



Managing the Transition to Climate Stabilization

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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 CO₂, N₂O, CH₄, HFCs, PFCs, and SF₆

- **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

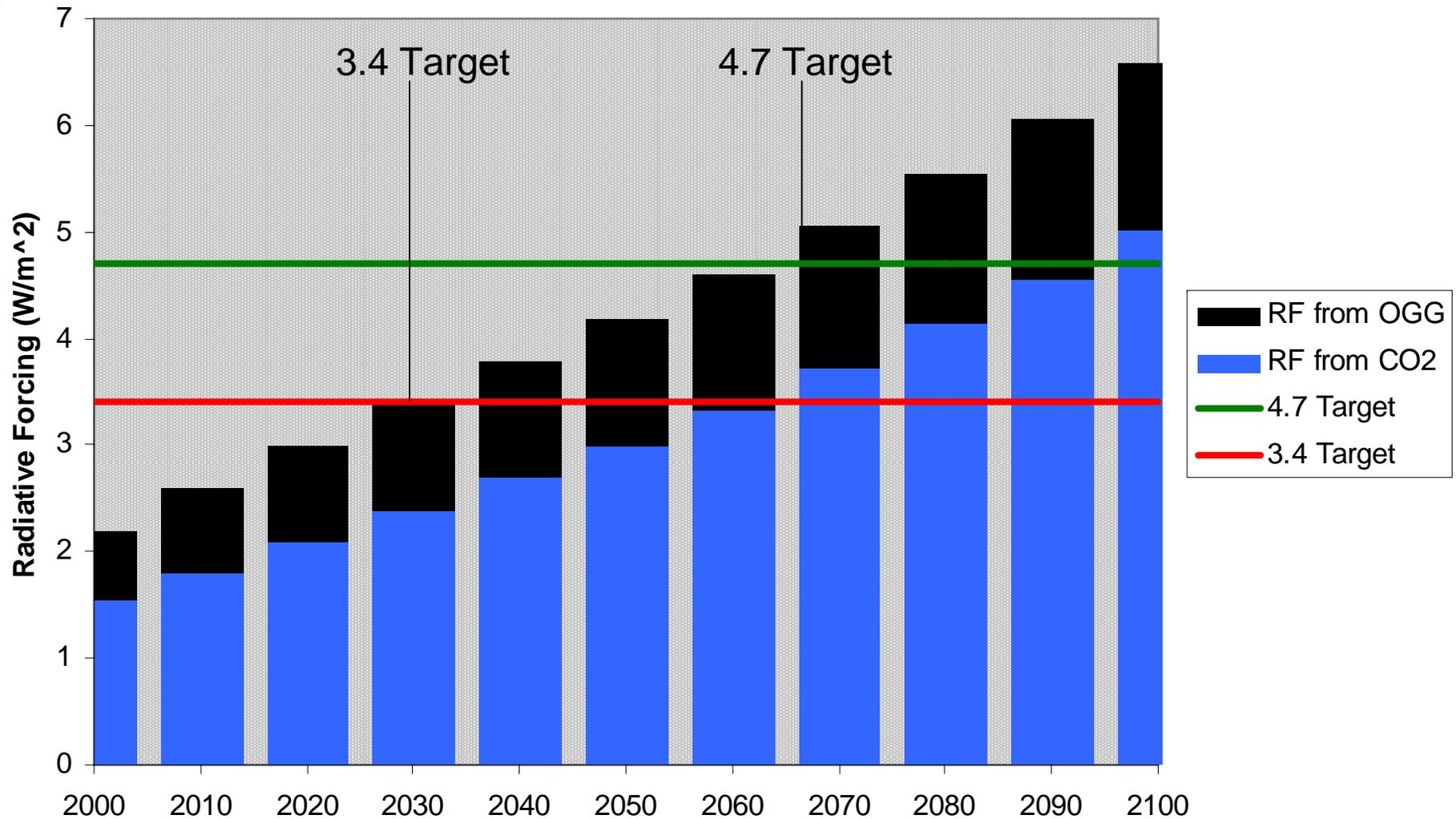
- Intertemporal optimization model with 200 year timeframe
- Each region maximizes its own utility
- Prices of each GHG determined endogenously, i.e. no GWPs
- Top down model of economic growth
- Process model of energy sector, with **new additions:**
 - **CCS Technologies**
 - Existing plants
 - New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



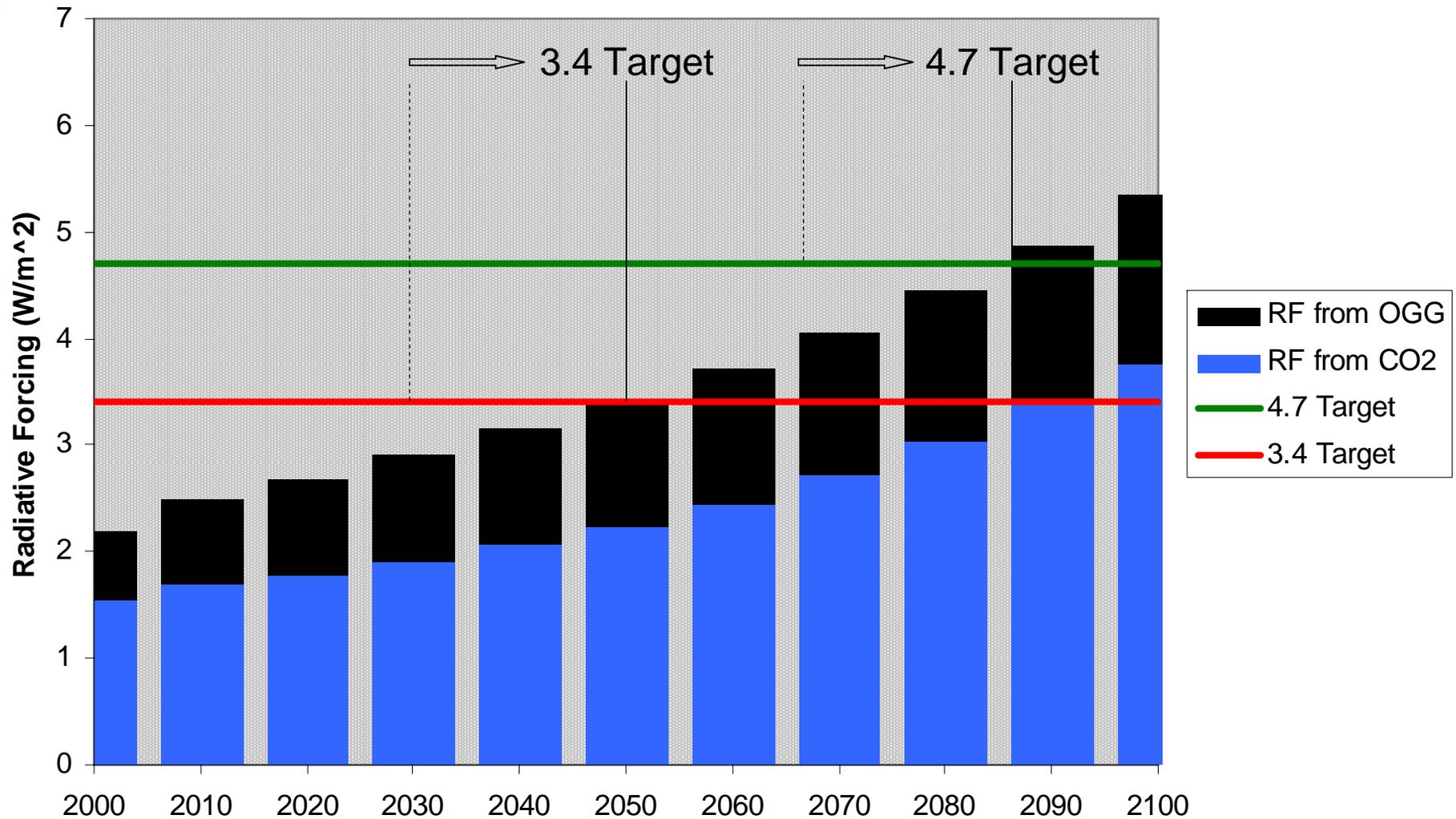
CAVEAT:

**THIS IS *NOT* A COST BENEFIT
ANALYSIS**

Reference Case Radiative Forcing



Reference *without* Annex B Emissions

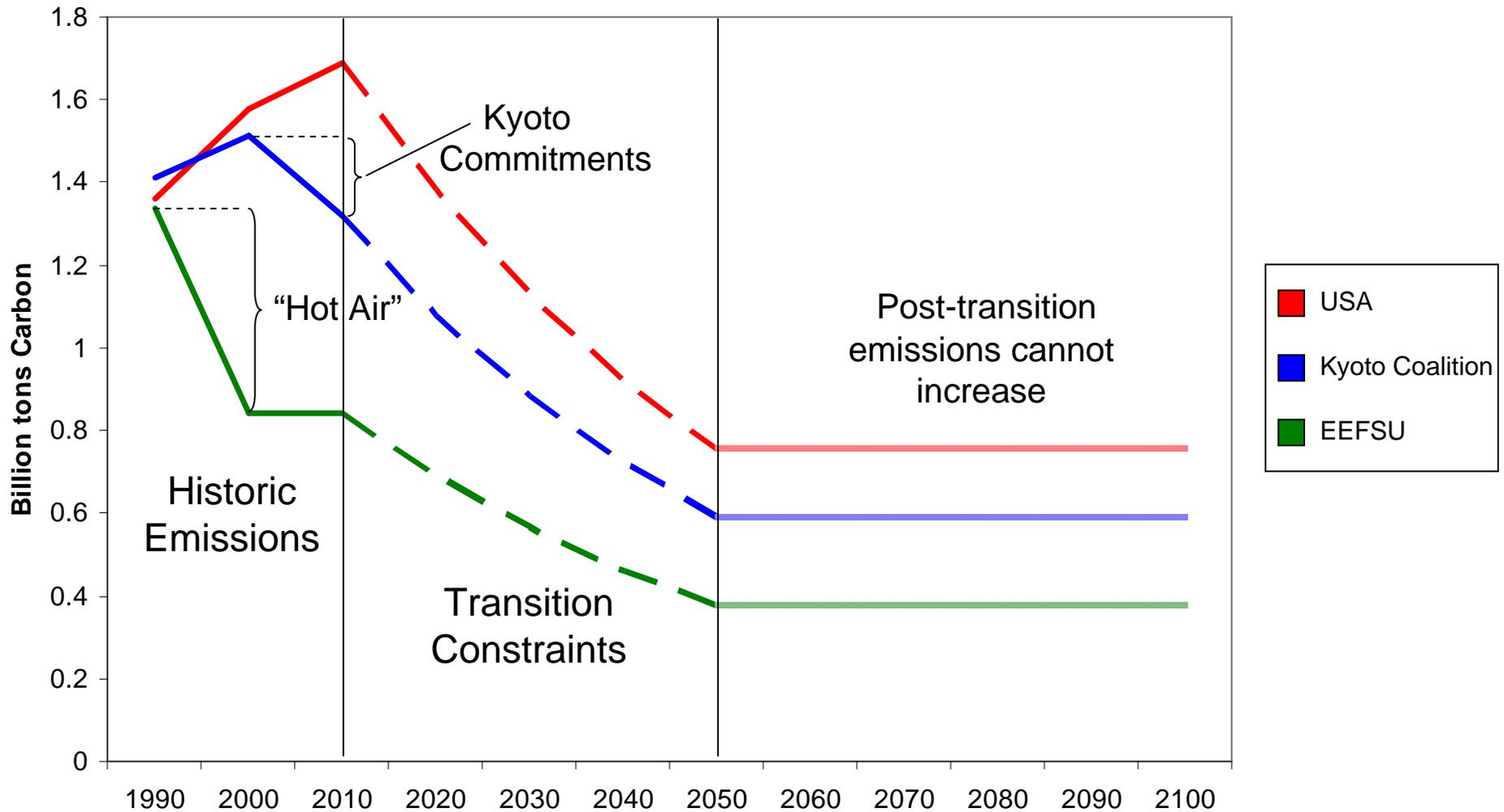


Two Policy Scenarios

- “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

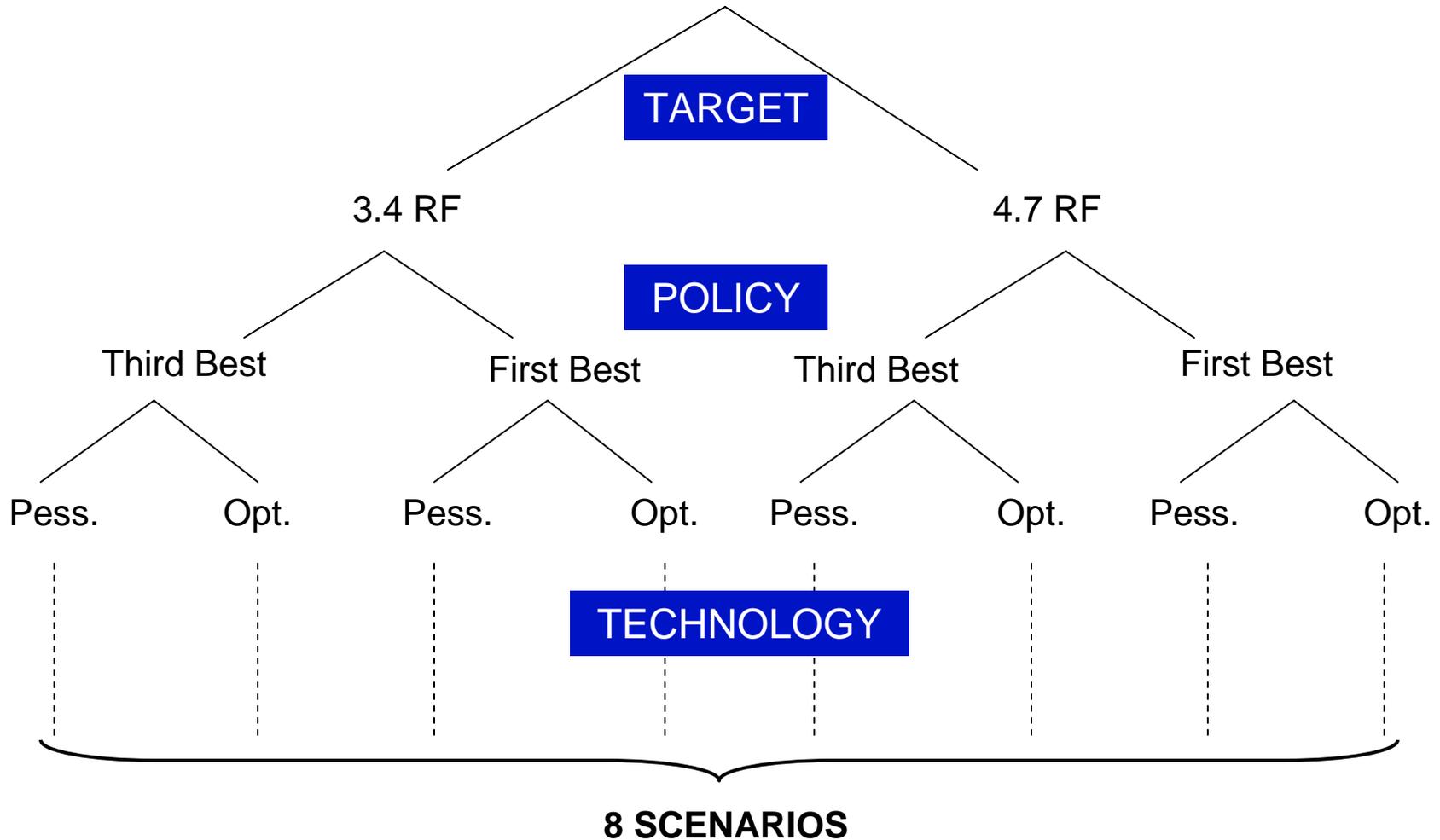
Technology	Description
HYDRO	Hydroelectric
NUC-R	Remaining initial nuclear
GAS-R	Remaining initial gas-fired
OIL-R	Remaining initial oil-fired
COAL-R	Remaining initial coal-fired
NUC-N	New nuclear
GAS-N	Advanced combined-cycle
COAL-N	Pulverized coal without CO ₂ recovery
RNW-LC	Low-cost carbon-free technologies (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

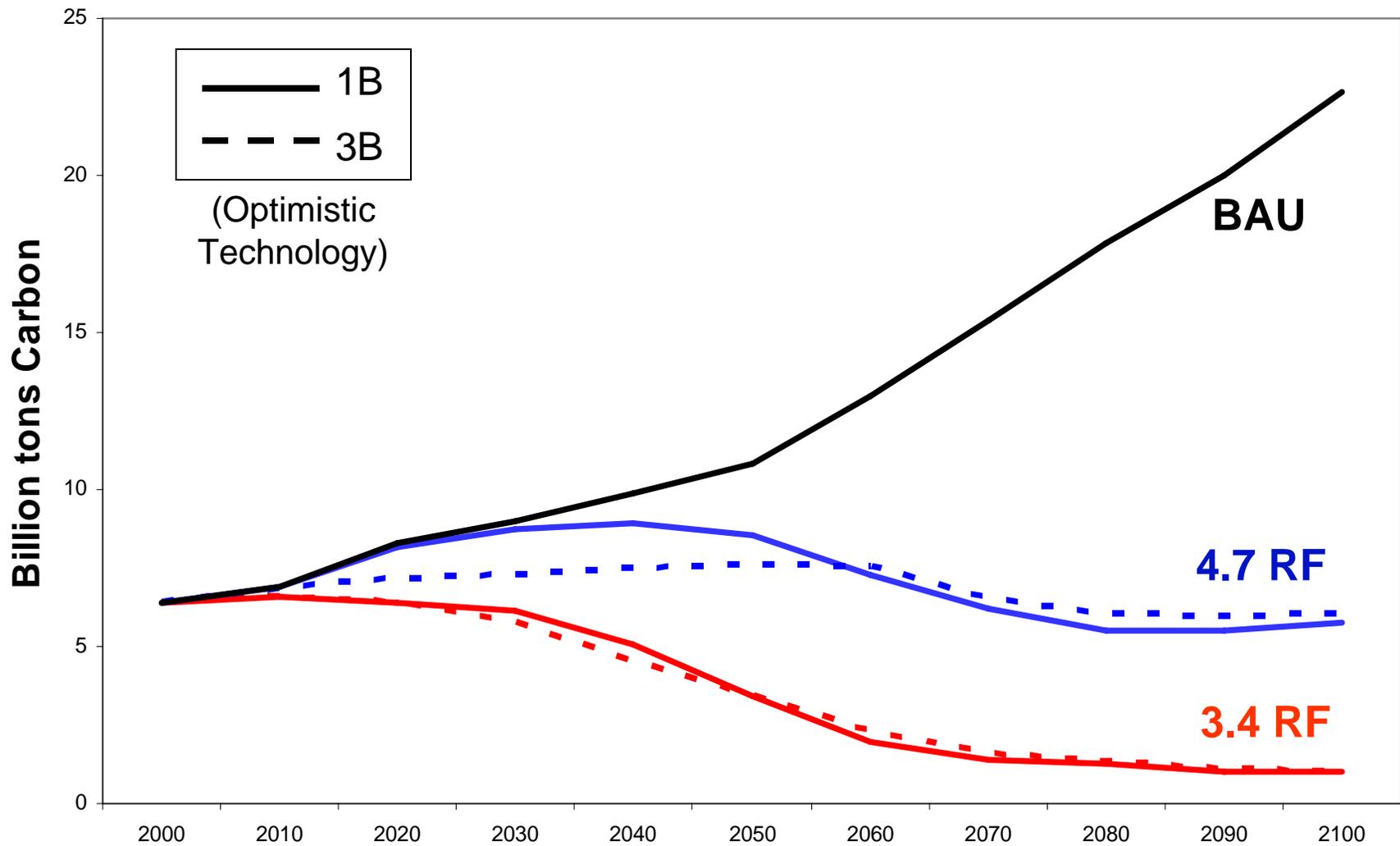
Technology	Description
CLDU	Coal – direct uses
OILNON	Oil (10 cost categories)
GASNON	Gas (10 cost categories)
BFUEL	Biofuels (ethanol, biodiesel, etc.)
SYNF	Synfuels (coal to liquids)
RNW-NE	Non-electric high-cost carbon-free technologies (unlimited quantity)

Reference Case Relies Heavily on Synfuels

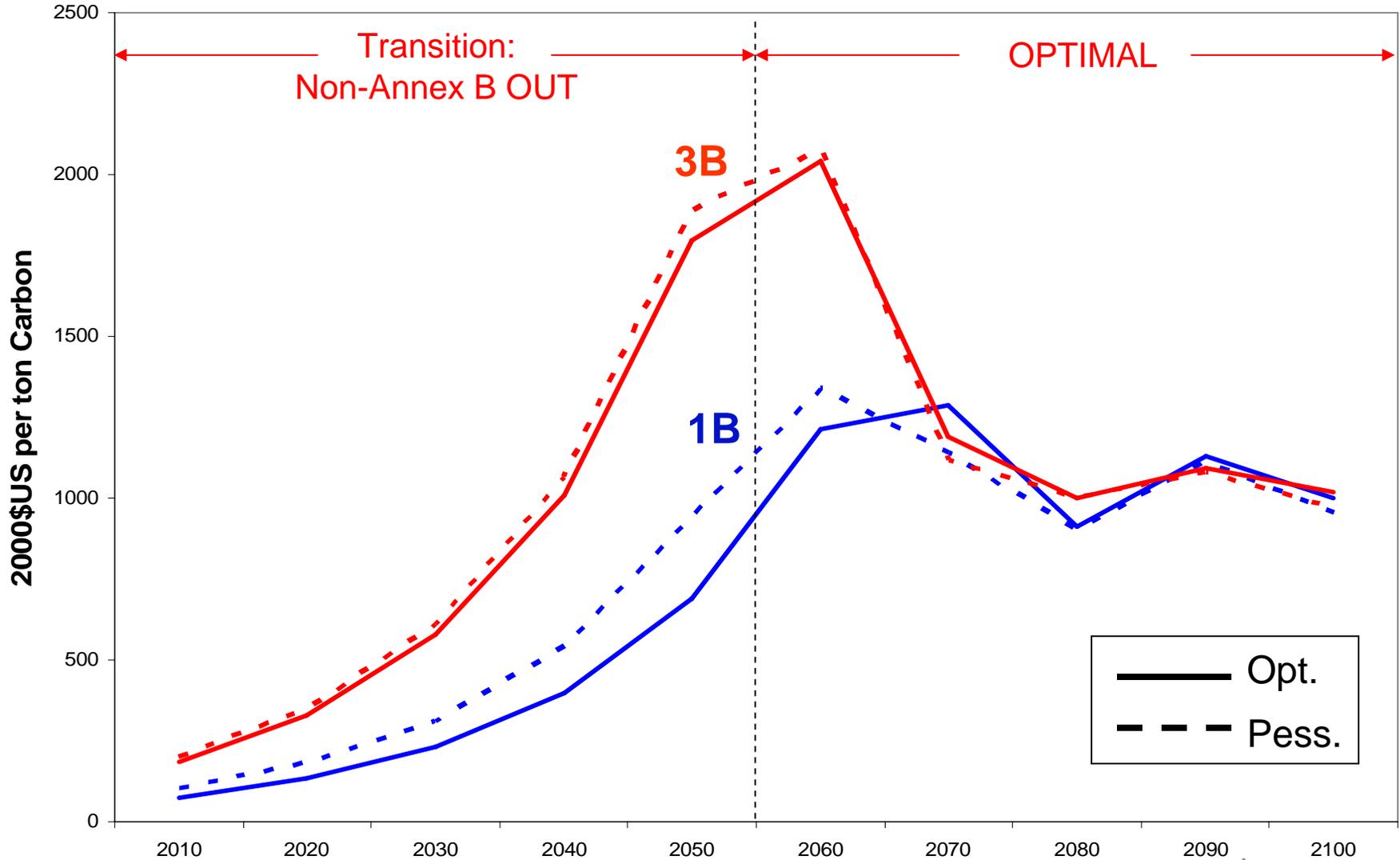
Scenario Design



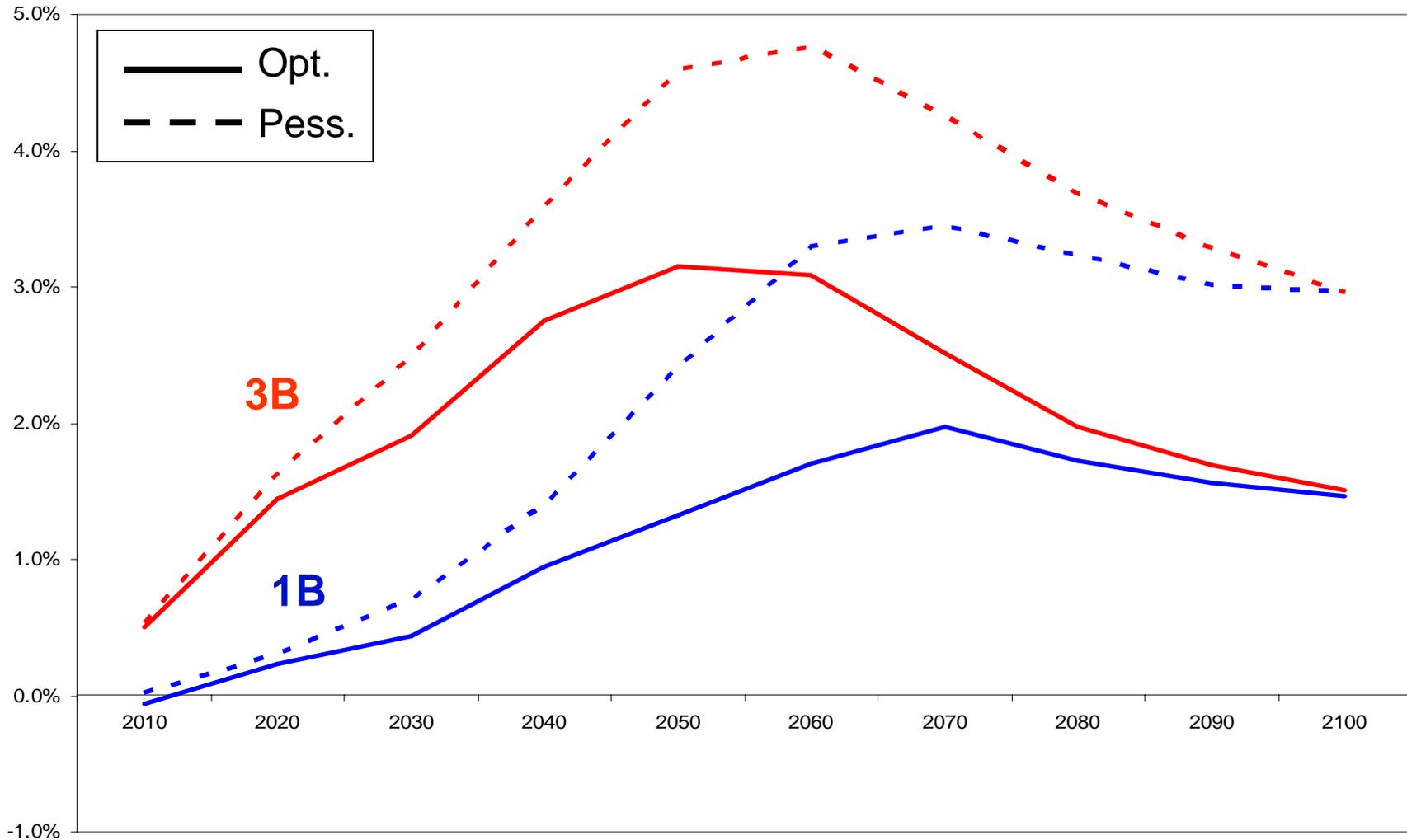
Global Carbon Emissions



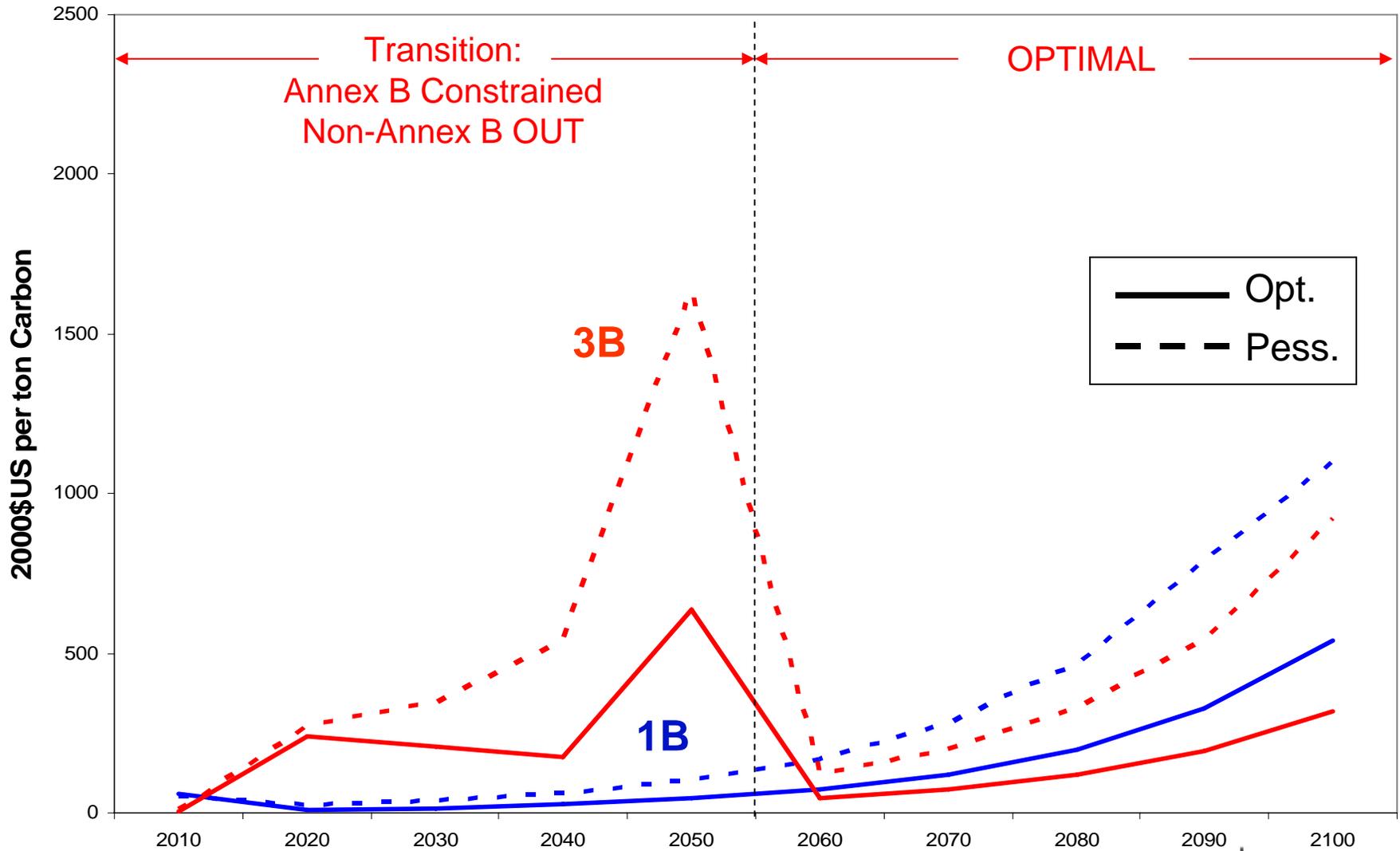
Annex B Carbon Price with 3.4 RF Target



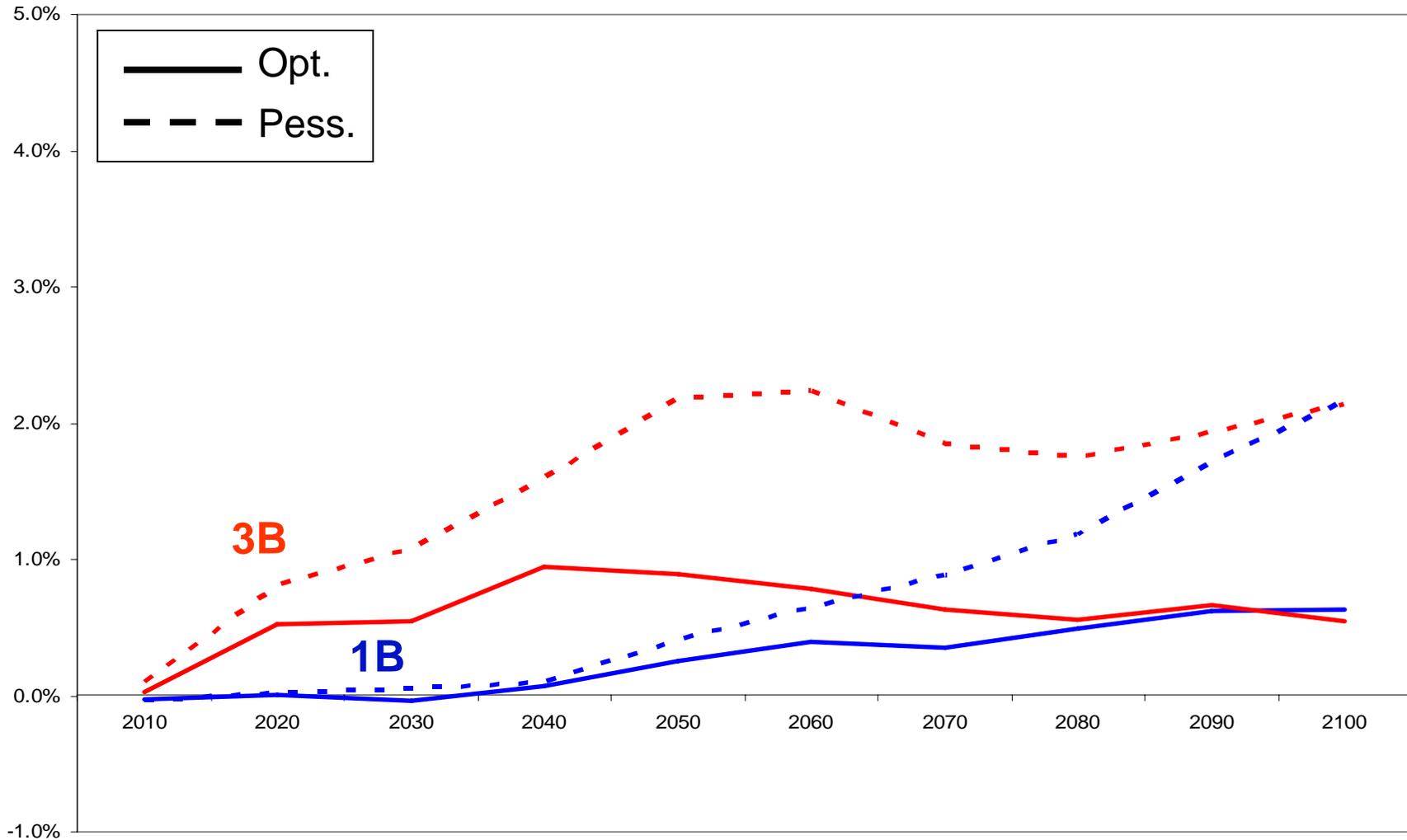
USA GDP Loss from Reference with 3.4 RF Target



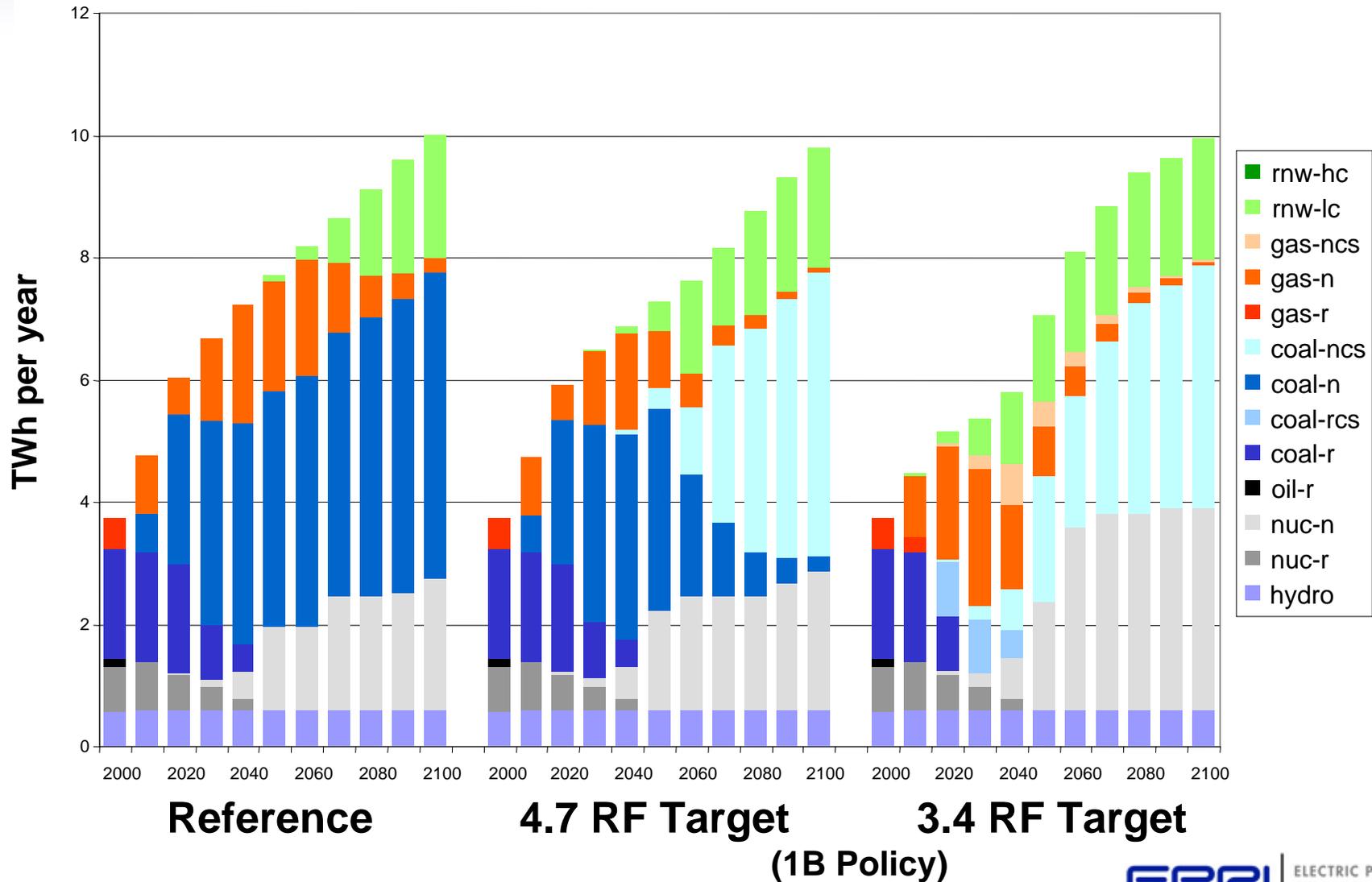
Annex B Carbon Price with 4.7 RF Target



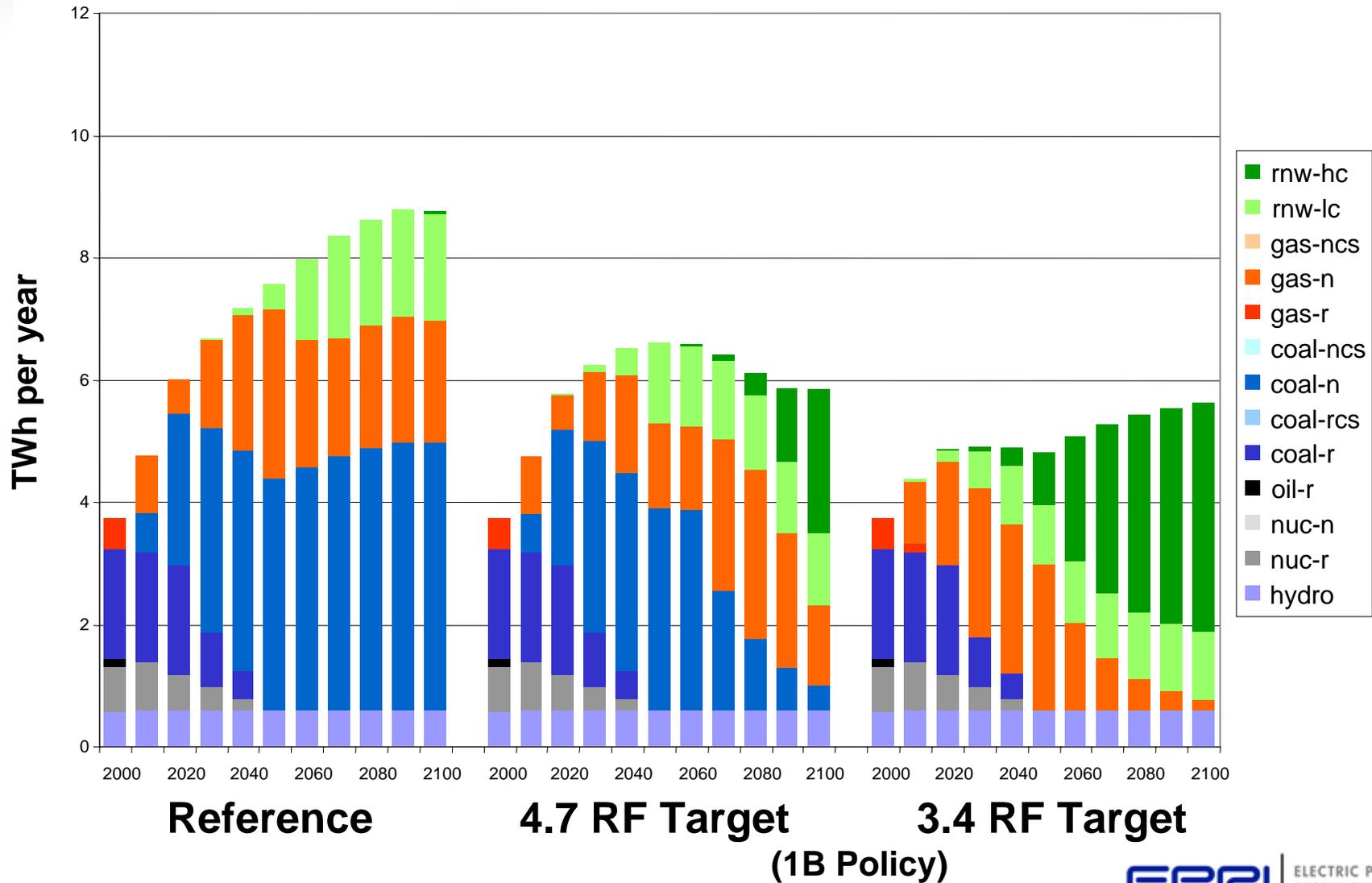
USA GDP Loss from Reference with 4.7 RF Target



U.S. Electric Generation, Optimistic Technology



U.S. Electric Generation, Pessimistic Technology



Global Discounted Sum of Economic Cost

At 5% through 2200

