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Economic modeling of technology choices in MERGE

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Snowmass, Colorado
August 1, 2008

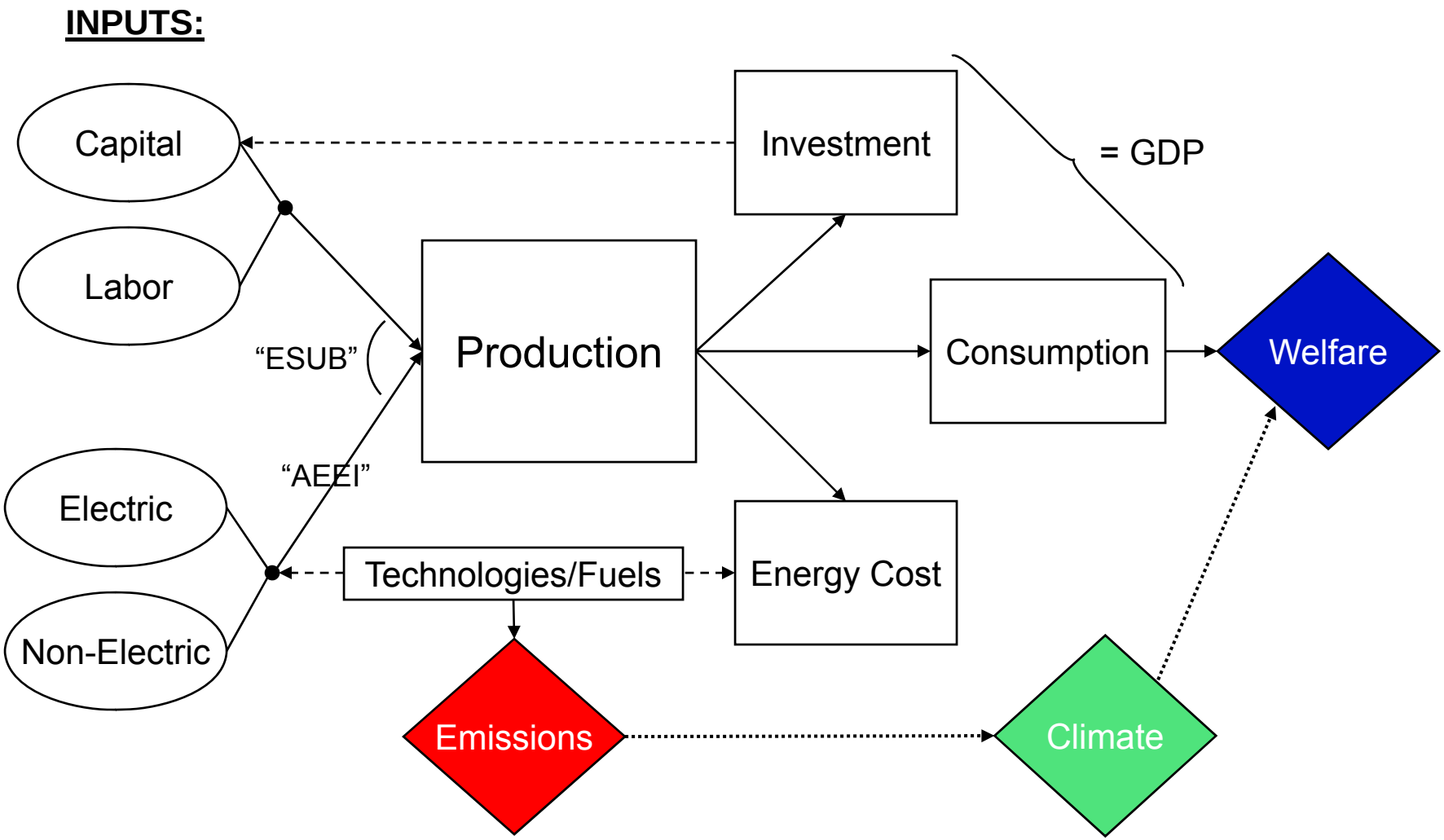
Technology and Policy in MERGE

- Part I: How the model works
- Part II: What the model can tell us

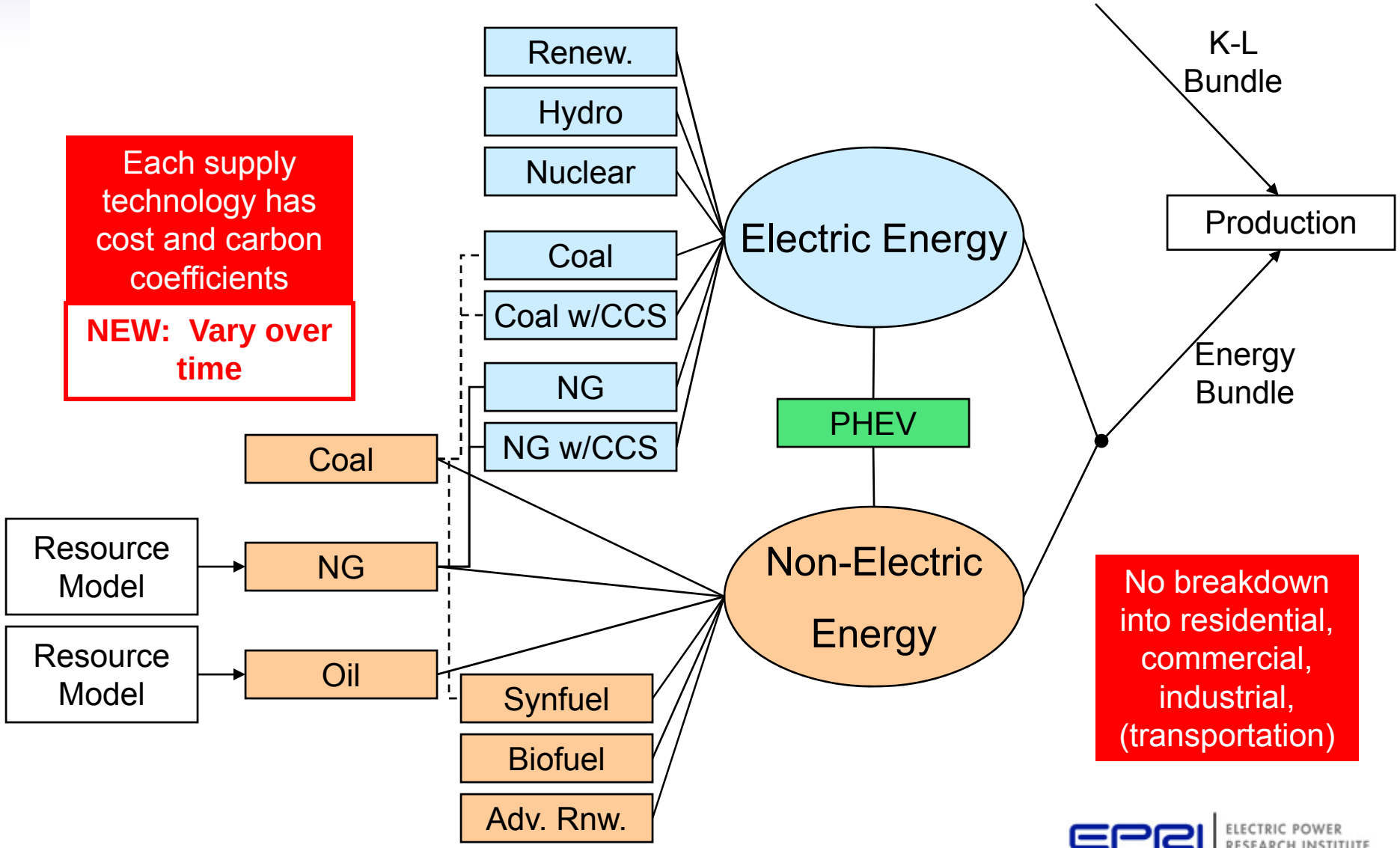
MERGE Model Overview

- A **M**odel for **E**valuating **R**egional and **G**lobal **E**ffects of GHG reduction policies
- Global intertemporal optimization model
- Nine regions (USA, Europe, FSU, China, India, etc.)
- Top-down model of economic growth and energy use
- Process model of energy supply technology:
  - Electric Generation
  - Non-Electric Energy
- Capable of representing a variety of greenhouse gas control scenarios
- Captures economy-wide impact of carbon policy

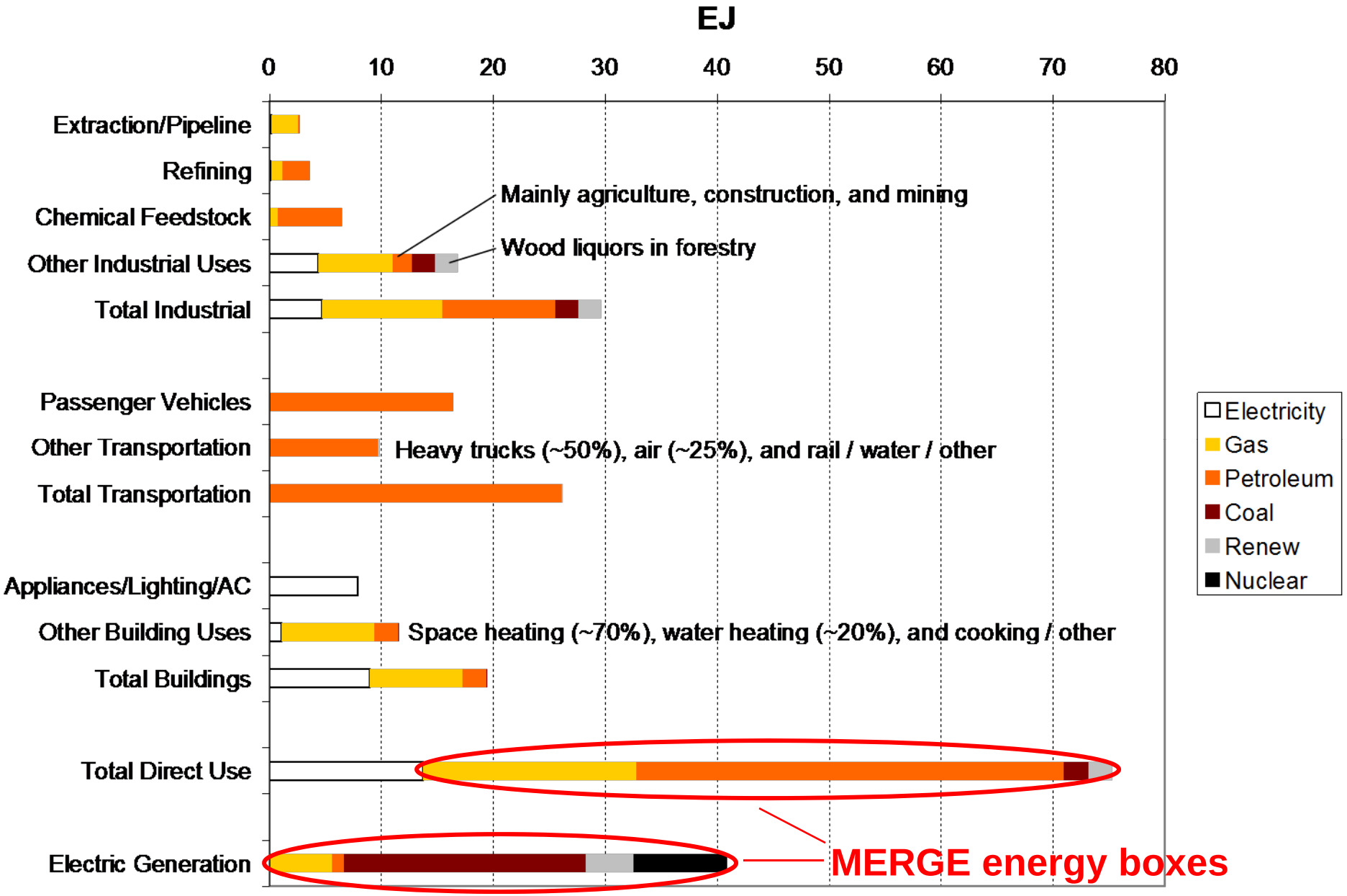
Structure of MERGE Model



Structure of Energy Sector in MERGE

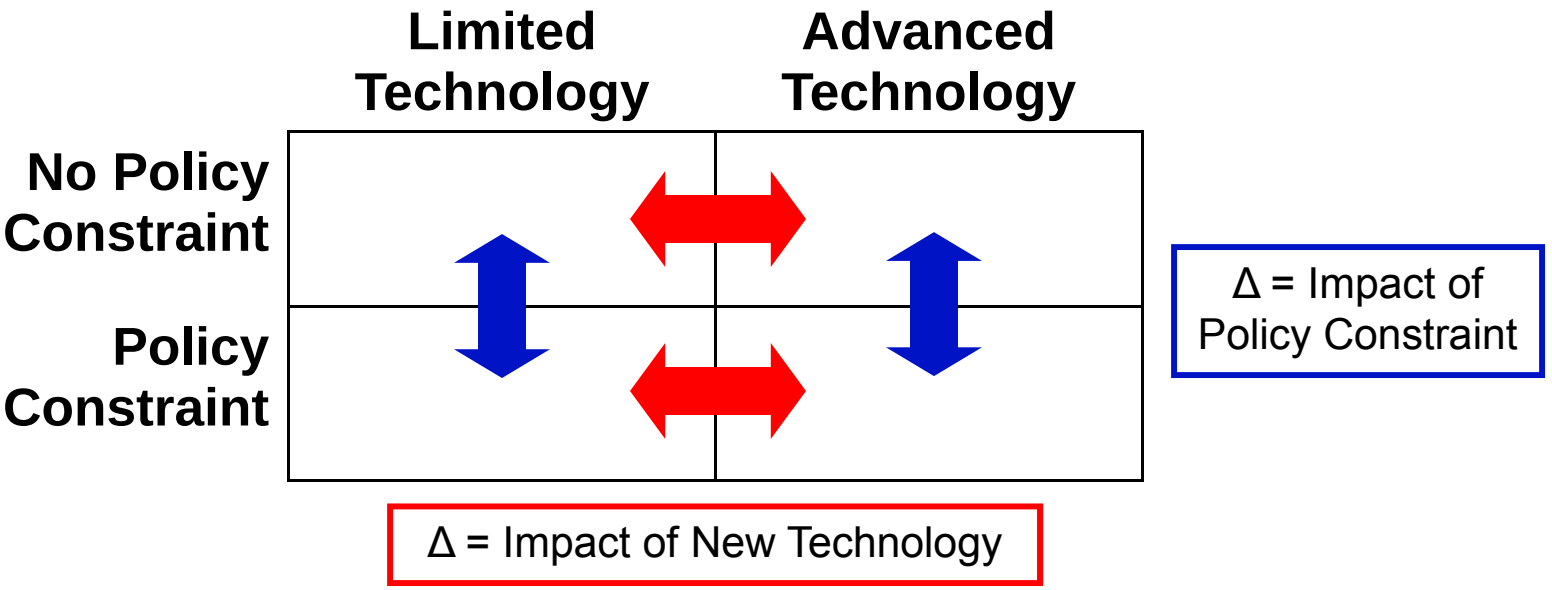


U.S. Energy in 2000 by End-Use and Fuel



Two-Dimensional Analysis

MERGE simulates each world and compares the outcomes:



2007 EPRI Technology Study

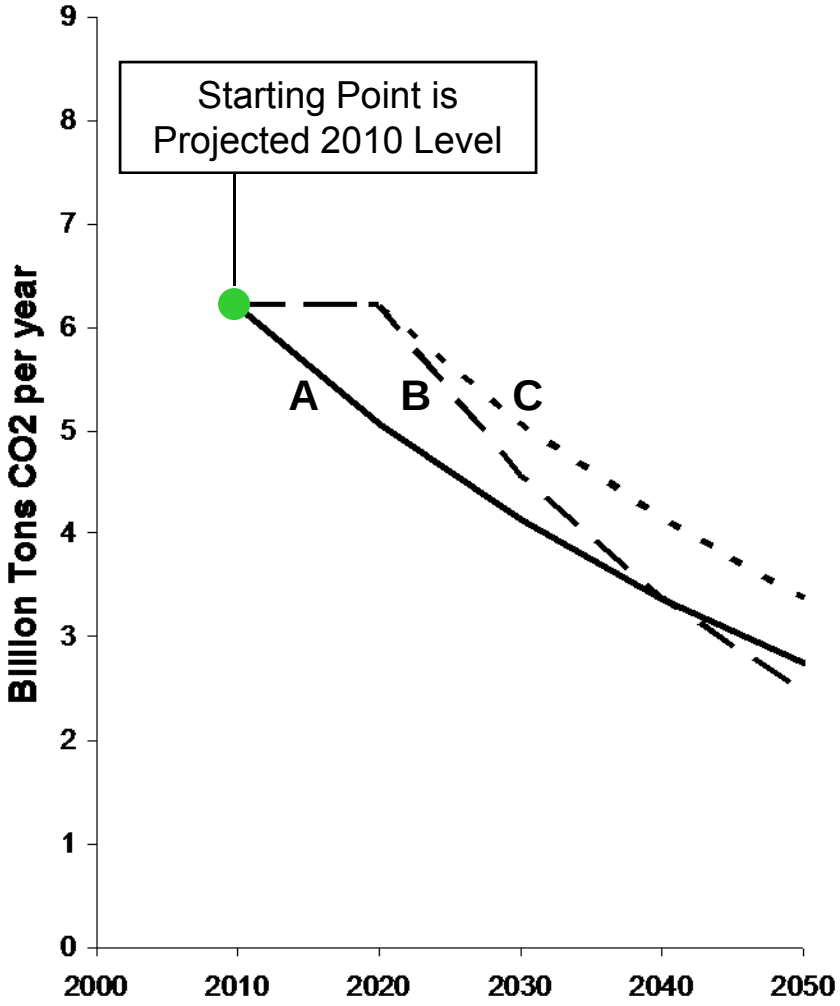
- What is the role of new technology in addressing climate change?
- Creation of technology scenarios in conjunction with EPRI experts (“Limited” vs. “Full Portfolio”)
- Use MERGE to demonstrate economic impact of the availability of advanced technology

= **Reduced cost of meeting a prescribed policy goal**

Technology Scenarios

	Limited Portfolio	Full Portfolio
Supply-Side		
Carbon Capture and Storage (CCS)	Unavailable	Available
New Nuclear	Existing Production Levels	Production Can Expand
Renewables	Costs Decline	Costs Decline Faster
New Coal and Gas	Improvements	Improvements
Demand-Side		
Plug-in Hybrid Electric Vehicles (PHEV)	Unavailable	Available
End-Use Efficiency	Improvements	Accelerated Improvements

Economy-Wide Policy Constraints on U.S. CO_2 Emissions



— Policy Constraint A:

- 2% Decline Beginning in 2010
- No "When" Flexibility

– – Policy Constraint B:

- 3% Decline beginning in 2020
- Limited "When" Flexibility

····· Policy Constraint C:

- 2% Decline beginning in 2020
- Limited "When" Flexibility
- Less Stringent Environmental Goal

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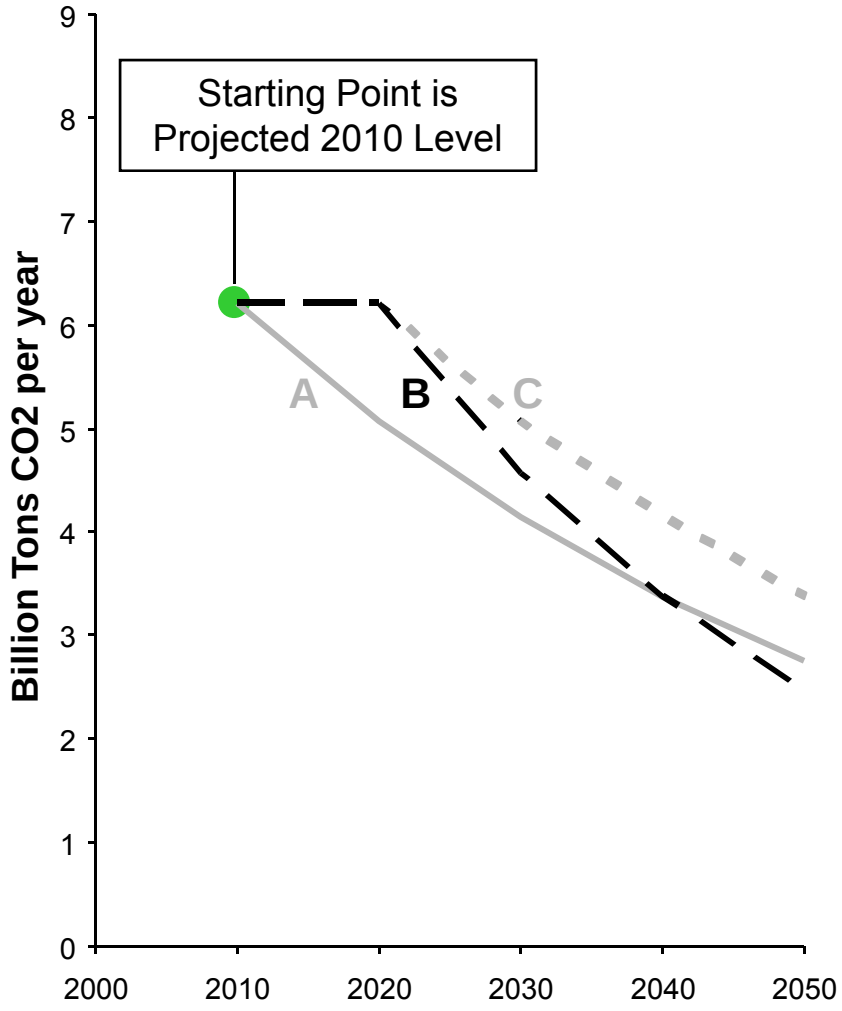

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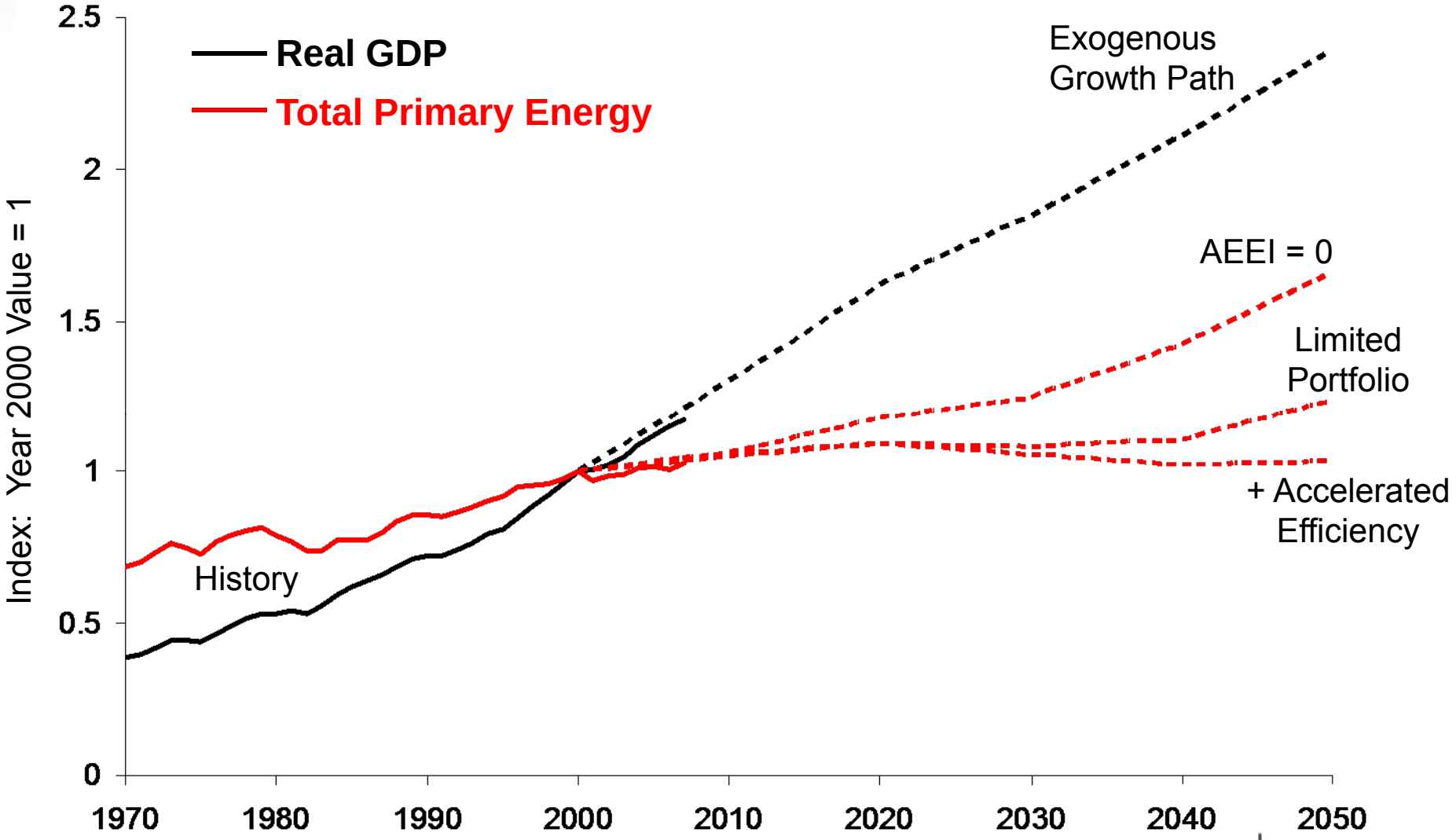
U.S. GDP and Total Primary Energy



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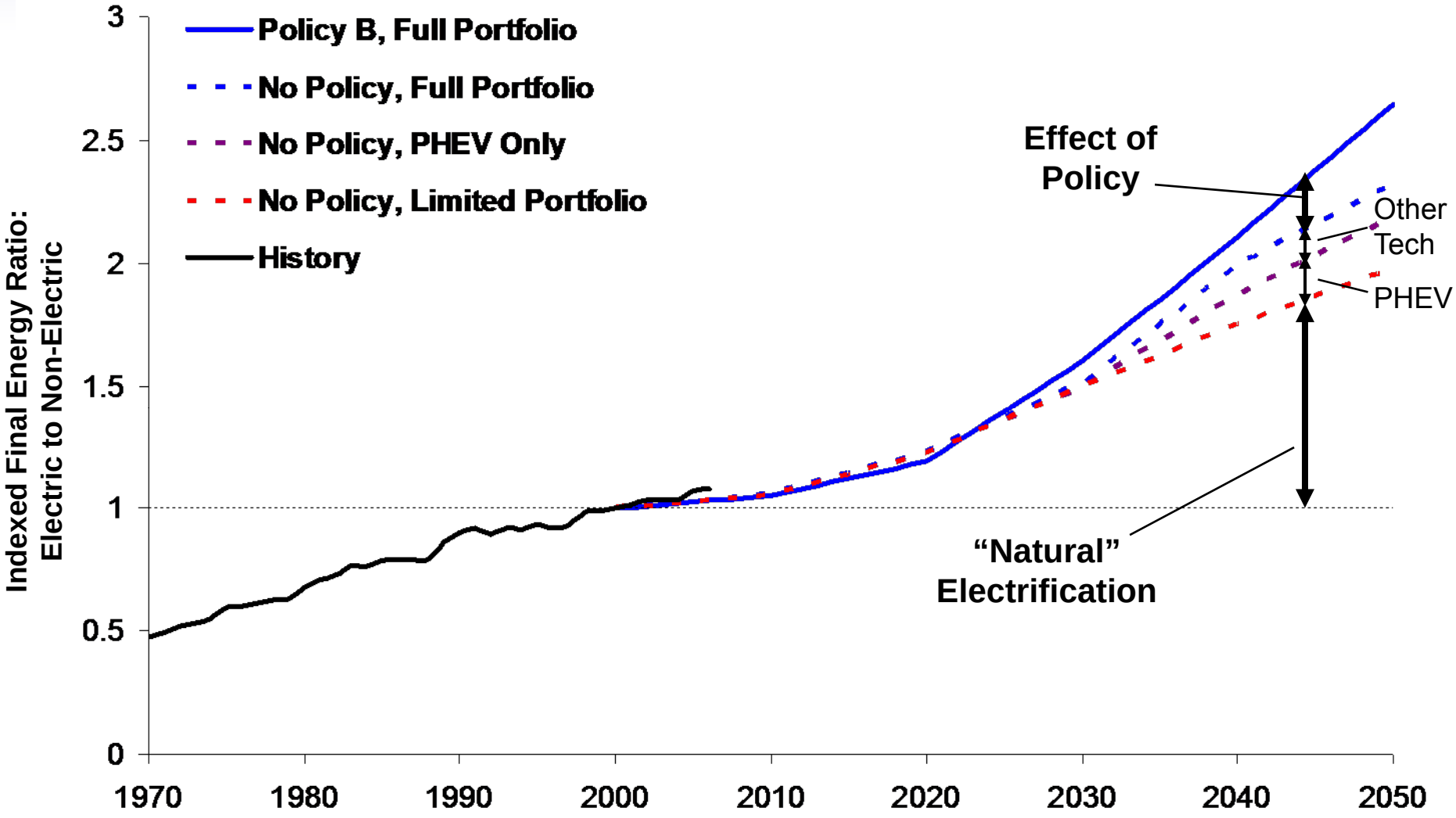
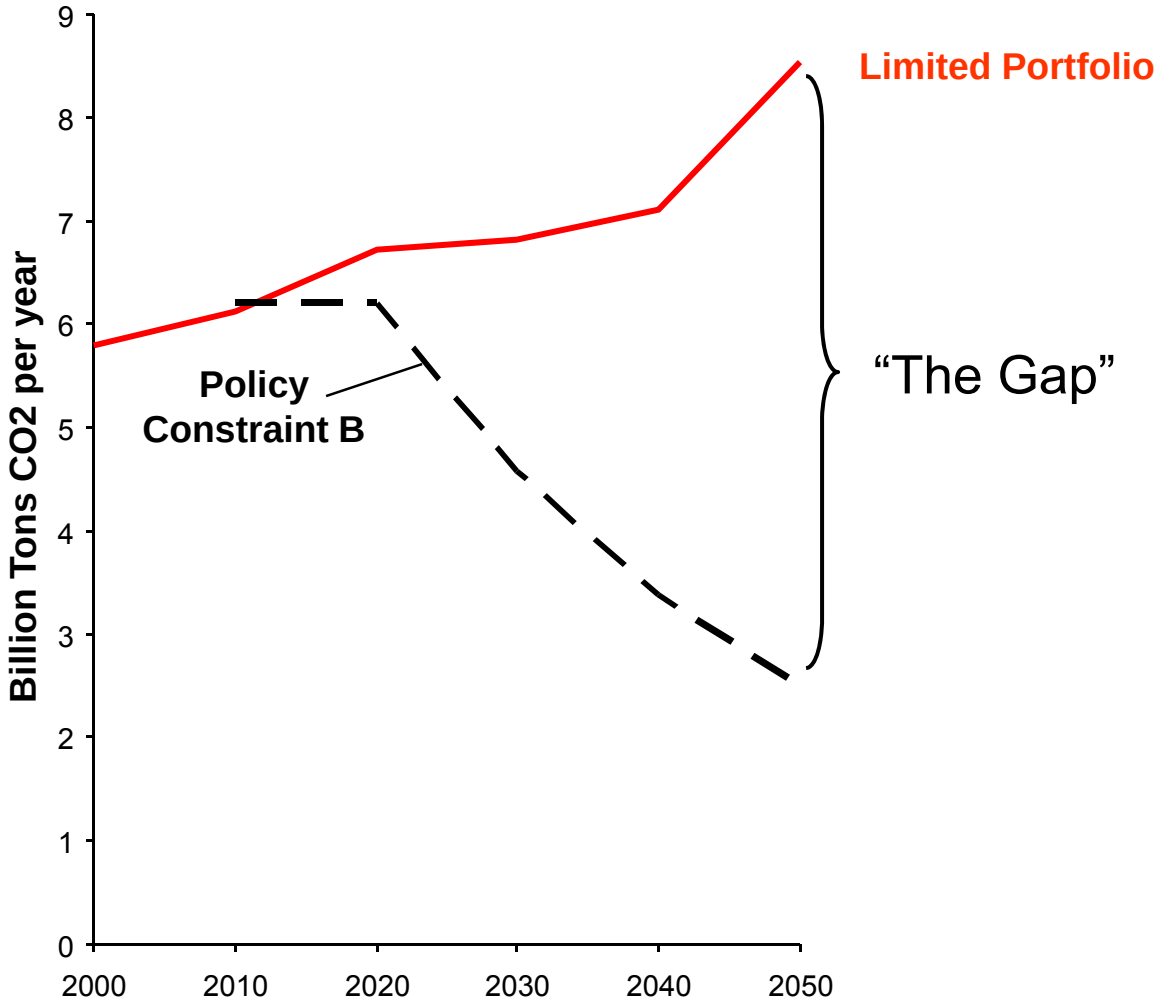
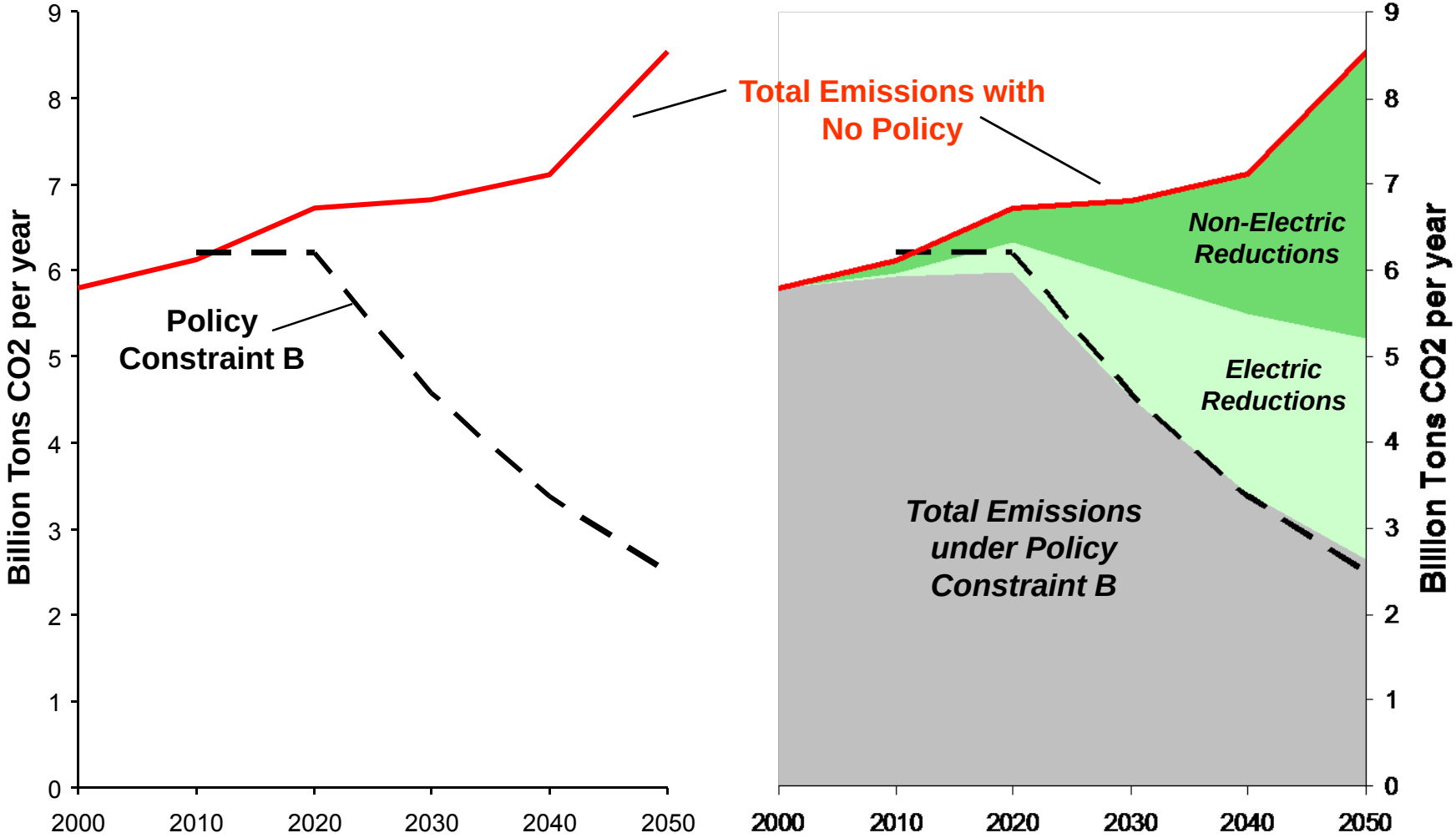
Electrification of U.S. Energy



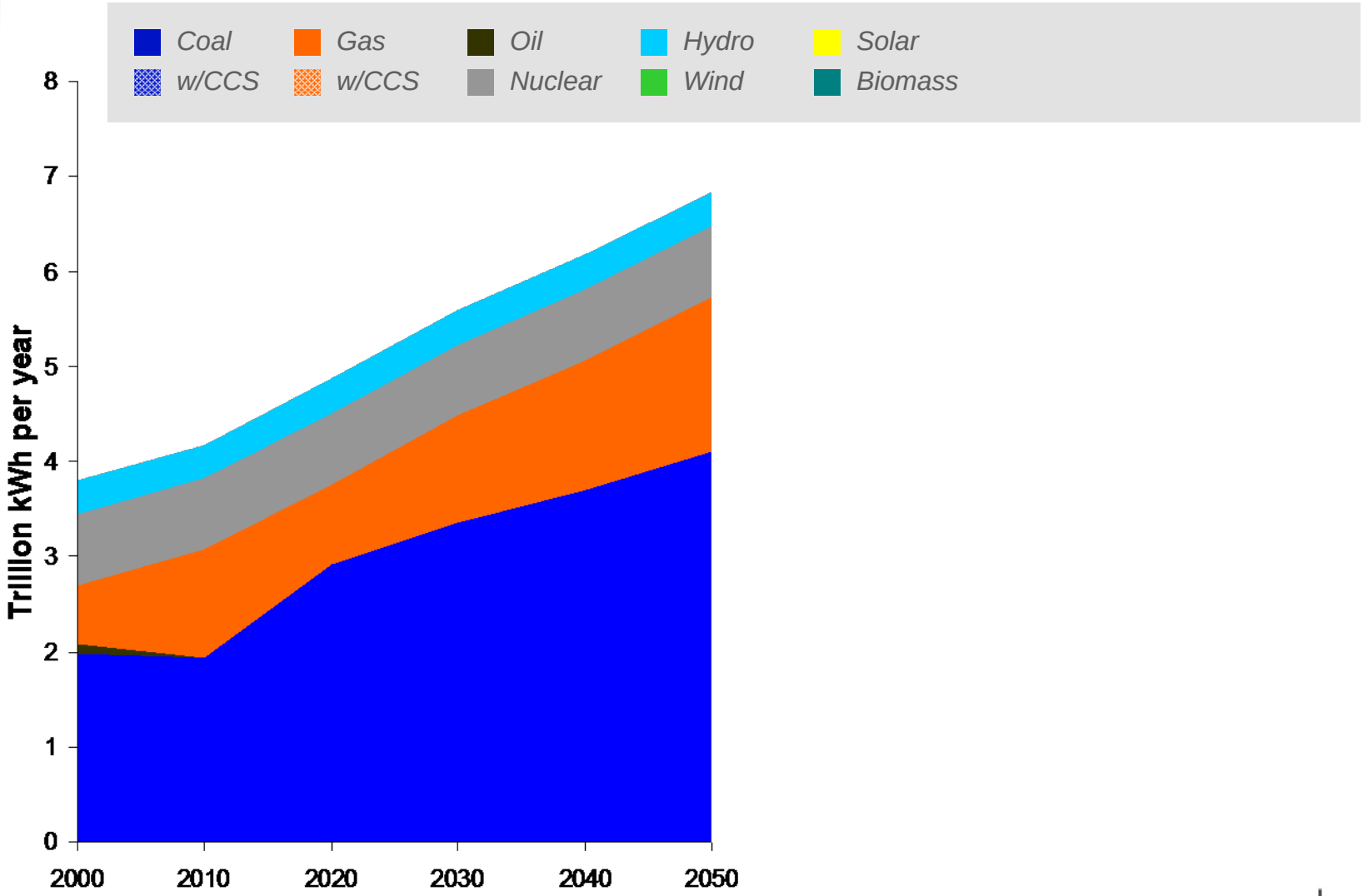
U.S. Total CO_2 Emissions: No Policy



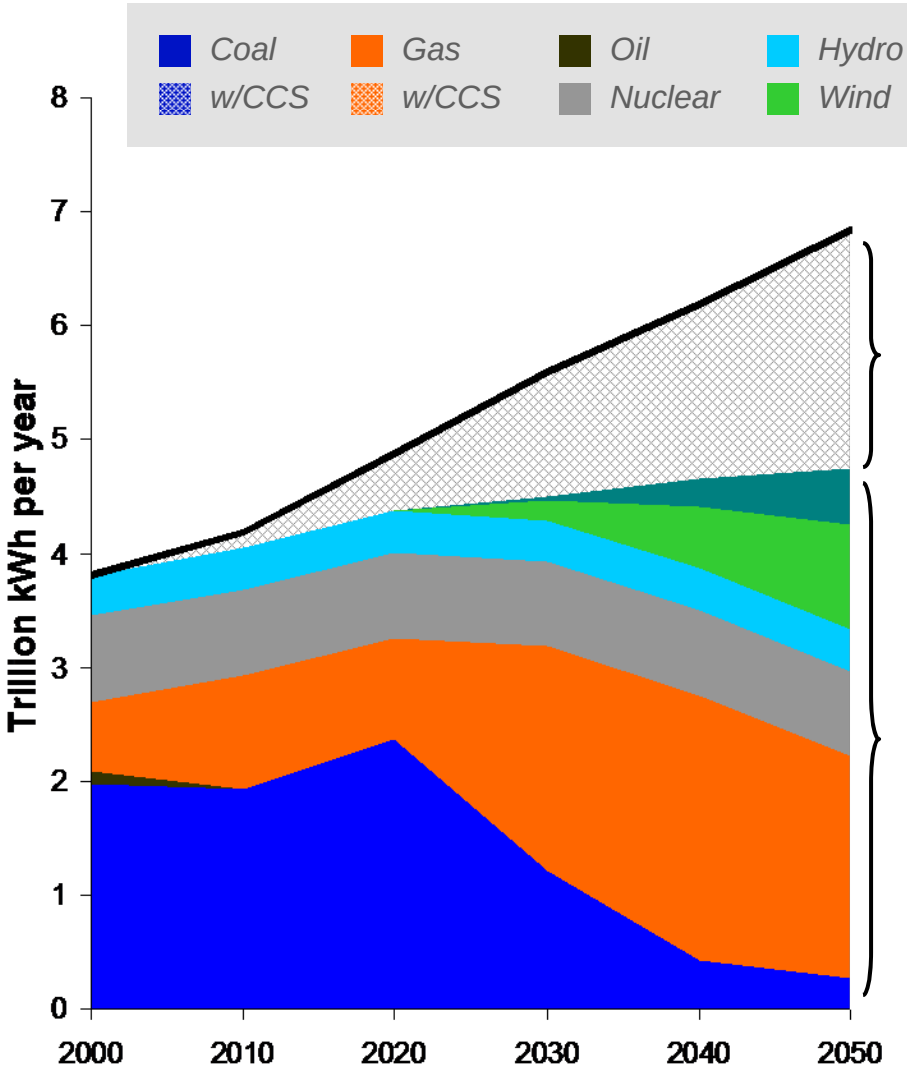
Closing The Gap with a Limited Portfolio



U.S. Electric Generation with Limited Portfolio (No Policy)



U.S. Electric Generation with Limited Portfolio (under Policy Constraint B)



Emissions are reduced in two ways:

- Carbon penalty drives price up, demand down

High Cost to Economy

- Supply shifts to less carbon-intensive technologies

Limited without R&D

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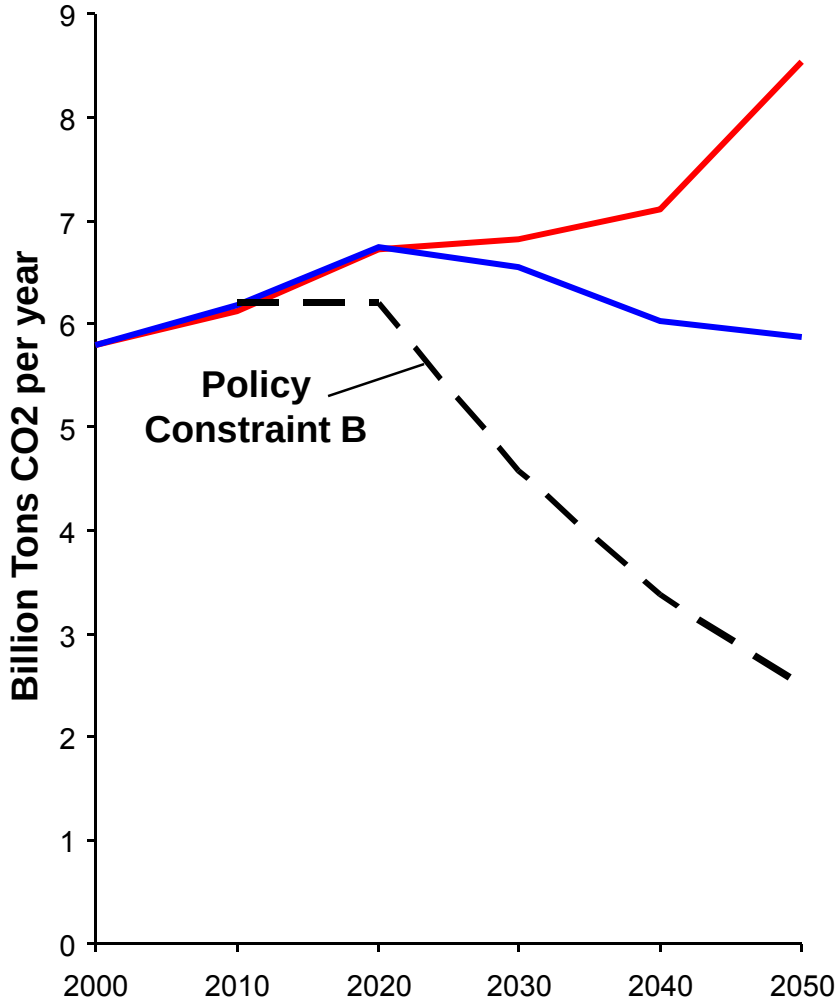
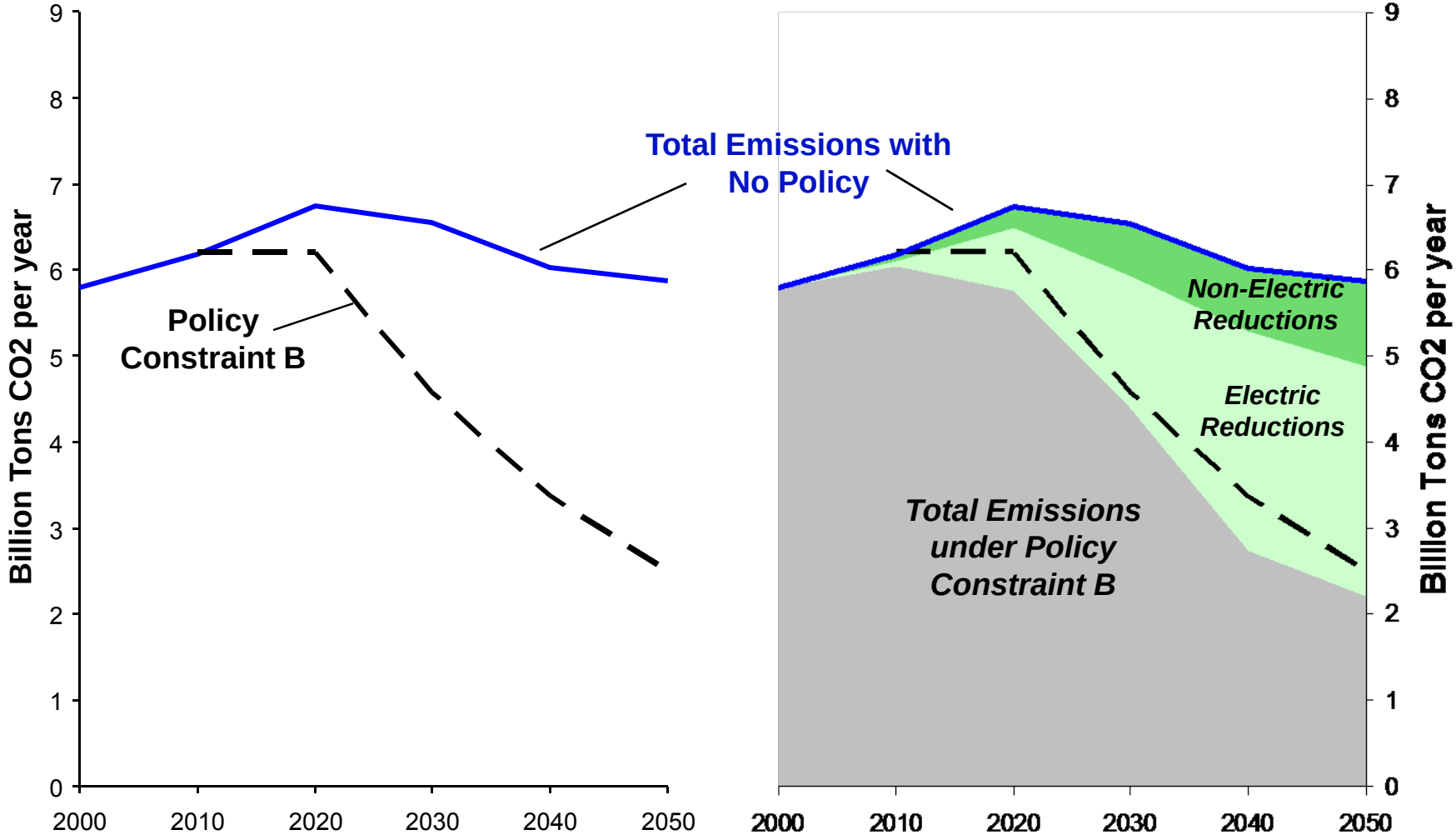


1. New technology narrows "The Gap"… (but doesn't close it)

2. New technology makes the remainder cheaper to close… (with the help of a price incentive)

Closing The Gap with a Full Portfolio



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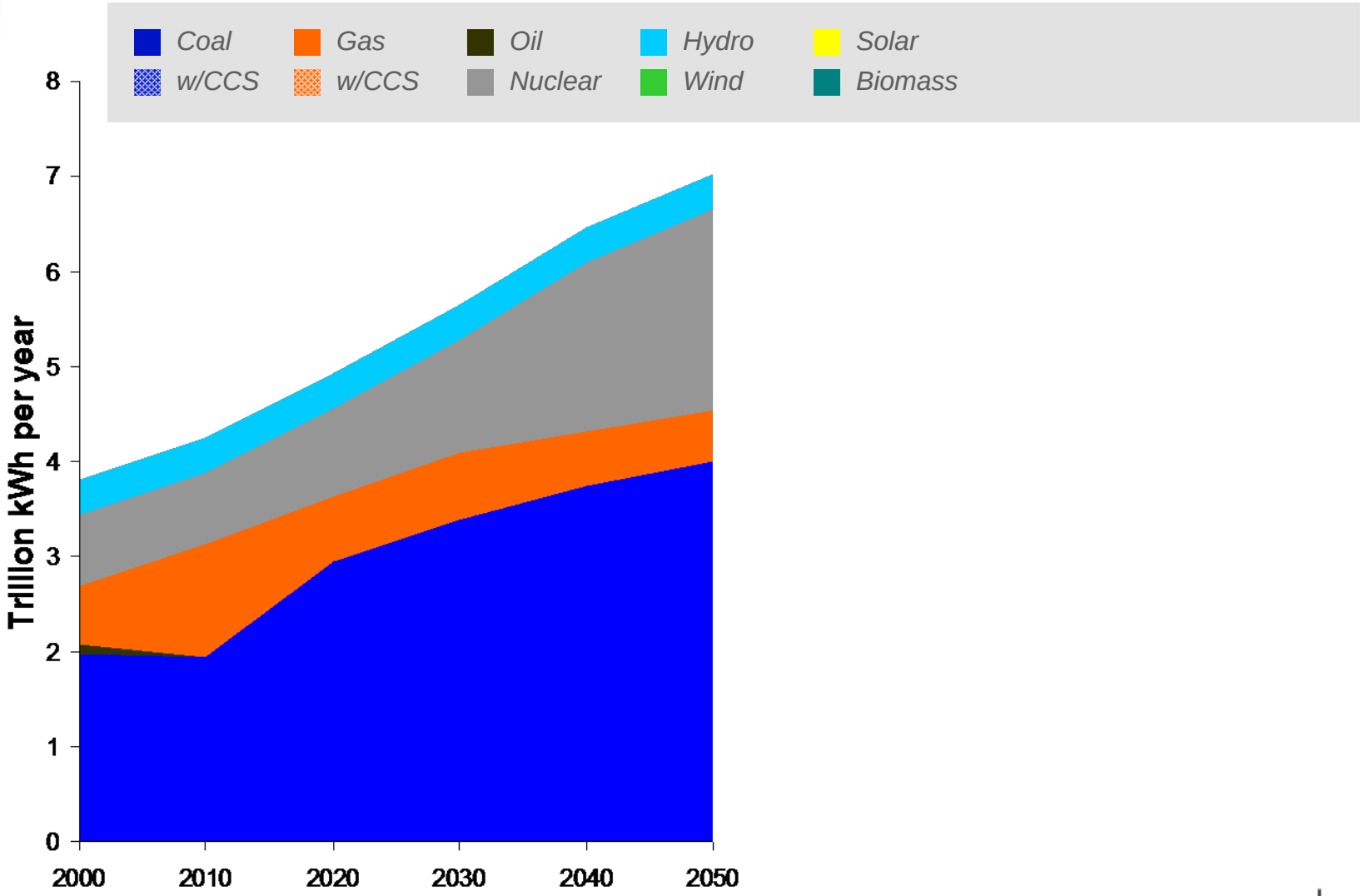
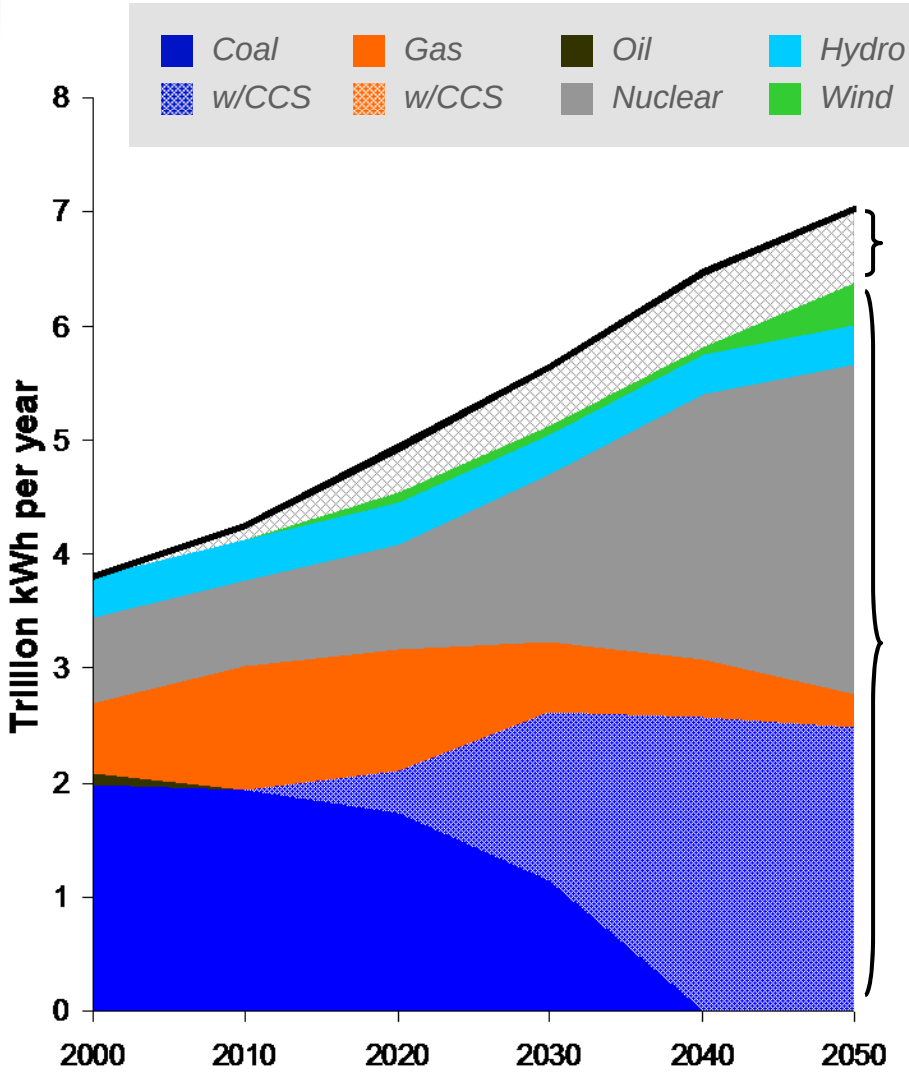
U.S. Electric Generation with Full Portfolio (No Policy)



U.S. Electric Generation with Full Portfolio (under Policy Constraint B)



- Demand reduction is limited, reducing deadweight loss cost to economy

- Availability of CCS and expanded nuclear allow large-scale low-carbon generation

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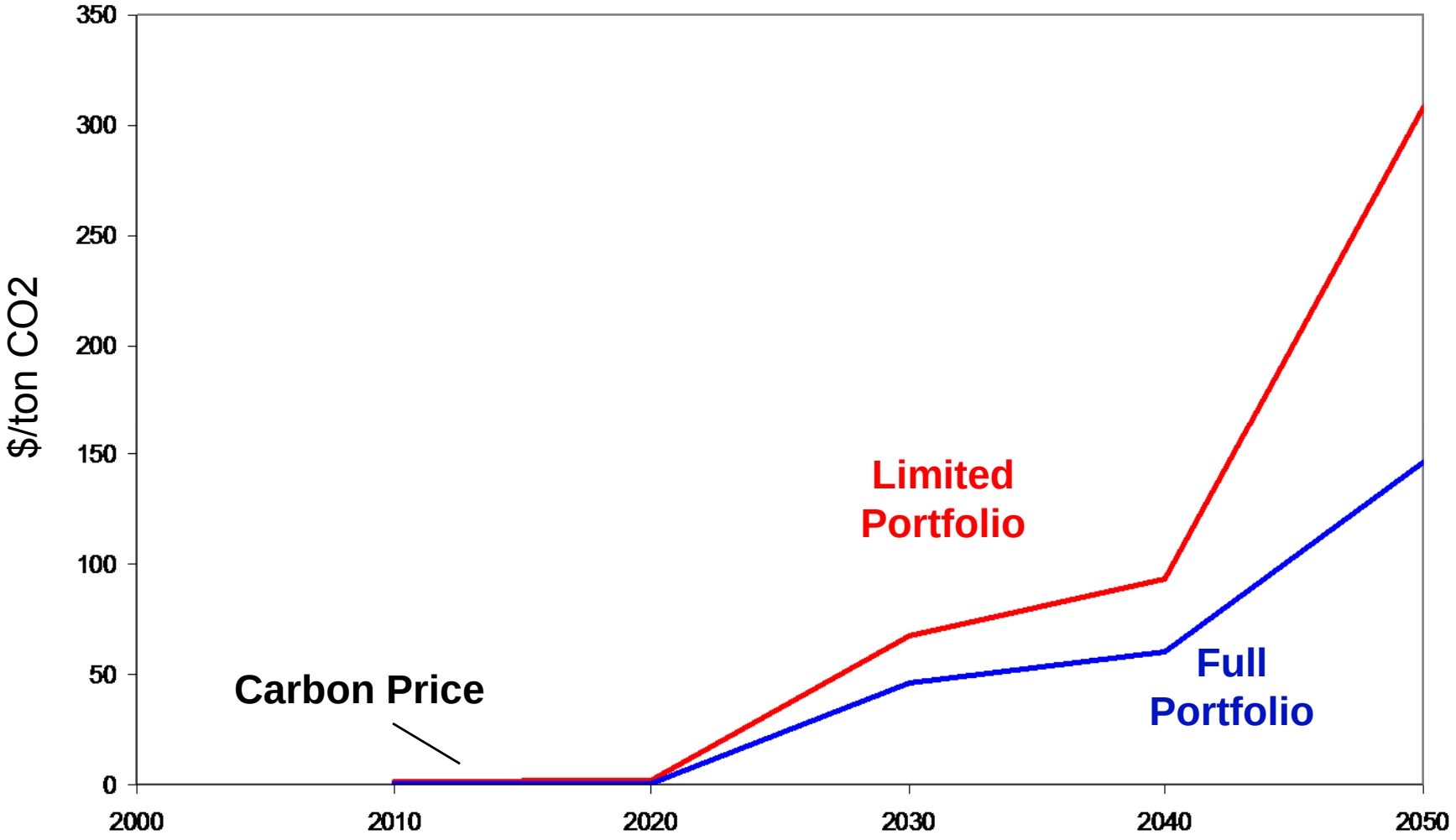
Market Prices under Policy Constraint B in Real (inflation-adjusted) 2000$



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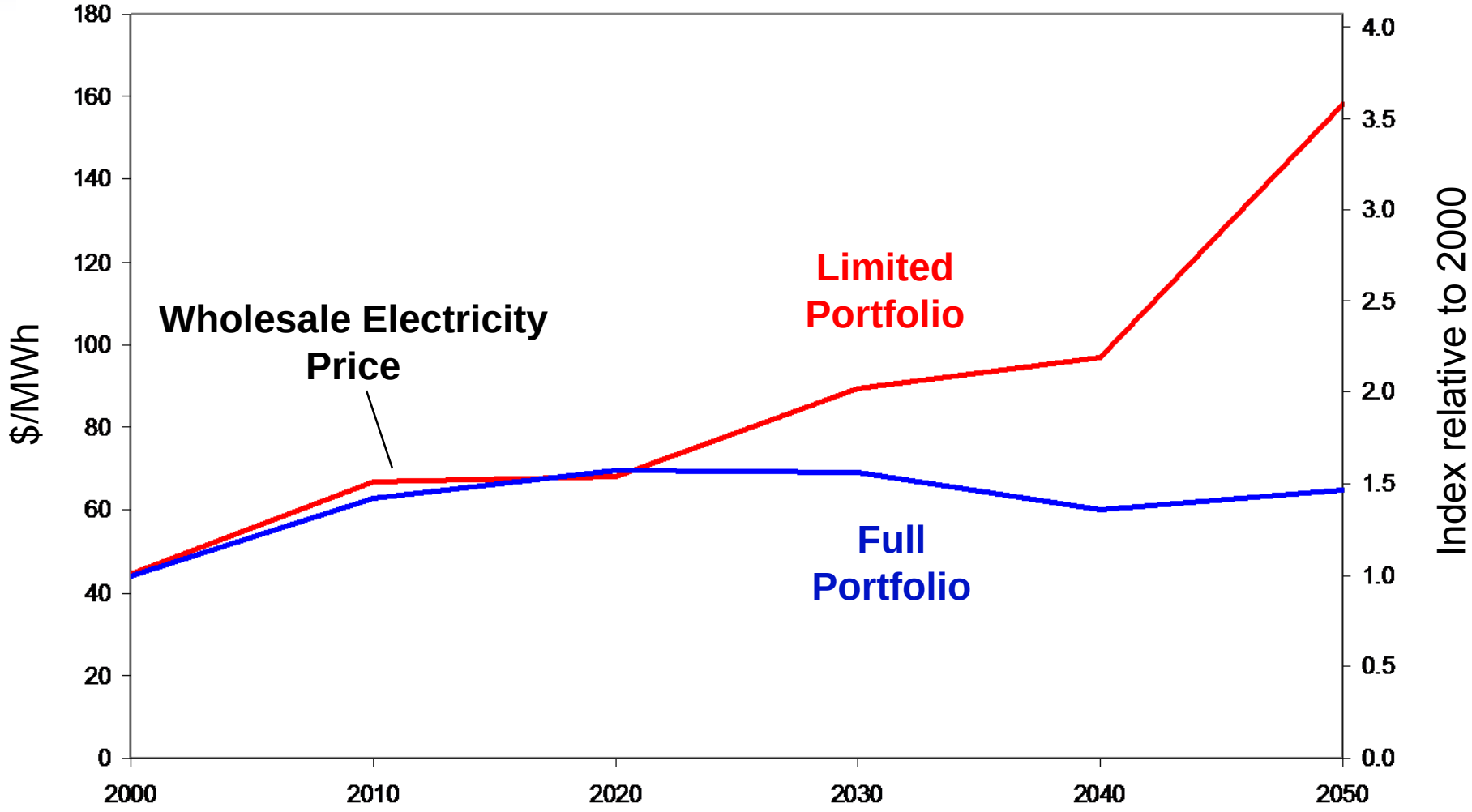
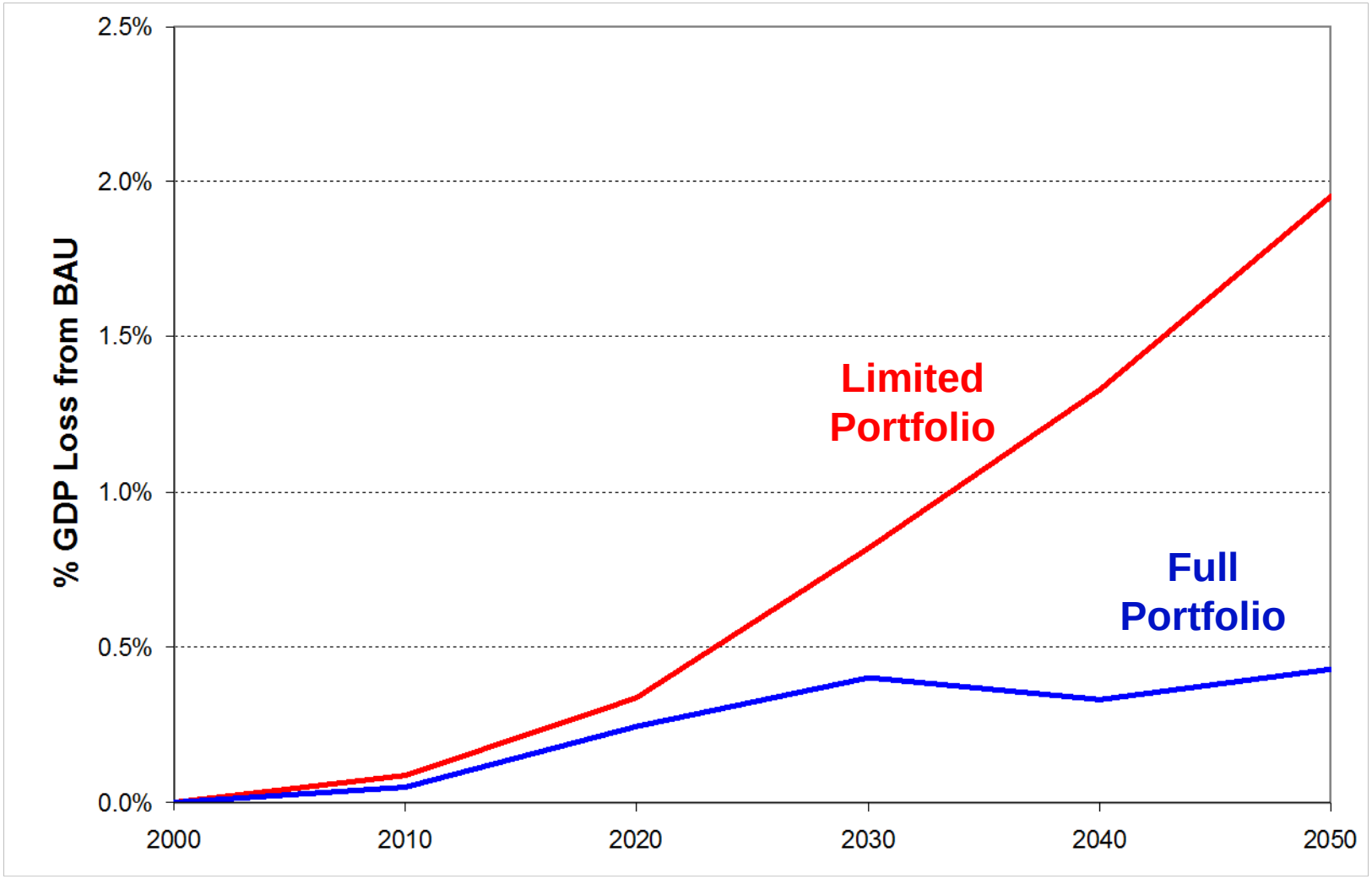


Impact on U.S. Economy of Policy Constraint B



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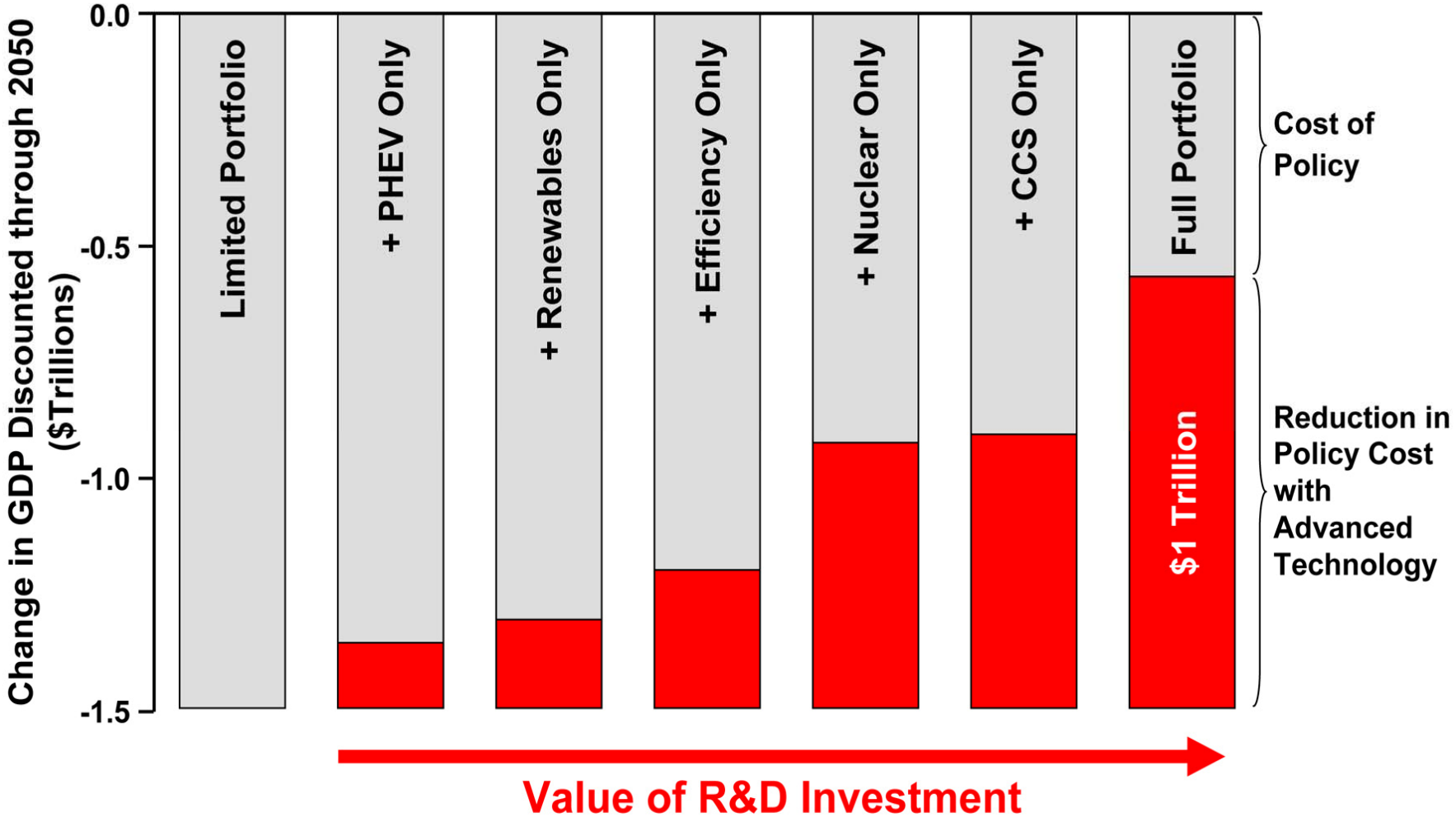

(In Year 2000 $)

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New MERGE developments since this study

- Completed or underway
  - Update of base year and growth rates
  - Flexible regional aggregation
  - Transportation services model

- Planned for 2009
  - Land use model (with revised carbon cycle)
  - Update of technology characterization in other regions
  - More detail in other end-uses
  - Re-evaluation of damage function