The Modeling of the Economics of Climate Change: Stocktaking and Future Challenges

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Model comparison in early 1990s

- 6 models in OECD Model Comparison
  - Carbon Rights Trade Model (CRTM); the Edmonds and Reilly model (ERM); the OECD GREEN model; the International Energy Agency (IEA); the Manne and Richels Global 2100 Model; the Whalley and Wigle Model
- Other
  - Nordhaus' DICE, ABARE, McKibbin and Wilcoxen (G-Cubed)
- Major policy issue—Kyoto Protocol

Model comparison today

- At least 28 models and counting
  - Many CGEs
  - A handful of dynamic optimization
  - A handful of bottom-up energy models
  - Hybrids
- Less labor intensive
  - Better and improving data (thanks to GTAP!)
  - Better analytical tools

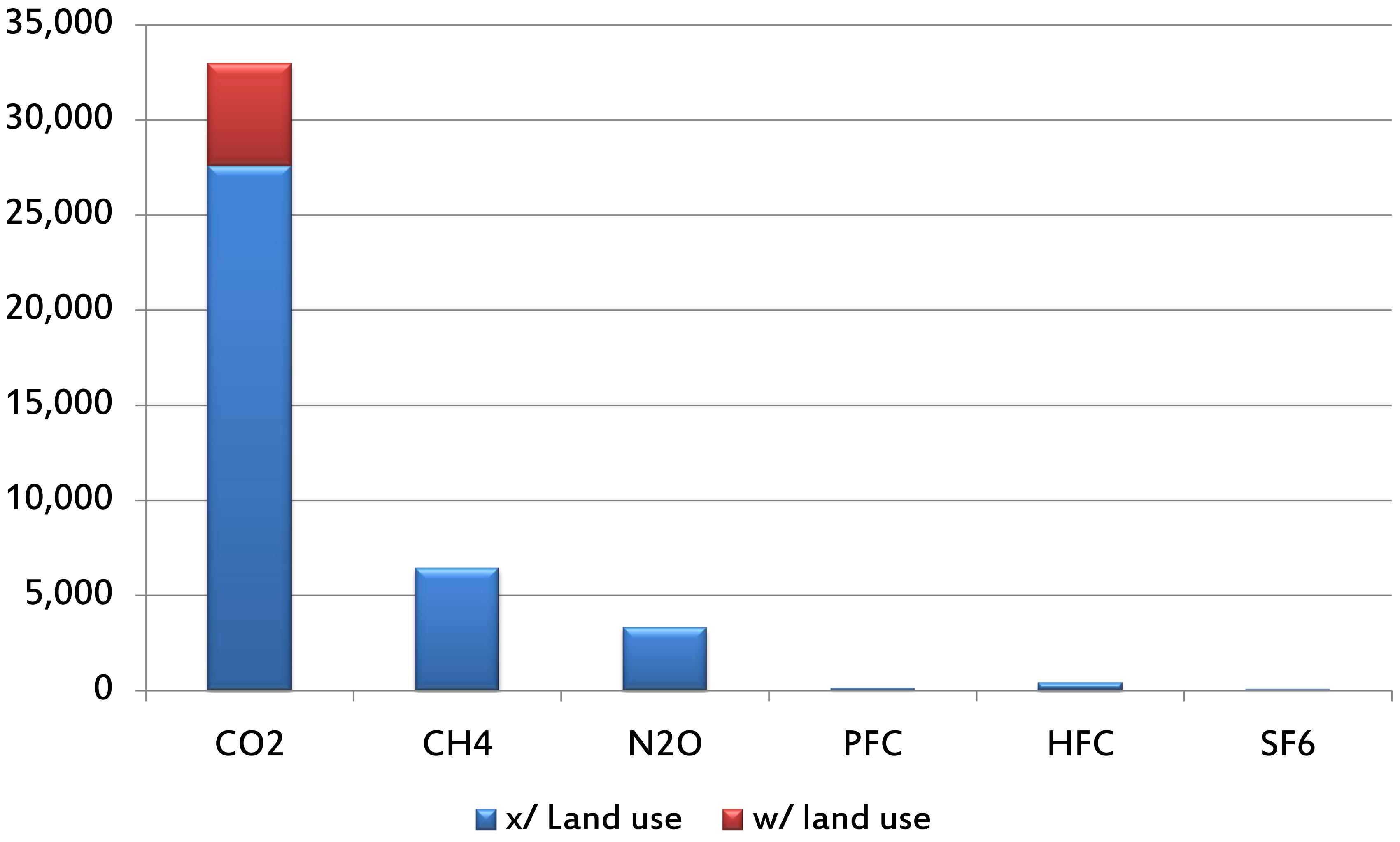
Major progress since the early 1990s

- More greenhouse gases
  - Particularly the Kyoto gases
- Improved specification of new energy technologies (e.g. biofuels, carbon capture and storage)

Other progress since the early 1990s

- More models with integrated climate modules (Integrated Assessment Models—IAMs)
  - Simple climate module (e.g. DICE, MERGE, PAGE)
  - Hard-linked to ‘simple’ climate models (mostly MAGICC)
  - Soft-linked to larger climate models (e.g. EPPA)
- Yet few models assessing climate change damage (some exceptions include DICE, ENVISAGE, PAGE and FUND)
- Land use and forestry in part linked to biofuels debate

2005 greenhouse gas emissions, Mt CO2e



Source: CAIT (Accessed 18-May-2010, http://cait.wri.org/)

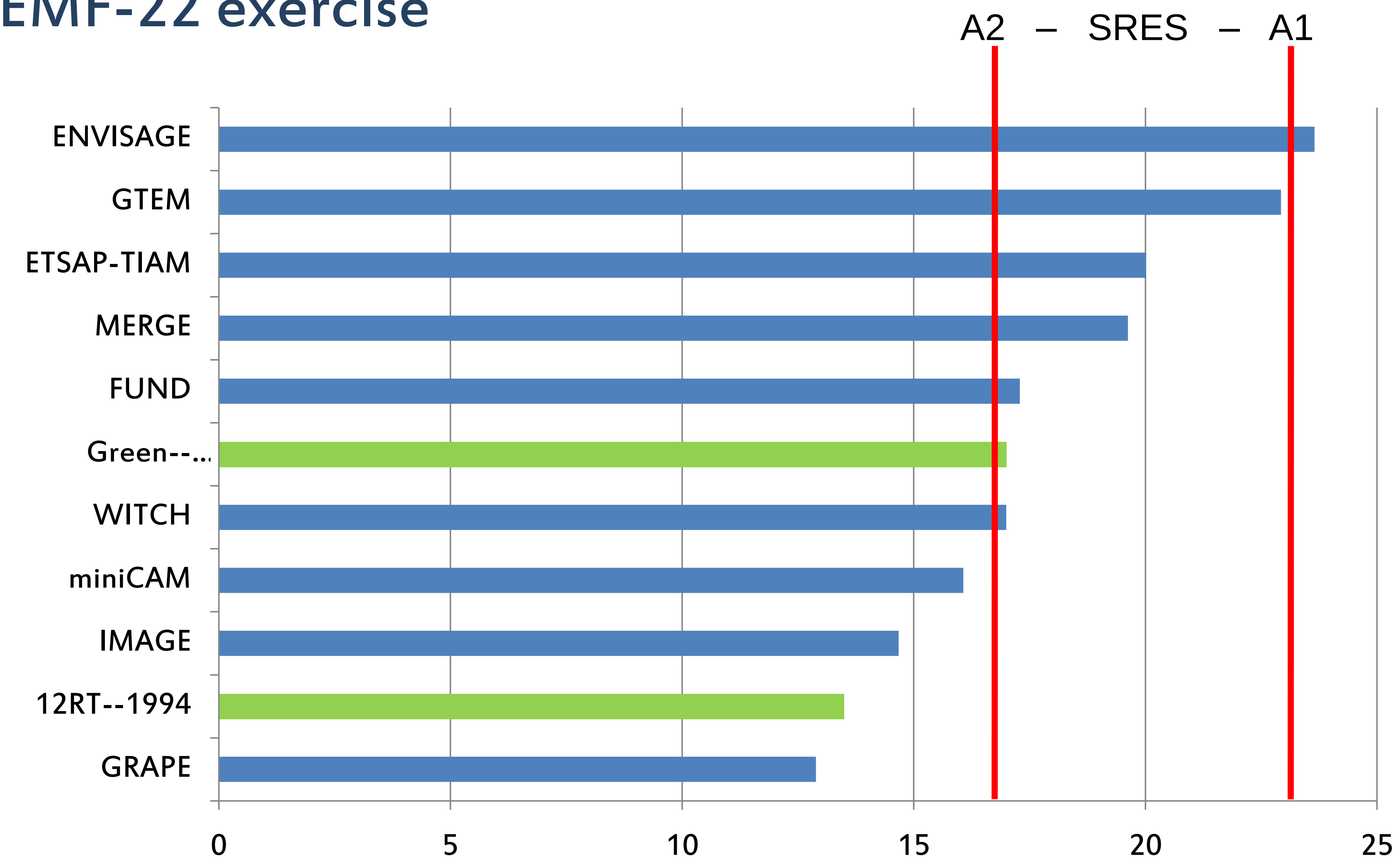
Model specific advances

- Endogenous technical change (in energy sectors, e.g. WITCH)
- Uncertainty and catastrophic events (PAGE)
- Adaptation (AD-DICE)

Lingering weaknesses

- Most models still highly stylized (large degree of regional/sectoral aggregation with focus mostly on large emitters and energy sectors)
- Capturing of dynamic effects needs improvement and validation—technology change on the production side and consumer tastes on the demand side
- Slow to update databases and baselines (e.g. many still use GTAP6 (or even 4!) and many are still SRES based.)

2050 global CO_2 emissions (gtC)—most from 2009 EMF-22 exercise



New scenario framework

- Parallel process
  - GCMs and IAMs working in parallel
- Representative concentration pathways (RCPs)
  - 3.0 (or less), 4.5, 6.0, 8.5 w/m2 in 2100

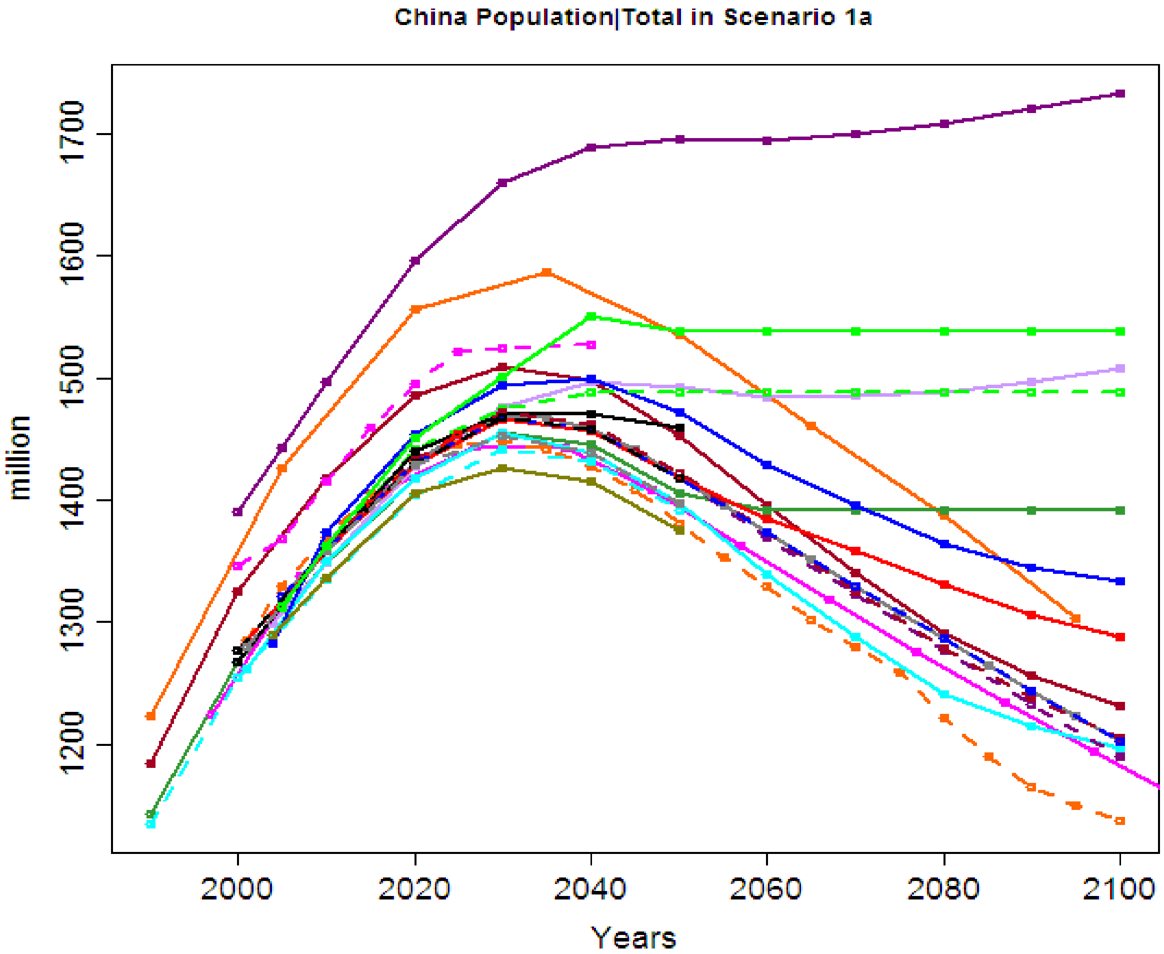
Policy framework

- International level—driven by IPCC periodic reports with significant support from the Energy Modeling Forum, Integrated Assessment Model Consortium, etc.
- Regional level
  - EU particularly for analysis of ETS and other EU initiatives
  - EPA/DOE for US proposals

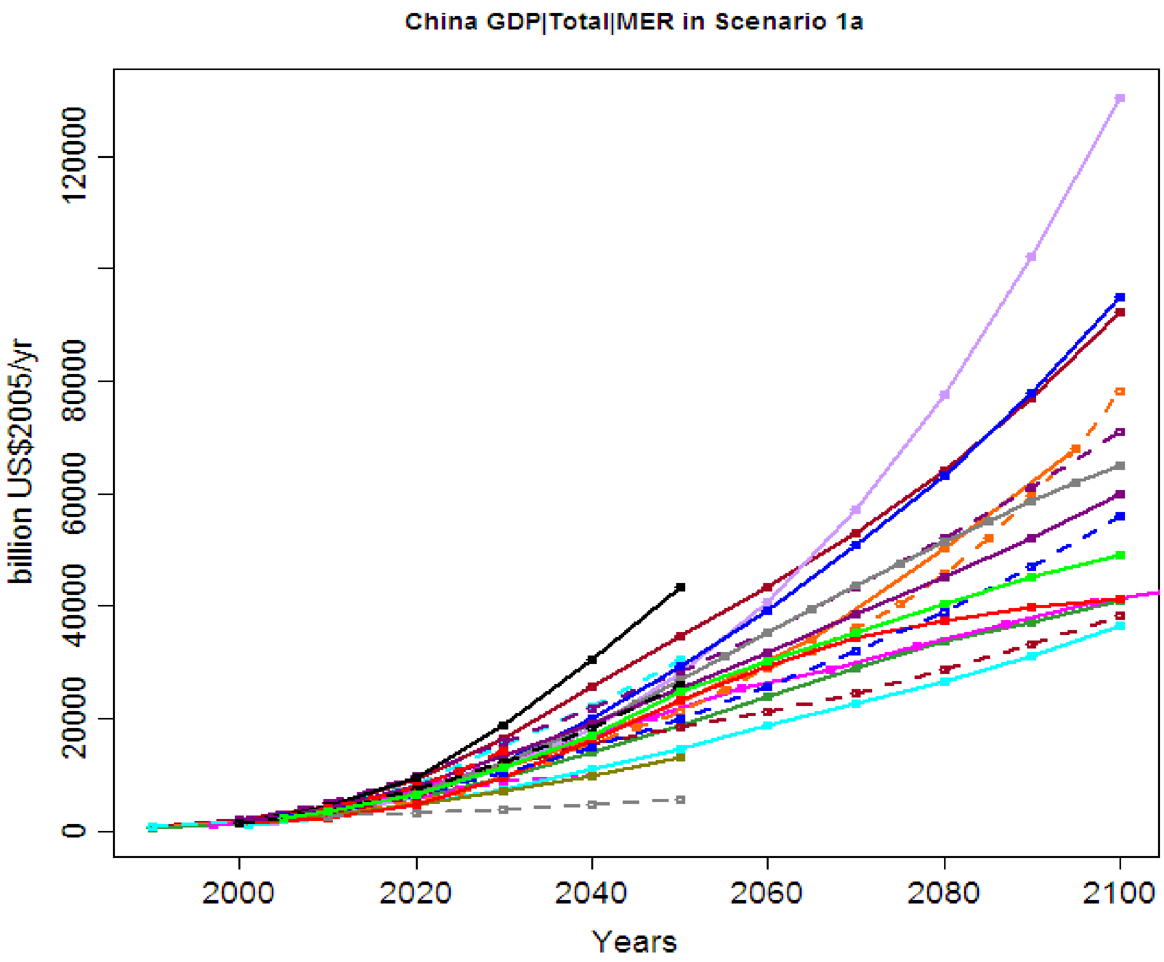
Assessment

- Model comparisons are 'soft'
  - Results oriented
- Low efforts to harmonize baselines
- Key results/assumptions often missing, for example cost of conventional fuels and/or cost of alternatives
- At the international level, most scenarios are stylized, with mostly perfect where, what and when policies (compare with trade scenarios)

Population scenario for China—AME



GDP scenario for China—AME



Challenges—data

- Energy prices including taxes/subsidies
  - Recent IEA revisions have increased aggregate subsidies to $557bn per year from $300bn.
- Extension of GTAP database to breakout electricity production
- Consumer demand—transition matrix approach

Challenges—empirical

- Validation
  - Backcasting
  - Better representation of technological change
  - Improved consumer behavior
- Climate change impacts
  - In agriculture—crop vs. Ricardian models, carbon fertilization
  - Other sources of impacts—better downscaling across regions/sectors

Challenges—baseline assumptions

- Fossil fuel prices
  - Resource depletion module
- New energy technologies
  - Cost and rate of penetration
  - Acceptance (nuclear, CCS)
  - Spillover impacts

Challenges—persistent gaps

- Modeling of water
- Uncertainty
  - Known unknowns
  - Unknown unknowns
  - ‘Black swan’ effects

Challenges—policies

- Modeling of domestic policies
  - US, EU—packages tend to be eclectic and not always amenable to easy policy analysis (efficiency targets, exemptions, rebates, offsets,...)
- More realistic international cooperation scenarios
  - EMF 22 a good start
  - Other departures from globally efficient—Copenhagen?
  - CDM, REDD etc.
- More emphasis on short-term impacts and strategies