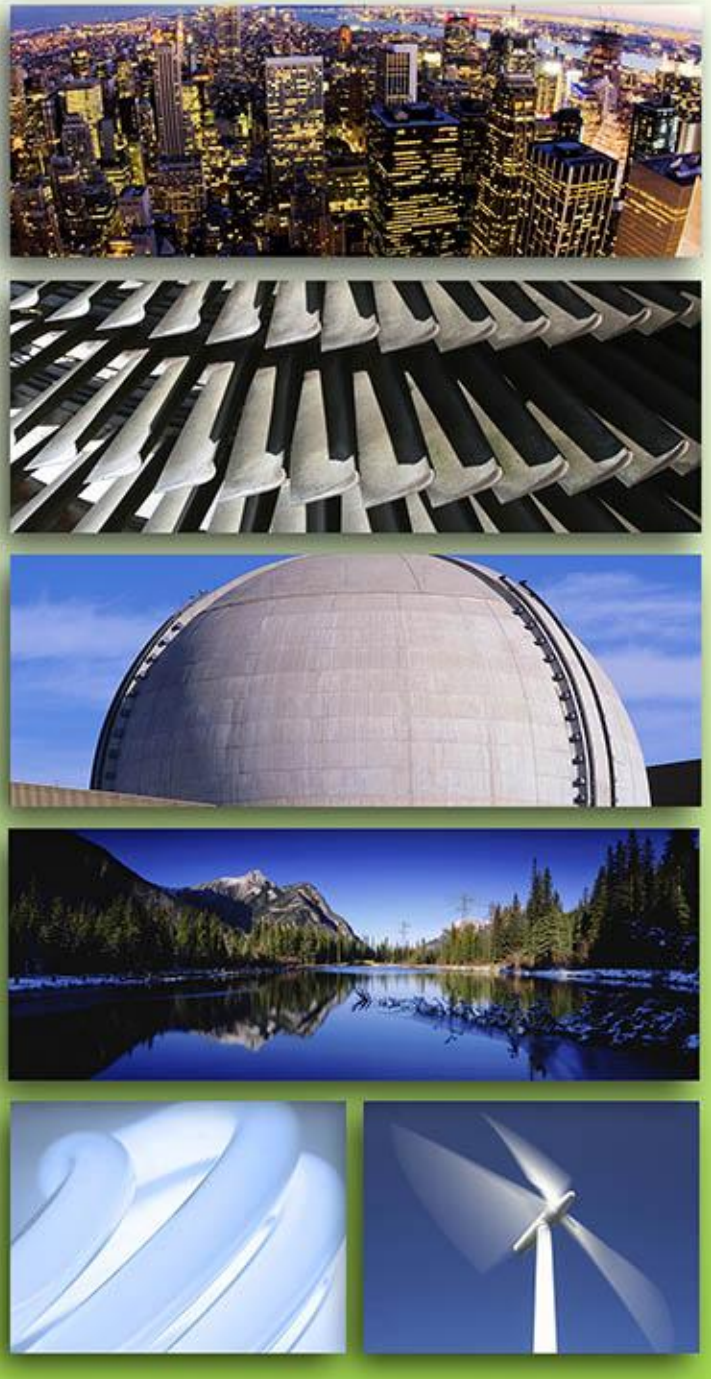

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Impact on CO_2 Price Expectations on Electric Generation Investment in the U.S.

Victor Niemeyer
Technical Executive

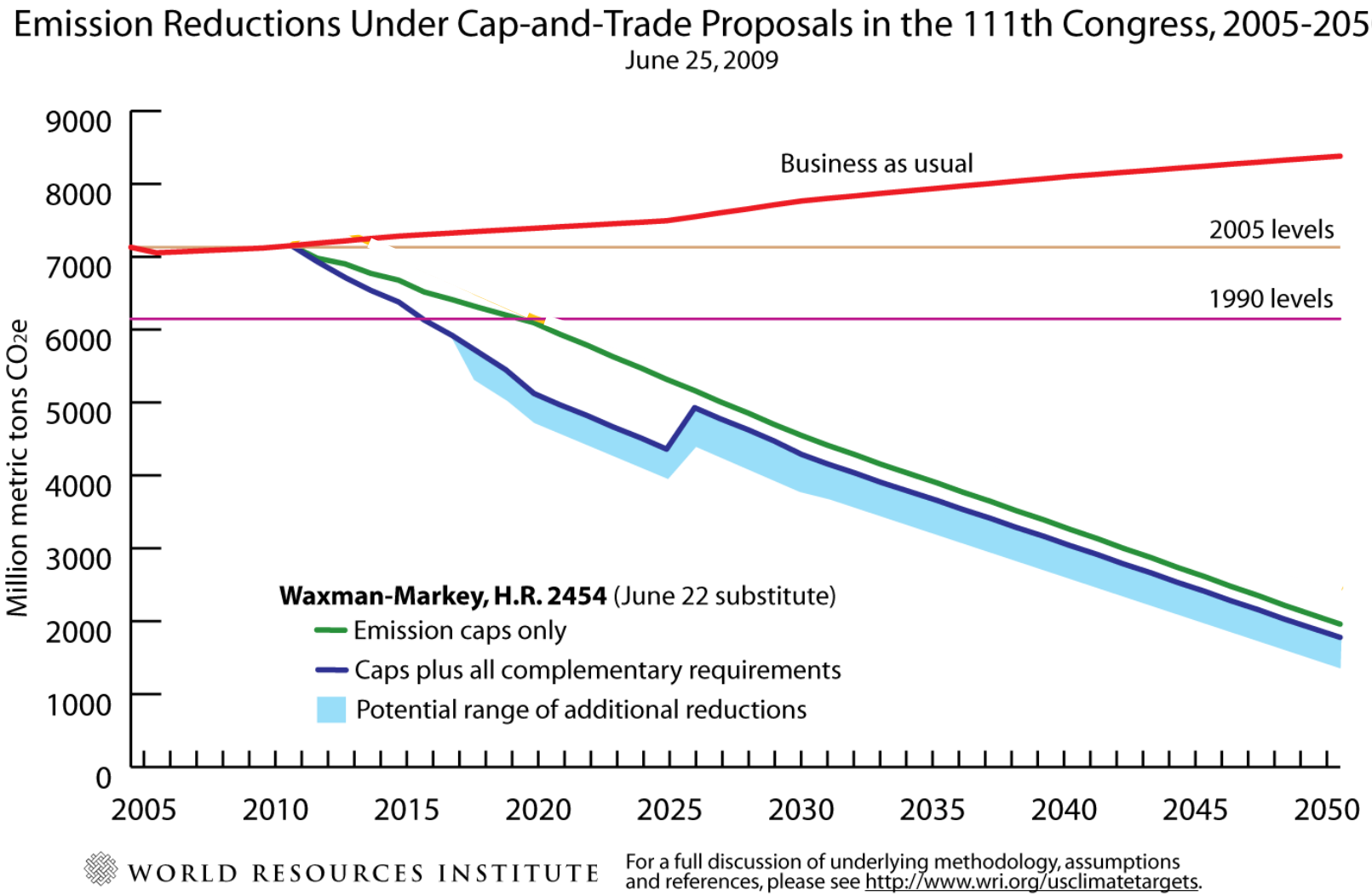
9th Annual Workshop on GHG Emission Trading
September 14, 2009

Outline

- Developing price expectations

- Implications for investment decisions to retrofit existing coal plants to cut SO_2, NOx, and Hg

Waxman-Markey Passed House 219-212 on June 26th: Seeks to Cut CO_2 Emissions Well Below Historic Levels



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Electric Sector is Major Source of CO_2 Emissions

Electric sector's share of national total (2006)

- 33% of total GHGs
- 39% of total CO_2

Shares within the electric sector CO_2

- 15% from natural gas ($6/MMBtu)
- **83% from coal ($1.5/MMBtu)**

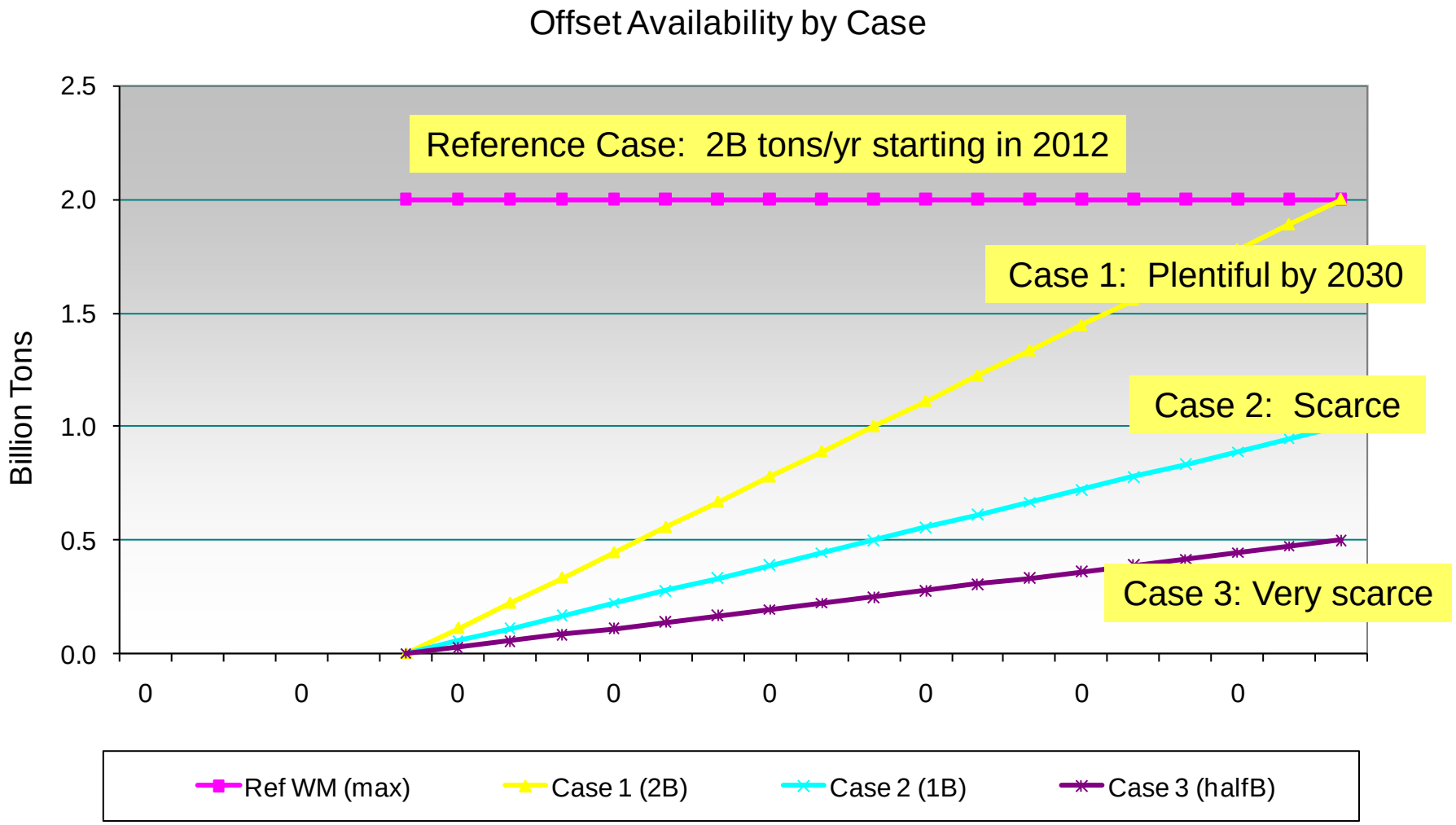
Private NEMS Analysis for PacifiCorp Provides Insights on CO_2 Prices Under Waxman-Markey

- Preliminary NEMS results courtesy of PacifiCorp, a subsidiary of MidAmerican Energy Holdings Company
- NEMS (National Energy Modeling System) used by EIA for AEOs (Annual Energy Outlooks) and policy analyses
  - Lieberman-Warner (2008)
  - Waxman-Markey (2009)
- NEMS and AEO 2009 publicly available from EIA
- EPRI applied model to represent Waxman-Markey on behalf of PacifiCorp
  - PacifiCorp assumptions on power plant costs (2008)
  - PacifiCorp/EPRI team set scenarios

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

ELECTRIC POWER RESEARCH INSTITUTE

Analysis Highlights Critical Role of Offset Availability Assumptions for Waxman-Markey



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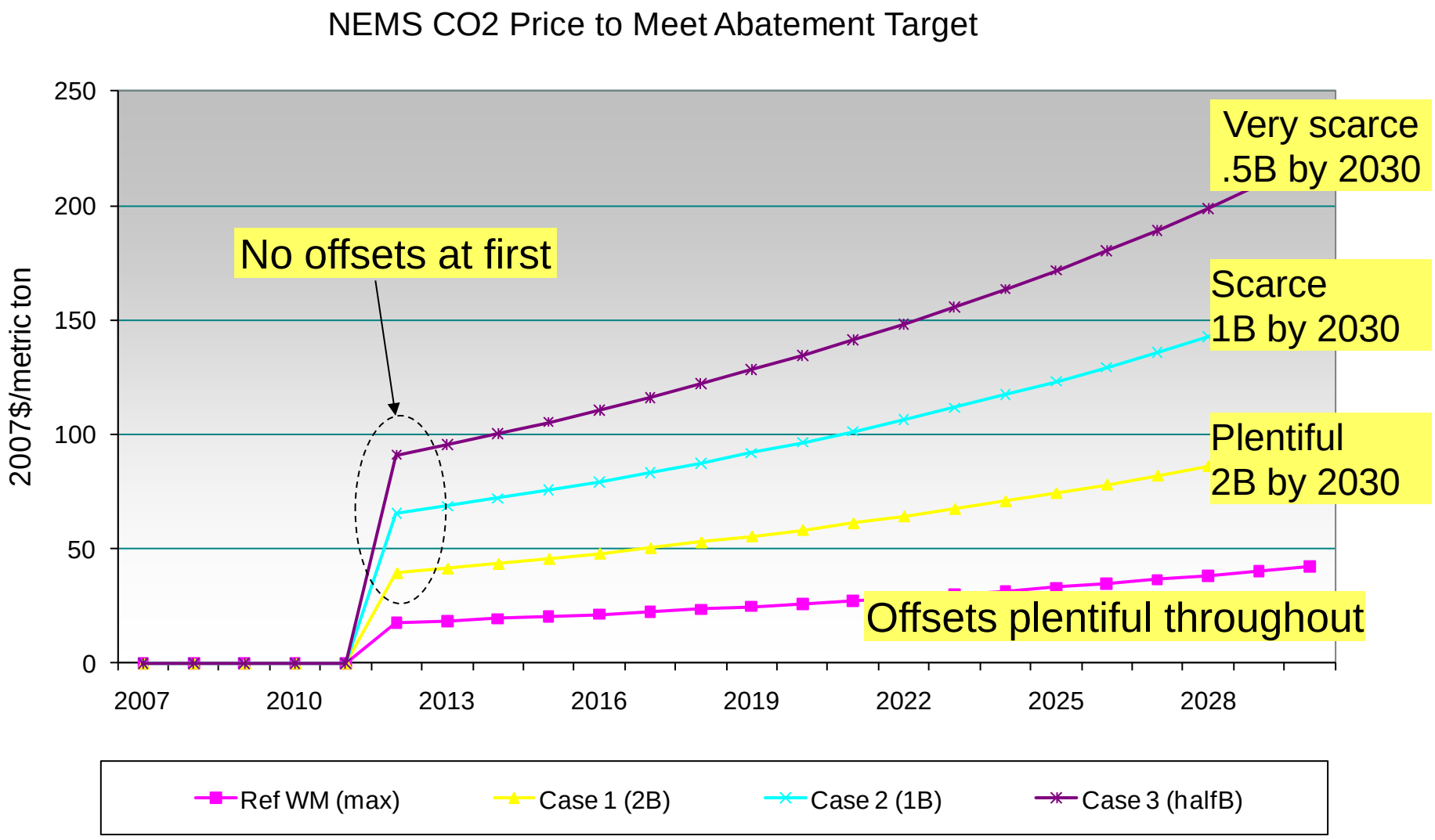
Results Highlight Critical Importance of Offset Availability for CO_2 Price



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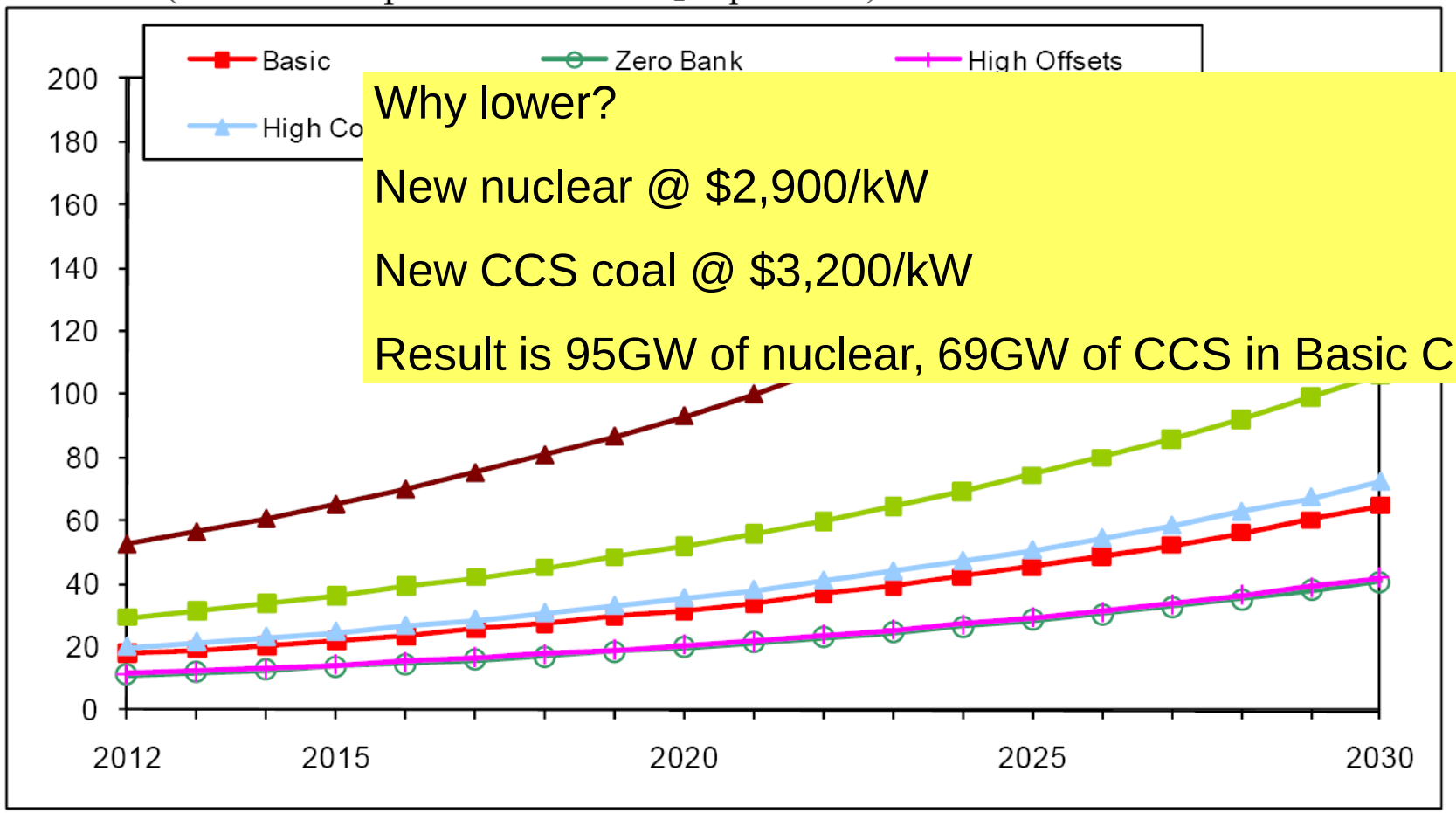
EIA and PacifiCorp-EPRI Results Differ Due to Scenario and Generation Cost Assumptions

Figure 5. Projected Allowance Prices in ACESA Main Cases, 2012-2030

(2007 dollars per metric ton CO_2-equivalent)



Why lower?

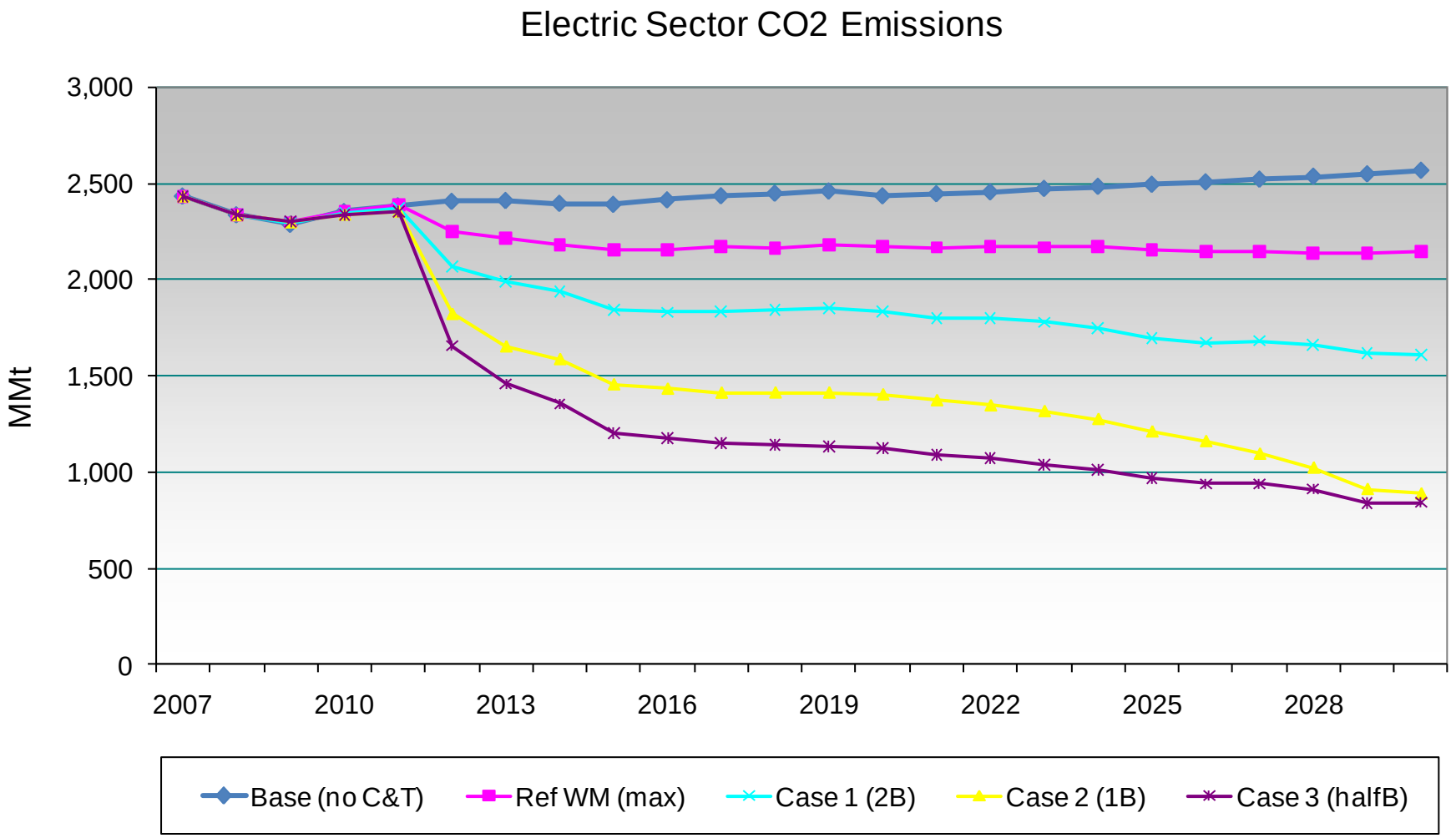
New nuclear @ $2,900/kW

New CCS coal @ $3,200/kW

Result is 95GW of nuclear, 69GW of CCS in Basic Case

Source: National Energy Modeling System runs, HR2454CAP.D072909A, HR2454NOBNK.D072909A, HR2454HIOFF.D072909A, HR2454HC.D072909A, HR2454NOINT.D072909A, and HR2454NIBIV.D072909A.

Electric Sector CO_2 Emissions Fall Dramatically When Offsets are Limited



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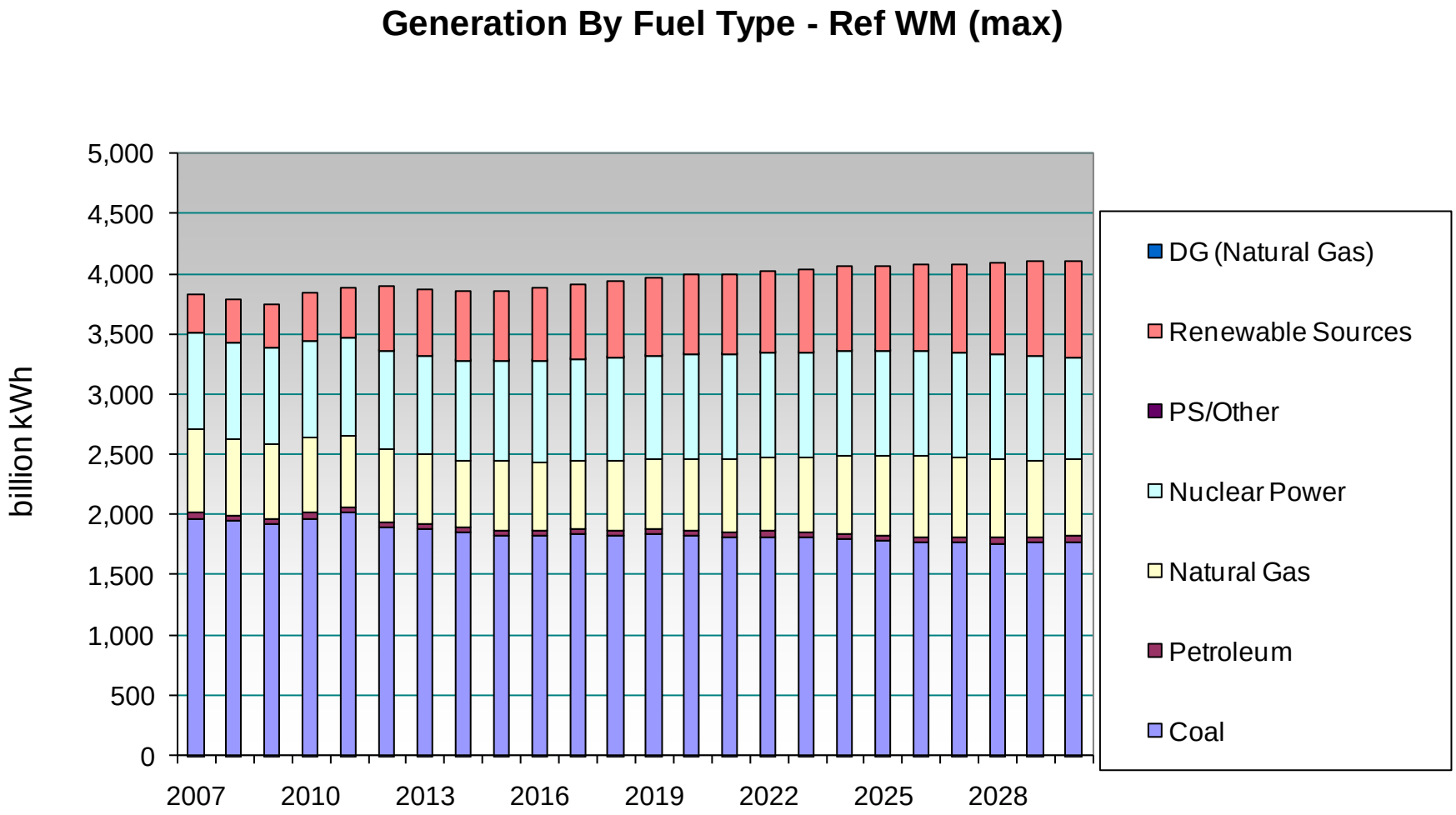
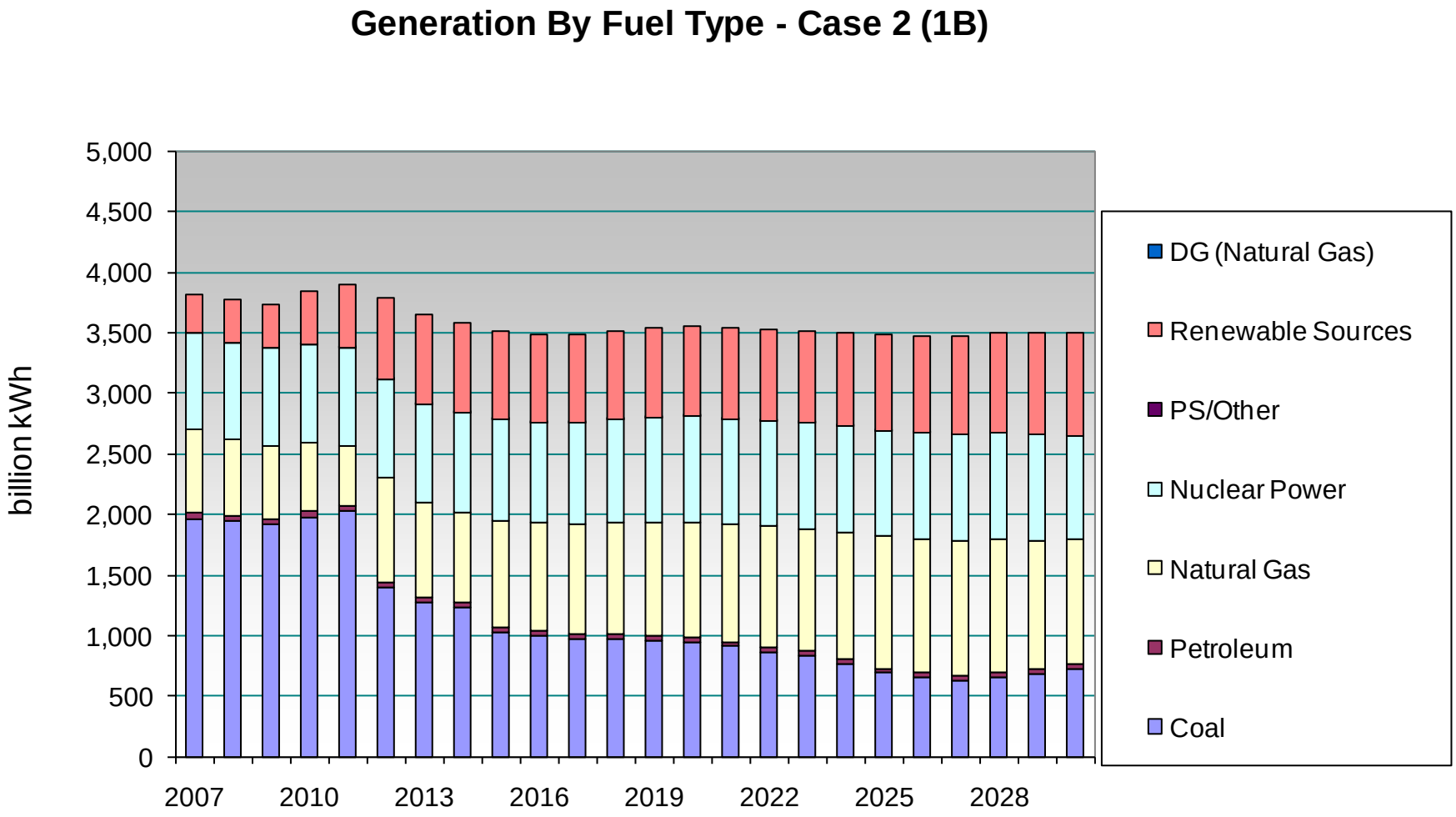
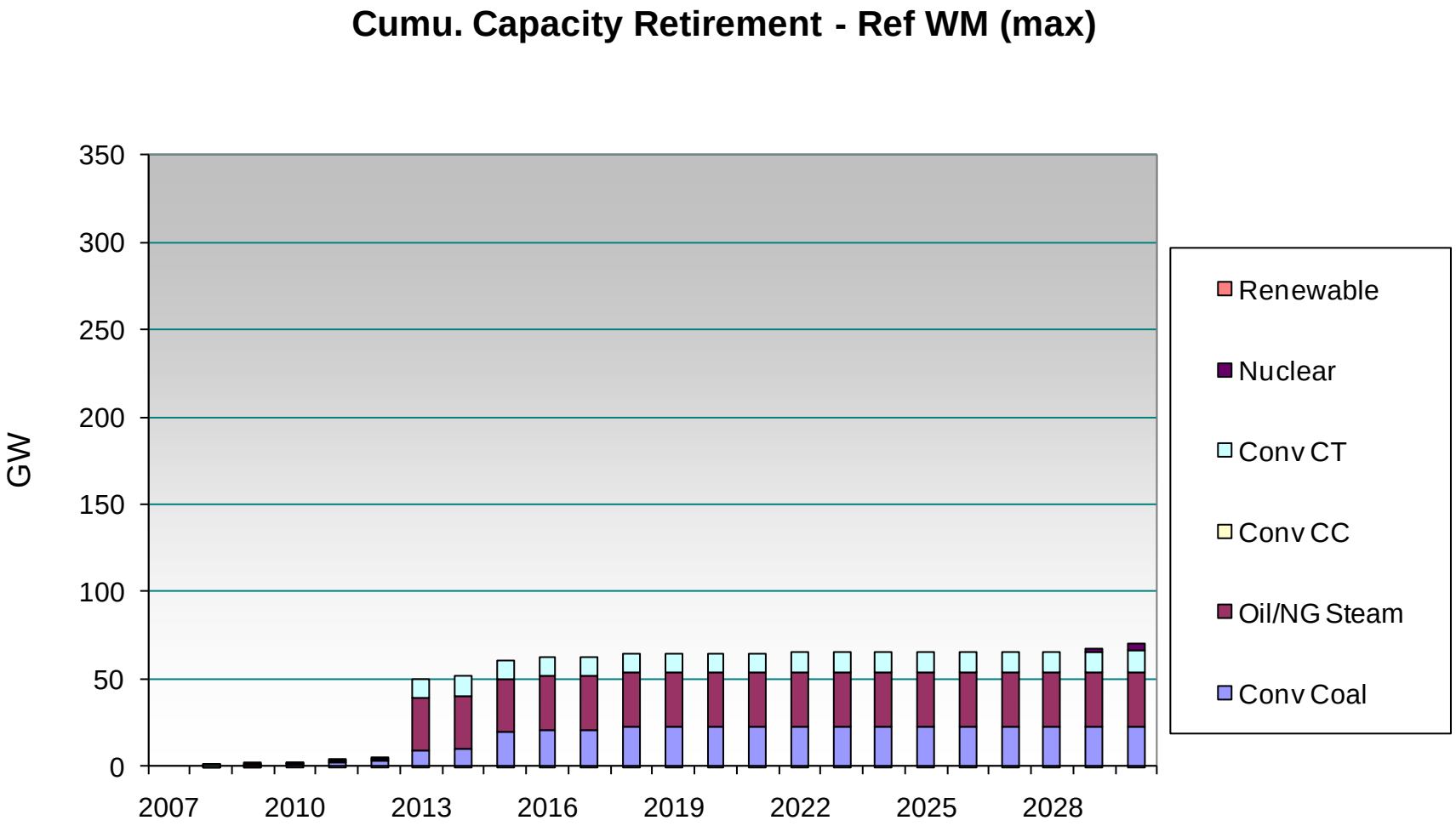
Generation By Fuel Type – Reference Case with Full Offsets



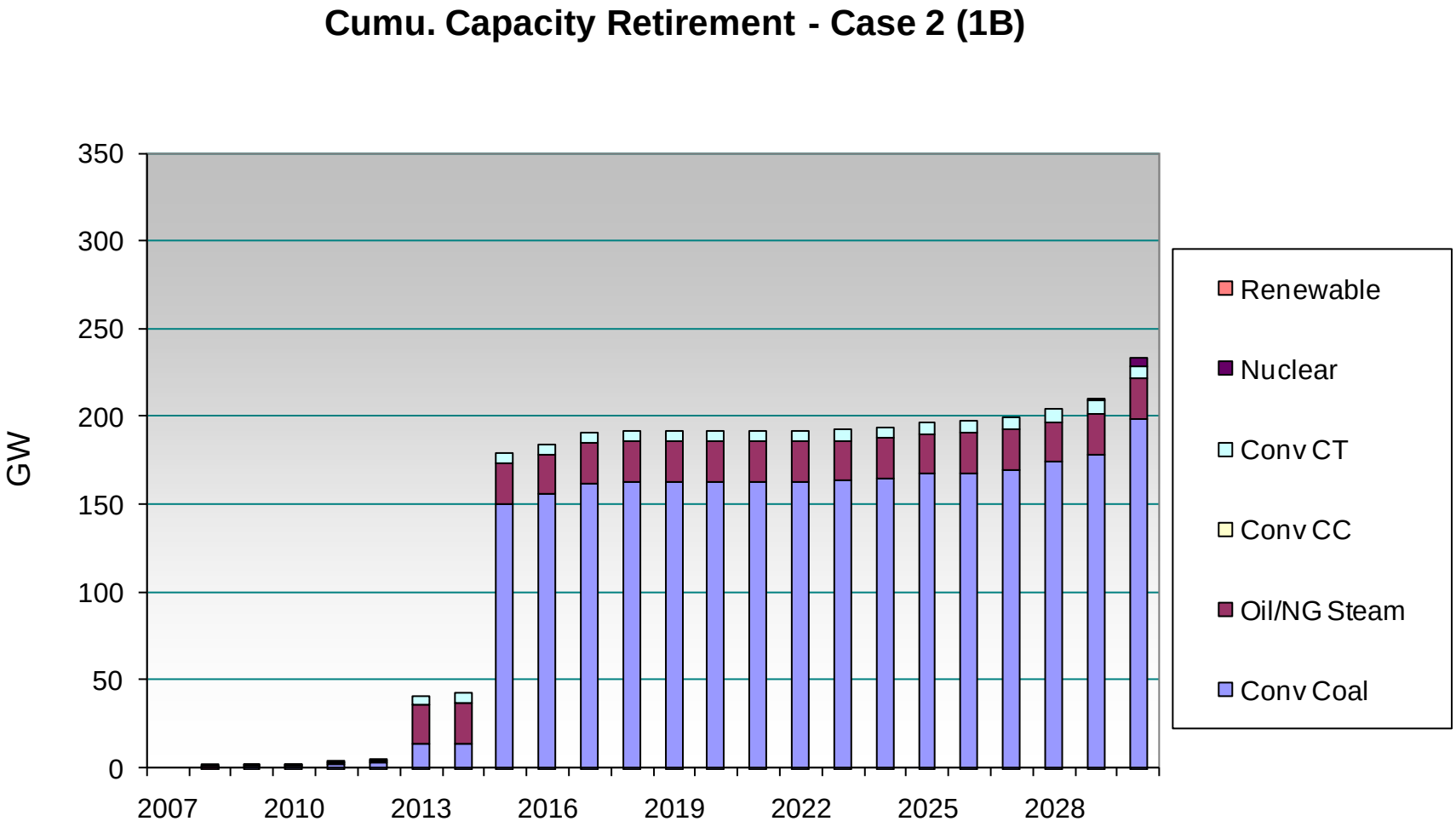
Generation By Fuel Type – Offsets Limited to 1B (burns less coal, more gas)



Little Coal Generation Retired in Reference Case (full offsets)



Massive Retirements of Coal Generation In Case With Limited Offsets



Implications for Electric Sector Decisions

How Much Should a Utility be Willing to Spend to Keep an Existing Coal Unit Running?

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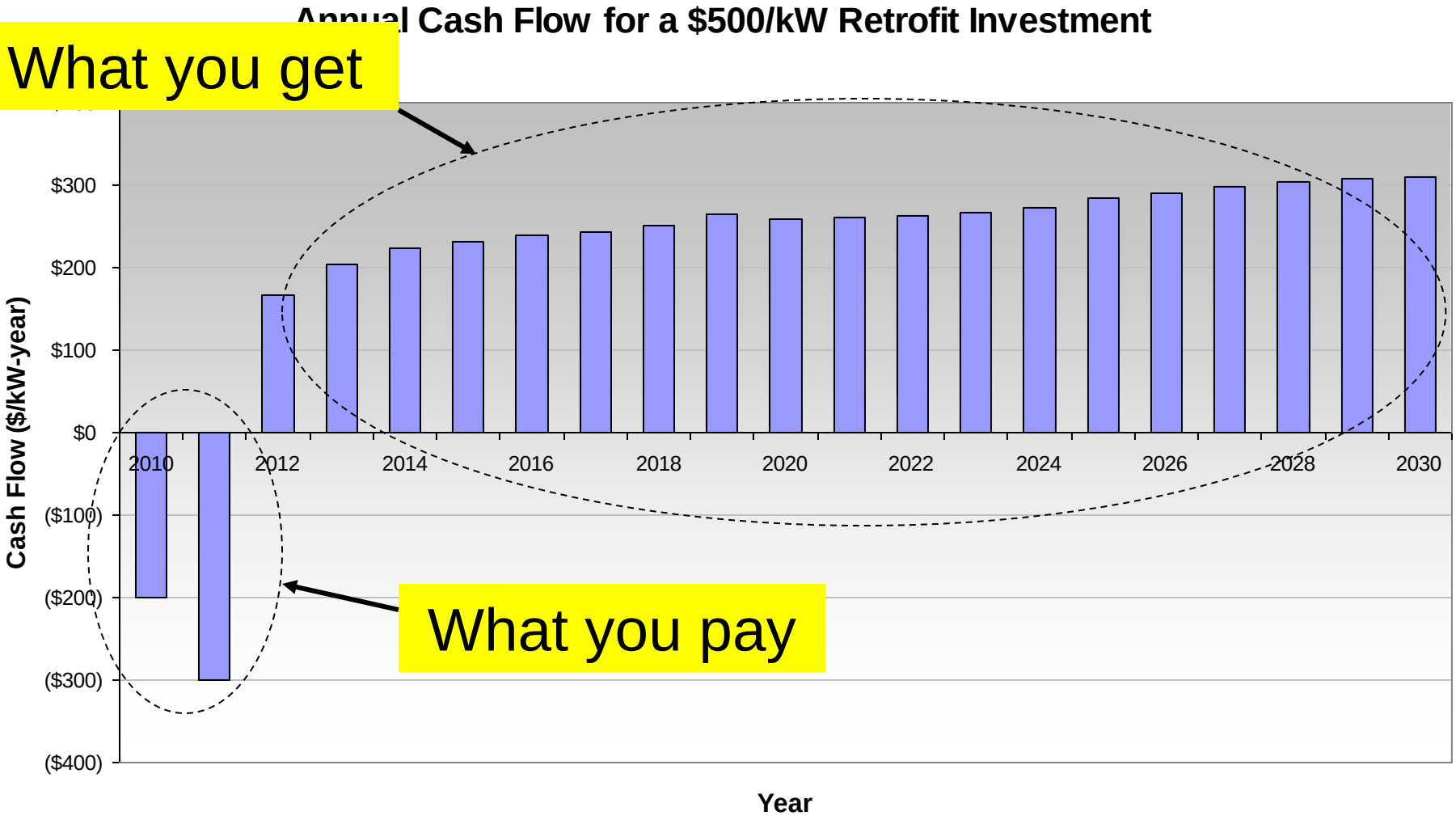
Framing the Decision to Retrofit SO_2, NOx, Hg Controls, or Cooling Towers

- Cost of retrofit highly dependent on plant specifics
  - layout,
  - age, size,
  - boiler type,
  - pre-existing controls,
  - region, etc.
- Retrofit costs may exceed $500/kW
- If don't retrofit, must close plant

- Question is, will the value of the plant's continued output exceed cost of its retrofit?

Cash Flows for $500/kW Retrofit of an Existing Coal Unit



What is the Impact of Climate Policy on Existing Coal Generation?

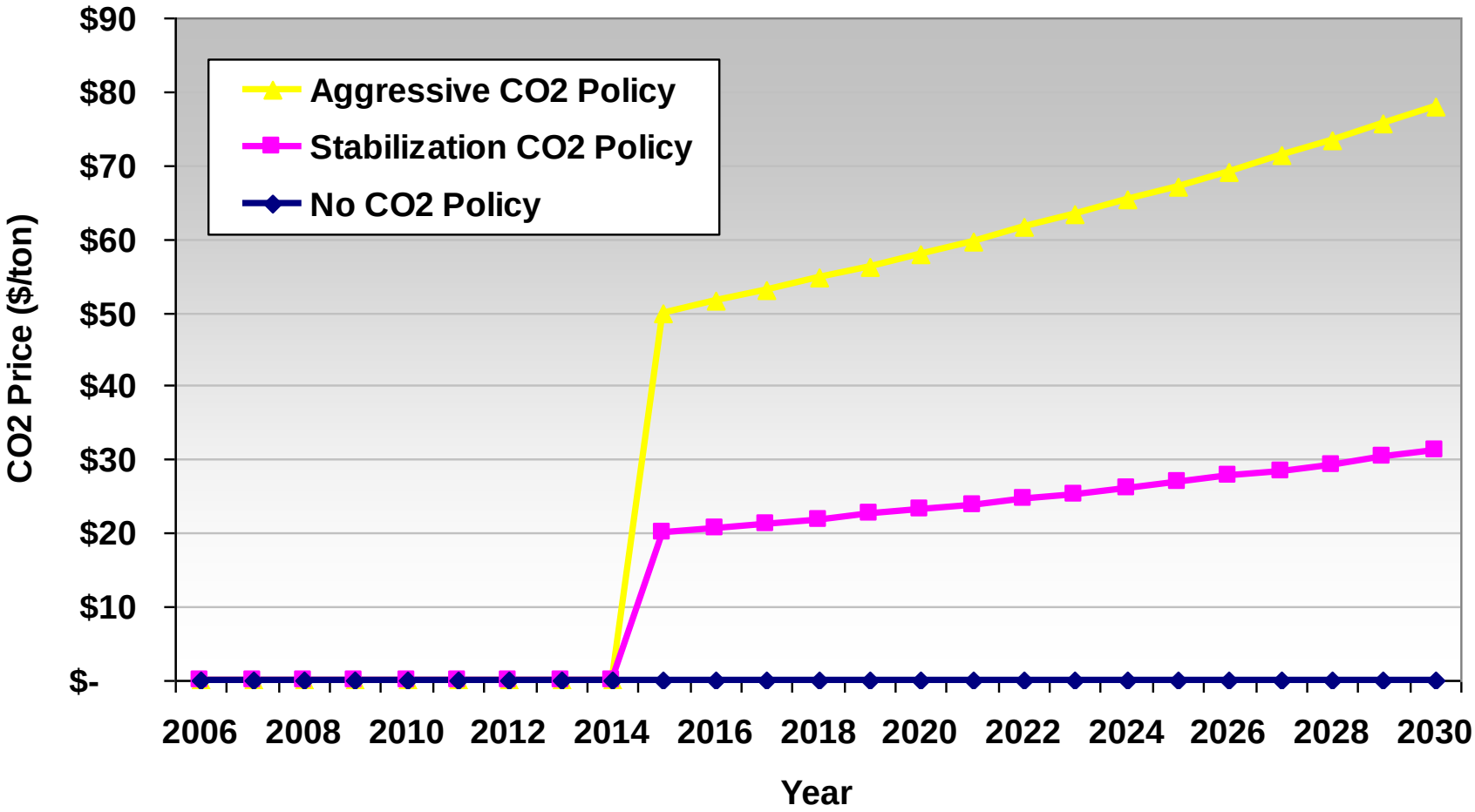
- Cap-and-trade climate policy will impinge on existing coal
- With high price on CO_2:
  - System redispatches gas more
  - New non/low-emitting generation added to stack
  - Customers cut load in response to price increases
- Coal units run less and less
- Cash flows to coal units drop even faster

- **But these forces take time**

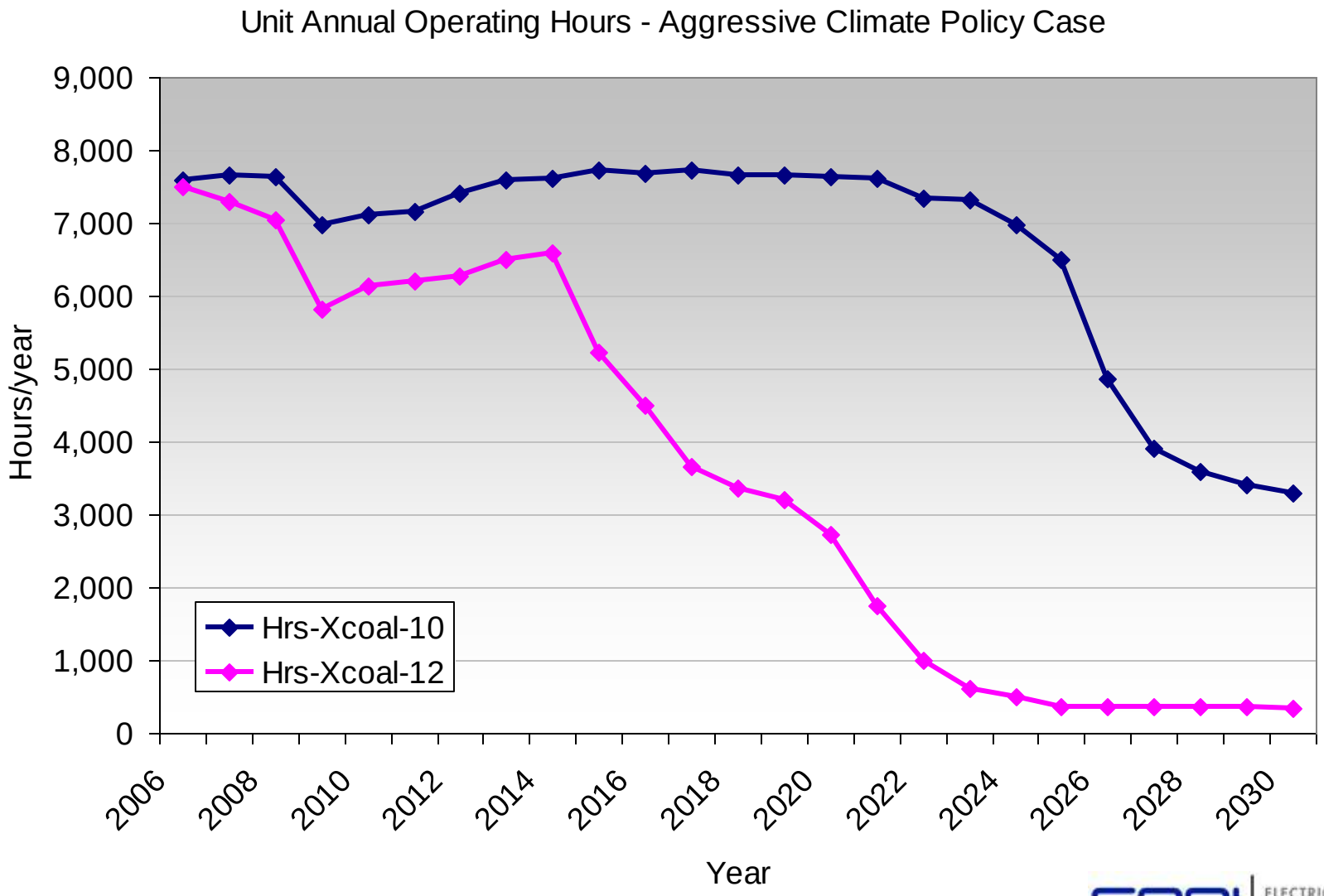
Results Here Contrast Impact of Climate Policy for Two Prototypical Coal Units

- Xcoal-10 (existing coal w. heat rate of 10,000)
- Xcoal-12 (existing coal w. heat rate of 12,000)
- Explore three climate policy cases starting in 2015
  - No policy
  - Stabilization policy ($20/ton, + 3%/year)
  - Aggressive policy ($50/ton, + 3%/year)
- Assume $500/kW retrofit investment
  - Spend $200 in 2010, $300 in 2011
  - Operating parameters remain unchanged after retrofit

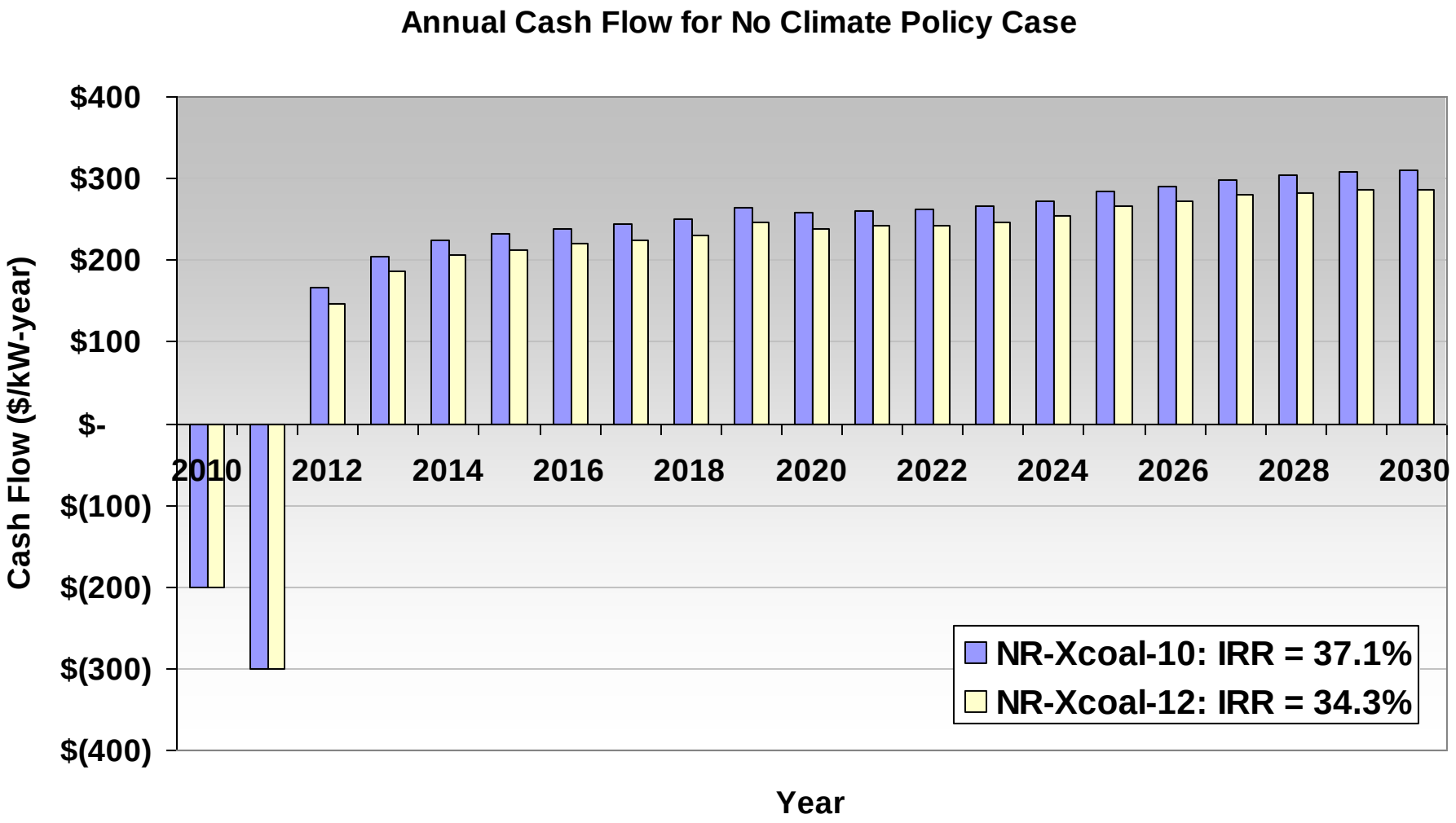
Three Bounding CO_2 Price Scenarios Capture Essence of the Uncertainty



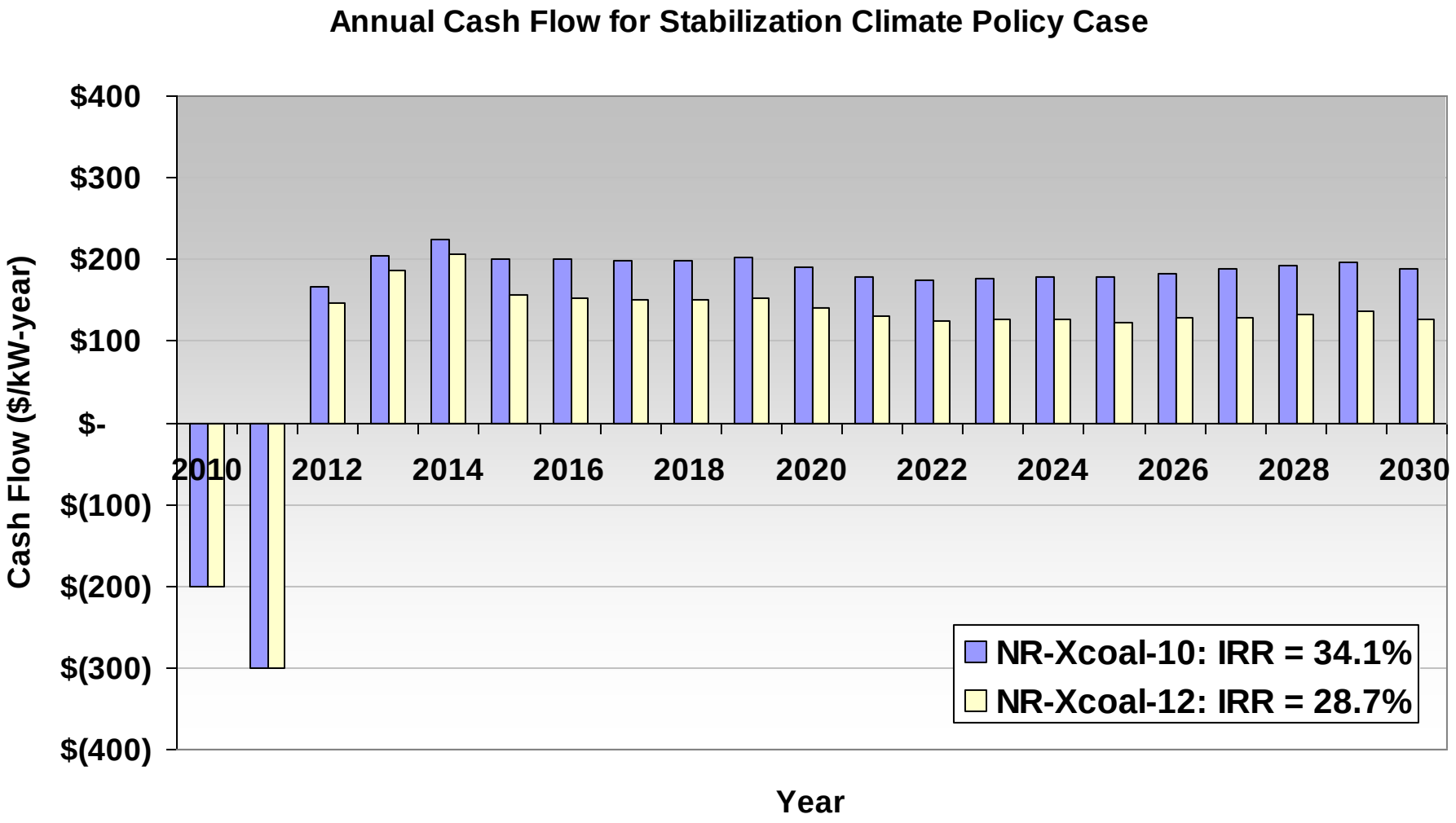
Operating Hours Decline Sharply in Aggressive Policy Case



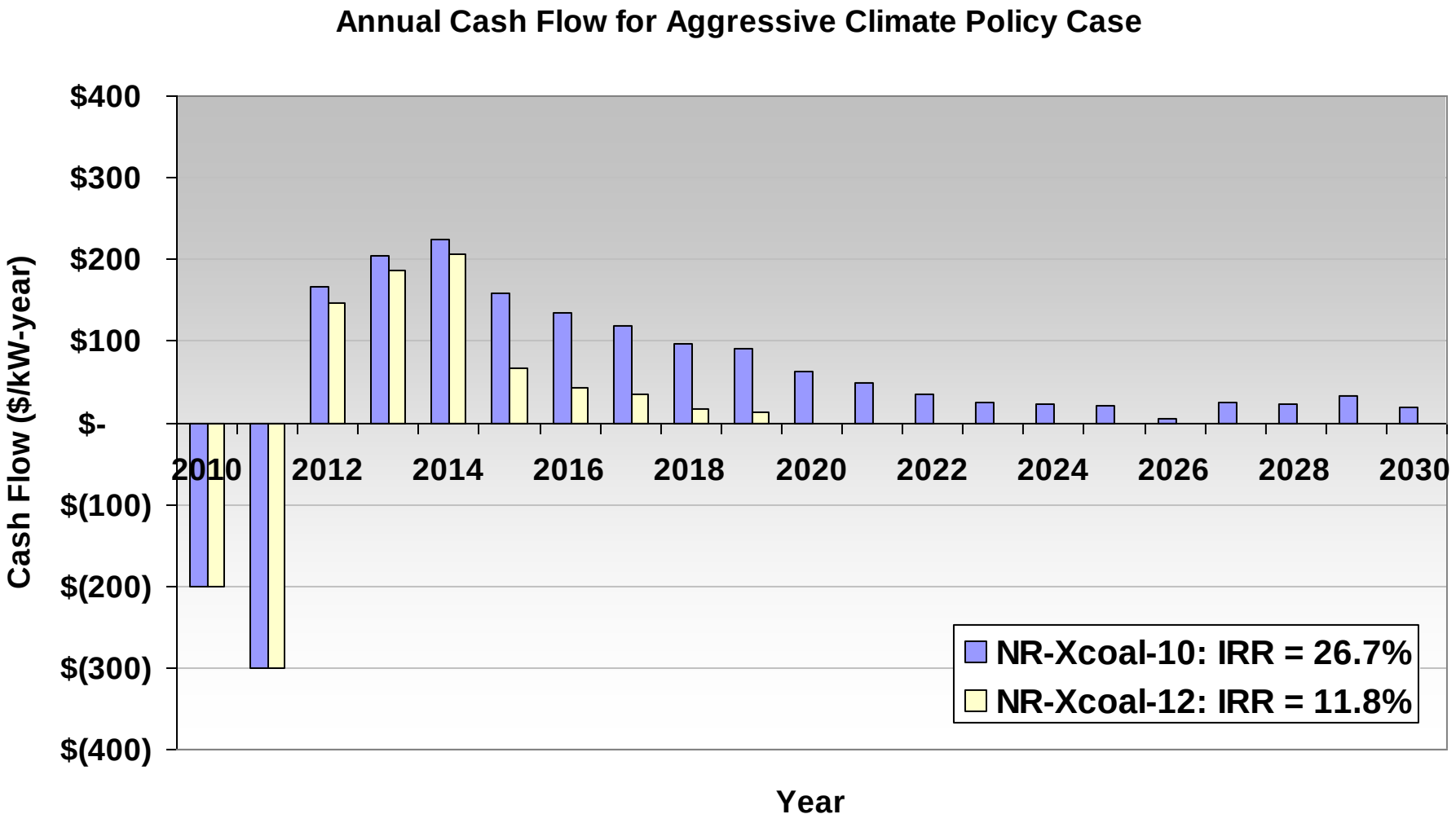
Cash Flows for $500/kW Retrofit – No Policy Case



Cash Flows for $500/kW Retrofit – Stabilization Policy Case



Cash Flows for $500/kW Retrofit – Aggressive Policy Case



Caveats and Insights

- CO_2 price highly uncertain so decision makers should develop contingency strategies

- Key drivers of CO_2 prices becoming clear
  - Ultimate supply of offsets
  - Cost of new nuclear and CCS if offsets “scarce”

- CO_2 price expectations are beginning to change electric sector investment decisions