Energy –Environmental Inter-Model Comparison Exercises: Past, Present and Future

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Outline

- Introduction
- EMF objectives, design principles & studies
- Lessons learned from past model inter-comparison studies
  - Things that worked well
  - Things that could be improved
  - Current trends in inter-model comparisons
- Suggestions for the future of model comparisons, diagnostics and assessment

Energy Modeling Forum Objectives

- Understand model differences
- Understand strengths and weaknesses of existing models/methodologies
- Identify useful information and insights for corporate planning and government policy making
- Identify high priority areas for development of new data, analyses, and modeling methodologies

EMF Design Principles

- Broad participation
- Focus on model comparisons
- Policy relevance
- Decentralized analysis
- Wide dissemination of results

EMF Studies

EMF 0: CONAES Modeling Group
EMF 1: Energy and the Economy
EMF 2: Coal in Transition
EMF 3: Electric Load Forecasting
EMF 4: Elasticity of Energy Demand
EMF 5: U.S. Oil and Gas Supply
EMF 6: World Oil
EMF 7: Macroecon. Impacts of Energy Shocks
EMF 8: Industrial energy Demand
EMF 9: North American Natural Gas
EMF 10: Electric Markets and Planning
EMF 12: Carbon Emission Reductions
EMF 11: International Oil
EMF 13: Markets for Energy Efficiency
EMF 14: Integrated Assessment of Climate Change
EMF 15: Markets for Power

EMF Studies (Continued)

EMF 16: IA of Climate Change: Post-Kyoto

EMF 17: Prices/Emissions in Restructured Elec. Mkts.

EMF 18: Trade Dimensions of Climate Policy

EMF 19: Technology and Climate Policies

EMF 20: North American Natural Gas

EMF 21: Multi-Gas Greenhouse Gas Mitigation

EMF 22: GHG Gas Transition Scenarios

EMF 23: World Natural Gas Markets & Trade

EMF 24: US Technology Strategies for GHG Mitigation

EMF 25: US Energy Efficiency Potentials

EMF 26: Energy System Impacts of Shale Gas

EMF 27: Global Tech. Strategies for GHG Mitigation

EMF 28: EU Technology Strategies for GHG Mitigation

EMF 29?: International Trade & GHG Mitigation

Lessons Learned From Past Inter-Model Comparison Studies; Things That Worked Well

- Timing is everything; address issues that are important and for which enough different models exist.
- Insights, not numbers .
  - Insights about markets.
  - Insights about policies.
  - Insights about model comparisons.
  - Insights about the adequacy of current methods.
- Tension between diagnostics and policy analysis.
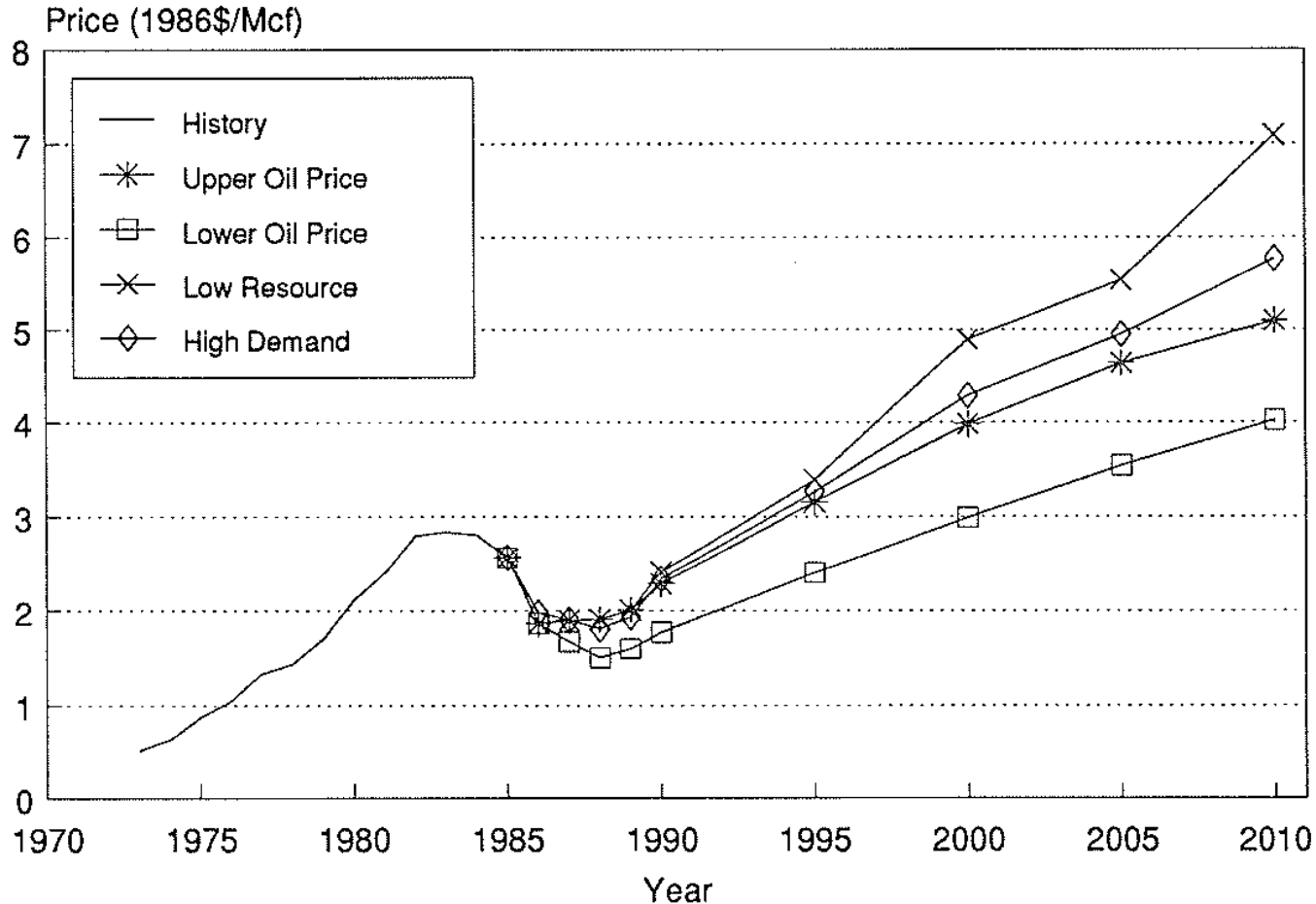- Importance of study groups.
- Forecasting in perspective.

Market Insight #1

Change in electricity consumption projections with 10% price increase relative to the reference case. Source: EMF 3
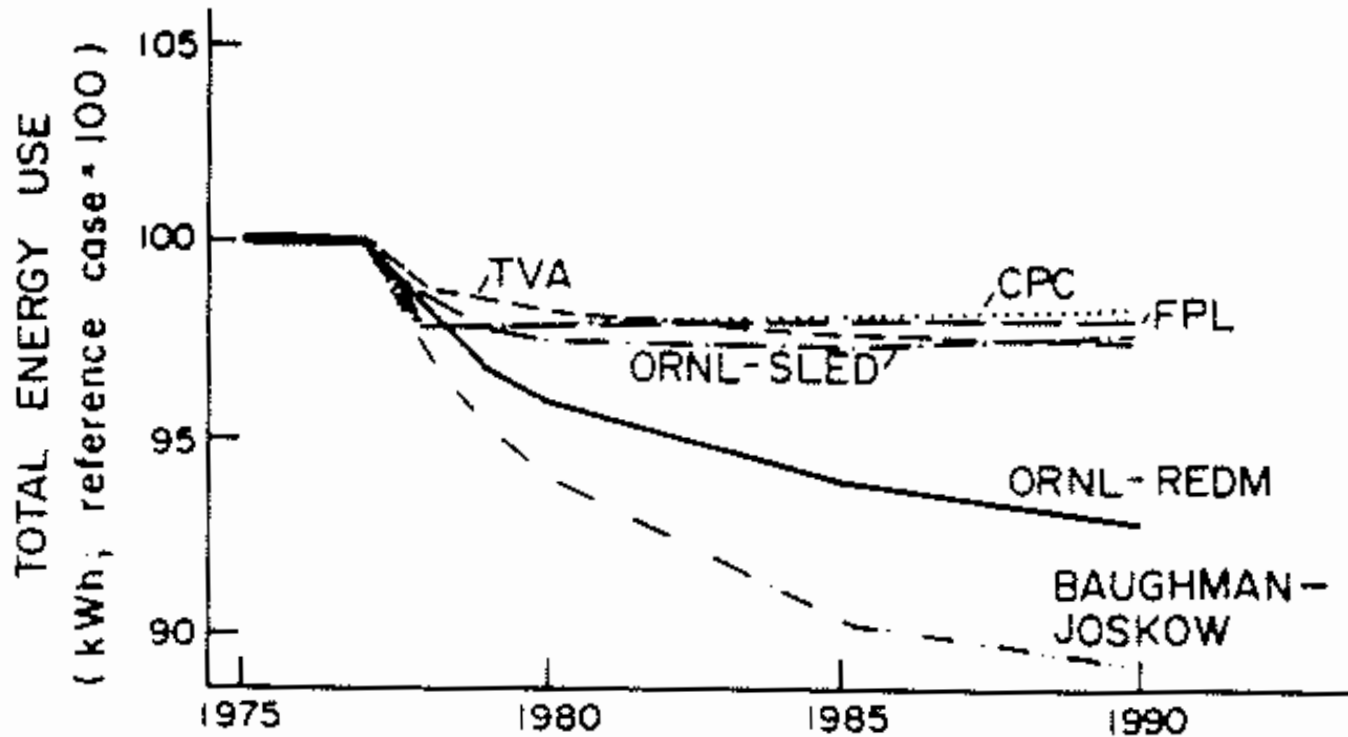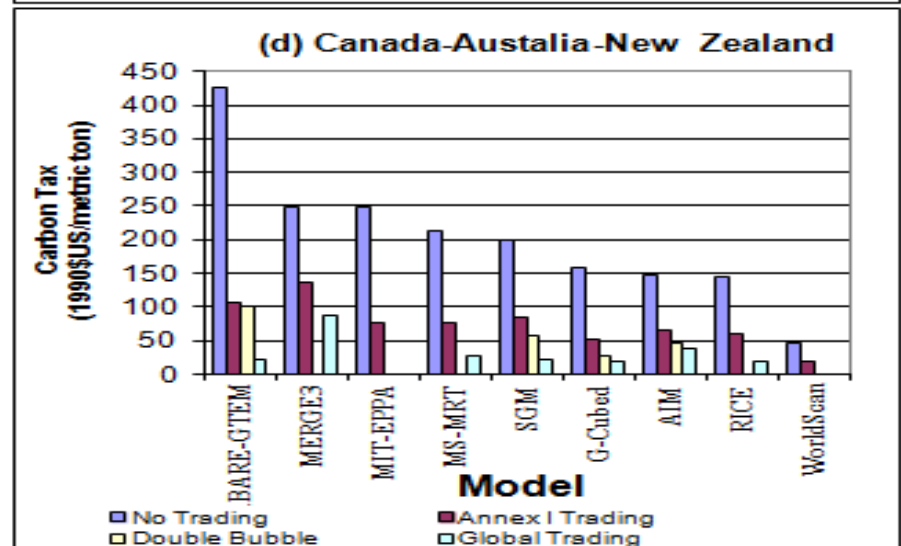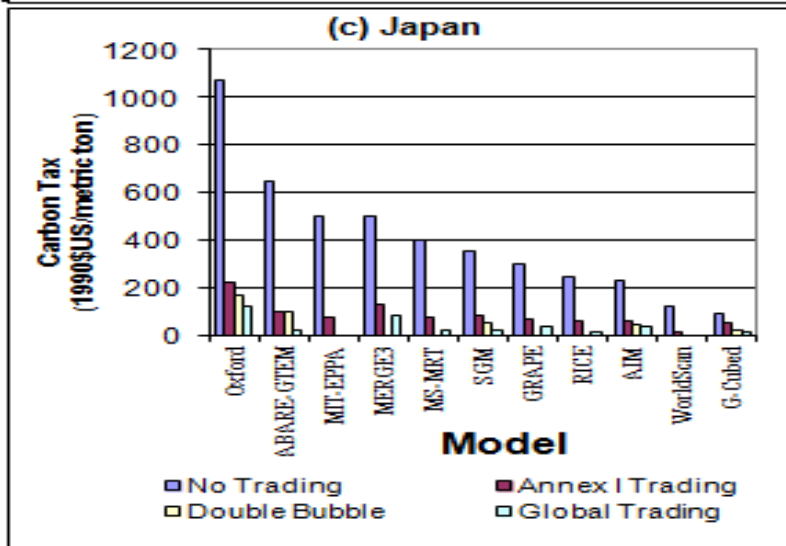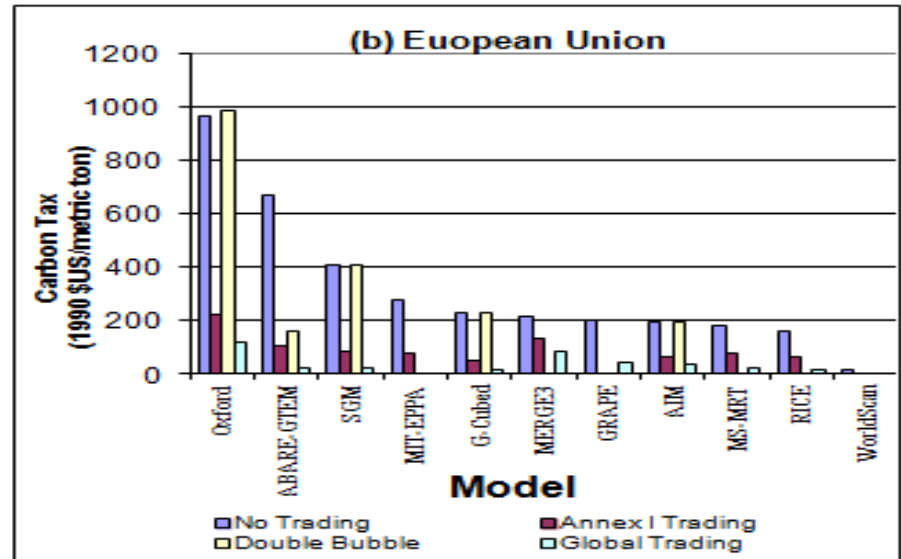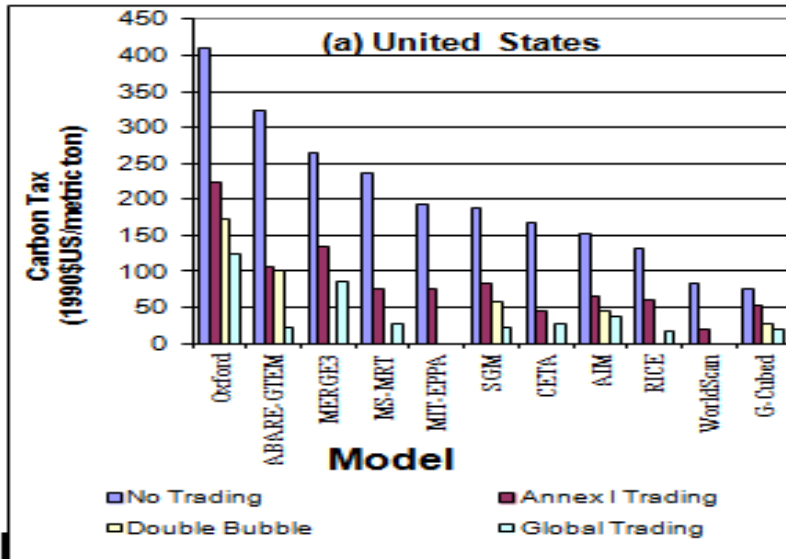
Market Insight #2
Model Means for Average U.S. Wellhead Price
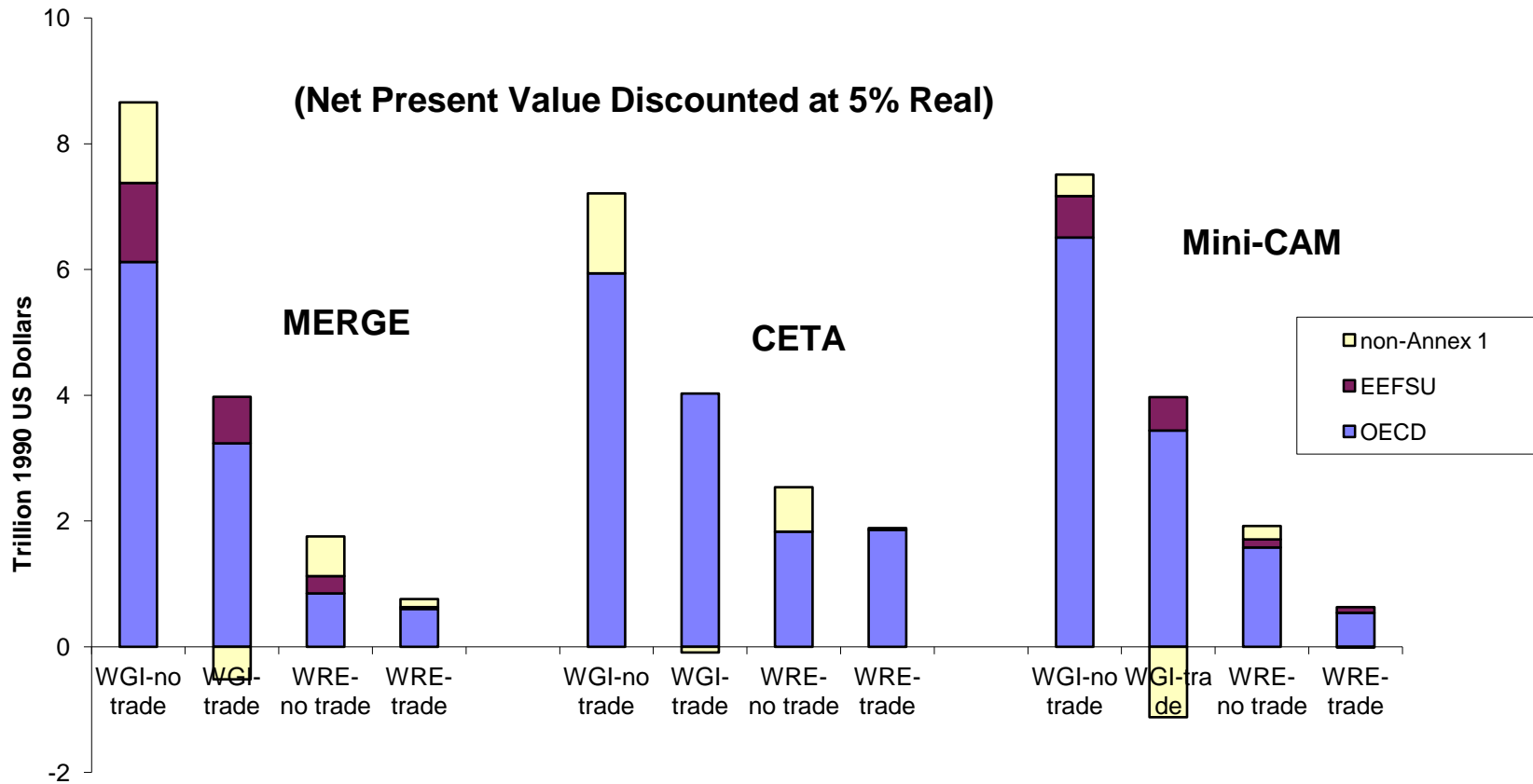## Source: EMF 9

Policy Insight #1
Projected 2010 Carbon Tax Under the Kyoto Protocol Commitments and Various Emissions Trading Assumptions

Policy Insight #2
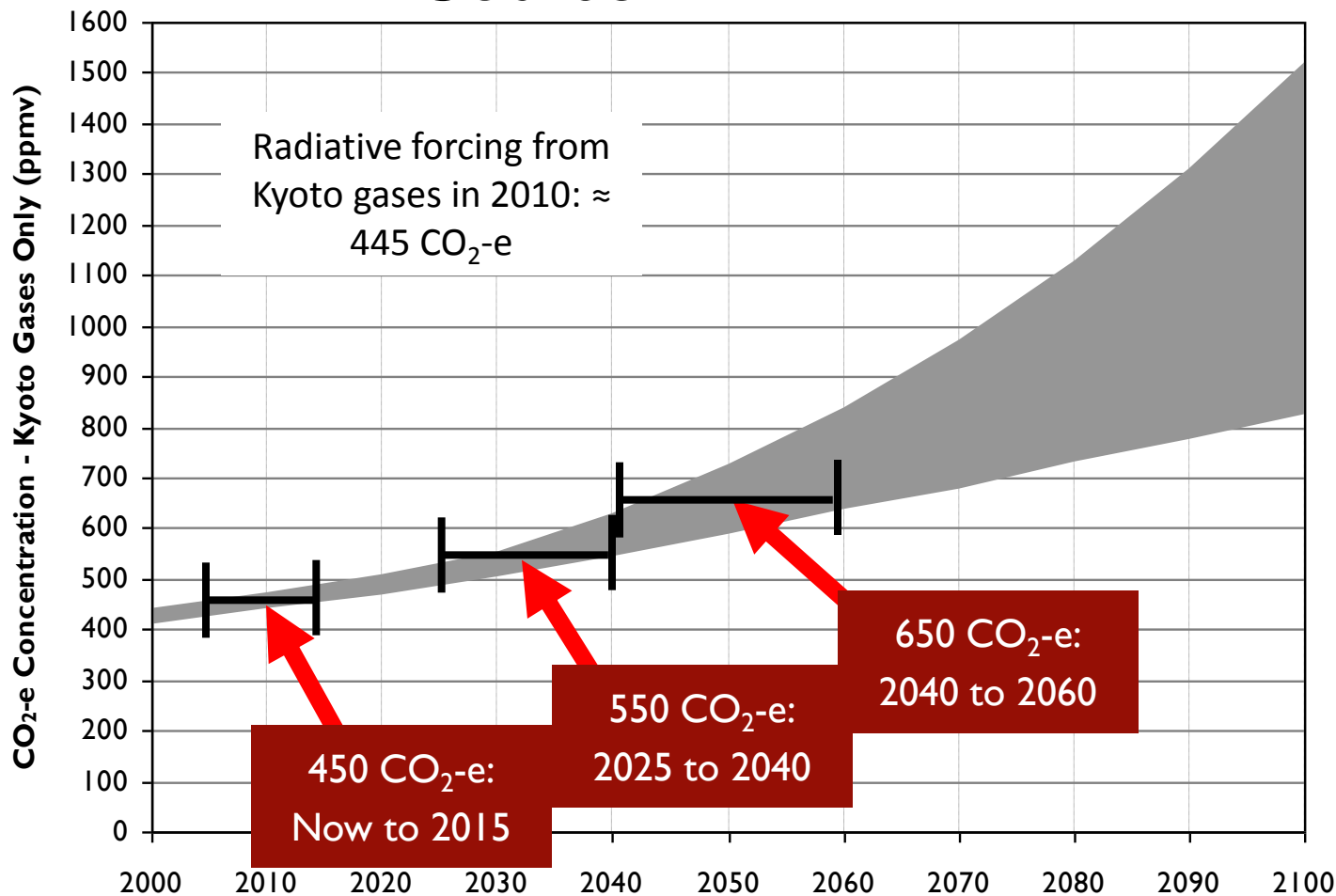## Where & When Flexibility in Stabilizing CO_2 Concentrations at 550 ppmv
Source: UNFCC-EMF Oslo Workshop (August 1997)

Policy Insight #3

Without mitigation, CO2-e concentrations will quickly pass the three long-term goals.
Source: EMF 22

Radiative forcing from Kyoto gases in 2010: ≈ 445 CO_2-e

450 CO_2-e: Now to 2015

550 CO_2-e: 2025 to 2040

650 CO_2-e: 2040 to 2060

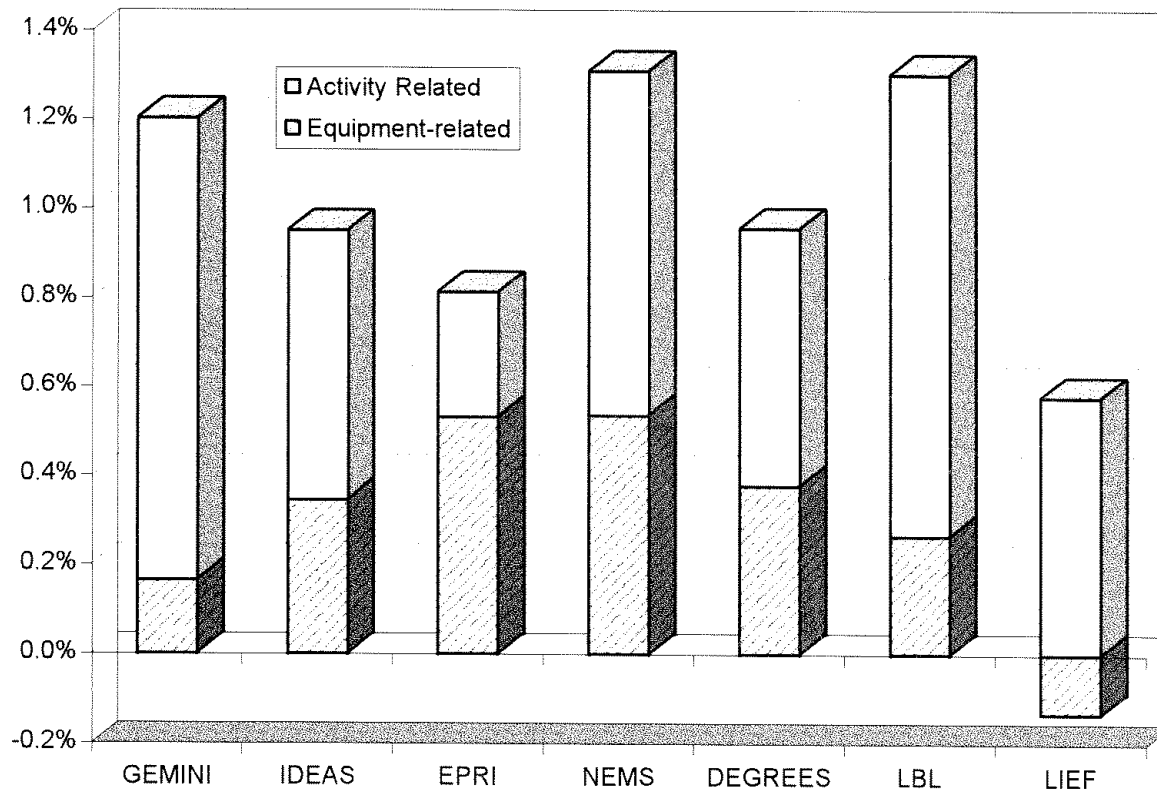CO_2-e Concentration - Kyoto Gases Only (ppmv)

Note: CO2e Now Growing at 3.5 to 4.5 ppmv per year

Policy Insight # 4

Relative Importance of New Equipment Efficiency Improvements in the Total Decline in U.S. Energy Intensity, 1990-2010. Source: EMF 13
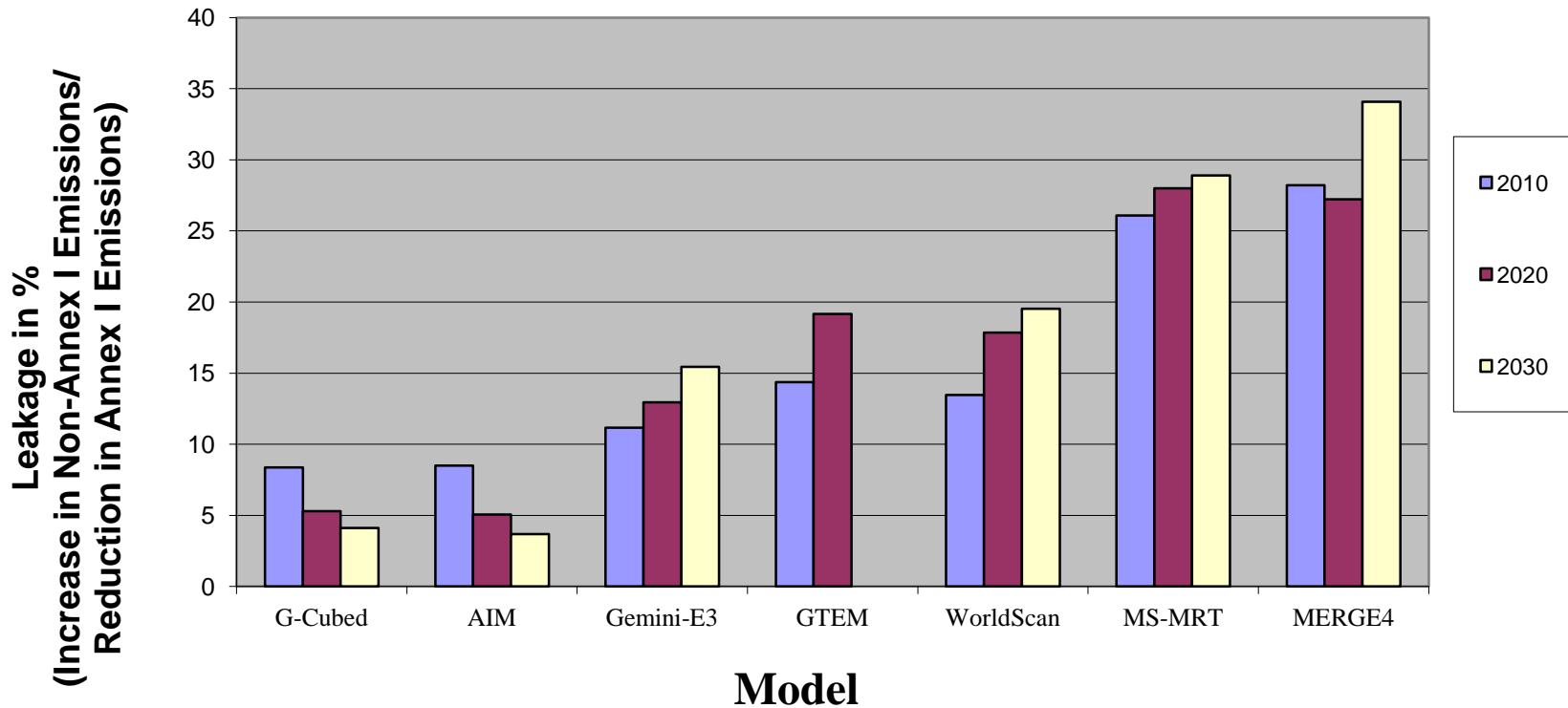

% ch p.a.

*negative effect due to increased electrification

Policy Insight # 5
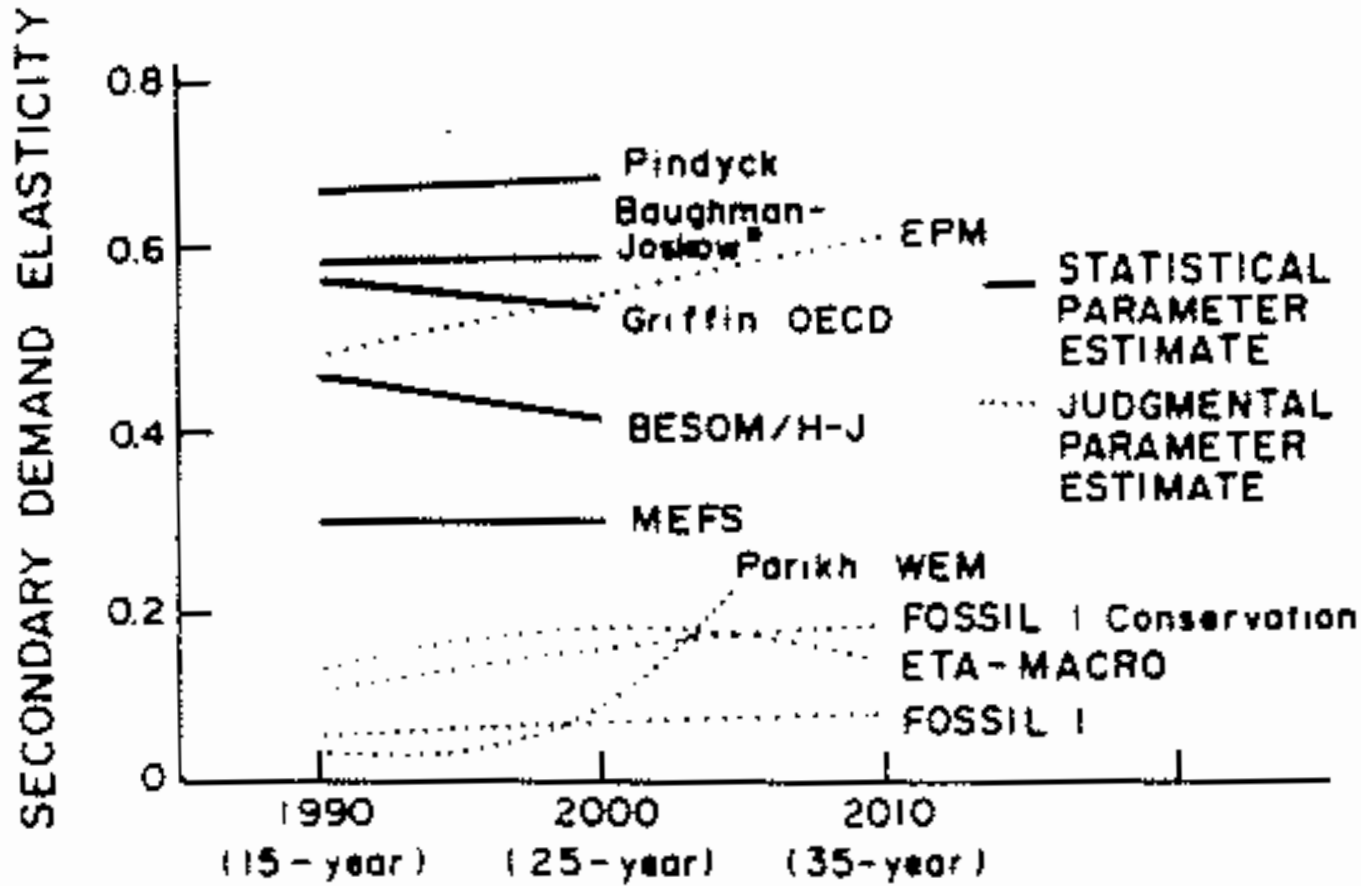## Annex I Leakage in the No Emissions Trading Case With Respect to the Reference Source: EMF 18

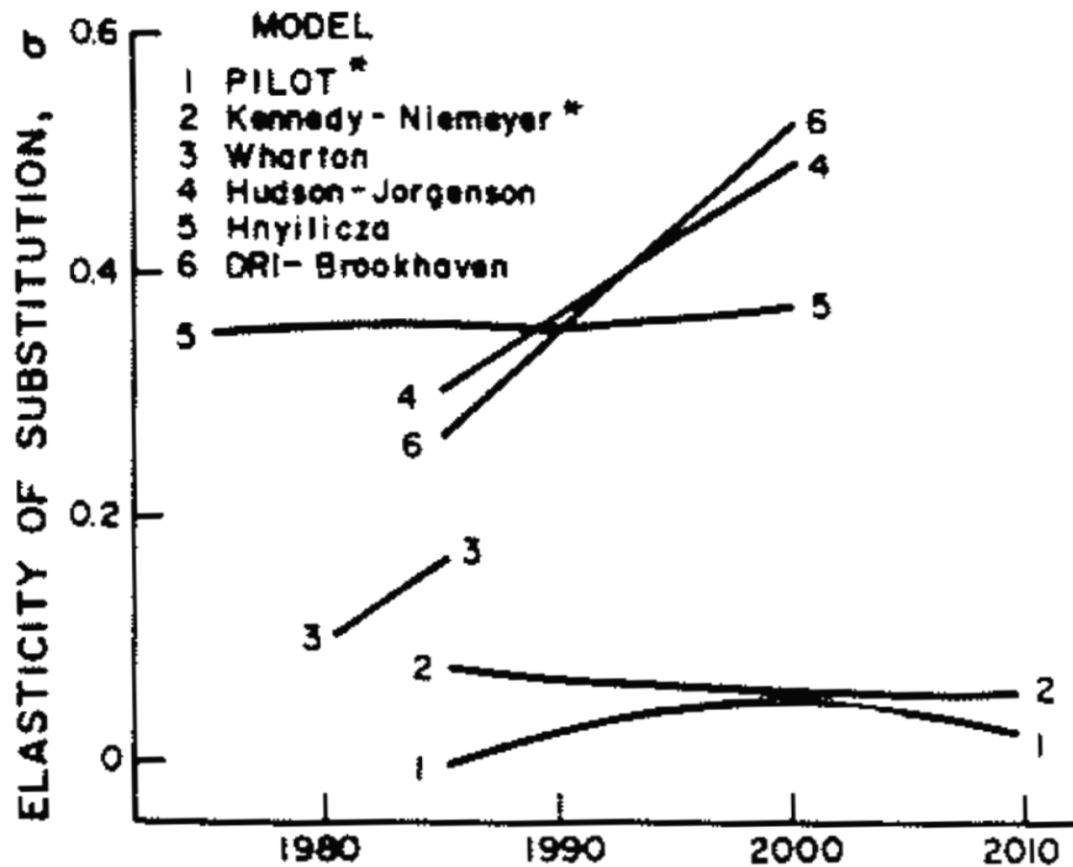# Inter-Model Comparison Insight #1

Aggregate total demand elasticity estimates.
Source: EMF 4

Inter-Model Comparison Insight #2

Aggregate elasticity of substitution calculated using the outputs for the base case and the base case with constraints. Source: EMF 1

Models Need Improvement Insight #1
Distributed Generation and T&D Constraints

- EMF 10: Electric Markets and Planning
  - IPP grid integration
- EMF 15: Markets for Power
  - More competitive electricity markets
- EMF 17: Prices/Emissions in Restructured Elec. Mkts.
  - Env. Impacts of competitive electricity markets
- EMF 24: US Technology Strategies for GHG Mitigation?
  - Grid integration of renewables

Models Need Improvement Insight #2
Carbon Permit Price (2000$USD/tC) in CO2-Only (solid) and Multigas (dashed) Scenarios
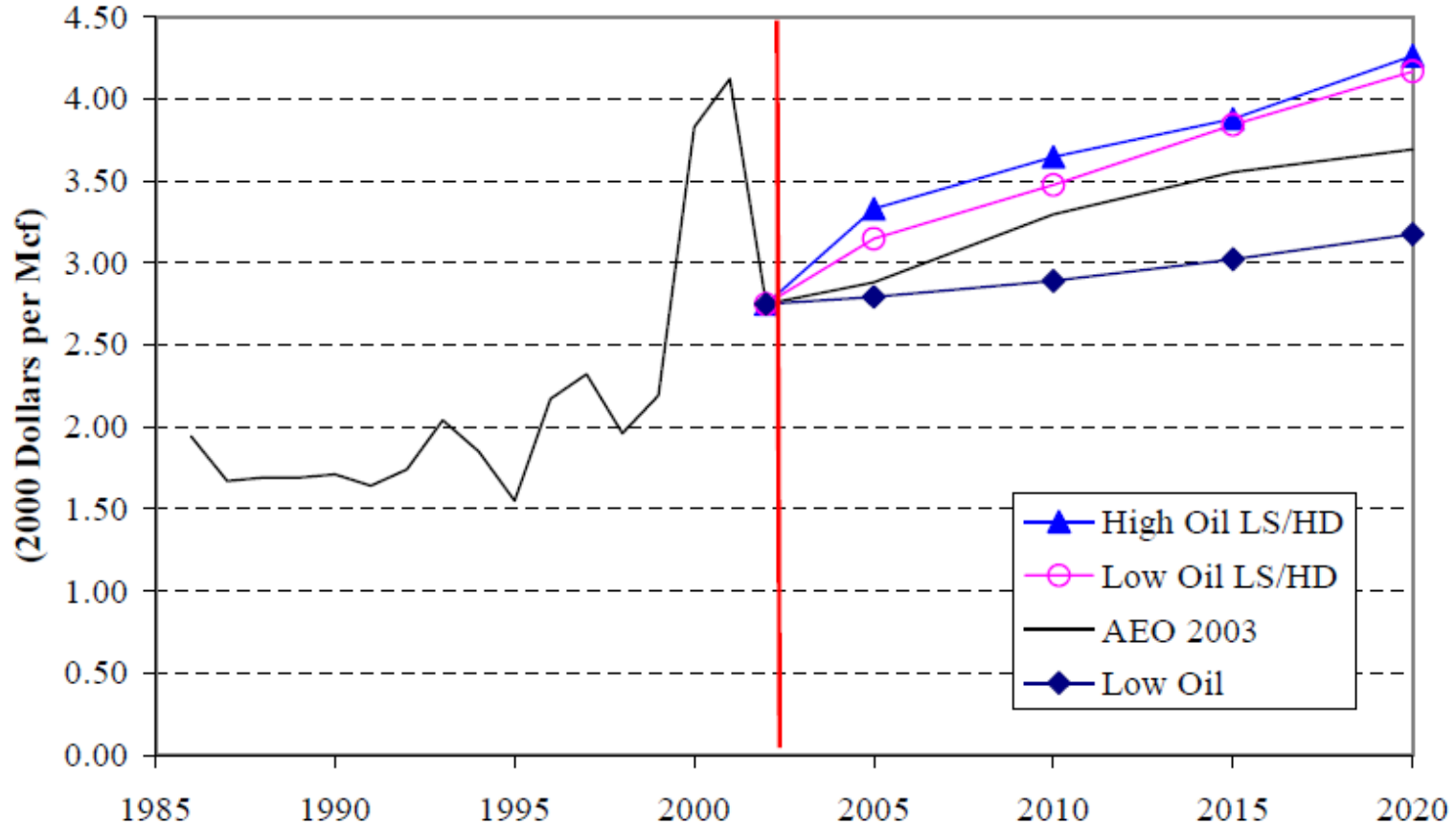## Source: EMF 21
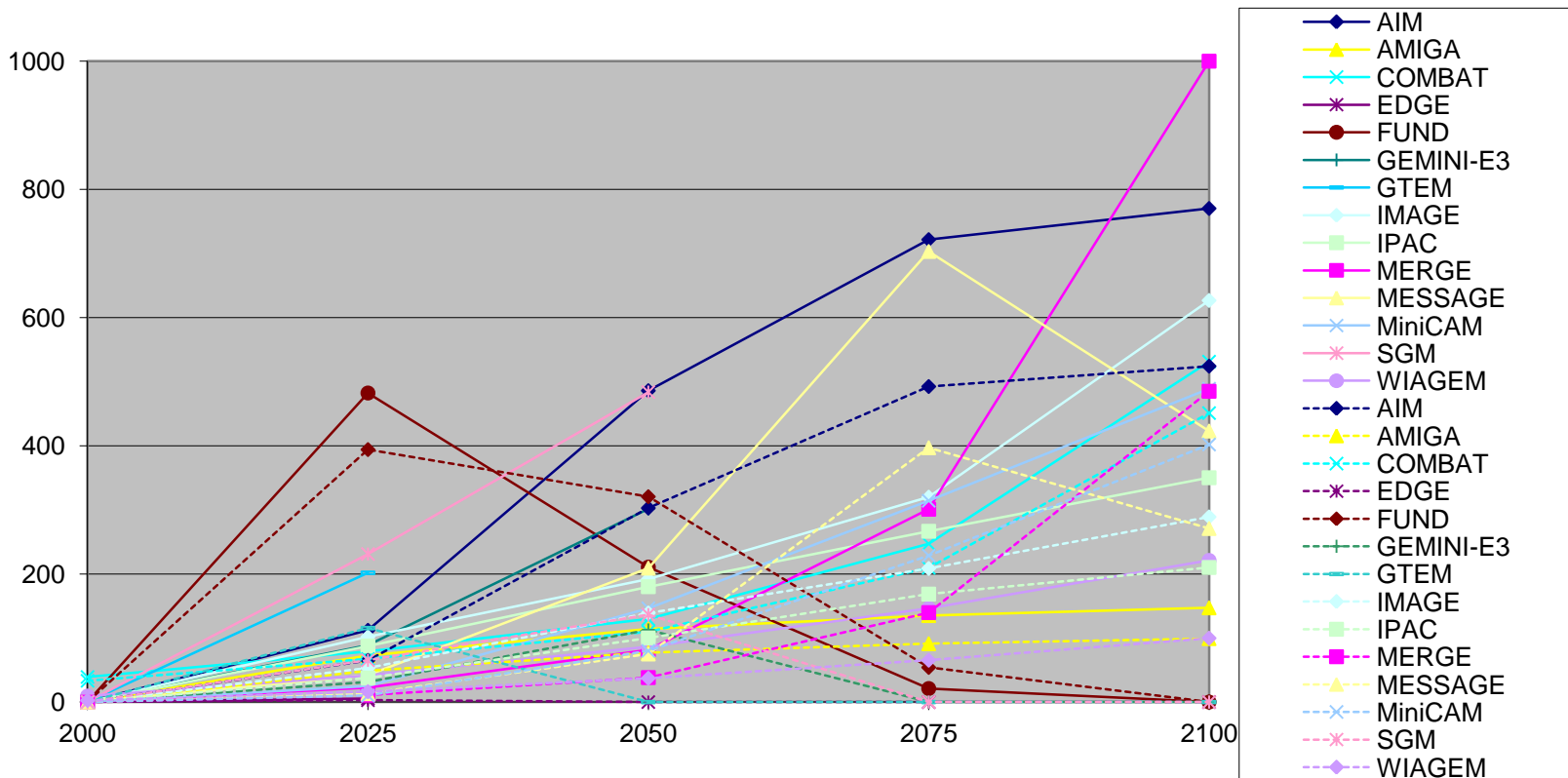
Lessons Learned From Past Inter-Model Comparison Studies; Things That Could Be Improved

- Consider a broader range of uncertainties.

- Do more diagnostics.

- Better communication of results vis a vis what's out there.

- Better communication of results to potential users.

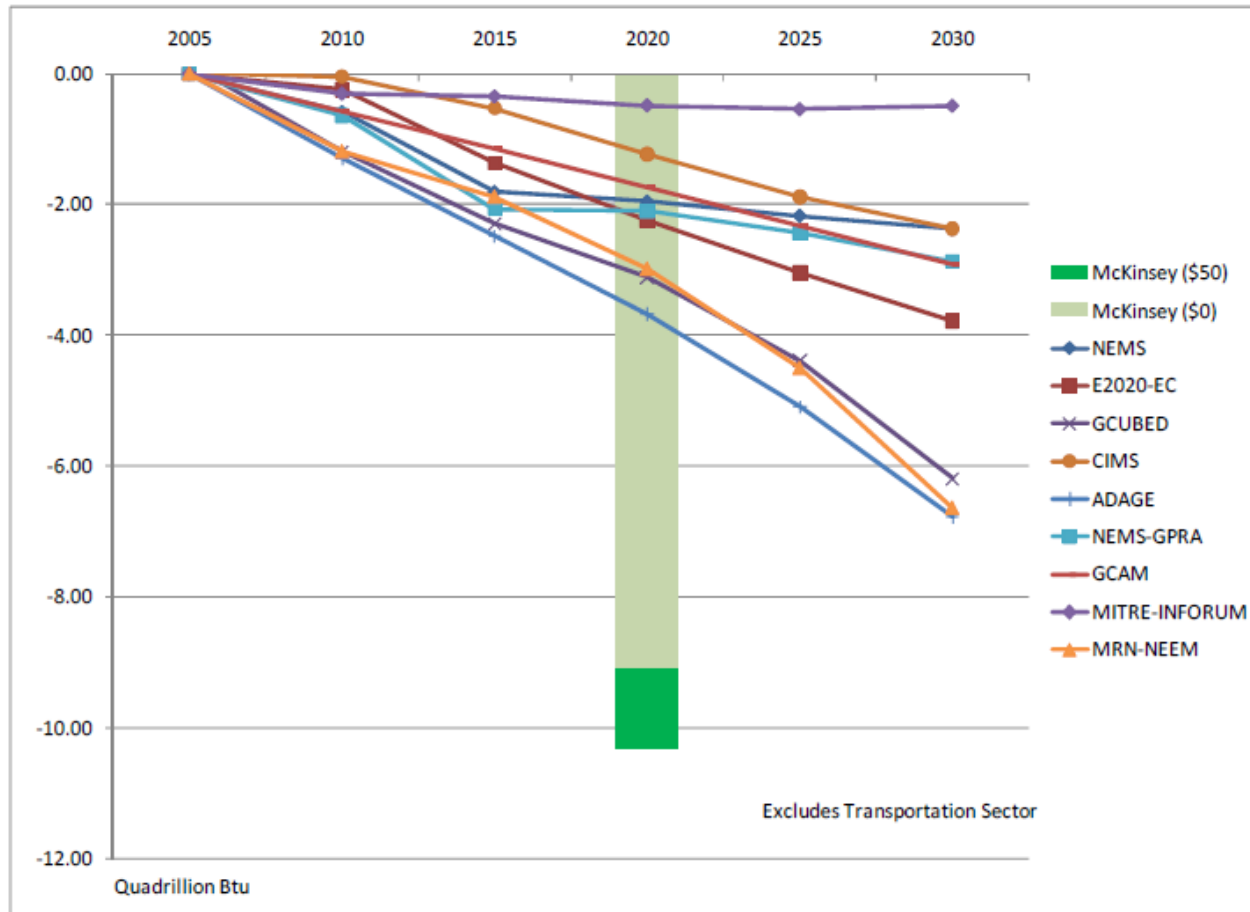- More thought/work on forecasting accuracy.

Could Have Done Better #1
Reference & Optimistic Crude Oil Price Projections From EMF 6

Could Have Done Better #2
Average Wellhead Natural Gas Prices Across Models
Source: EMF 20

Could Have Done Better #3
Energy Demand Reductions Achievable for Similar Carbon Prices Source: EMF 25

Current Trends in Inter-Model Comparisons

- With IT improvements, can do more.
- More people, modeling centers, global collaborations: e.g., IAMC.
- Implementation modeling.
- "Forecasting".
- More openness and better communication.

Suggestions for the Future of Model Comparisons, Diagnostics and Assessment

- Better accounting for uncertainty

- Better integration of assessment, model inter-comparisons and validation

- More implementation modeling and policy relevant metrics

- Better communication of all, especially the above to decision makers

- Tie high priority directions for future research directly into assessments-VOI, etc.

Thank You