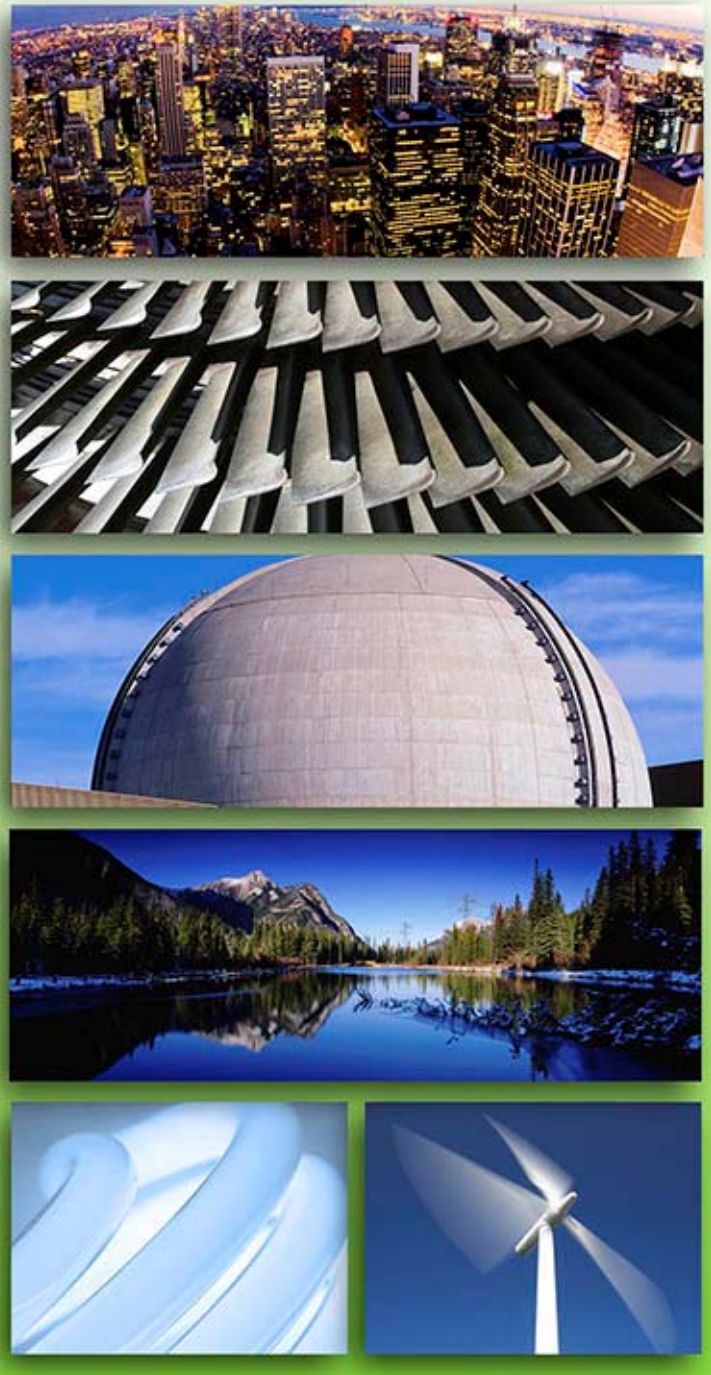

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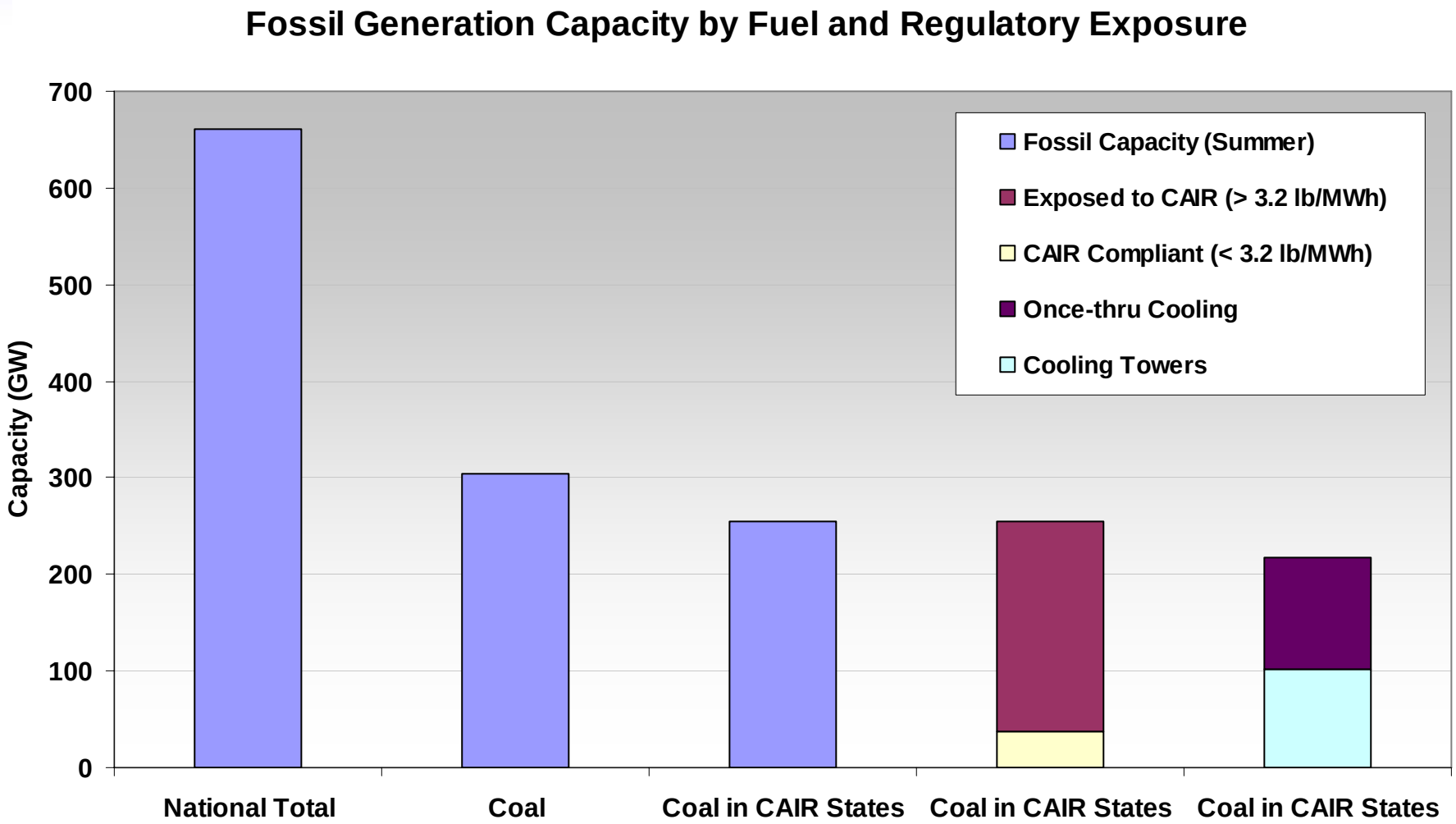
Retrofit Investment in Existing Coal-fired Generation in a 4P World

Victor Niemeyer
Technical Executive

Electric Utility Environmental Conference 2009

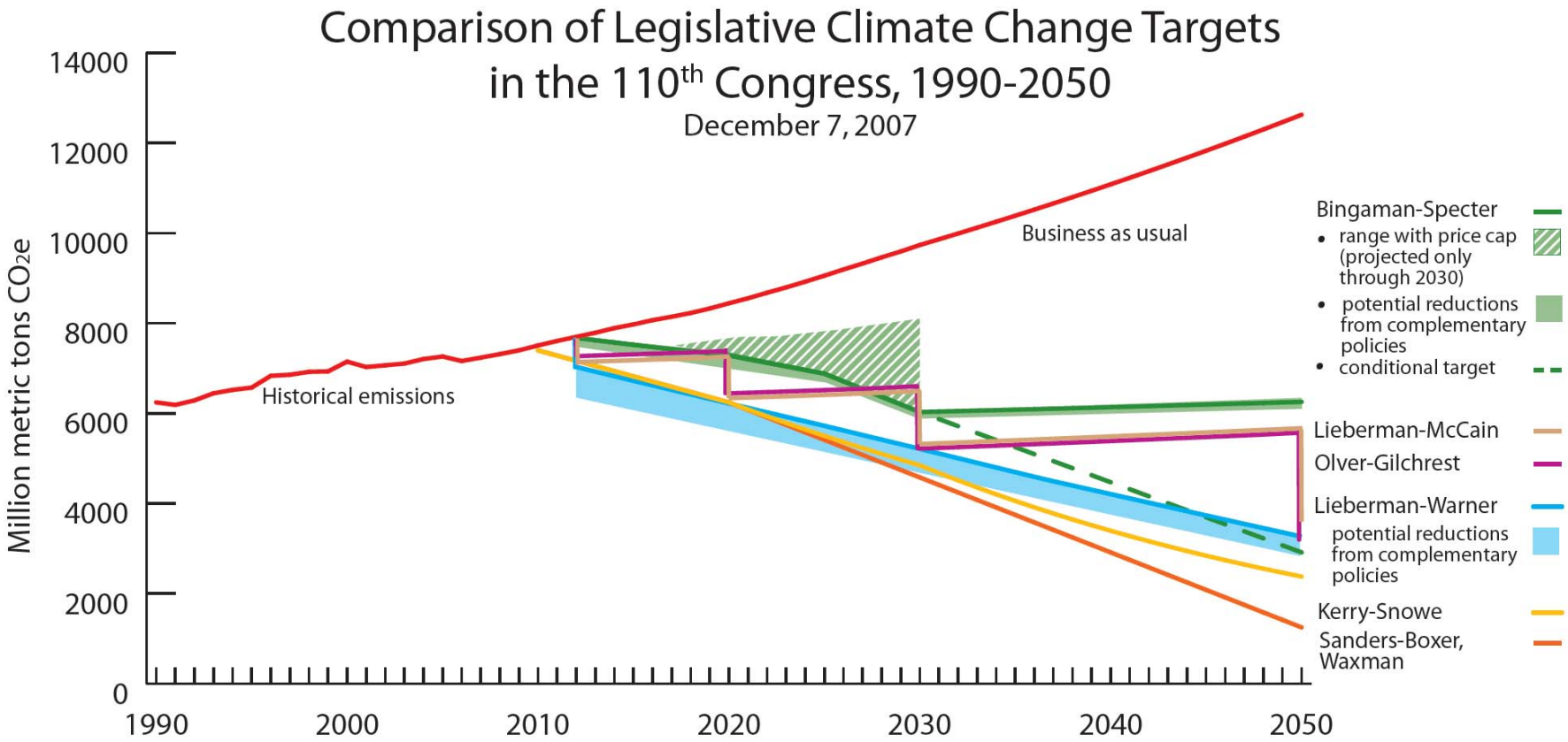
February 3, 2009

A Large Amount of Coal Generation May Face Retrofits for SO_2, NOx, Hg, or Cooling Towers



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

U.S. Climate Policy Proposals Focused on Cutting Emissions Below Historic Levels



For a full discussion of underlying methodology, assumptions and references, please see http://www.wri.org/usclimatetargets. WRI does not endorse any of these bills. This analysis is intended to fairly and accurately compare explicit carbon caps in Congressional climate proposals and uses underlying data that may differ from other analyses. Data post-2030 may be derived from extrapolation of EIA projections.

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Policy Cost Estimates will Be All Over the Map … Much more Complex than SO_2 Program Estimates

And the Cost of Lieberman-Warner is ….

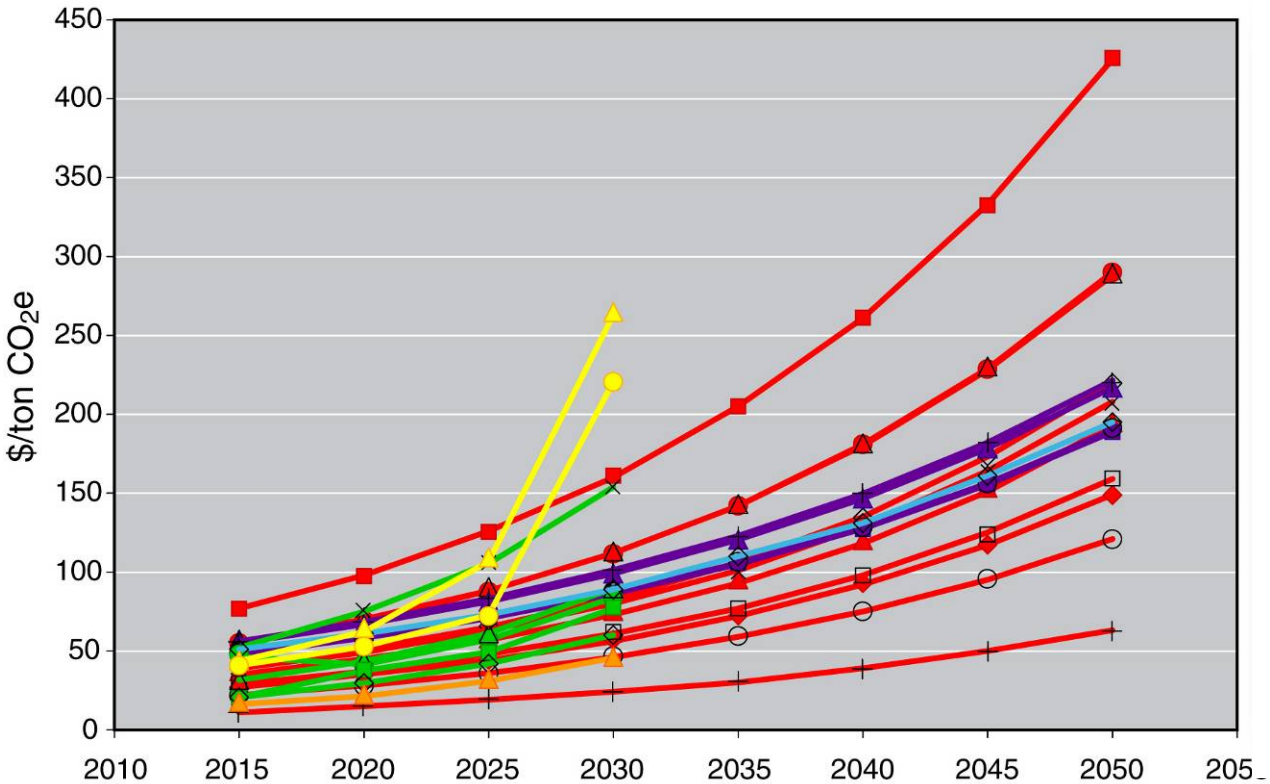


Figure shows published estimates of CO2 price for Lieberman-Warner.

- Red = EPA Scenarios
- Green = EIA Scenarios

Estimates range from \$25/ton CO_2 to \$430/ton CO_2

Most of the differences are due to assumptions rather than differences in the models

L-W Studies Show Economy Primarily Relying on Electric Sector for Heavy Cuts in CO2

Timing	**Electric Sector**	**Trans -portation**	**Off-sets**	**ROE** (rest of econ)
Near term	✓	0	?	?
Long term	✓	✓	✓	?

- Electric sector cuts are possible, near and long term, but are costly
- Transportation has role in longer term with bio fuels and EVs/PHEVs, even more costly
- Offsets a play “wild card” role

Electric Sector is Major Source of 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 ($7/MMBtu)
- **83% from coal ($1.5/MMBtu)**

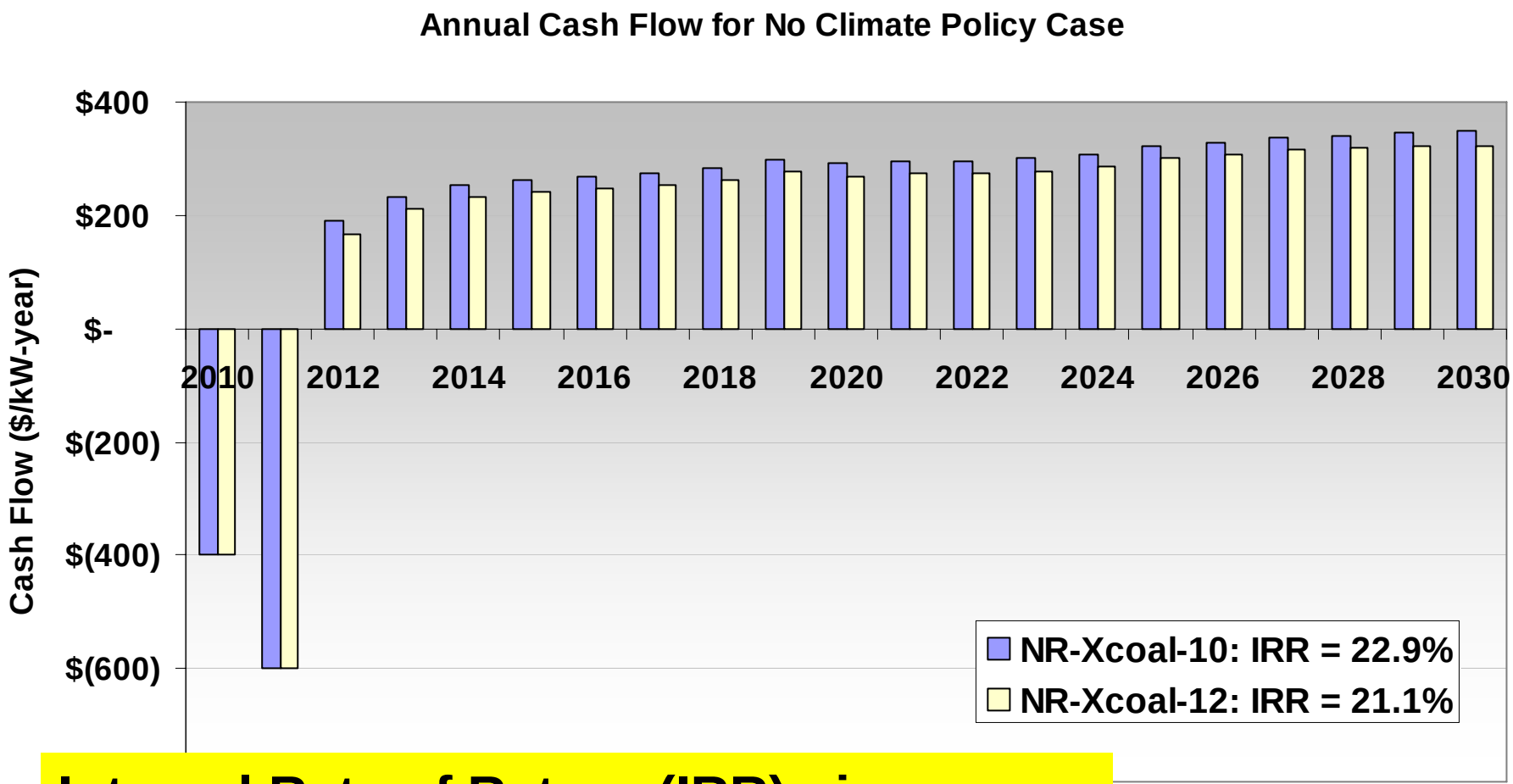
Framing the Decision to Retrofit SO_2, NOx, Hg Controls, or Cooling Towers

- Cost of retrofit highly dependent on plant specifics
  - layout,
  - age, size,
  - boiler type,
  - pre-existing controls,
  - region, etc.
- Retrofit costs can approach or exceed $1,000/kW
- If don't retrofit, must close plant
- Question is, will the value of the plant's continued output exceed cost of its retrofit?

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 $1,000/kW retrofit investment
  - Spend $400 in 2010, $600 in 2011
  - Operating parameters remain unchanged after retrofit

Cash Flows for $1,000/kW Retrofit of Two Existing Coal Units with Heat Rates of 10,000 and 12,000



Internal Rate of Return (IRR) gives breakeven rate of return on cash flows

What is the Impact of Climate Policy on Returns?

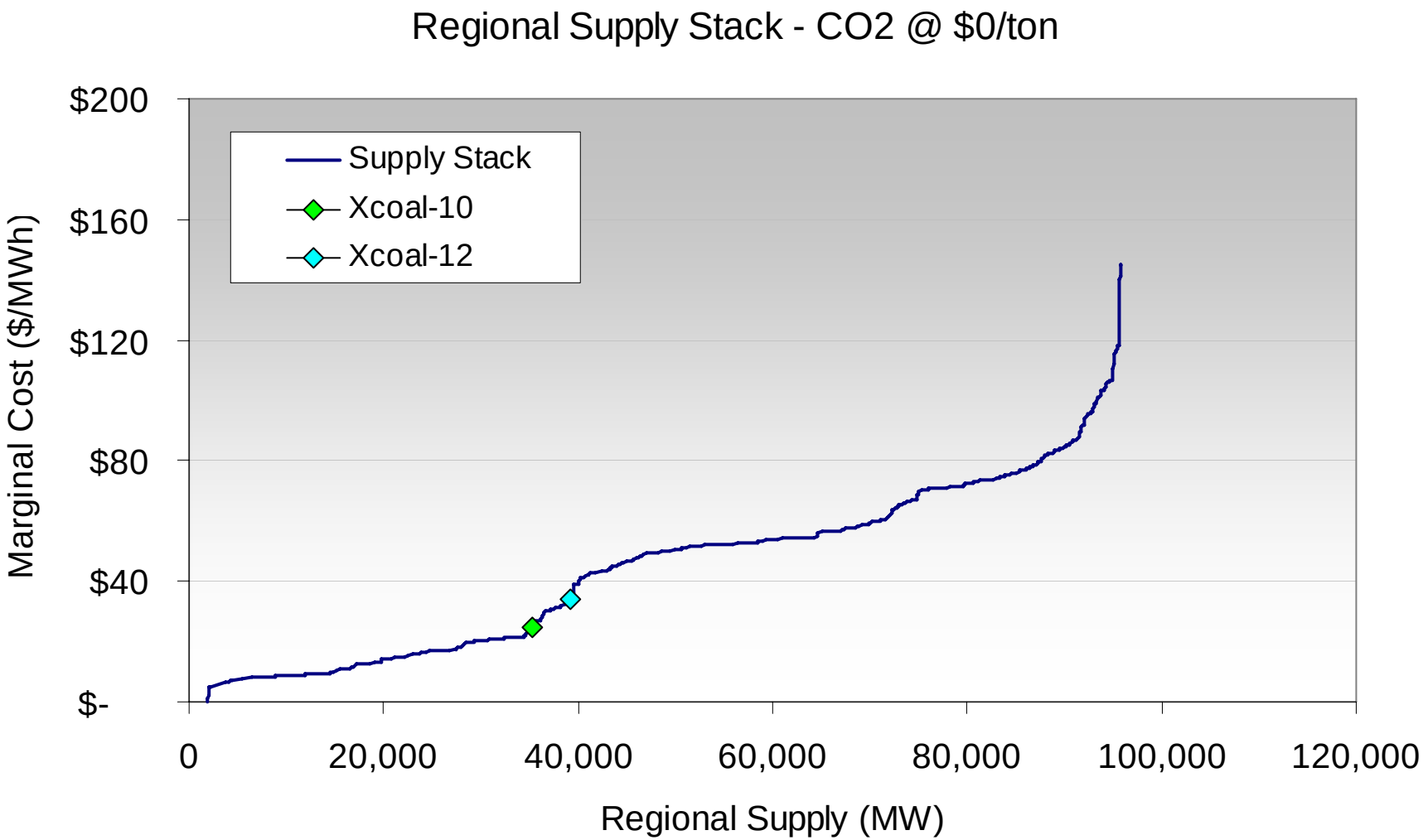
- Cap-and-trade climate policy will impinge on existing coal
- With high price on CO_2:
  - System redispatches gas more
  - New non emitting generation added to stack
  - Customers cut load in response to price increases
- Coal units run less and less
- Cash flows to coal units drop even faster

- But these forces take time

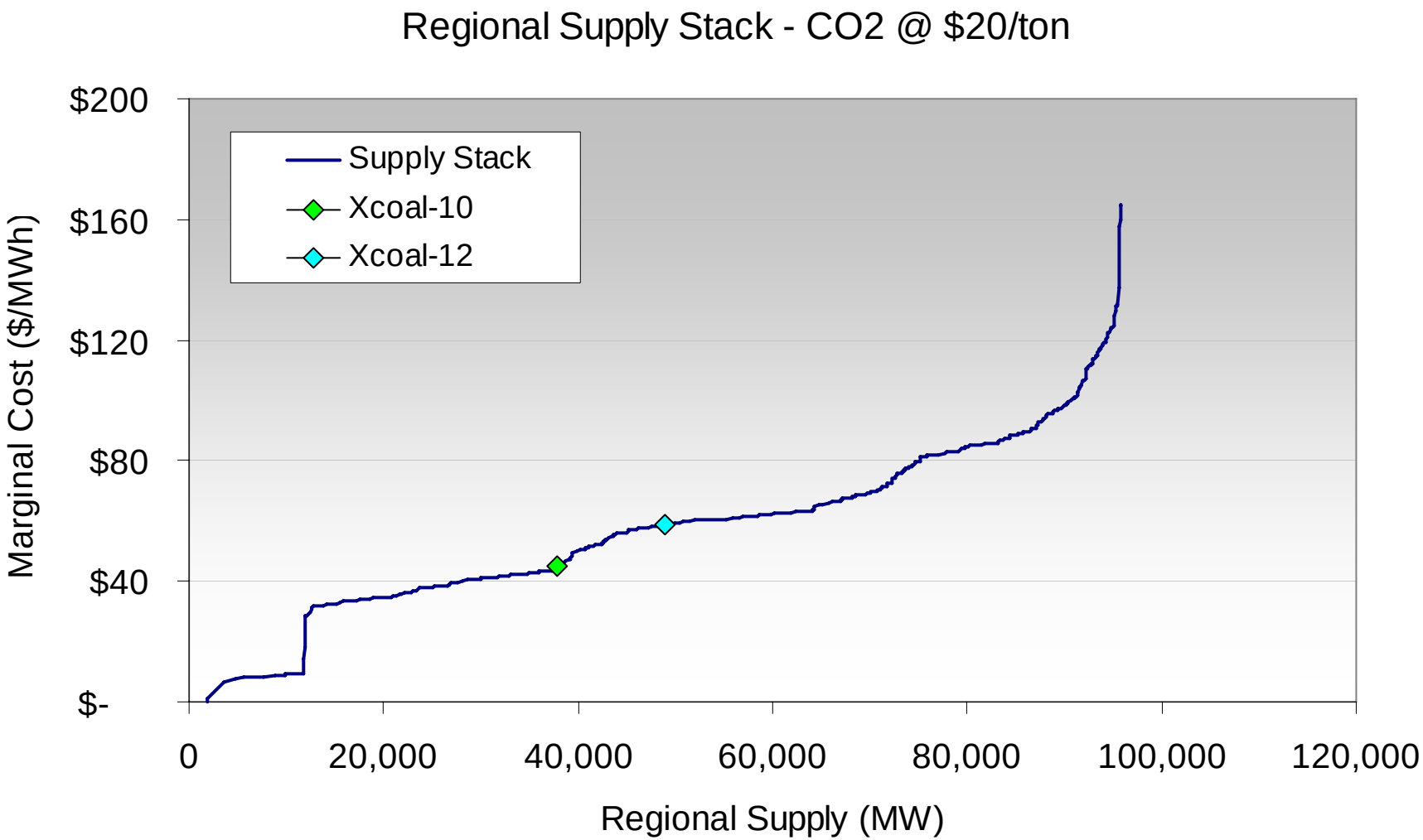
EPRI Modeling System Integrates All Major Options for Reducing Electric Sector CO2 Emissions

- Combines three CO_2 reduction activities for generation in integrated cost-minimizing mix
  - Redispatch existing generation (short-term effect)
  - Add new generation to cover growth and retirements (long-term effect)
  - Substitute new generation to cut existing source emissions (long-term effect)
- Reflects lead times to build new capacity
- Does not incorporate detailed system constraints on operations, transmission or new investment
- Includes role of customer load response to higher power prices (and the interaction over time with needs for new generation)

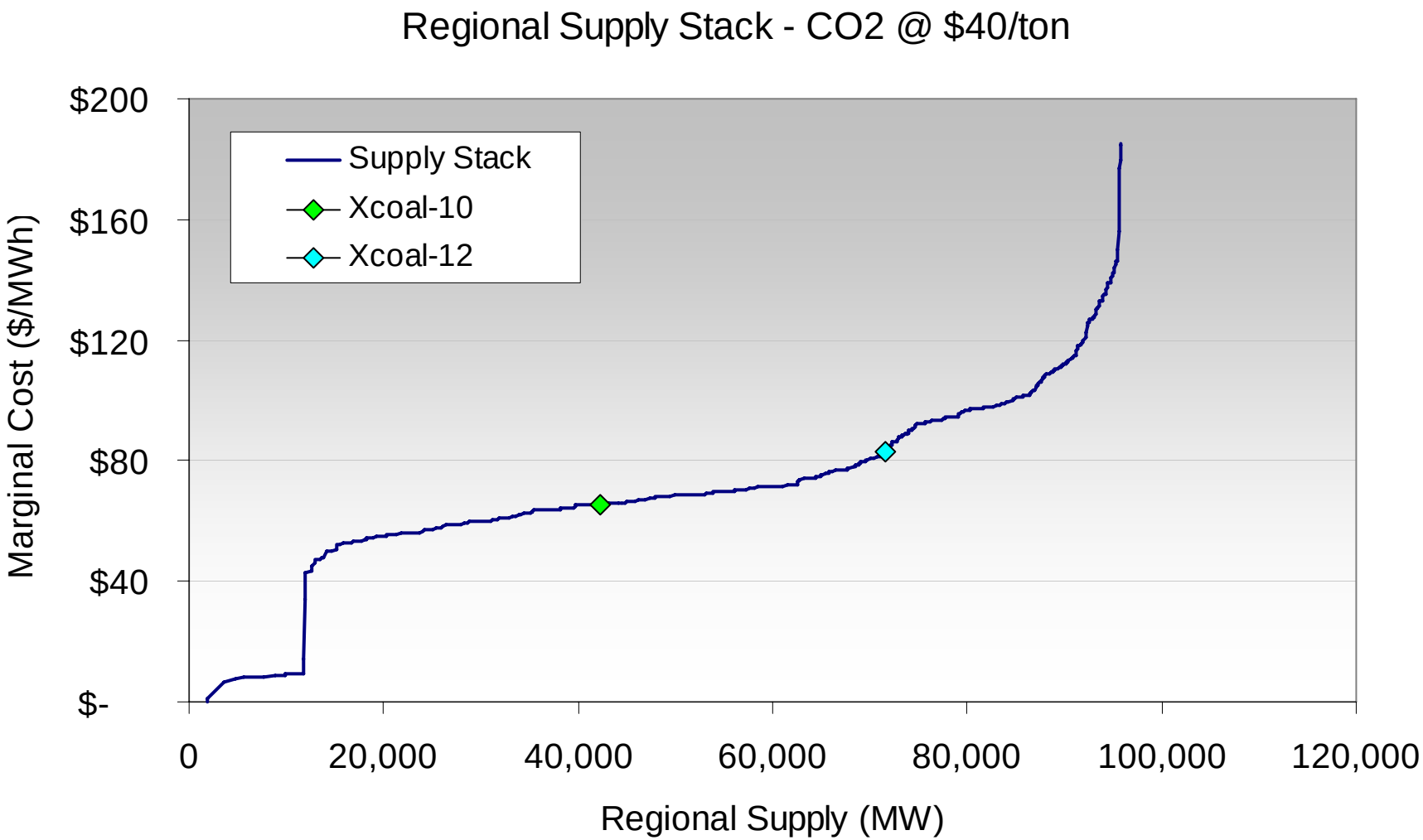
The Effect of CO_2 Price



The Effect of CO_2 Price - $20/ton



The Effect of CO_2 Price - $40/ton



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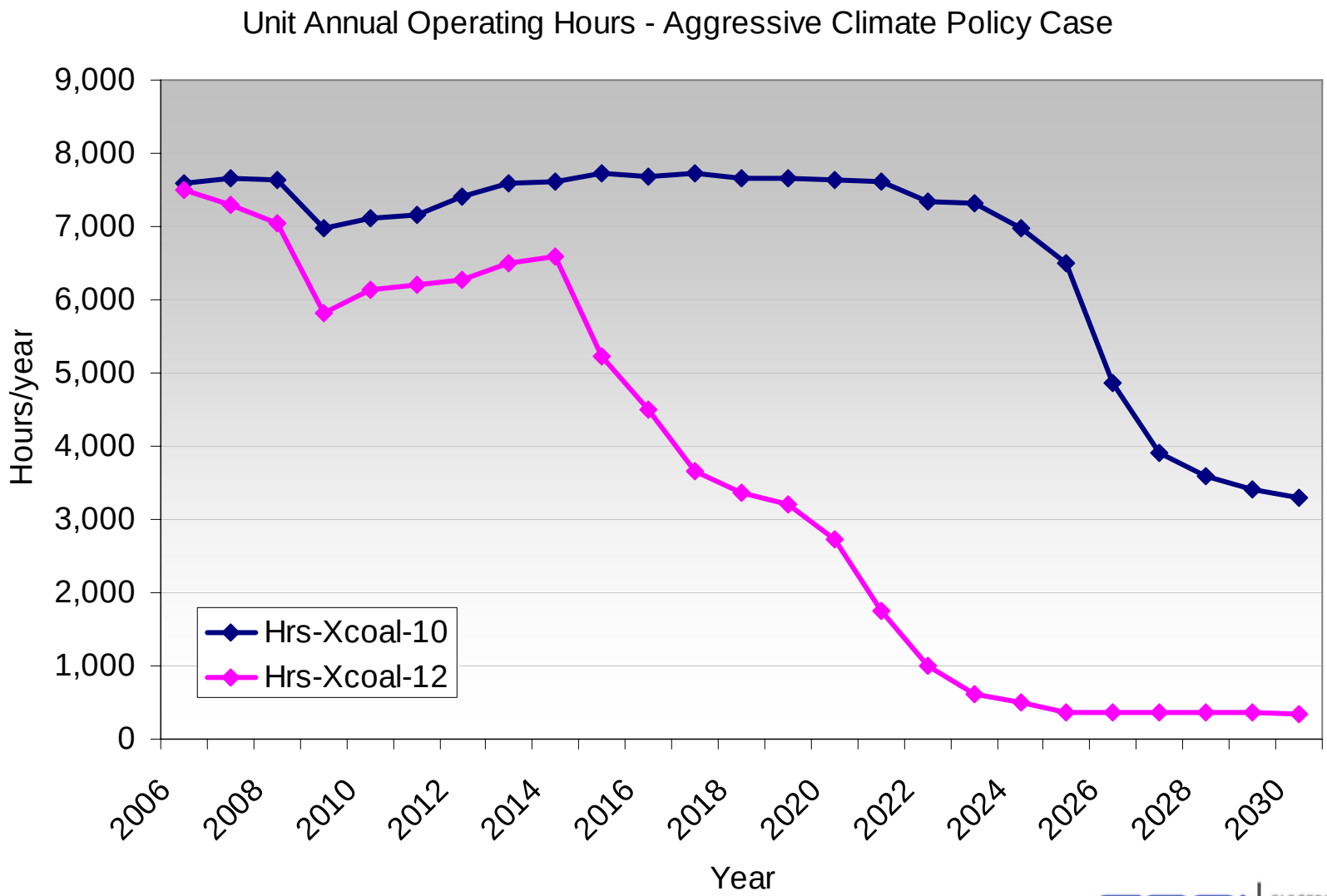
Operating Hours Decline Sharply in Aggressive Policy Case



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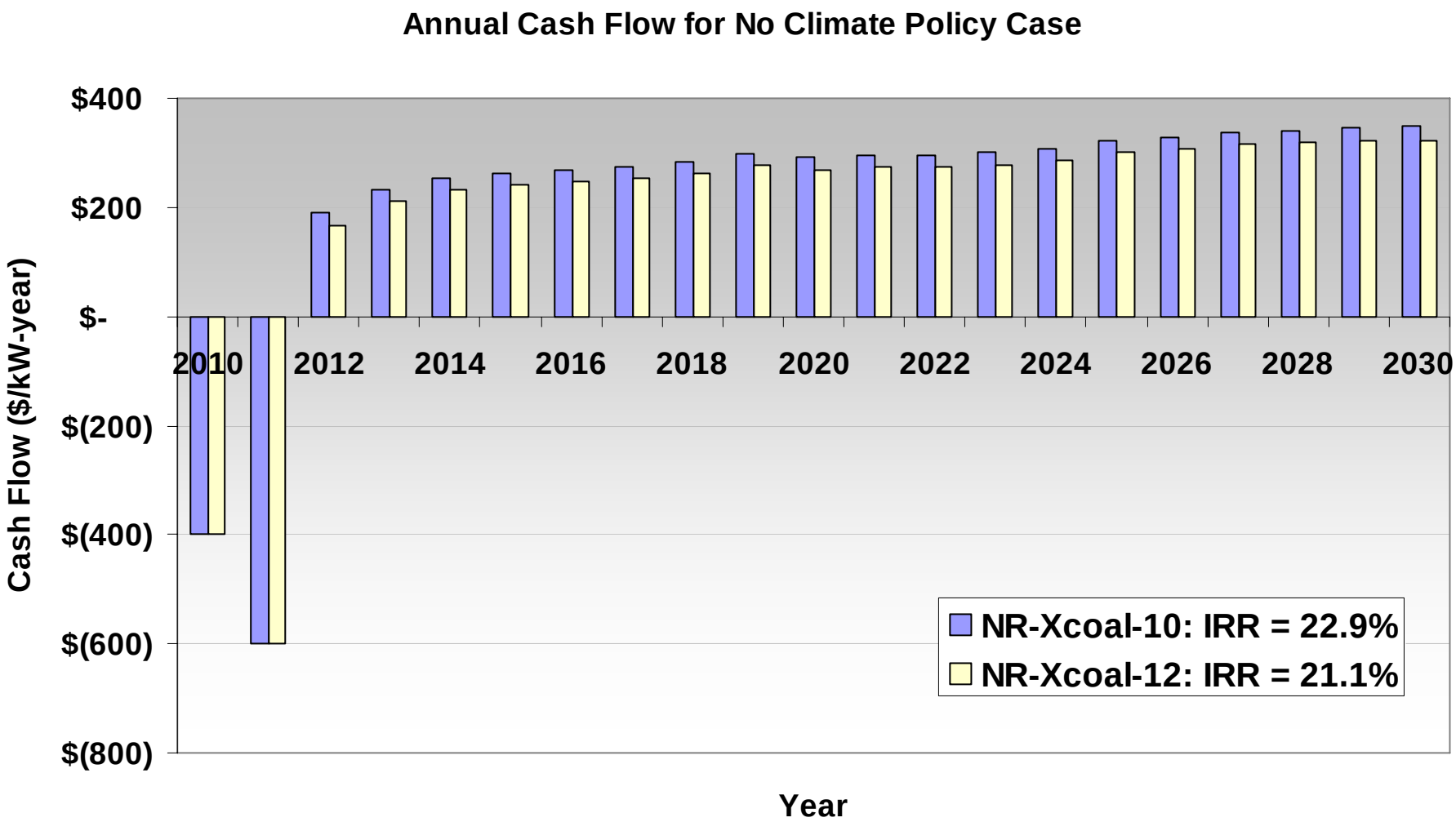
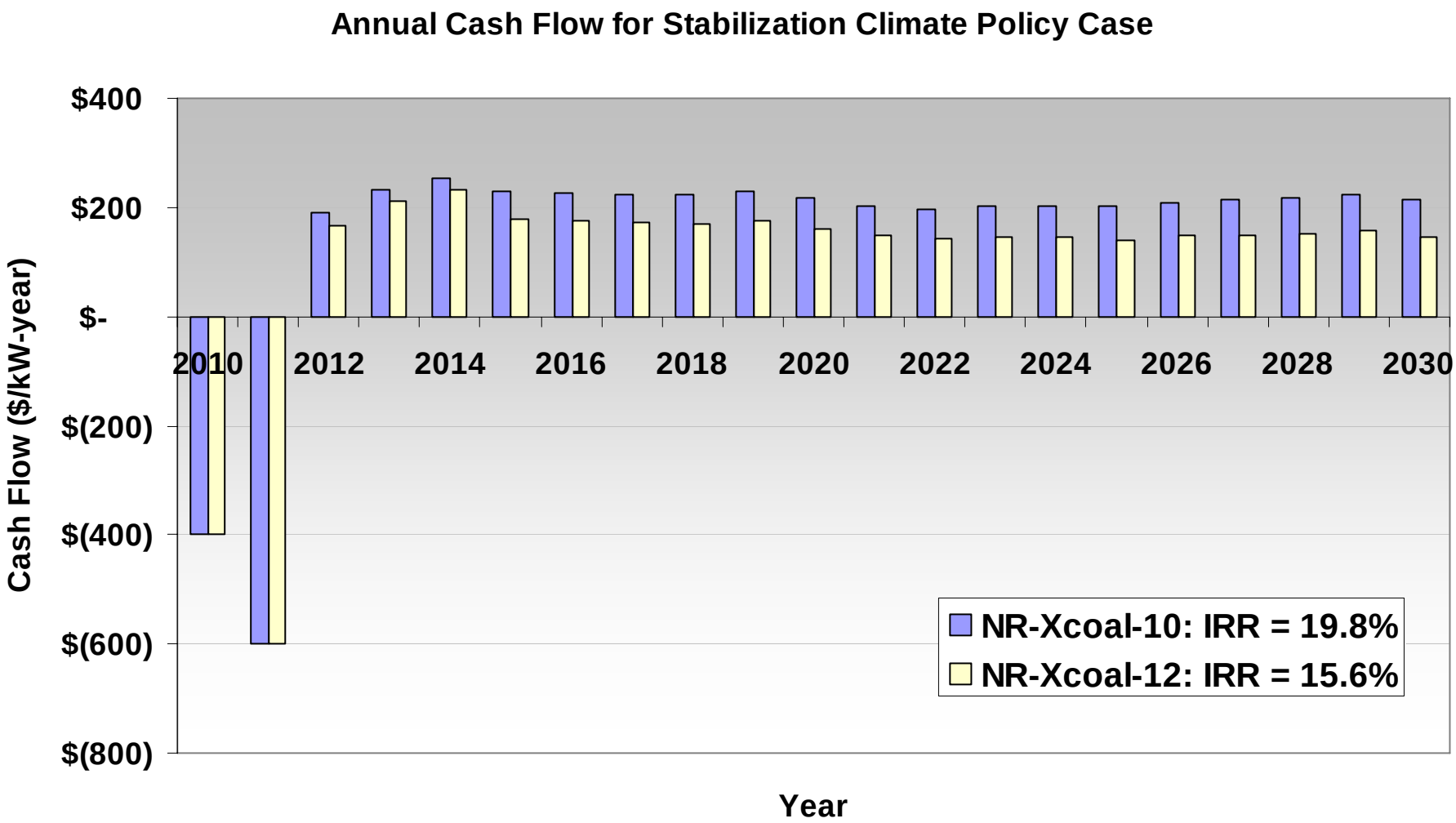
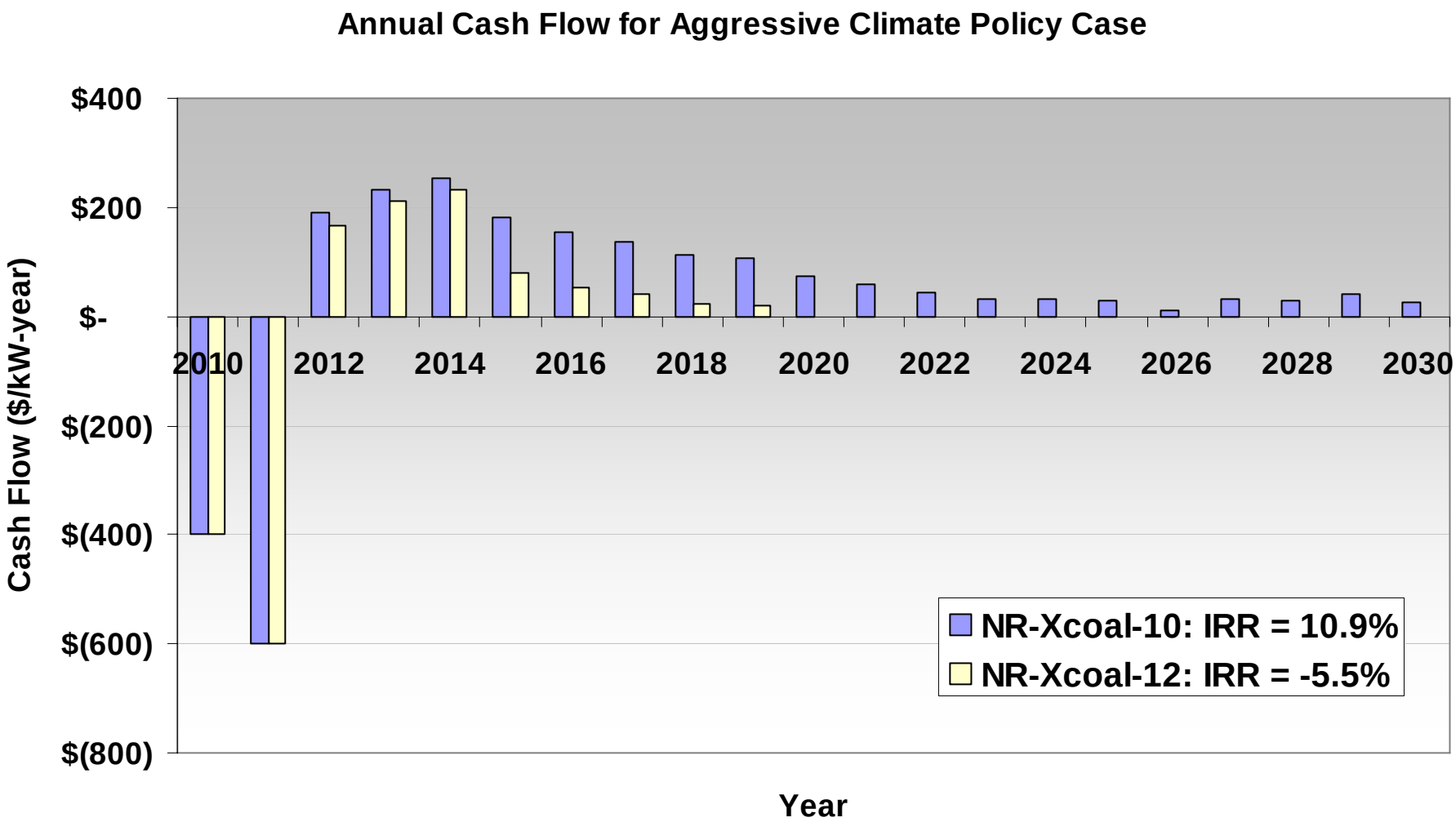
Cash Flows for $1,000/kW Retrofit of Two Existing Coal Units with Heat Rates of 10,000 and 12,000



Cash Flows for $1,000/kW Retrofit – Stabilization Policy Case



Cash Flows for $1,000/kW Retrofit – Aggressive Policy Case



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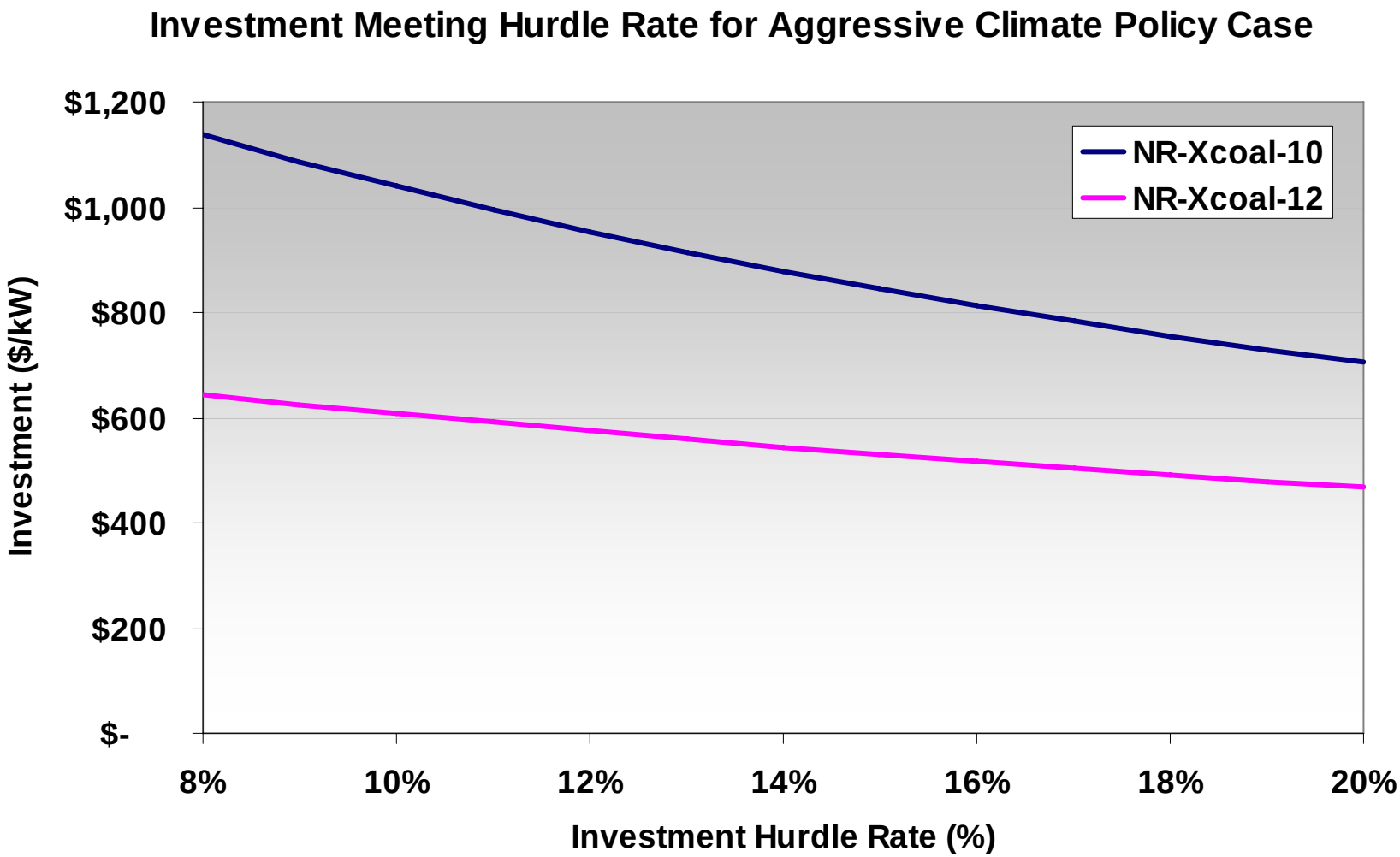
Even in Aggressive Policy Case Existing Units Worth Substantial Retrofit Investment



Your Results May Differ

- What form will climate policy take?
  - When would it start?
  - Is goal stabilization, or cuts below historic levels?
  - How broad the coverage?
- Investment worthiness depends on many other factors
  - Regional power market
  - Natural gas prices
  - Unit's heat rate
  - Minimum sustainable annual fixed O&M

Insights

- Existing coal units produce substantial value, justifying substantial investment to keep them operating
- Timing and stringency of climate policy can greatly reduce how much retrofit investment can expect to be recovered
- Even with aggressive climate policy, however, substantial investment in existing generation may be warranted
  - The higher the unit efficiency the more “worthy”
  - Higher natural gas prices increase worthiness too

Questions?

- Contact: Victor Niemeyer- niemeyer@epri.com; 650-855-2744