Energy Modeling: Past, Present and Future - an IEW Centric View

John P. Weyant

International Energy Workshop

30th Anniversary Celebration

Stanford University

July 6, 2011

Outline

- A Small Tribute
- The World in 1981
- The IEW in 1981
- The IEW Today
- The Modeling World in 1981
- The Models Today
- Trends Over the Last 30 Years
- Present Challenges
- Future Opportunities

A Simple Tribute to Alan and Leo

Dona eis requiem

Dona eis requiem sempiternam

Overarching Themes

- 283 abstracts submitted, 120 accepted!
- We see the trees a lot better than 30 years ago,
- But do we see the forest any better?
- I am not too sure about that!

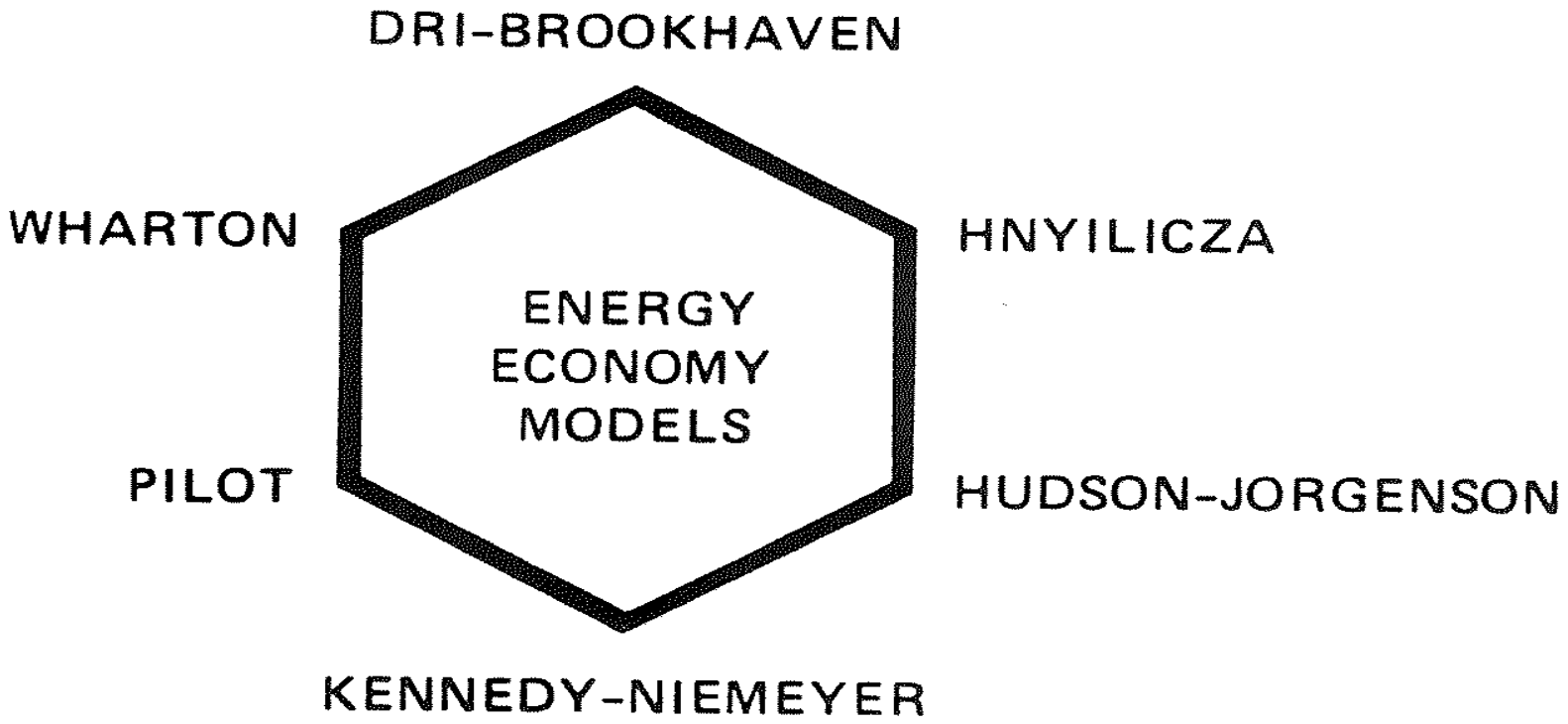
The World in 1981

- Ronald Reagan was US president and was shot
- John Paul II was pope and was shot
- Oil Prices had doubled-Iranian rev. and Iran-Iraq war
- Model 5150 IBM PC Introduced (August)
  - MS DOS operating system-crude WP and spreadsheets
  - Intel 8088 processor could not run models
  - No generally available internet service
  - Windows still 9 years away
- First Heart-Lung Transport at SU Hospital
- Sandra Day O'Connor woman to Supreme Court
- Most energy modeling done in universities
- Journalists/communicators had little technical credibility

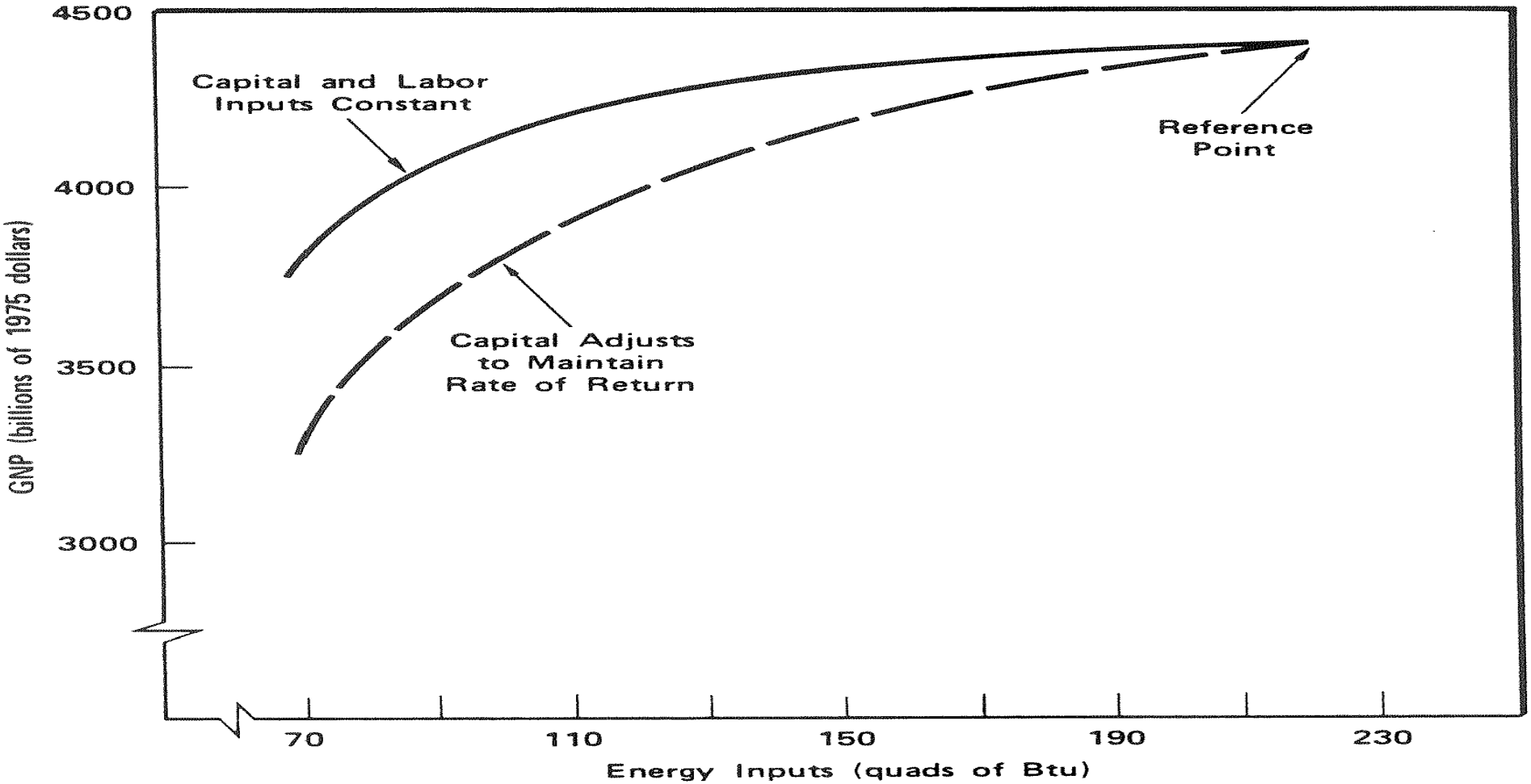
Energy Modeling Forum #1

Energy and the Economy

Volume 1



EMF 1: Elasticity of Substitution and Capital Accumulation Effects



SOURCE: See Note 2.

Figure 4 Economic Impact of Energy Scarcity in the Year 2010 for Alternate Capital Assumptions (Elasticity of Substitution $\sigma = 0.3$)

EMF 6 World Oil:1981

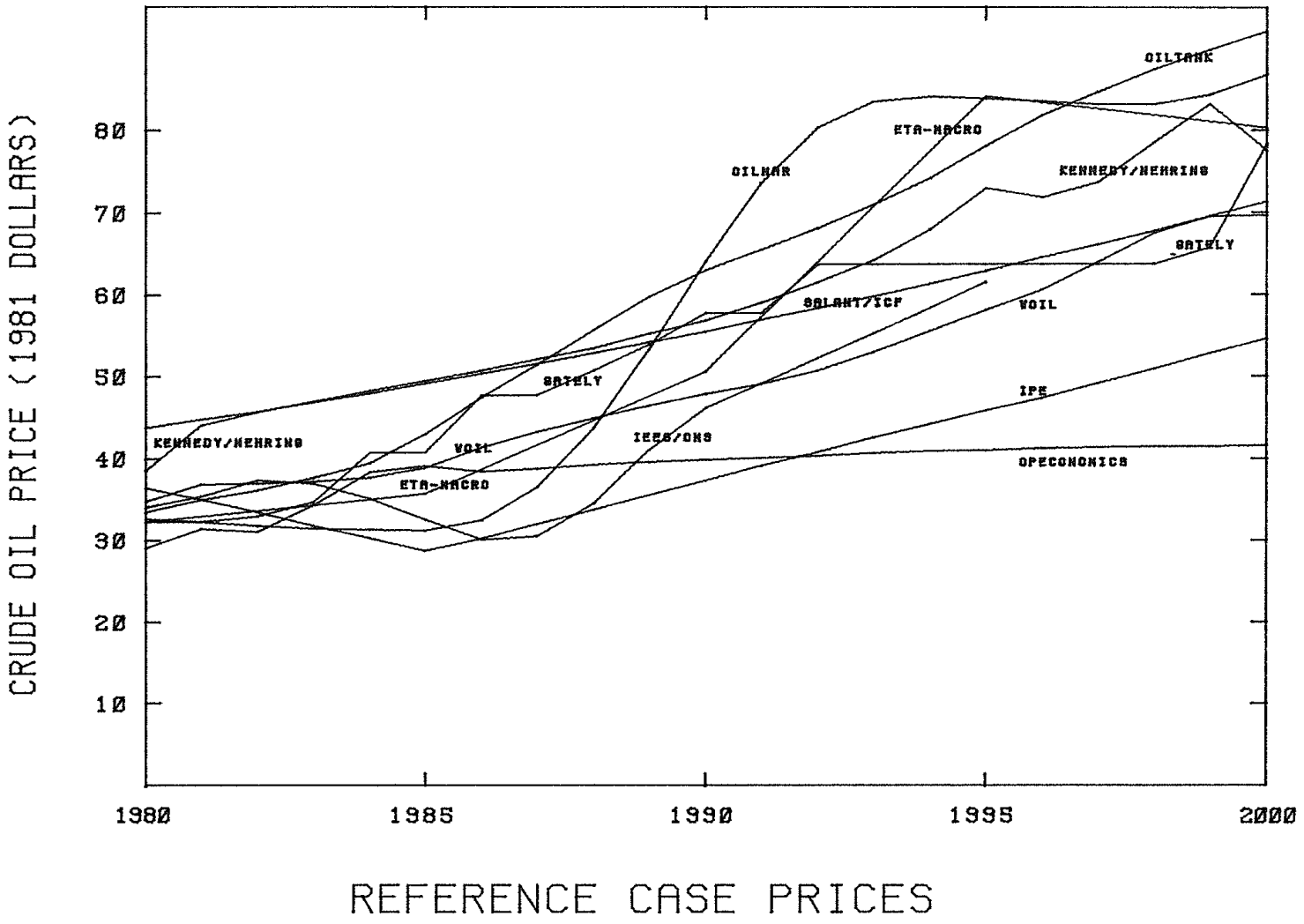
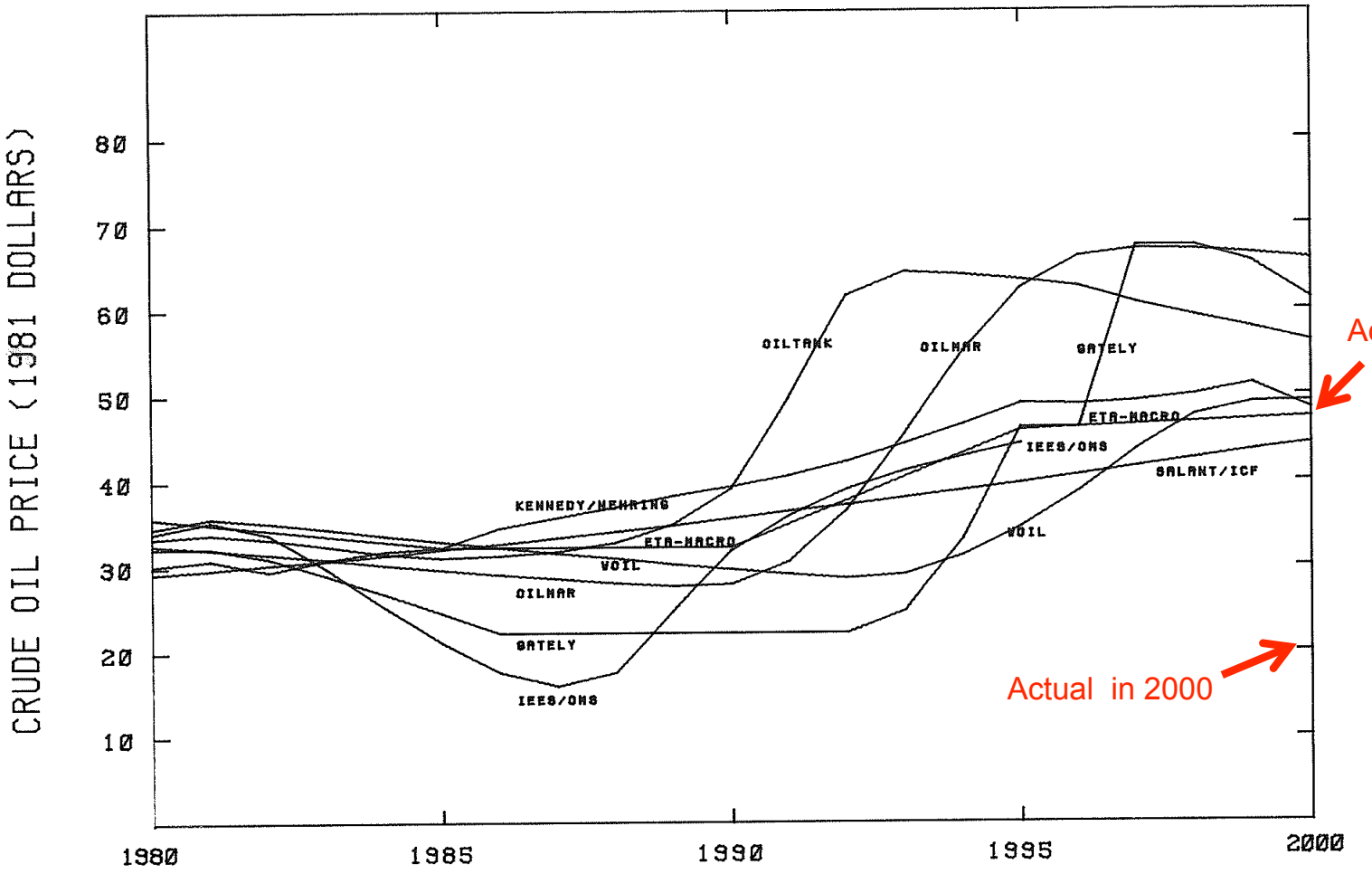


Figure 1

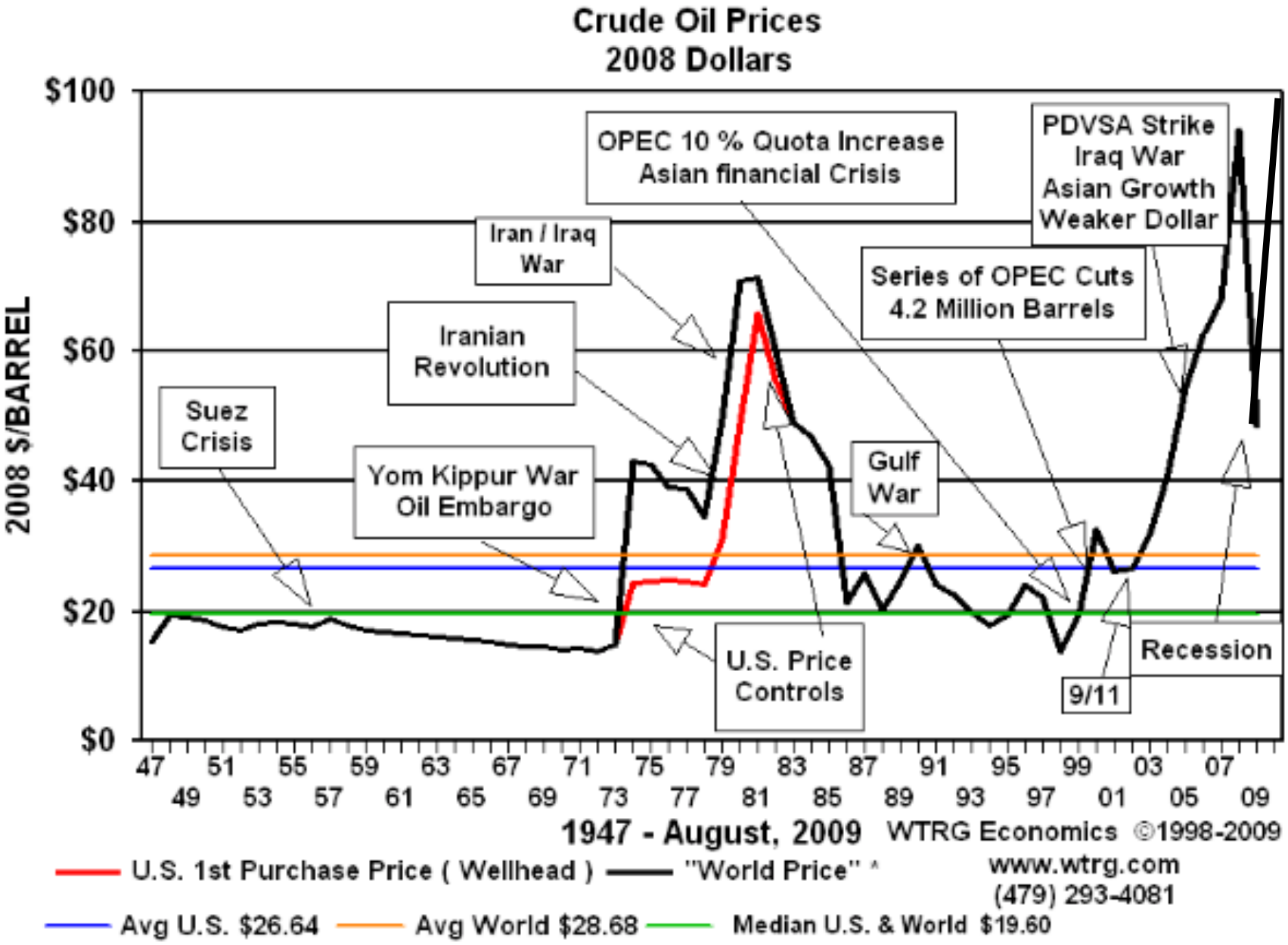
EMF 6 “Optimistic Case”



OPTIMISM CASE PRICES

Figure 2

Model That?


Crude Oil Prices
2008 Dollars
2008 $/BARREL
$100
$80
$60
$40
$20
$0
OPEC 10 % Quota Increase
Asian financial Crisis
PDVSA Strike
Iraq War
Asian Growth
Weaker Dollar
Iran / Iraq War
Series of OPEC Cuts
4.2 Million Barrels
Iranian Revolution
Suez Crisis
Yom Kippur War
Oil Embargo
Gulf War
U.S. Price Controls
9/11
Recession
47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87 89 91 93 95 97 99 01 03 05 07 09
1947 - August, 2009
WTRG Economics ©1998-2009
www.wtrg.com
(479) 293-4081
U.S. 1st Purchase Price (Wellhead)
"World Price"
Avg U.S. $26.64
Avg World $28.68
Median U.S. & World $19.60

Roots of the IEW

- Alan Manne (Stanford) Dec. 1981 (40 people)
- Leo Shrattenholzer (IIASA) June 1983 (50 people)
- Started with focus on world oil
  - Models not included in EMF 6
  - Included non model using prognosticators
  - Establishment of annual world energy poll
- No parallel sessions initially
- Mostly econ people from US and engineers from Europe

JW in 1981

IEW Today

- 200+ participants
- Broad range of energy-environment issues addressed
- Proliferation of parallel sessions
- IT revolution readily apparent
- Many more models
- Models more complex, if not more sophisticated
- Many non-university modelers
- Many communities, but OR may be the single biggest overarching commonality
- Fuzzies have a lot more credibility

Models in 1981

- Maybe 4-5 dozen models
- No GTAP or GAMS, ETSAP just getting started
- NAS CONEAS Modeling Resource Group (1976-77)
  - ETA (Energy Technology Assessment)
  - Nordhaus
  - DRI
  - SRI-Gulf
  - Brookhaven
  - PIES (Project Independence Evaluation System)
- EMFs 1-6

Generic Types of Energy/Environment Policy Models

- Process Engineering
  - Individual Technologies Represented
  - Need to Add in Market and Economy Wide Effects
- Energy Market Models
  - Bring in Energy Market Feedbacks
  - Weaker on Technology & Economy
- General Equilibrium Models (Inc. CGE)
  - Bring in Economy-Wide Feedbacks
  - Weaker on Energy Markets and Technology

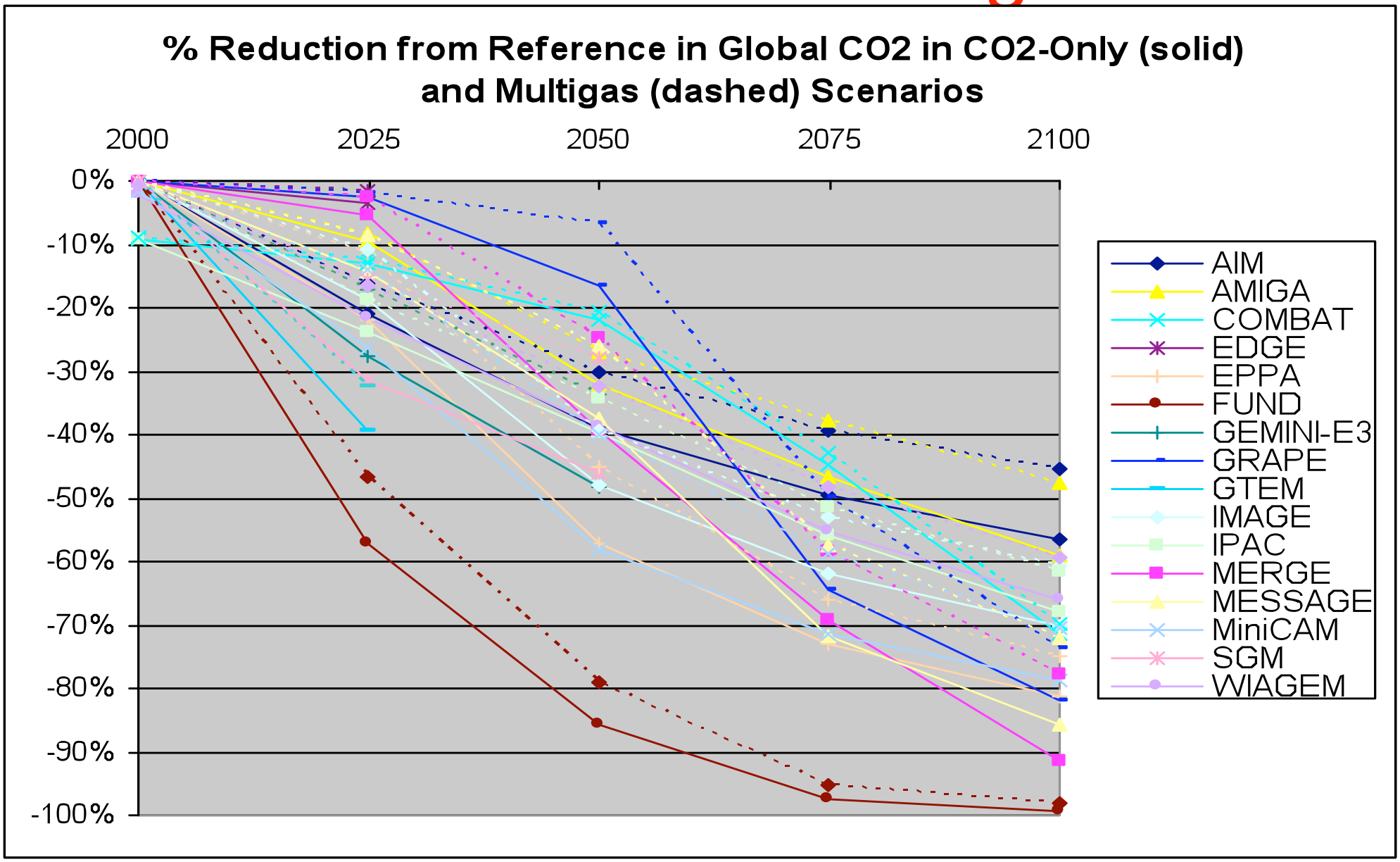
Models in 2011

- Around 500 National/International Models
- ETSAP Technology Group (maybe 100 groups)
- GTAP Based CGE Group (maybe 75 groups)
- MERGE-GCAM-DICE-MESSAGE Group
  - Over 40 institutions in registered GCAM user group
  - Many more DICE and MERGE users
  - Integrated Assessment Modeling Consortium (2007)

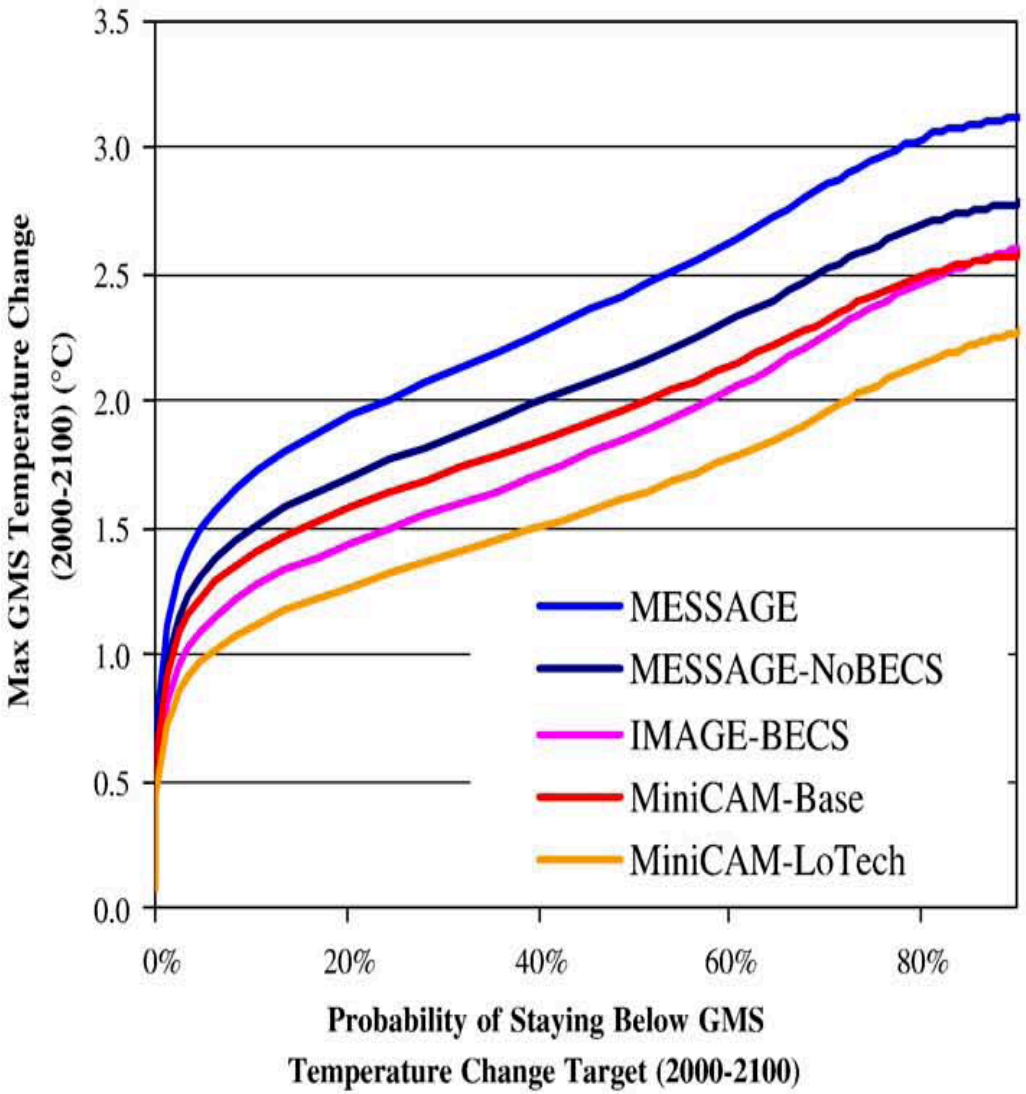
The IAMC Members

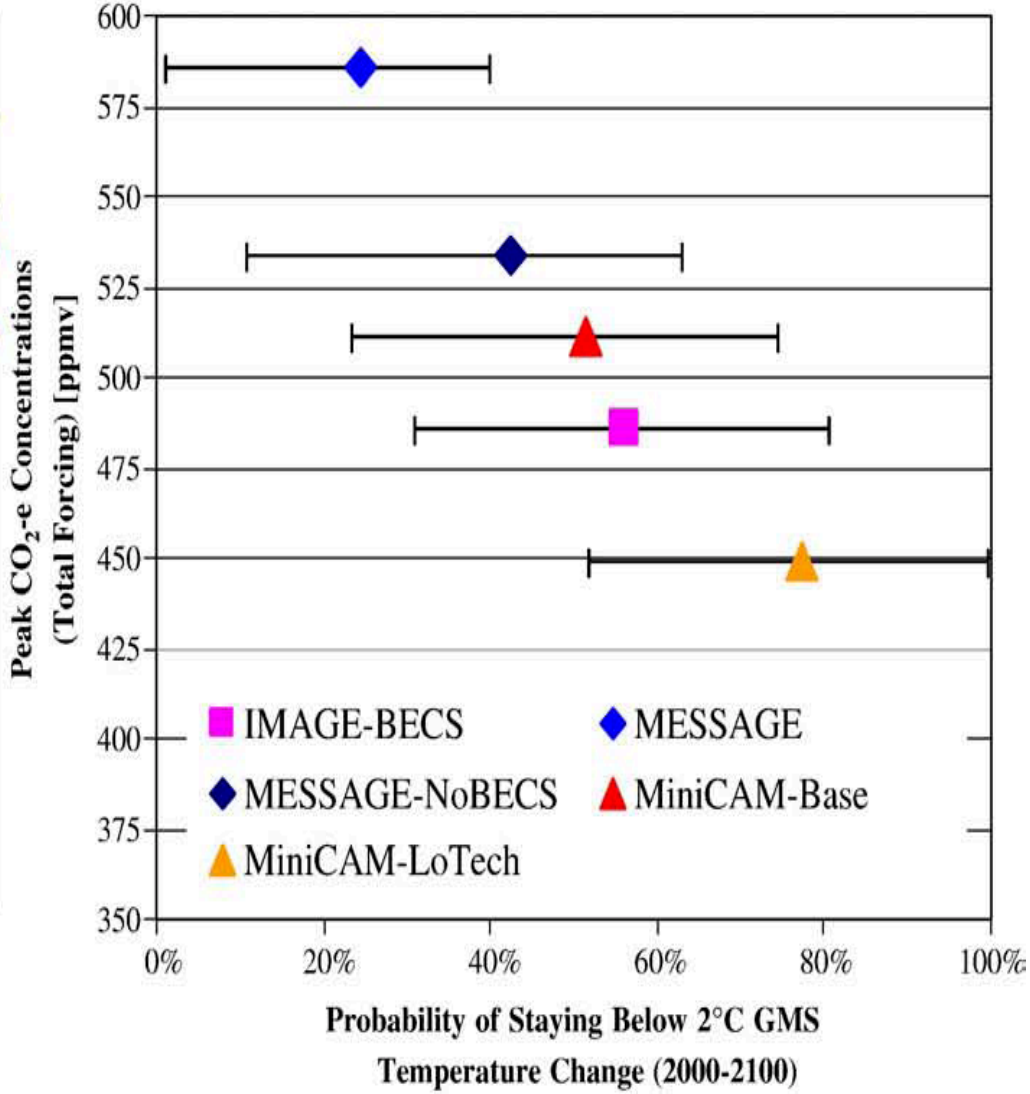
- Australian Bureau of Agricultural and Resource Economics (ABARE)
- Bundeswehr University, Munich
- Business Council for Sustainable Development – Argentina
- CEA-LERNA, University of Social Sciences
- Centre for International Climate and Energy Research (CICERO), University of Oslo
- Argonne National Laboratory
- Centre International de Recherche sur l'Environnement et le Developpement (CIRED)
- CRA International
- DIW Berlin
- Electric Power Research Institute (EPRI)
- Energy Research Institute, National Development and Reform Commission (NDRC)
- Energy Technology Systems Analysis Programme (ETSAP)
- ETH Zurich
- European Commission, Joint Research Centre, Institute for Prospective Technological Studies (IPTS)
- Fondazione Eni Enrico Mattei (FEEM)
- Hamburg University and Economic and Social Research Institute (ESRI)
- Indian Institute of Management
- Institut d'Economie et de Politique de l'Energie (IEPE-CNRS)
- Institute of Applied Energy
- International Institute for Applied Systems Analysis (IIASA)
- San Marcos University
- National Institute for Environment Studies (NIES)
- National Center for Atmospheric Research (NCAR)
- Ohio State University
- Pacific Northwest National Laboratory, Joint Global Change Research Institute at the University of Maryland
- Potsdam Institute for Climate Impact Research (PIK)
- Programa de Planejamento Energético - PPE/COPPE/ UFRJ
- Purdue University
- RAND
- Research Institute of Innovative Technology for the Earth (RITE)
- Stanford University Energy Modeling Forum (EMF)
- Tellus Institute
- Texas A&M University
- The Netherlands Environmental Assessment Agency (PBL)
- Tyndall Centre for Climate Change Research, The University of East Anglia
- Universidad de Los Andes / Universidad Nacional de Colombia
- Universidad Iberoamericana Puebla
- University of Cambridge
- University of Oldenburg
- US Environmental Protection Agency
- VTT
- World Bank

EMF #21: Multi Gas Mitigation 4.5 w/m^2 Global Target



EMF #22: Overshoot 450 ppmv CO2-e scenarios with full participation





Trends Over Last 30 Years

- Hybid ization
- Global ization
- Environmental ization
- Input-Output ization
- Technology ization
- Integration (many disciplines & approaches)
- Popular ization
- Extreme Cycles of Interest ization

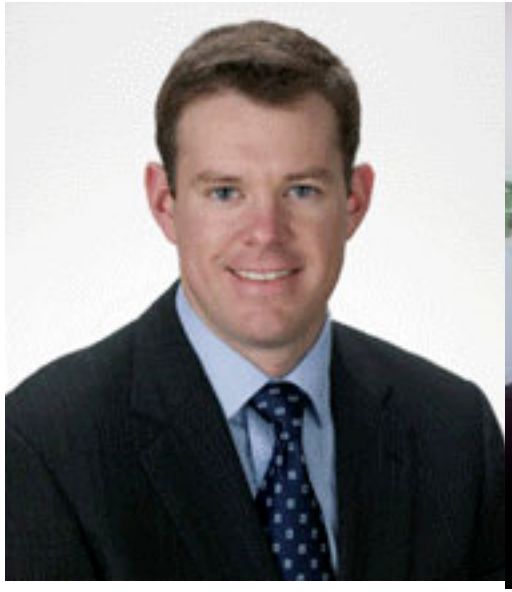
Challenges

- Data Availability and Quality
- Dealing With Uncertainty
  - Formulation, computation, illicitation, interpretation
- Understanding Trends in Demand
  - Economic growth elements
  - Behavioral elements
  - Technology elements
- Understanding Technology Change
  - Invention, Innovation, Diffusion
- Model Assessment
- Insights, Not Numbers or Not

Directions for the Future

- Policy Driven Data, Model and Analysis Development
  - What's a good model? scenario? way to deal with uncertainty? approach to model assessment?
  - Answer: It depends on the question being asked.
  - Need more implementation level modeling.
- Need to get away from free societies=free markets=perfect markets=welfare maximization
- Demand, behavior, technology and incentives
- Sequential decision making under uncertainty
- Integrated technology assessment
  - e.g., climate
  - Need much better approach to inter-discipinary research
- Better integration of data driven and structural models
- Put additional computational power to good use
  - Hardware, software, graphics/GIS

The Heroes the Show



Happy 30th Birthday IEW

Thank You

Some Early EMF Studies

- EMF #1
  - Hudson Jorgenson
  - Kennedy-Niemeyer
  - PILOT
  - Wharton
  - DRI-Brookhaven
  - Hnyilicza
- EMF #6
  - Gately/Kyle/Fisher
  - IEES/OMS (EIA)
  - IPE
  - Salant/ICF
  - ETA-Macro
  - WOIL
  - Kennedy/Nehring
  - OILTANK
  - Opececonomics
  - OILMAR