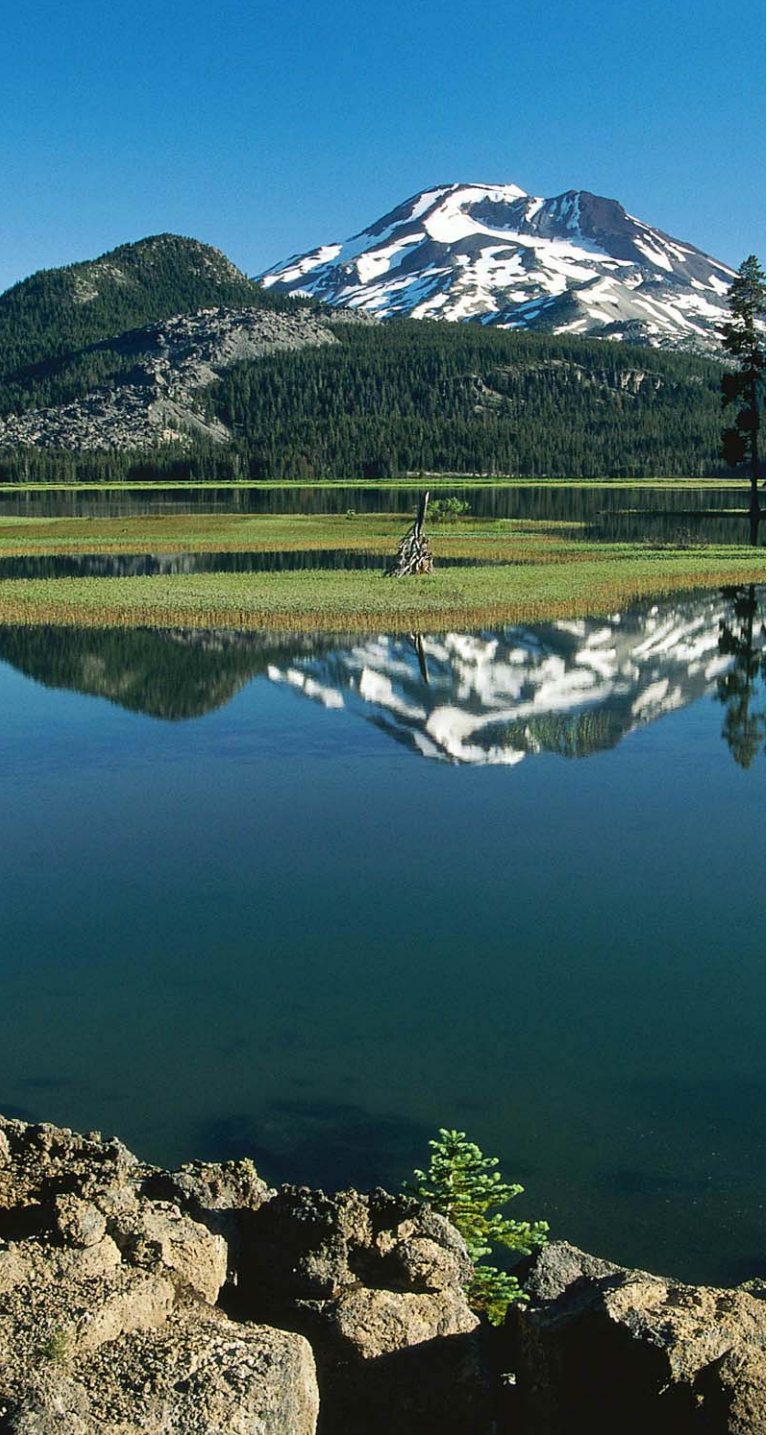

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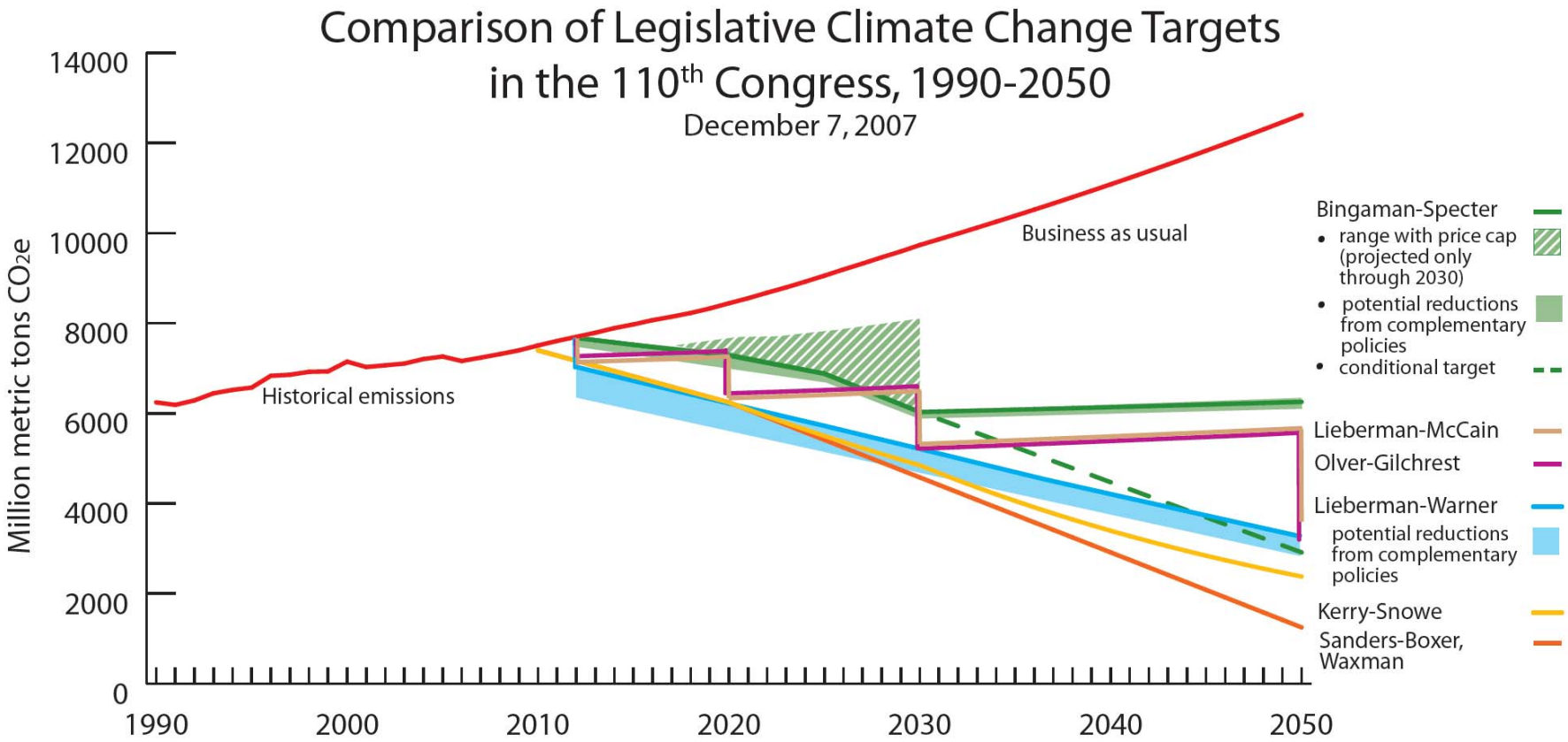
Understanding Model Estimates of the Economic Costs of Climate Policy

EPRI Global Climate Change Research Seminar

May 22, 2008

Tom Wilson
Senior Program Manager

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



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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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Elements of Lieberman-Warner Climate Security Act of 2007

- Economy-wide Coverage – about 87% of 2005 emissions
  - Downstream on coal (units > 5,000 tons/yr)
  - Upstream on oil, gas, F-gases, N_2O
- Targets for Covered Sectors (in $MtCO_2e$)

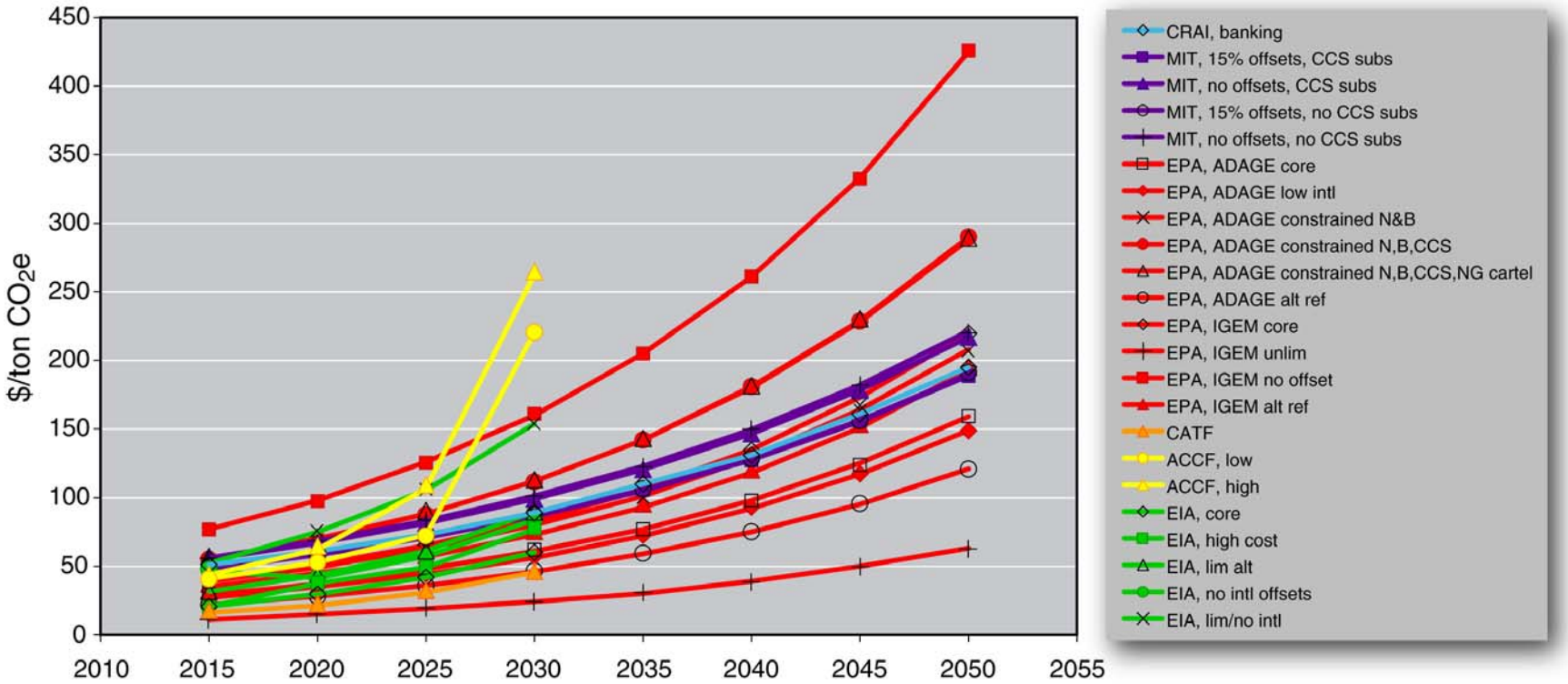
  2012: 5,775

  2020: 4,924

  2030: 3,860

  2050: 1,732 (~ 70% below 2005 level)
- Cap-and-trade system
  - 22.5% auction phasing to 69.5% by 2030
  - Permits/auction revenues designated for a wide array of uses
- Provisions for limited use of offsets
- Cost containment via a Carbon Market Efficiency Board

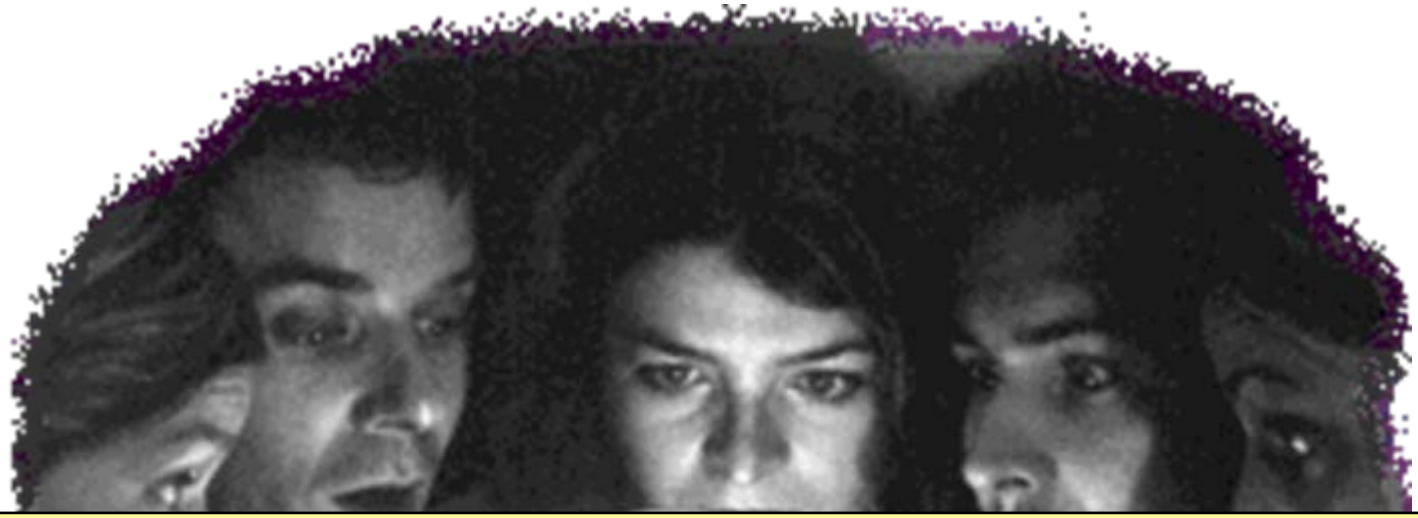
And the Cost of Lieberman-Warner 2007 is ….



Topics

- A Digression – A Perspective on Using Models
- Models and Modelers
- Different Assumptions Often Make the Biggest Differences
- Concluding Thoughts

Part I:
What Are Models Good For?



"It's hard to make predictions, especially about the future"

-Yogi Berra

Famous American philosopher
(and baseball player)

The Challenge of Modeling (Thanks to Jae Edmonds)

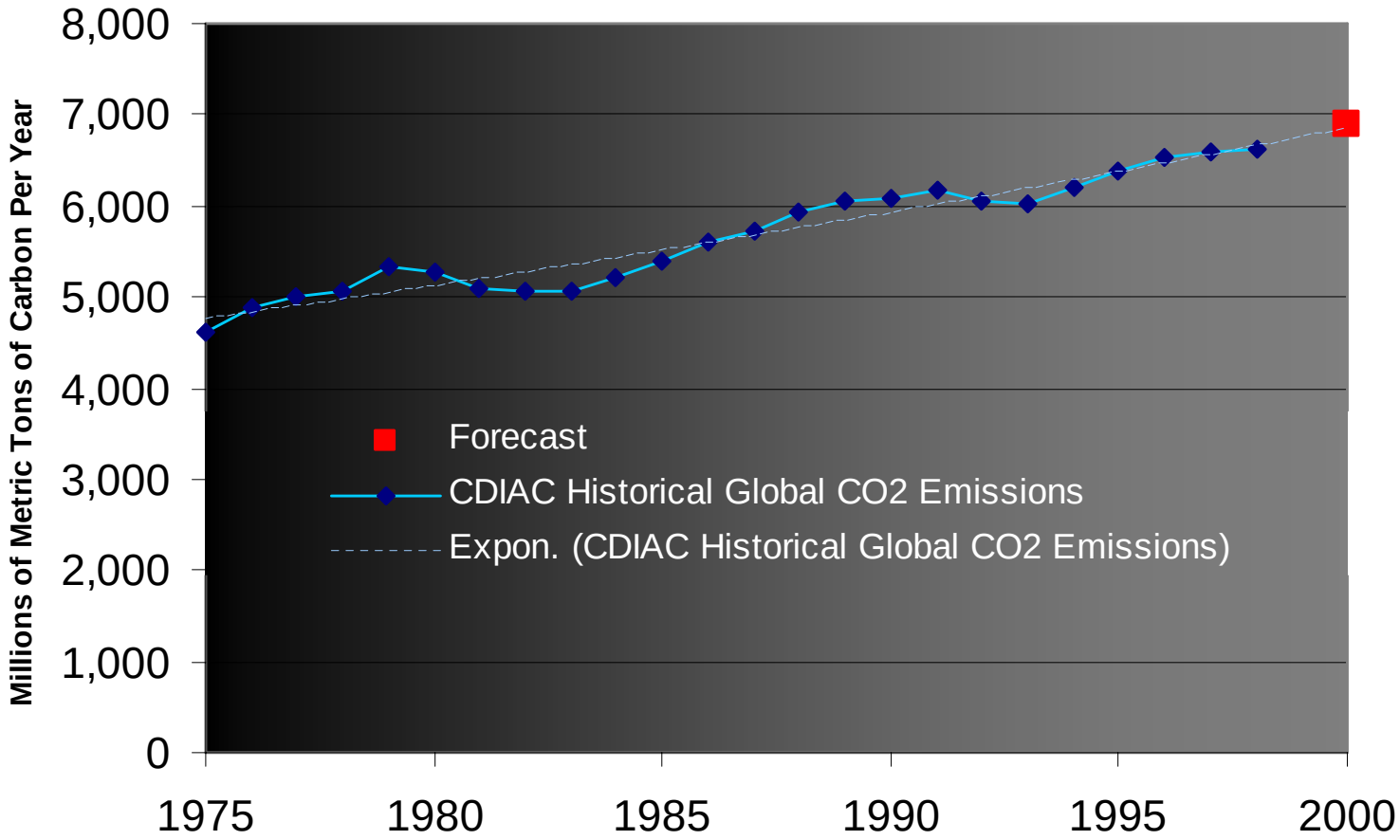
Examine Jae and John's Forecasts of 2000 CO_2 Emissions + Oil Prices

… Made in 1982

"I'm amused year after year by your high emissions scenarios – and happy to see others now chuckle at them too!"

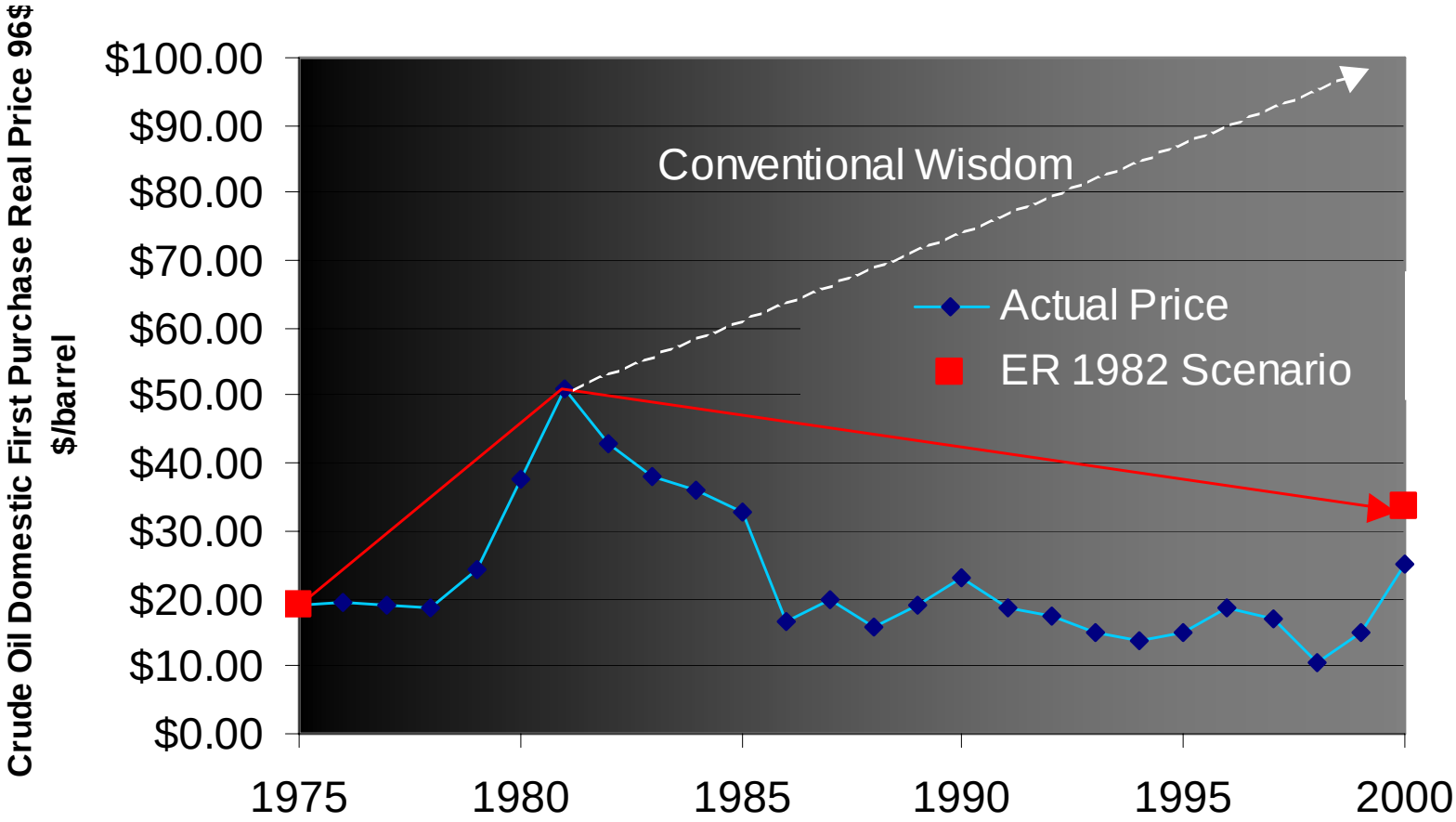
– Note Jae got from a friend in 1983

Projected and Actual 2000 Global CO_2 Emissions



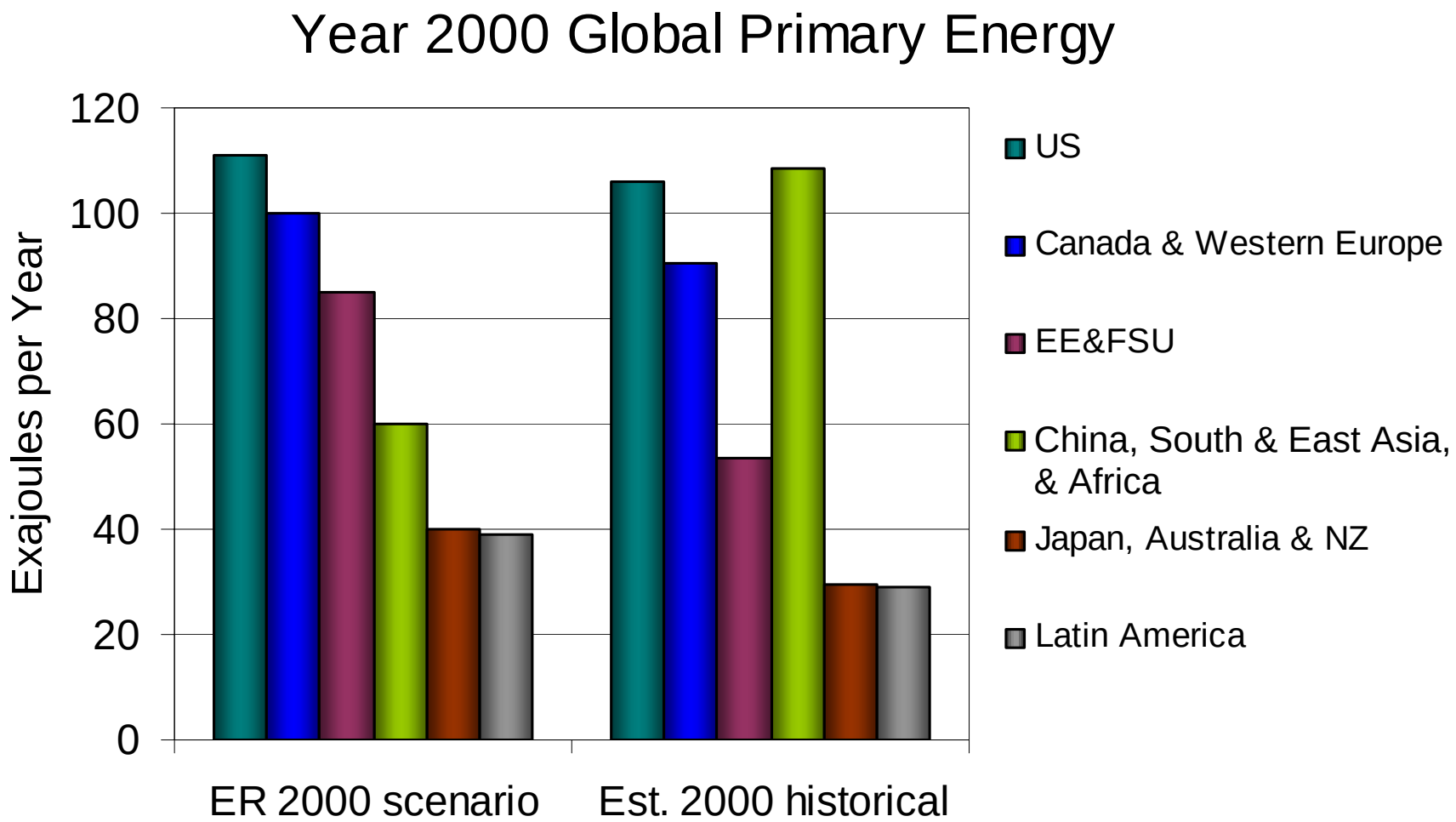
Source: Edmonds and Reilly -- Global Energy Production And Use To The Year 2050. Institute for Energy Analysis, Oak Ridge Universities, ***1982***

Projected and Actual 2000 World Oil Prices

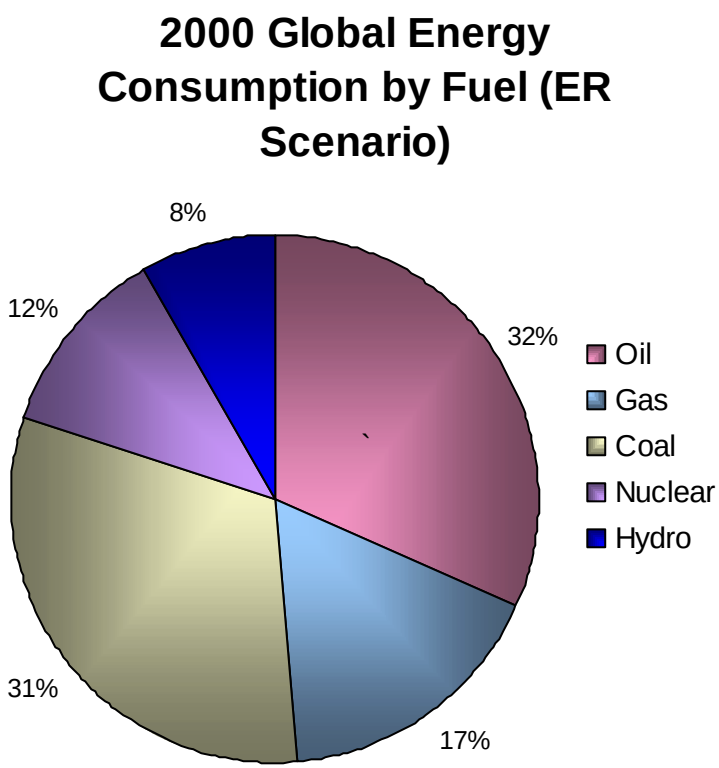


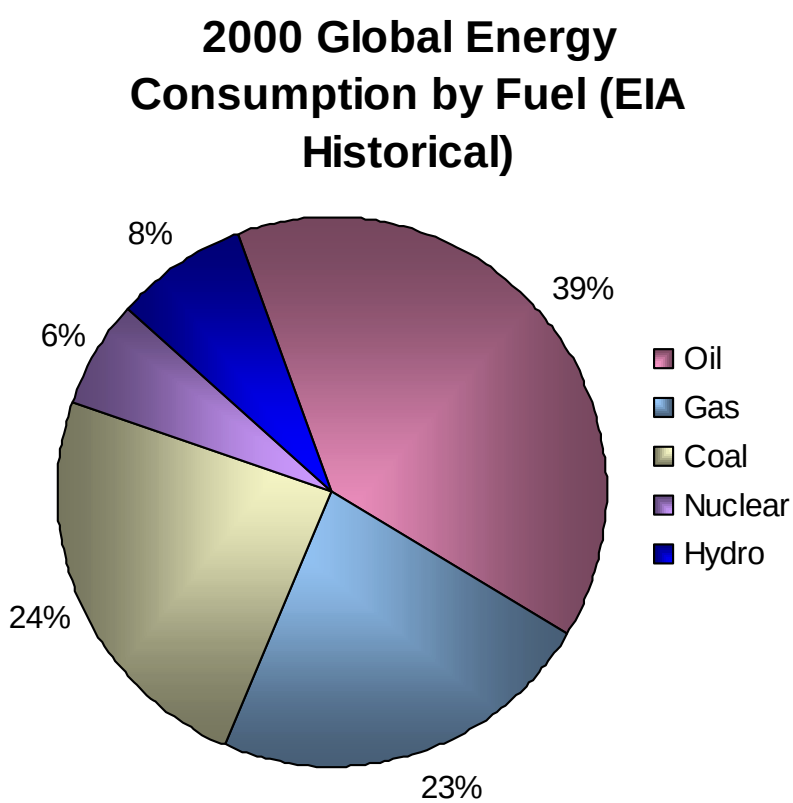
Source: Edmonds and Reilly -- Global Energy Production And Use To The Year 2050. Institute for Energy Analysis, Oak Ridge Universities, 1982

The Magic of Countervailing Errors – Geographic



The Magic of Countervailing Errors – Technology Choice





Insights from This Example

- Important stuff happens, especially over 10, 20, or 40 year time horizons
  - Models can provide very useful insights … but are less useful for providing "predictions"
  - Some things are easier to "predict" than others
- What could happen to change "predictions" dramatically?
  - Extended recession?
  - Rebound of the US$?
  - Technology accident?
  - Technology breakthrough?
- What modeling insights seem robust?

Part II:
Modelers and Models

Models with Public Estimates of Lieberman-Warner

- EIA NEMS=National Energy Modeling System
- CATF NEMS
- ACCF NEMS

- EPA ADAGE = Applied Dynamic Analysis of the Global Economy
  IGEM = Intertemporal General Equilibrium Model
  IPM = Integrated Planning Model
  Others
- MIT EPPA = Emissions Prediction and Policy Analysis Model
- CRAI MRN-NEEM = Multi-Region National Model + North American Electricity and Environment Model

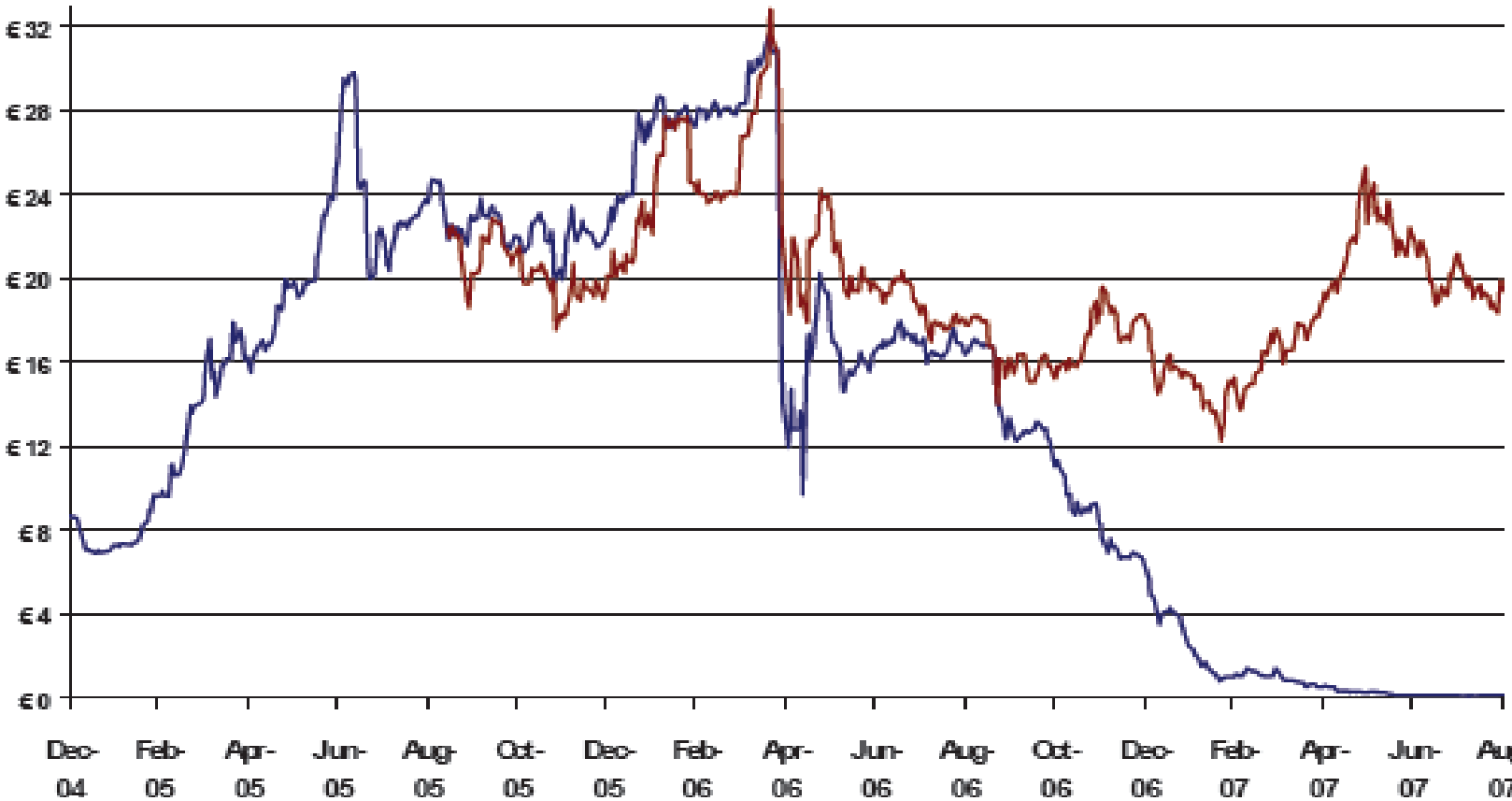
Selected Model Characteristics
(Draft)

Model/Modeling Effort	Geographic Scope	Sectors	Time Horizon	Foresight	Electric Sector Detail
EIA/CATF/ACCF					
• NEMS	U.S. – Regional	All, Process	2030	Recursive	Plant type
EPA					
• ADAGE	Global(?)	All, Trade[1]	2050	Perfect	Production function
• IGEM	U.S.	All, Trade[1]	2050	Perfect	Production function
• IPM	U.S. – Regional	Electric	2025	Perfect	Plant type/unit
MIT: EPPA	Global	All, Trade[1]	2050	Recursive	Production function
CRAI: MRN-NEEM	U.S. – Regional	All, Trade[1]	2050	Perfect	Plant type/unit

[1]Based on IMPLAN state-level, SIC code trade data with energy trade adjusted to match EIA physical trade data and reference scenario calibrated to EIA-AEO projections.

None of the Models Address Price Volatility … A Critical Factor for Some

EU CO_2 Allowance (EUA) Prices (2005–2007)



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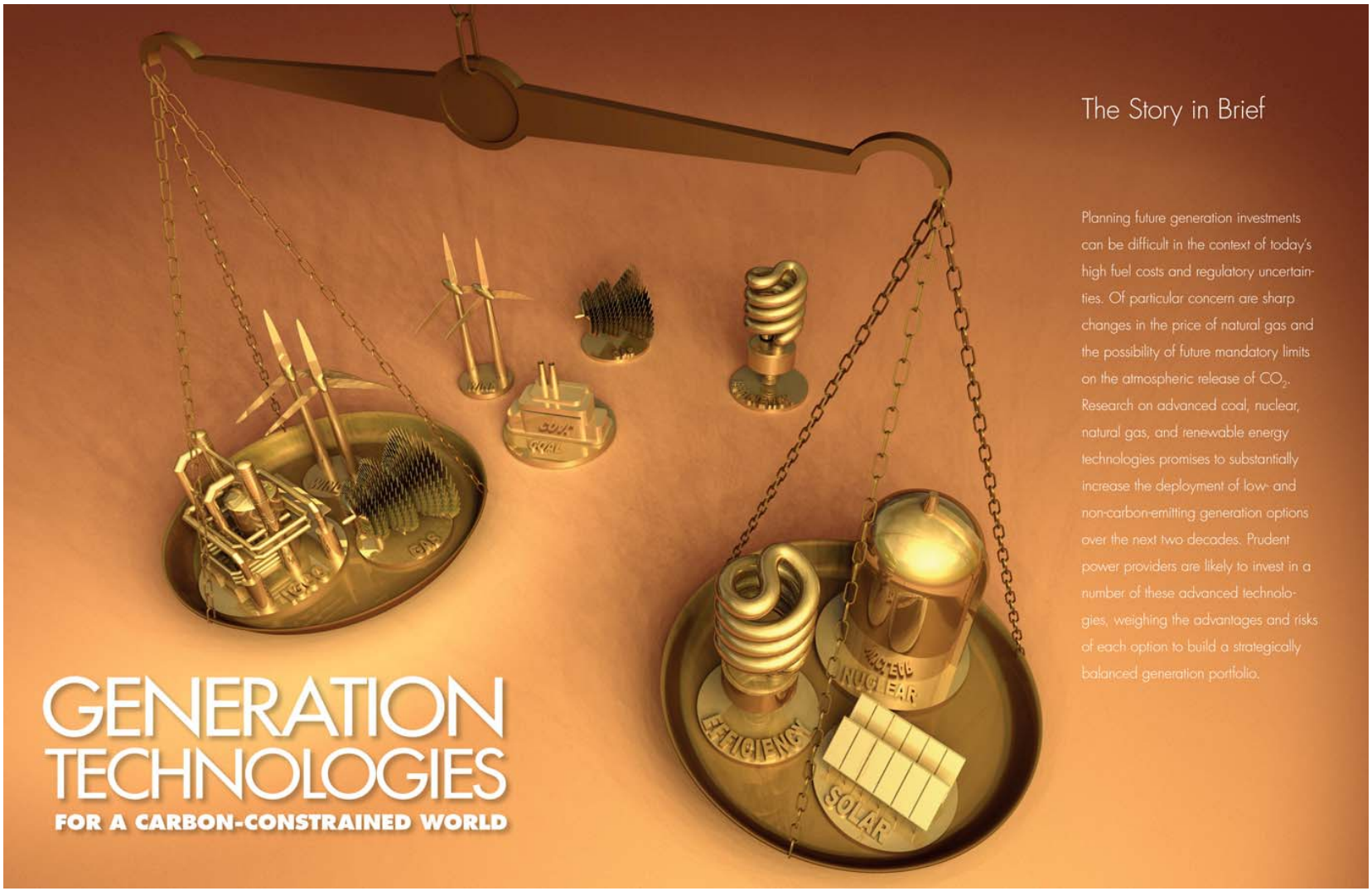
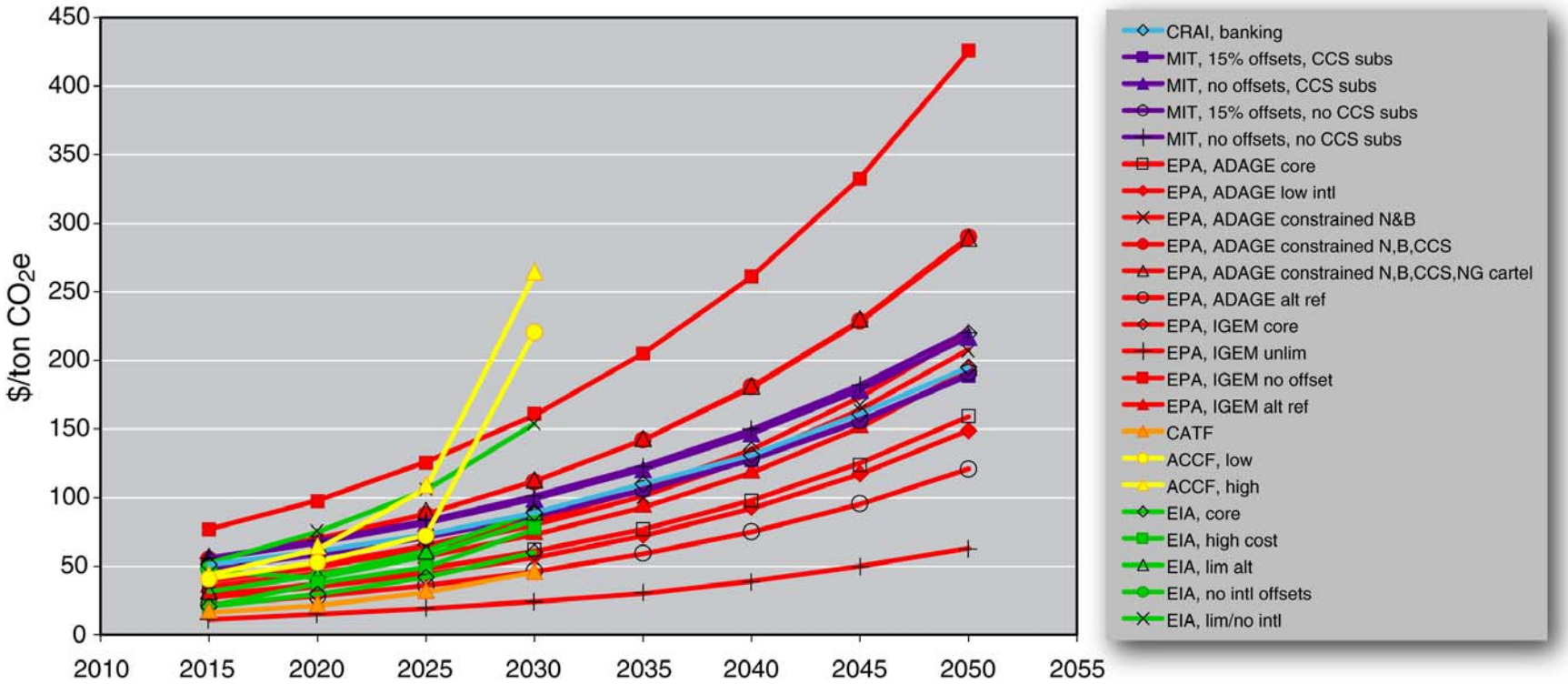
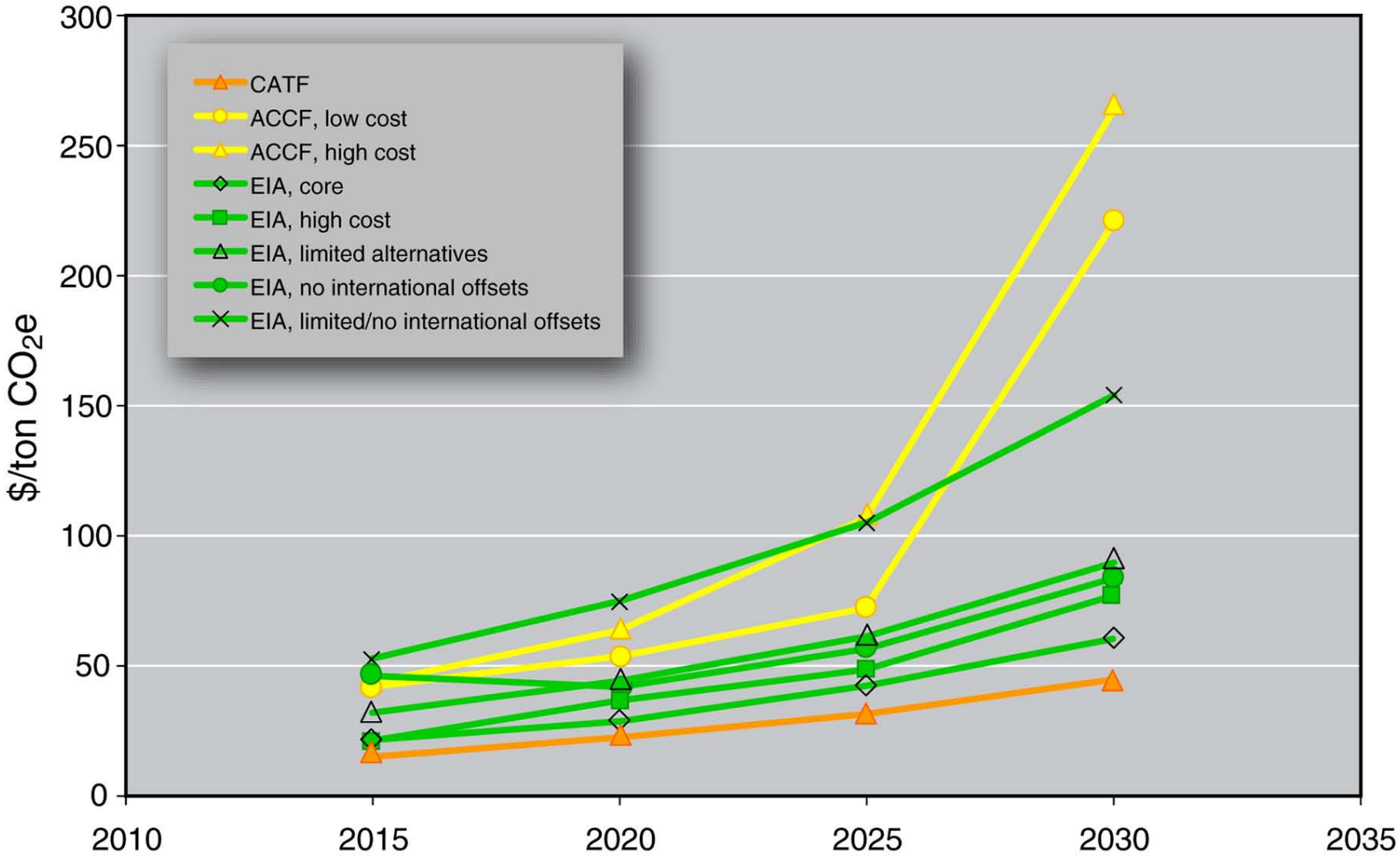
Part III
Different Assumptions Often Make the Biggest Differences



Recall the Cost of Lieberman-Warner 2007 is ….



Cost Estimates from Application of NEMS by EIA, CATF, and NAM/ACCF



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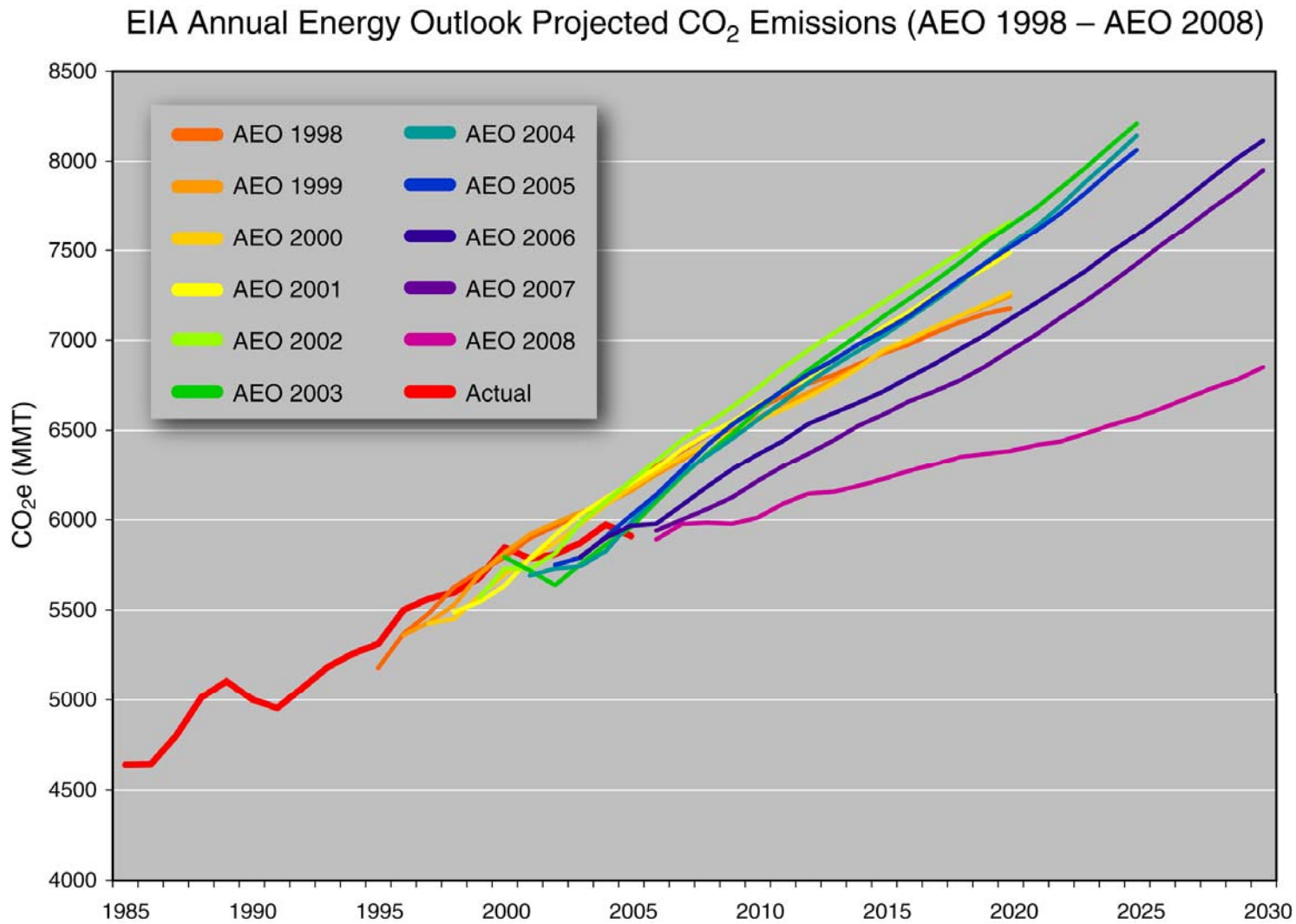
Key Assumptions Include Uncertainties and Policy Levers

I will talk about four uncertainties:

- Reference Case
- Technology Cost
- “Non-economic” limits on technology deployment
- Offsets

Policy Cost Depends on the Reference Case… Reference Cases Change Over Time



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Energy Technology Costs Are Highly Uncertain: All Nuclear and CCS Costs are Engineering Estimates

Pleasant Prairie Chilled Ammonia, Post-Combustion Capture Demo

Late 2007 photo, courtesy of Alstom

we energies

ALSTOM

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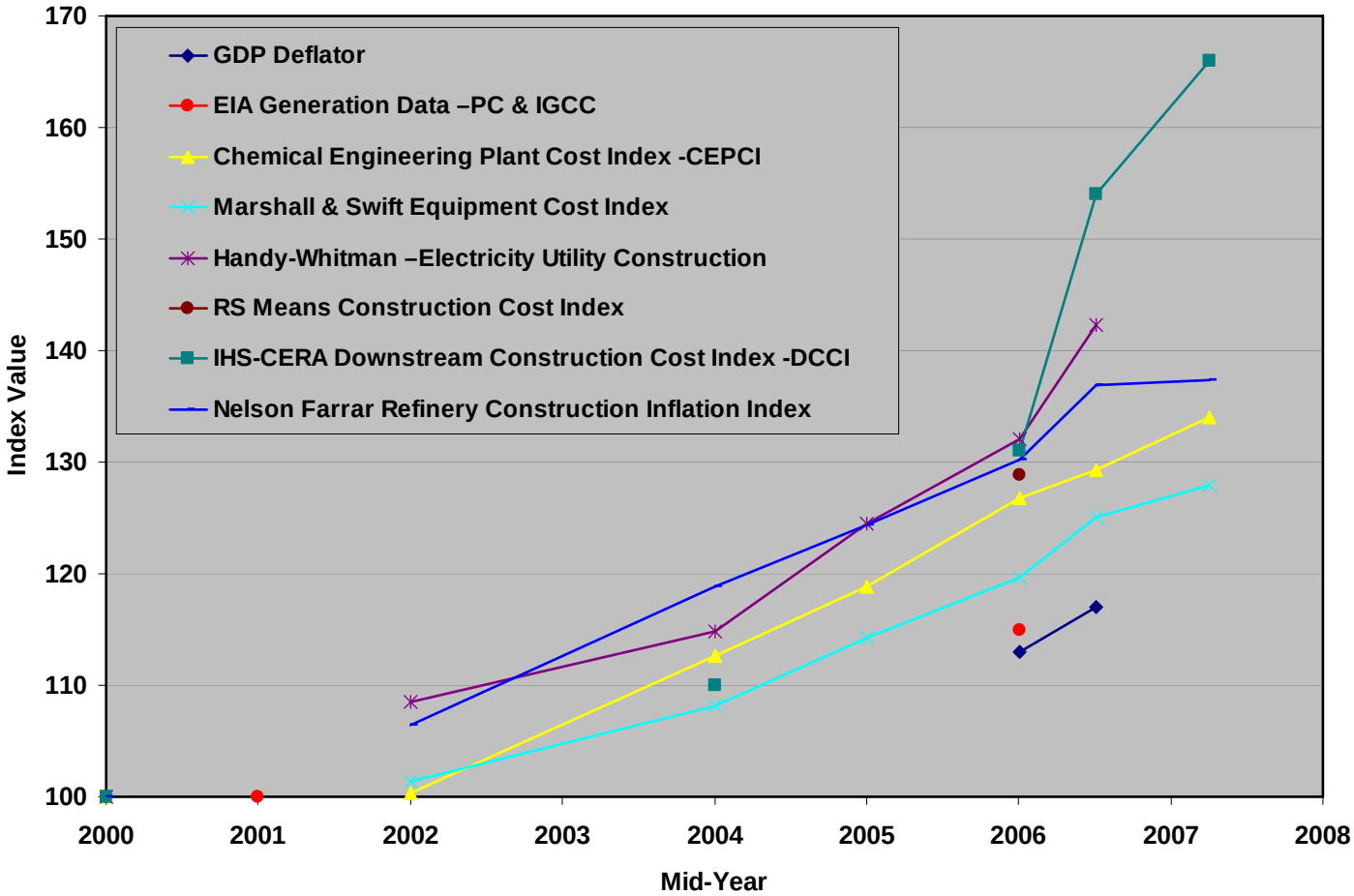
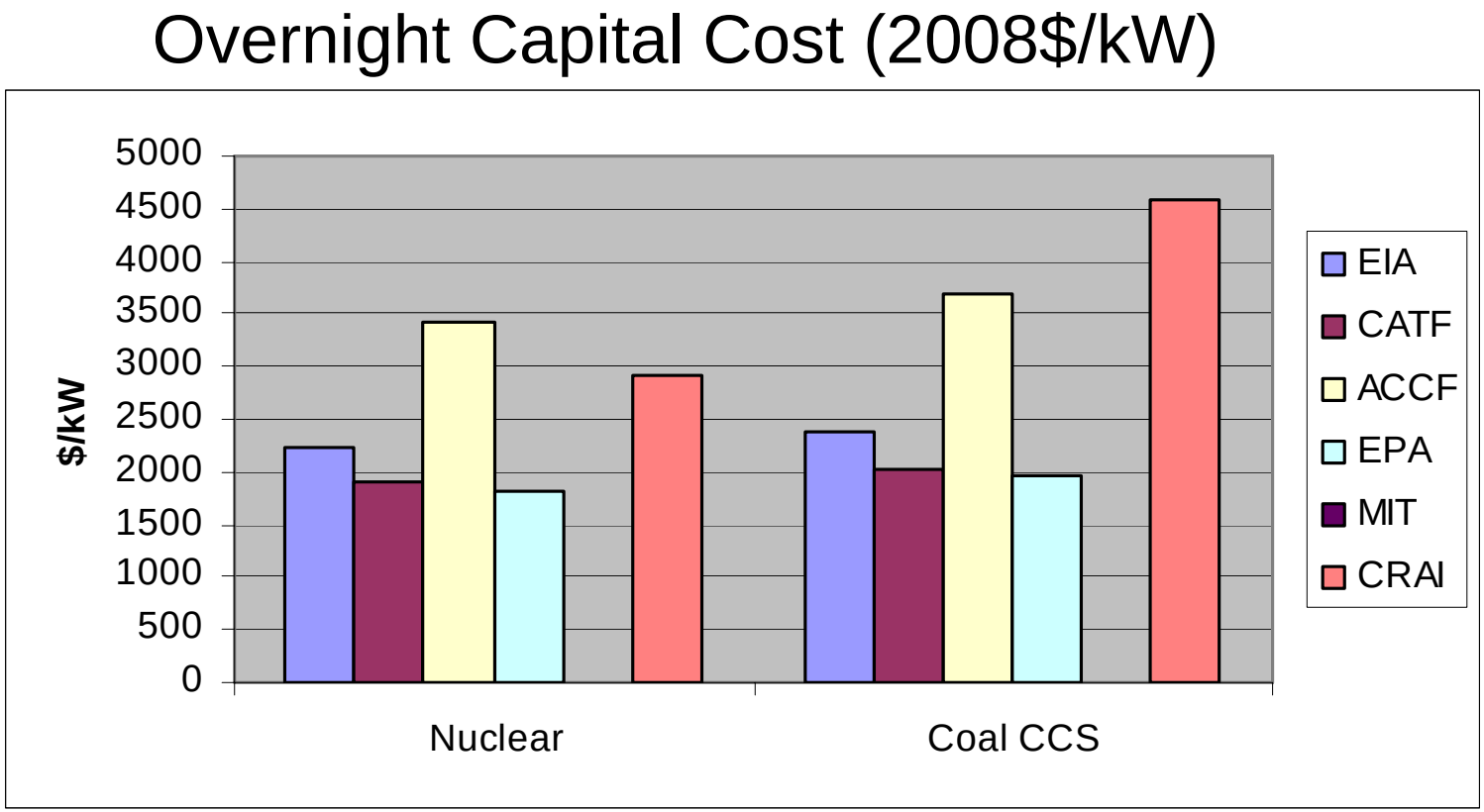
Energy Technology Costs Are Highly Uncertain: Are Today's Costs a New "Plateau" or a "Bubble"

Construction Cost Escalation Continues (Comparison of Several Cost Indices, Mid-2000 = 100)



Reported and Guesstimated Technology Cost Estimates for Analyses you Will See Today

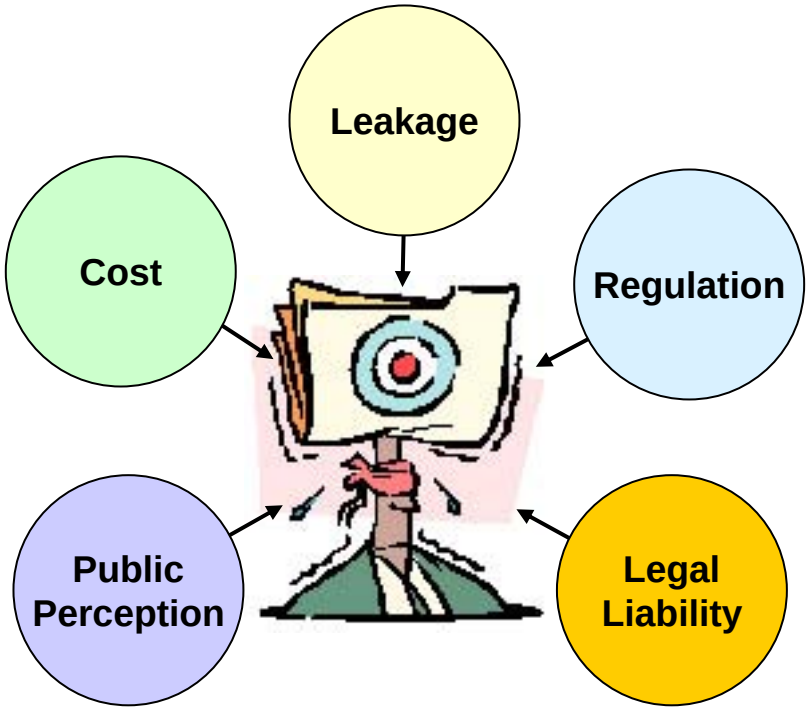


Caveats: Converted to 2008$

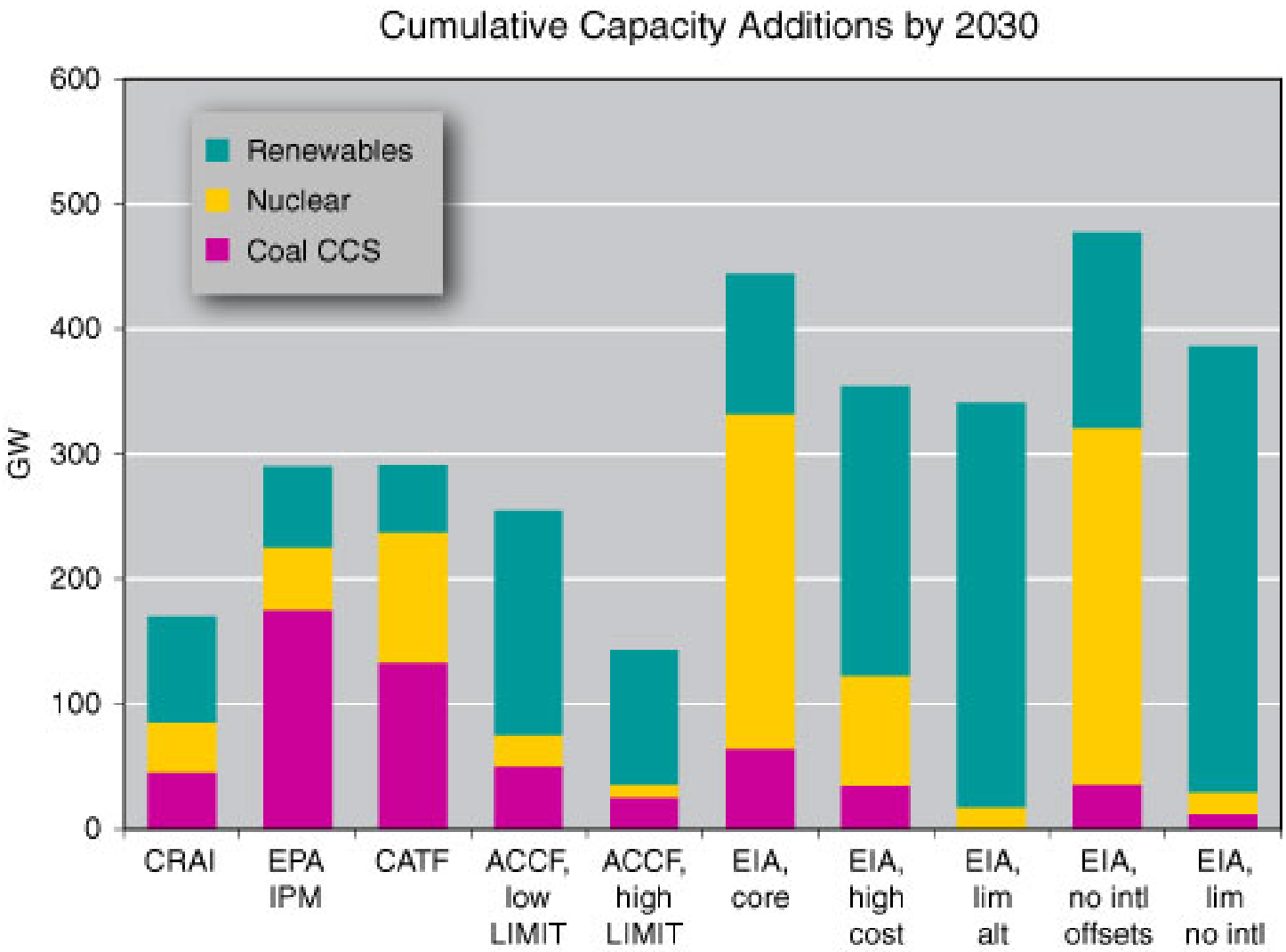
CATF= AEO2007, EPA/IPM= AEO2005, CRAI= updated AEO2007

Some costs decline rapidly over time, e.g., CRAI Coal CCS to $3203/kW by 2050

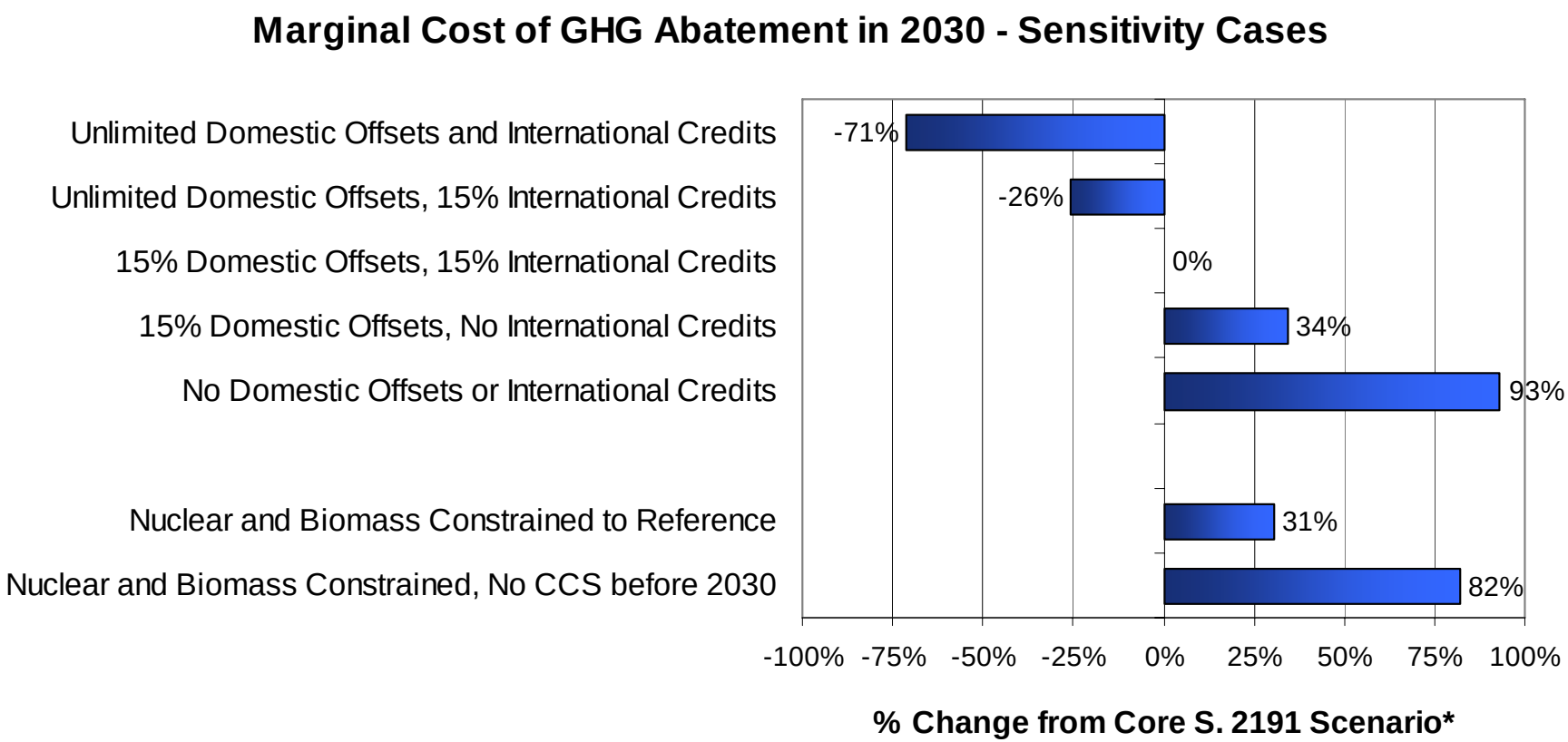
Technology Deployment is Even More Uncertain



Cumulative Capacity Additions of Coal CCS, Nuclear and Renewables

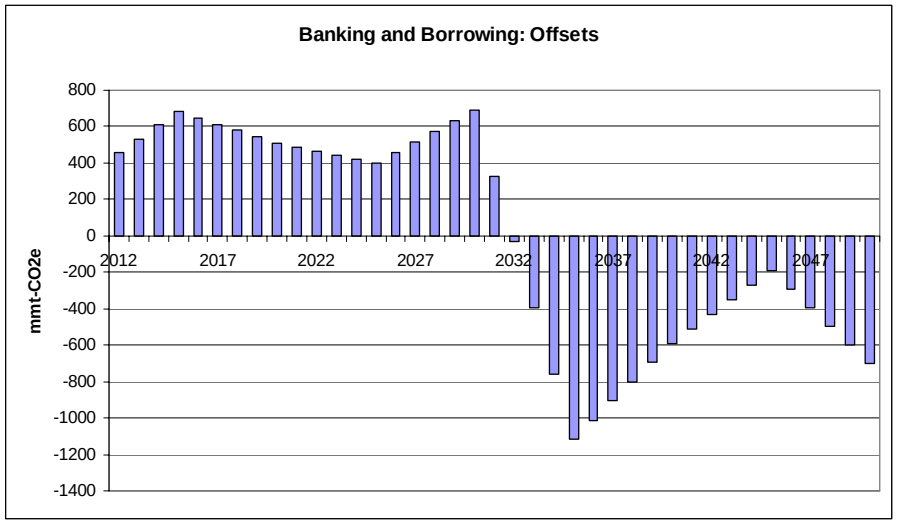


EPA Analyses
Offset Provisions of S. 2191 Significantly Influence Costs

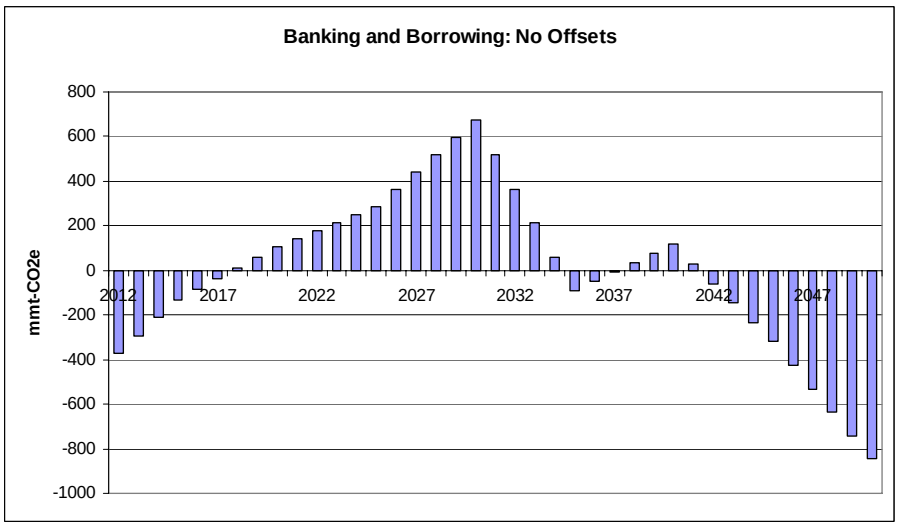


Need increased attention on offset modeling

MIT -- Banking Strategy is Not Obvious



With Offsets



Without Offsets

Concluding Thoughts

- US climate policy analyses likely to be released frequently over the next few years
- All of the models here are credible
- None are great predictors; but all can provide important insights about policy
- Differences in cost estimates appear to represent true uncertainties (e.g., technology deployment) and effects of policy choices (e.g., use of offsets) more than differences in models

I would be more worried and feel less-informed if there were little diversity in the cost estimates

May 8 Workshop Presentations at www.epri.com

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Welcome, Tom Wilson of Electric Power Research Institute (EPRI)

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Welcome to EPRI

EPRI Workshop on Cost Estimates of Lieberman-Warner Climate Legislation

EPRI recently convened a workshop on the cost estimates of Lieberman-Warner climate legislation in Washington, DC to develop further understanding of the wide range of cost estimates that have been made public over the last six months. The meeting was attended by Congressional staff, government officials, energy-economy modelers and electricity company staff.
>> Read more

Cultivating Clean Tech

EPRI is featured in this May 2008 *Public Utilities Fortnightly* article.
>> Article reprint

Specker Named to Class of 2008

Steve Specker, EPRI President and CEO, has been named to the *World-Generation* Class of 2008
>> Article reprint (281KB PDF)
>> Class of 2008

Shining a Light on Blackouts

Arshad Mansoor, EPRI's VP of Power Delivery & Utilization, is featured in the current issue of *Utility Automation & Engineering T&D*
>> Read the Article

Grid-Powered Cars

Plug-in hybrid electric vehicles could reduce greenhouse gas emissions, improve air quality.
>> Read EPRI/NRDC joint research

Confronting the CO2 Challenge

EPRI is proposing an aggressive but feasible approach to reverse atmospheric carbon dioxide concentrations while meeting the growing demand for electricity. We call our approach "The Full Portfolio."

Article: A summary of EPRI's strategy to cut CO_2 emissions and meet electricity demand is featured in the Jan/Feb 2008 issue of Electric Perspectives.
>> Read the article (7MB PDF)

Video: The Full Portfolio of electricity technologies can stabilize and reverse industry CO_2. EPRI's CEO, Steve Specker, discusses the concepts.
>> Watch the video (14MB)
Video file courtesy of NRECA

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