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Managing the Transition to Climate Stabilization

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EMF 22 Working Group Meeting,

Tsukuba, Japan, December 12-14, 2006

Participants in CCSP

- MIT (IGSM – Integrated Global Systems Model)
  - Henry (Jake) Jacoby
  - John Reilly
- PNNL (MiniCAM – Mini Climate Assessment Model)
  - James (Jae) Edmonds
  - Hugh Pitcher
- EPRI (MERGE Model for Evaluating Regional and Global Effects of greenhouse gas reductions)
  - Richard Richels
- Coordinator
  - Leon Clarke

CCSP Study Design

- All models assume existing climate mitigation programs (Kyoto, U.S. intensity target) but then assume perfect “what” “where” and “when” flexibility going forward.
- Assumptions (e.g., population, economic growth, technological change) developed individually by the modeling teams.
- No likelihoods assigned to any scenarios or parameters.
  - Teams directed to develop assumptions they consider “plausible” and “meaningful”.
  - These are not the only sets of assumptions that these three modeling teams could have developed.

CCSP Study Design

- Develop Reference (Business as Usual) Case
- Stabilize total radiative forcing from CO_2, N_2O, CH_4, HFCs, PFCs, and SF_6

- **Four stabilization scenarios** roughly consistent with 450 ppmv through 750 ppmv CO2, along with one reference case.

Stabilization Level	Long-Term Radiative Forcing Limit (Wm^{-2} relative to pre-industrial)	Approximate 2100 CO_2 Limit (ppmv)
Level 4	6.7	750
Level 3	5.8	650
Level 2	4.7	550
Level 1	3.4	450

Goal of Present Study

- To extend earlier work done as part of US Climate Change Science Program
- Provide sensitivity analysis focusing on:
  - Policy design
  - Near-term transition constraints
  - Coalition membership
  - Technology availability

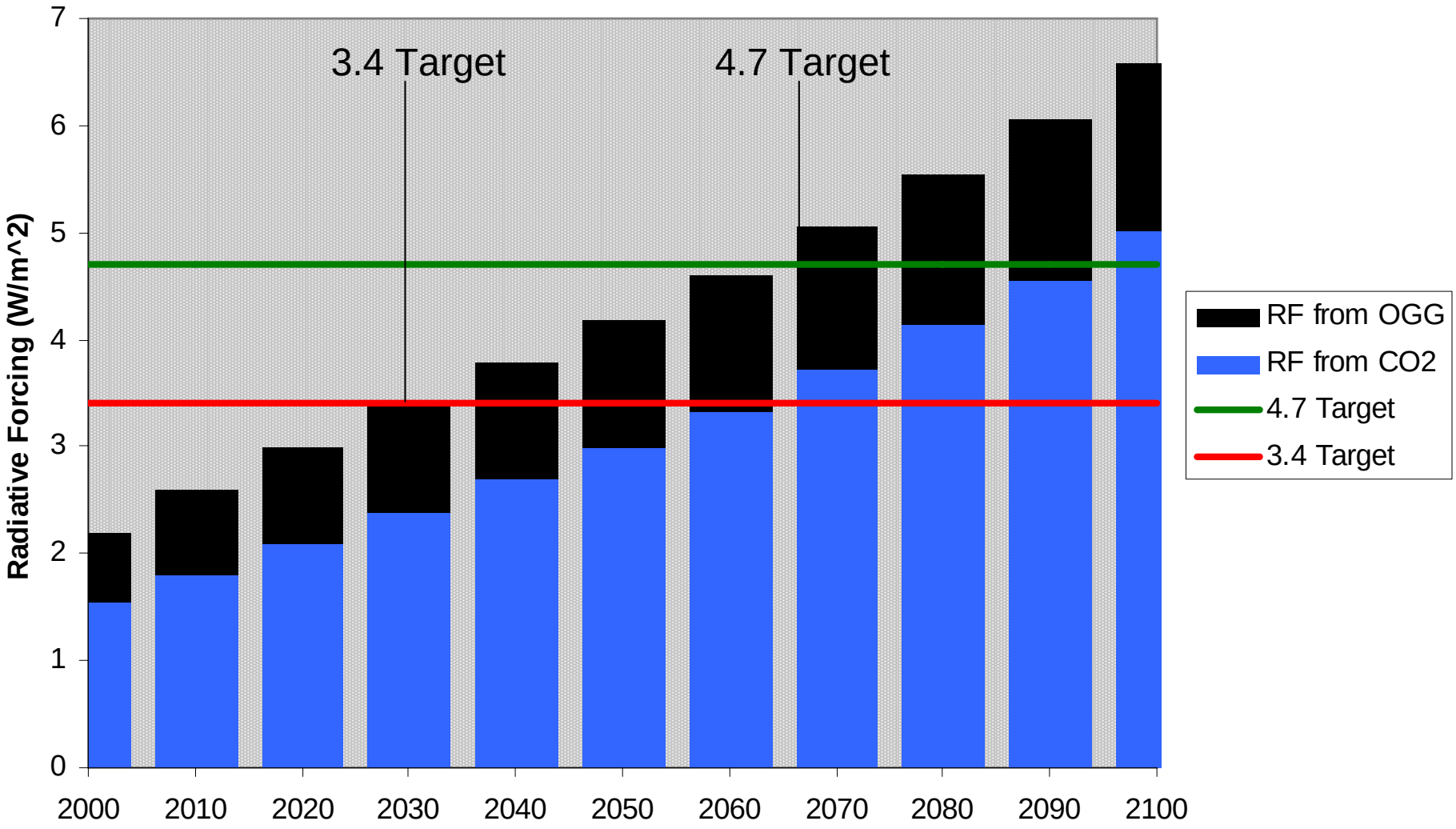
Overview of MERGE 5.5

- Intertemporal optimization model with 200 year timeframe
- Each region maximizes its own utility
- Prices of each GHG determined endogenously, i.e. no GWPs
- Top down model of economic growth
- Process model of energy sector, with **new additions**:
  - CCS Technologies
    - Existing plants
    - New plants
  - Considers market *and* nonmarket costs of nuclear power

CAVEAT:

THIS IS *NOT* A COST BENEFIT ANALYSIS

Reference Case Radiative Forcing



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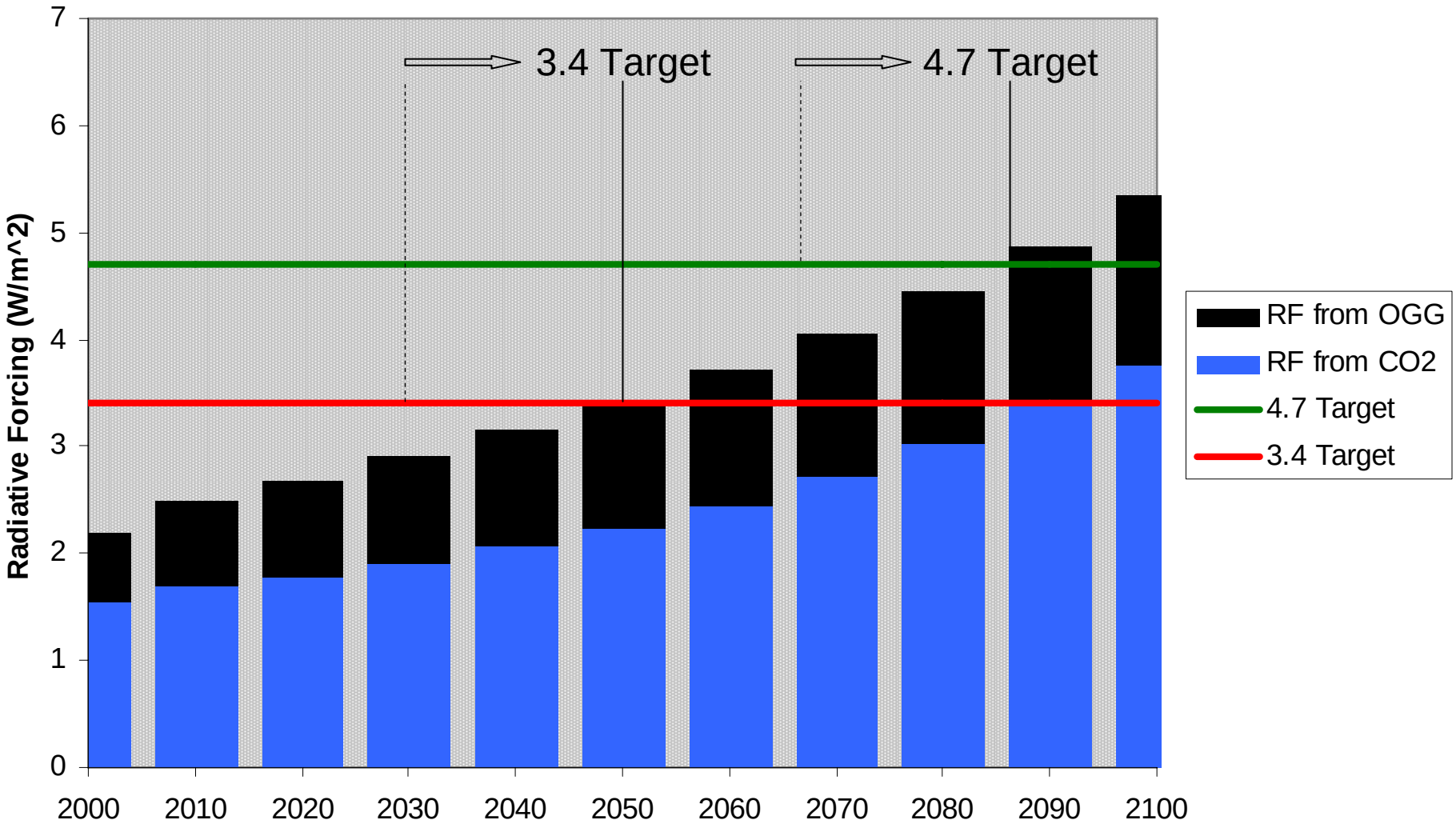
Reference *without* Annex B Emissions



Two Policy Scenarios

- "First Best" (1B):

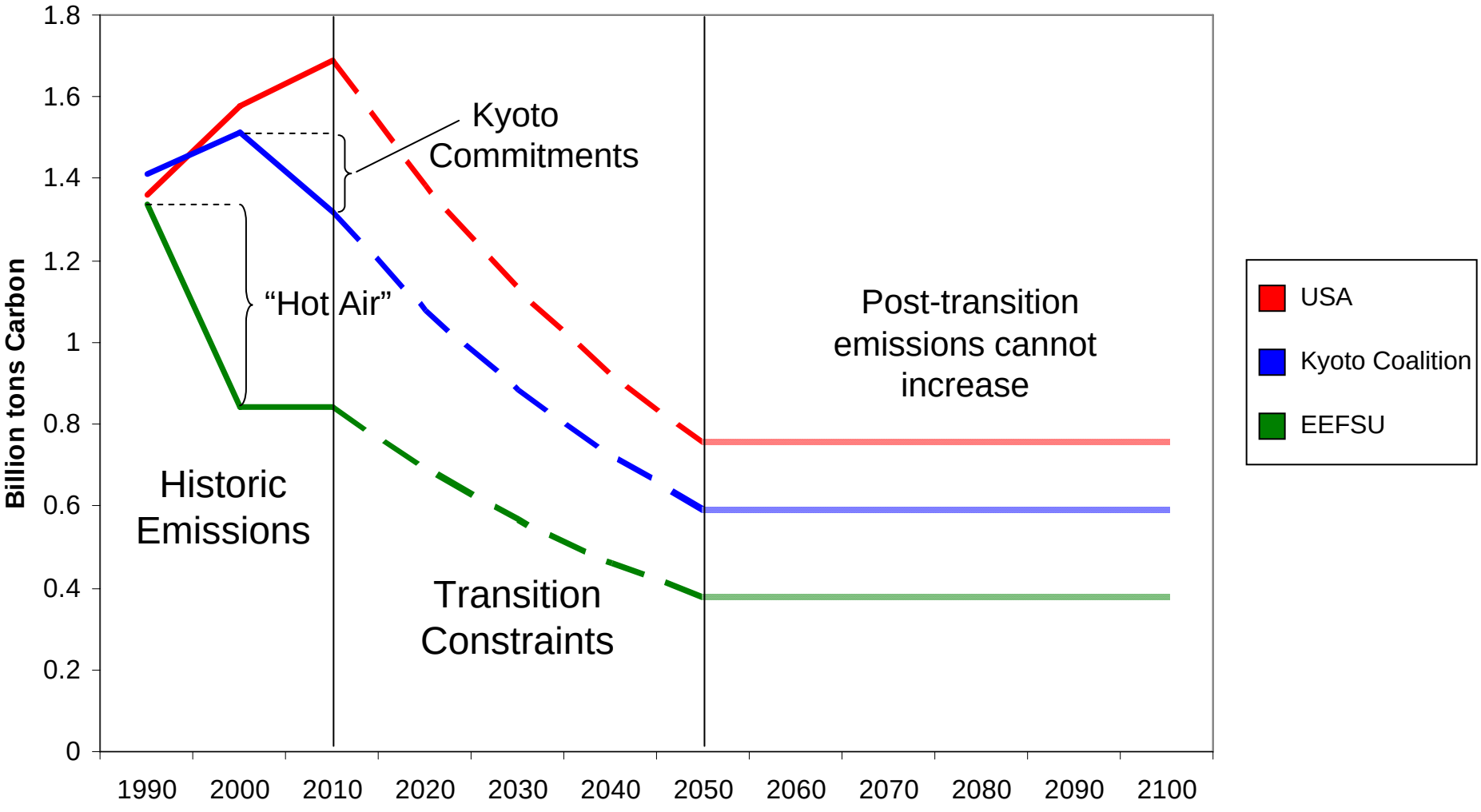
  When and where flexibility (except in 2010)

- "Third Best" (3B):

  Near-term transition constraints on Annex B countries
  Non-Annex B does not participate in near-term

3B Designed to Reflect Realistic Policies

3B Transition Constraints for Annex B



Two Technology Scenarios

- "Optimistic":

  All technologies available

- "Pessimistic":

  New nuclear and carbon capture and sequestration (CCS) are not available in electric sector

Electricity Generation Technologies in MERGE 5.5

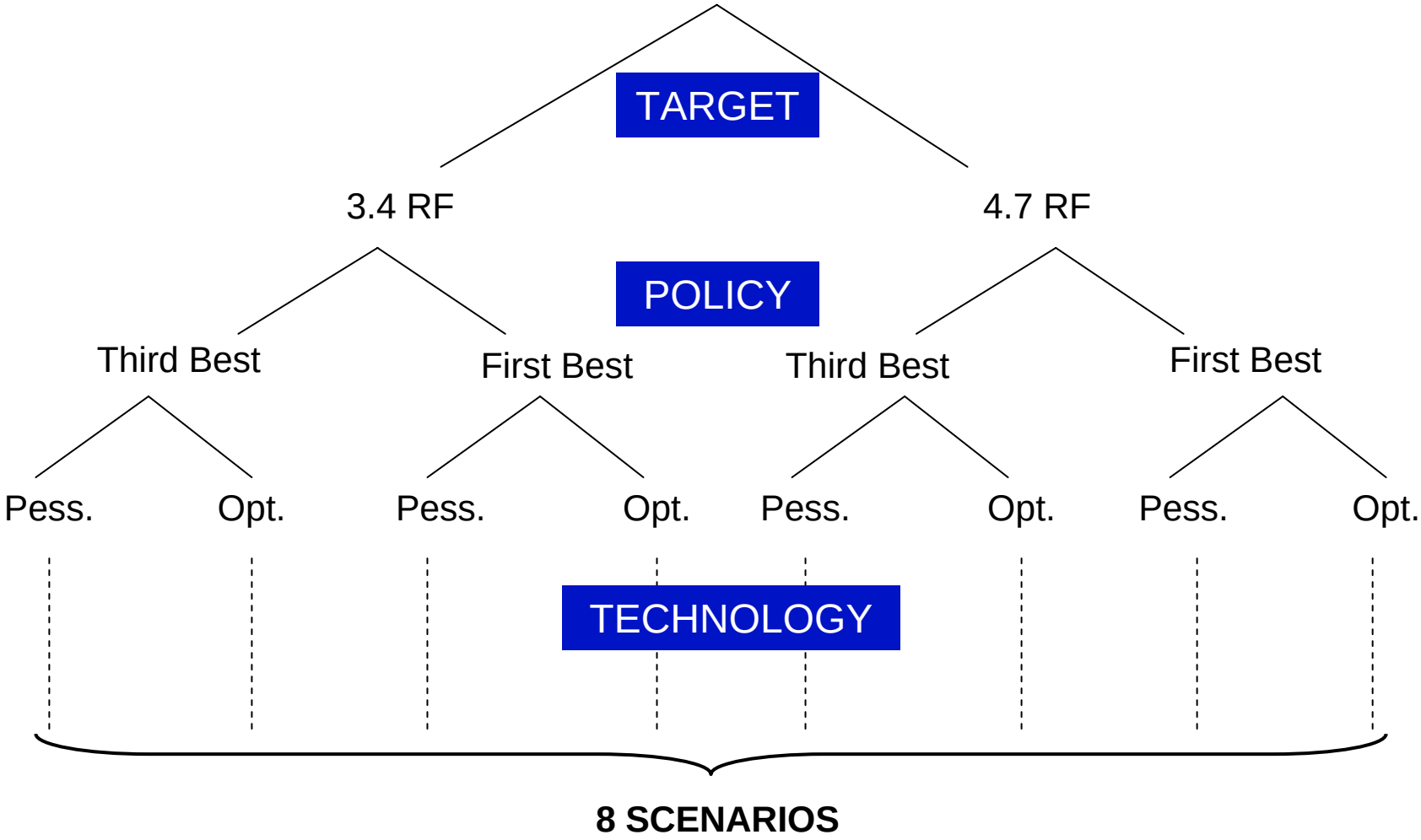
Technology	Description
HYDRO	Hydroelectric
NUC-R	Remaining initial nuclear
GAS-R	Remaining initial gas-fired
OIL-R	Remaining initial oil-fired
COAL-R	Remaining initial coal-fired
NUC-N	New nuclear
GAS-N	Advanced combined-cycle
COAL-N	Pulverized coal without CO_2 recovery
RNW-LC	Low-cost carbon-free technologies (quantity constrained)
RNW-HC	High-cost carbon-free technologies (unlimited quantity)
GAS-NCS	**New gas with carbon capture and sequestration**
COAL-NCS	**New coal with carbon capture and sequestration**
COAL-RCS	**Remaining coal with carbon capture and sequestration**

Non-electric Energy Supplies in MERGE 5.5

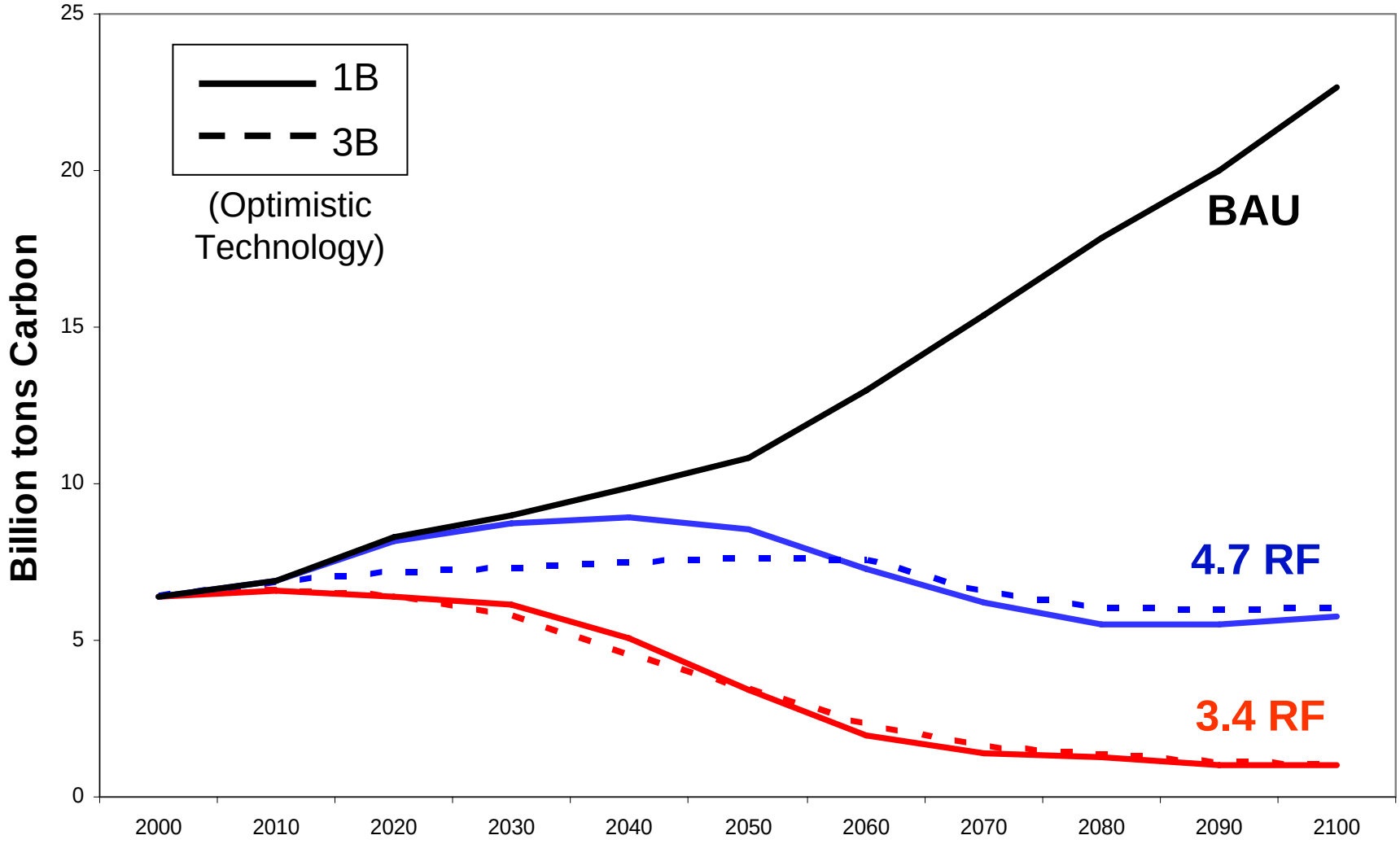
Technology	Description
CLDU	Coal – direct uses
OILNON	Oil (10 cost categories)
GASNON	Gas (10 cost categories)
BFUEL	Biofuels (ethanol, biodiesel, etc.)
SYNF	Synfuels (coal to liquids)
RNW-NE	Non-electric high-cost carbon-free technologies (unlimited quantity)

Reference Case Relies Heavily on Synfuels

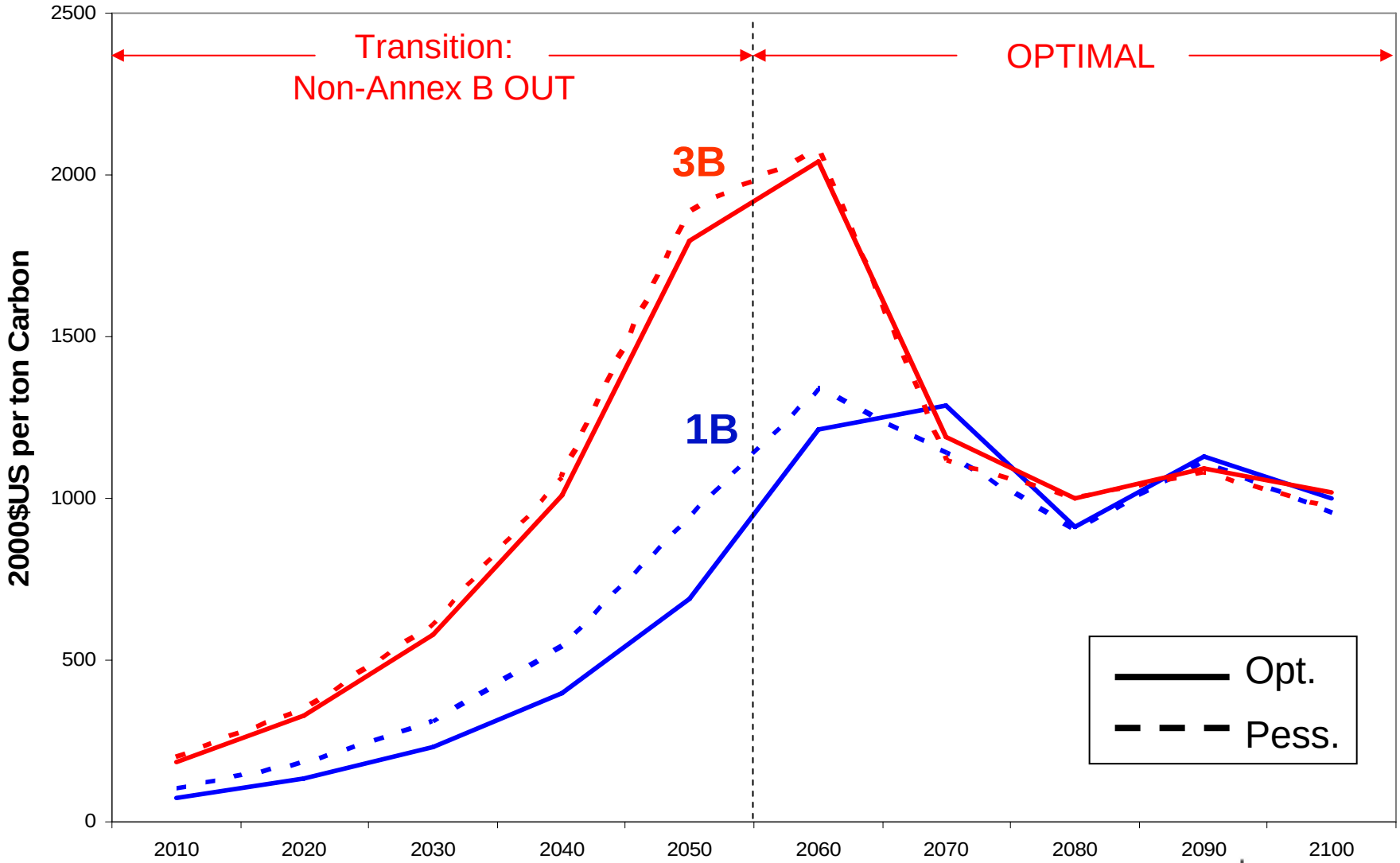
Scenario Design



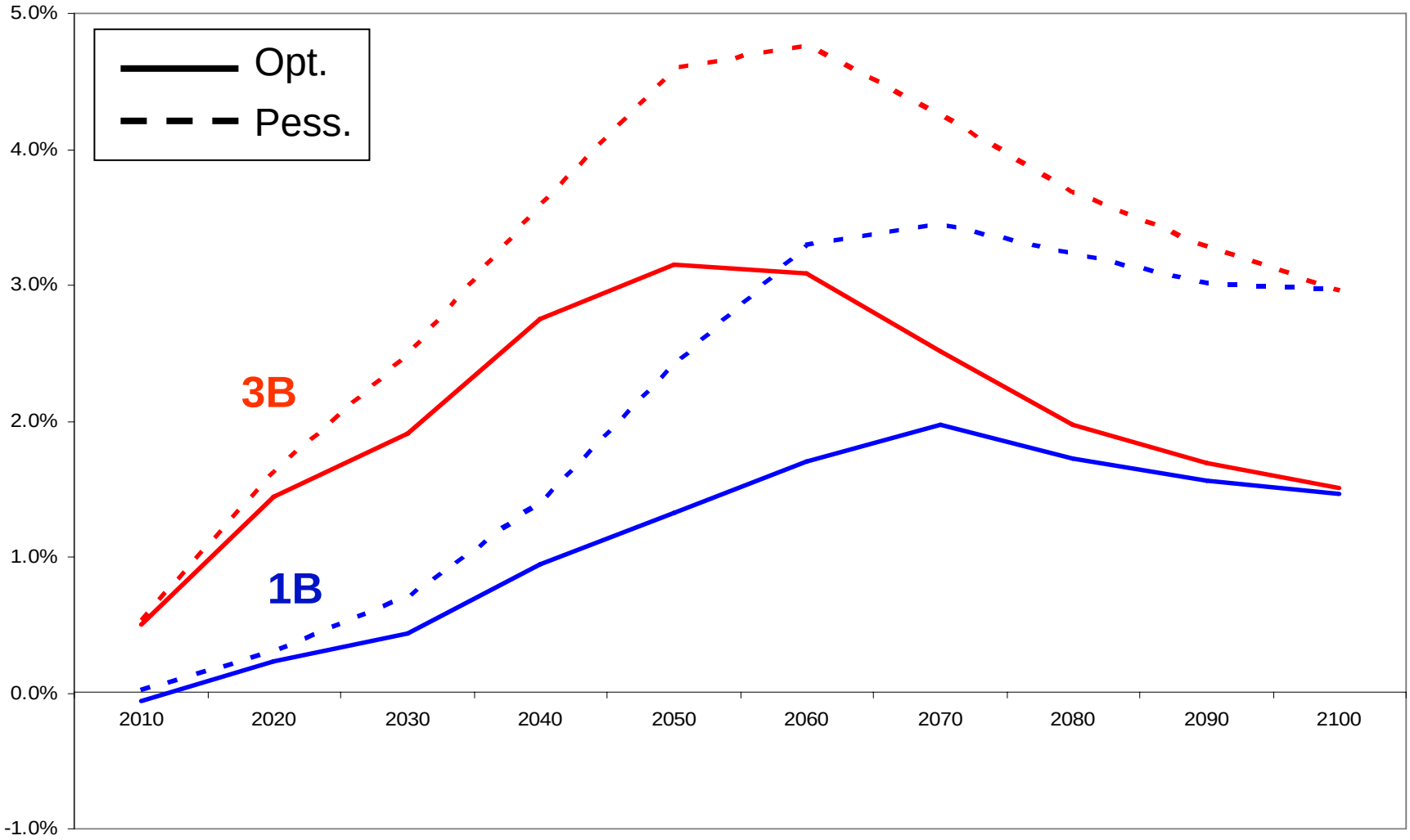
Global Carbon Emissions



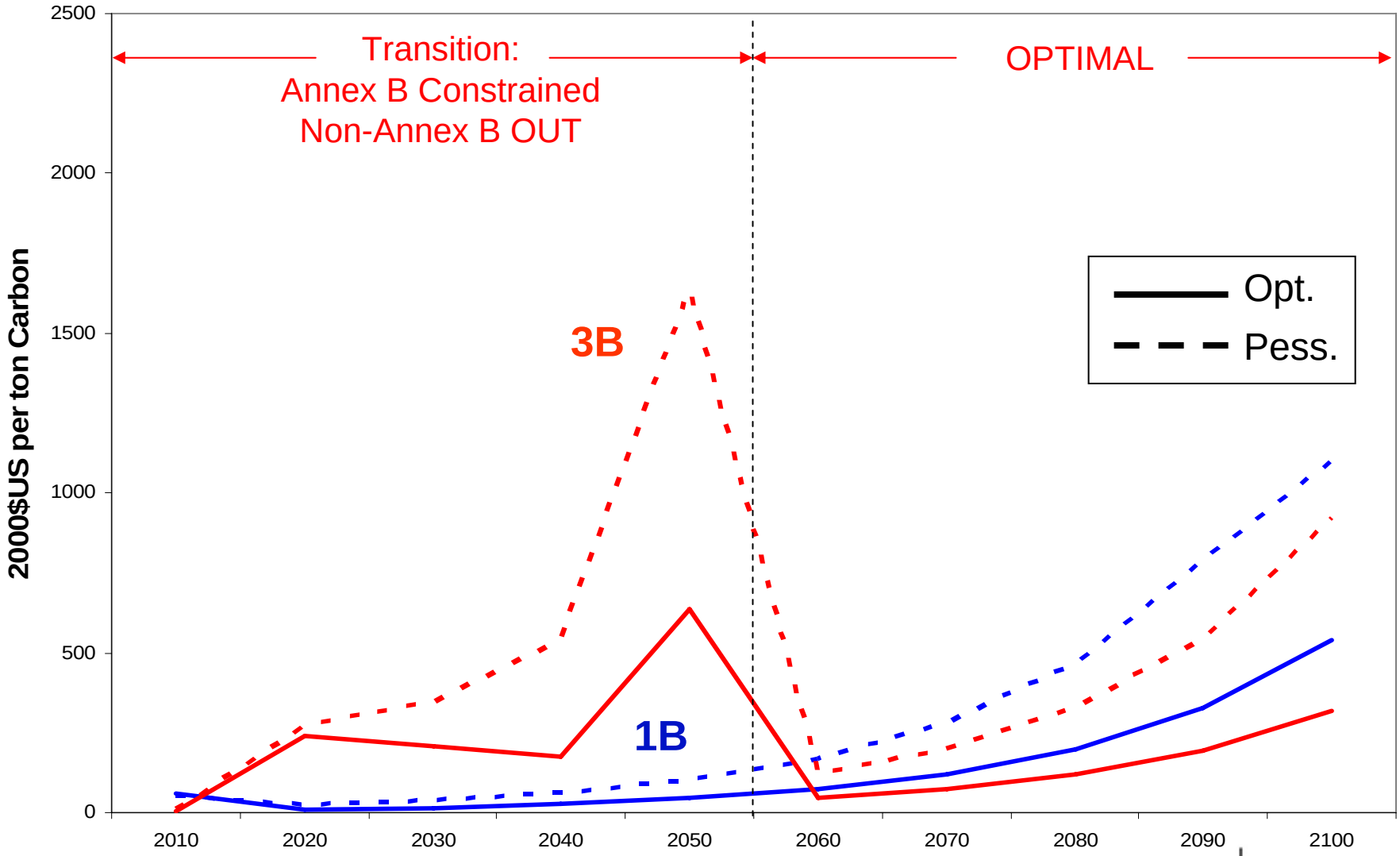
Annex B Carbon Price with 3.4 RF Target



USA GDP Loss from Reference with 3.4 RF Target



Annex B Carbon Price with 4.7 RF Target



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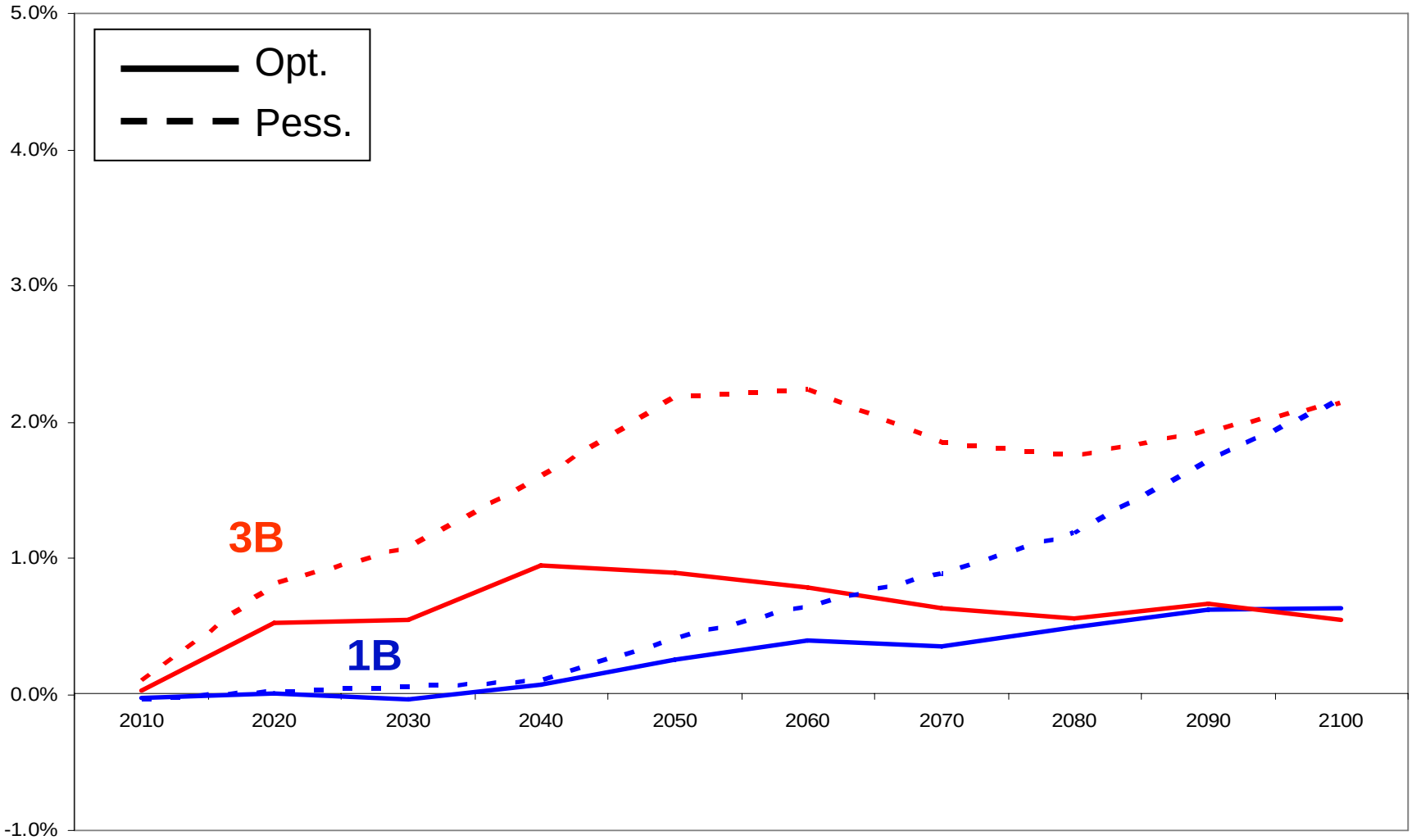
USA GDP Loss from Reference with 4.7 RF Target



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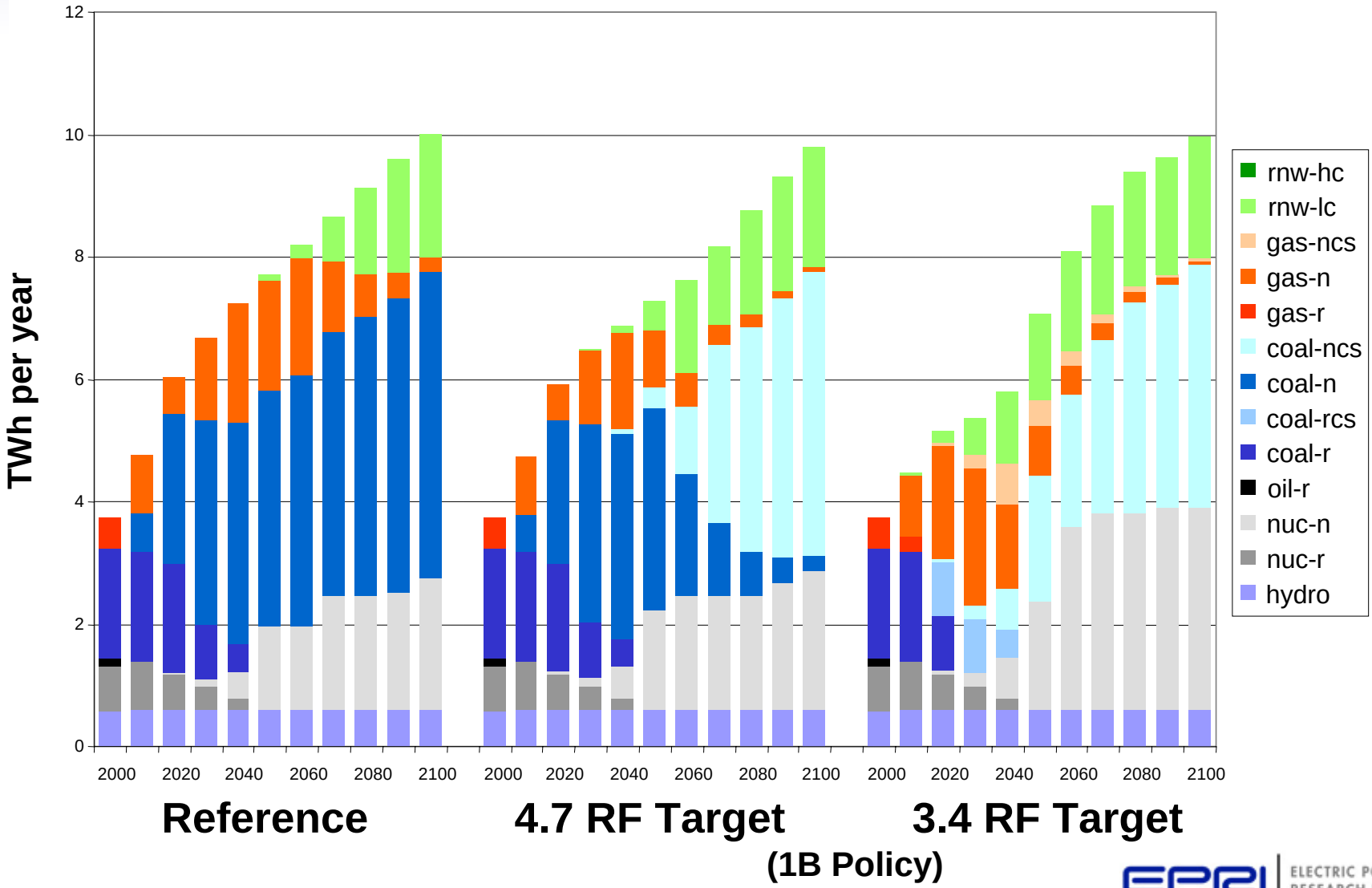
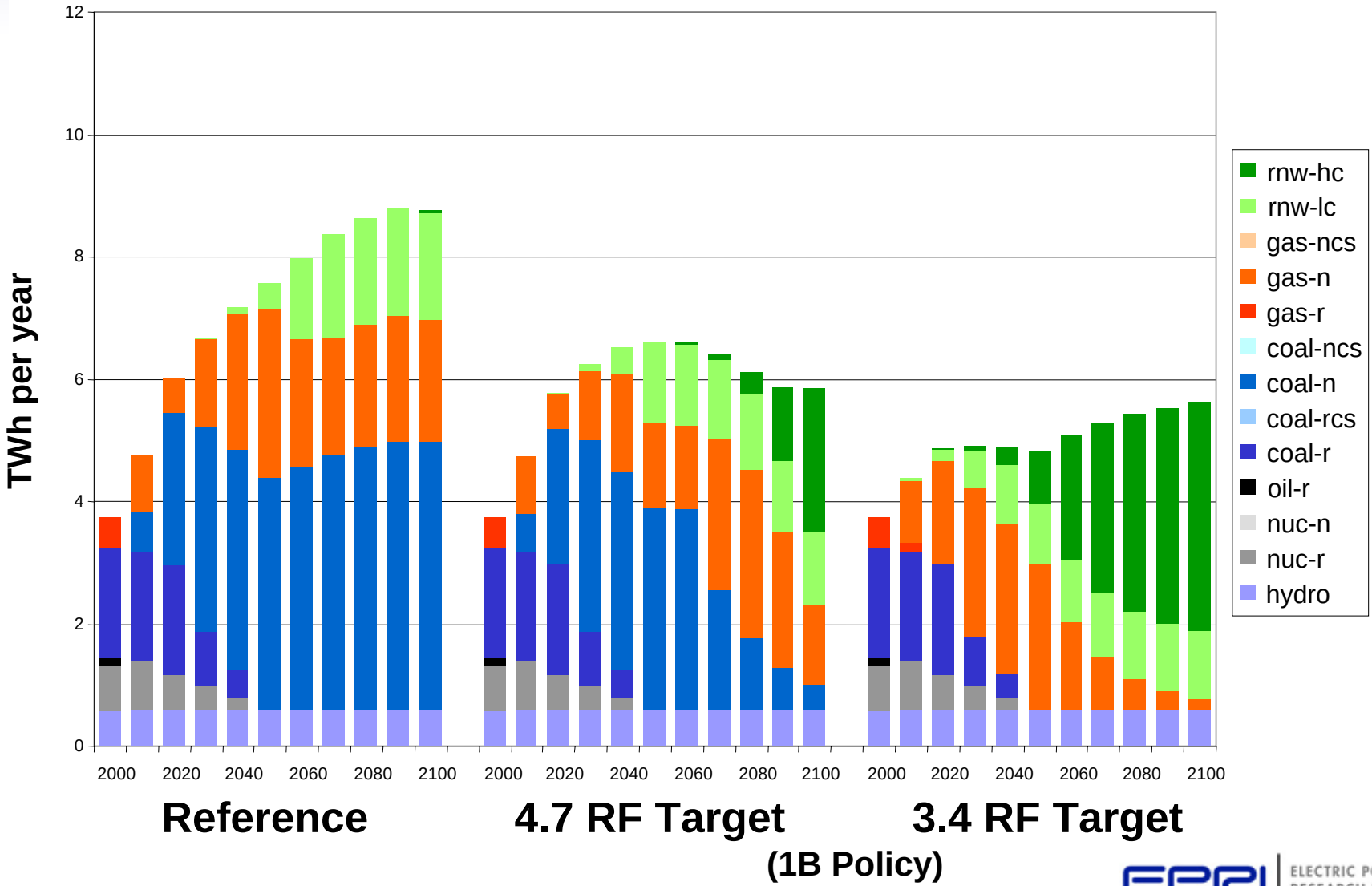
U.S. Electric Generation, Optimistic Technology

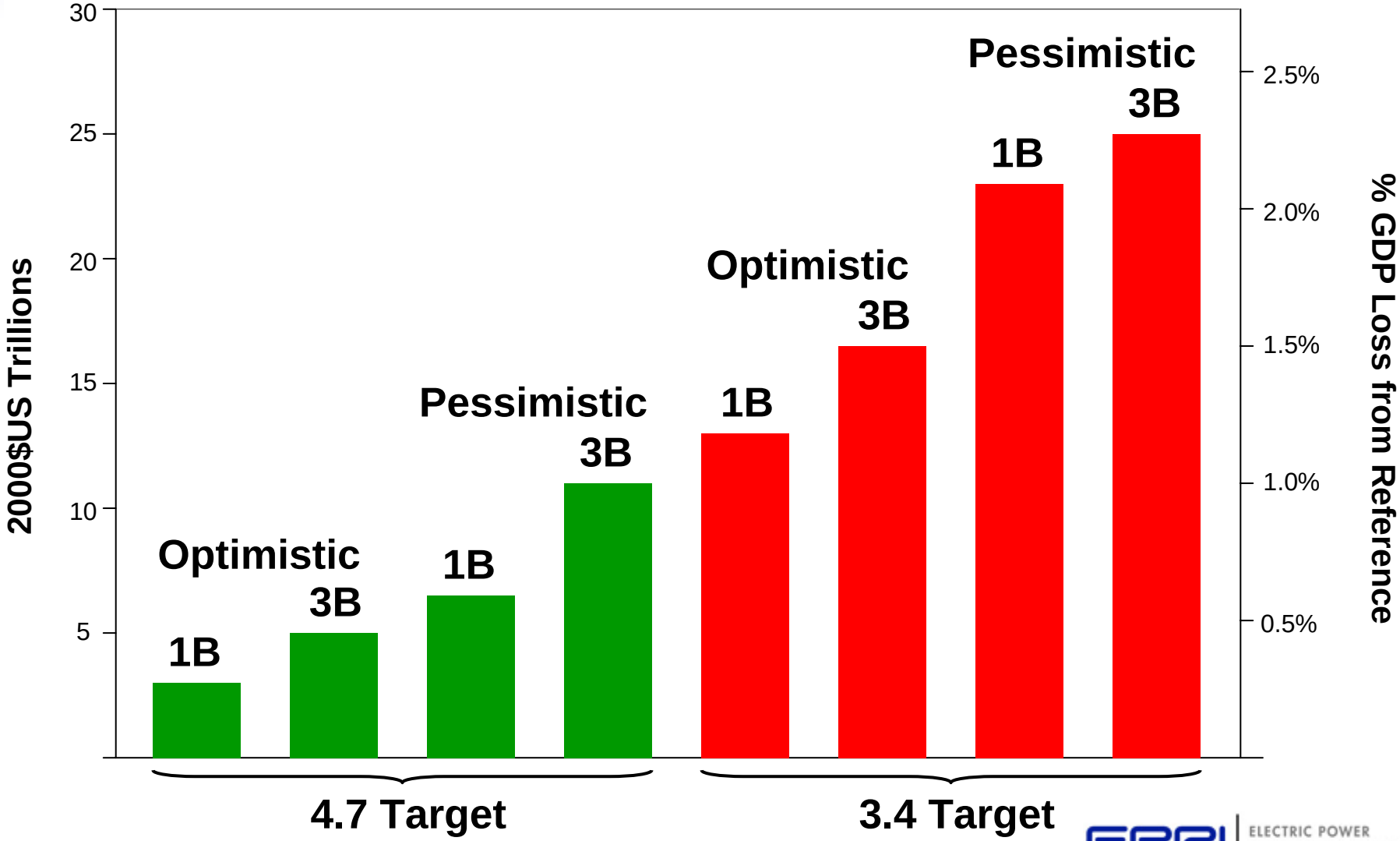


U.S. Electric Generation, Pessimistic Technology



Global Discounted Sum of Economic Cost

At 5% through 2200



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