Energy Modeling Forum 21:
Multigas Mitigation and Climate Change
Study Update

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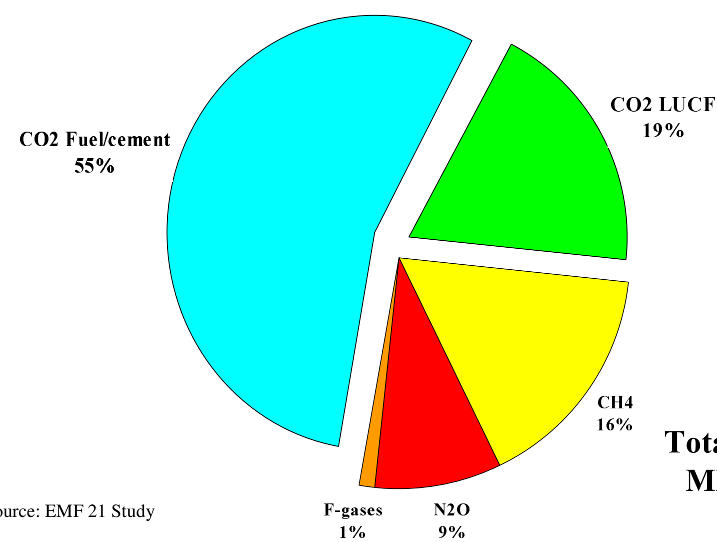
2000 Global Net GHG Emissions



Total 11,100 MMTCE

Source: EMF 21 Study

Economy, Technology, & Integrated Assessment Models (18)

Asia / Australia

ABARE (Guy Jakeman & Brian Fisher) with GTEM
CICERO - University of Oslo (H.A. Aaheim) with COMBAT
Energy Research Institute China (Jiang Kejun) with IPAC
IAE Japan (Atsushi Kurosawa) with GRAPE
National Institute for Environmental Studies, Japan (Junichi Fujino) with AIM
Indian Institute of Management (P. Shukla) with SGM-India

Europe

CEA - IDEI (Marc Vielle) with GEMINI-E3
Cntr for European Econ Research-(C. Boehringer & A. Loschel) with EU PACE
Copenhagen Economics (Jesper Jensen) with the EDGE Model
Hamburg Univ. (Richard Tol) with FUND
IIASA (Shilpa Rao) with MESSAGE
Oldenburg University, Germany (Claudia Kemfert) with WIAGEM
RIVM (Detlef van Vuuren, Tom Kram, & Bas Eickhout) with IMAGE
UPMF (Patrick Criqui) & CIRAD (Daniel Deybe) with POLES/AGRIPOL

US

Argonne Nat Lab (Don Hanson) & EPA (Skip Laitner) with AMIGA
EPRI (Rich Richels) & Stanford Univ (Alan Manne) with MERGE
MIT (John Reilly) with EPPA
PNNL-JGCRI (Jae Edmonds, Hugh Pitcher, & Steve Smith) with SGM & MiniCAM

Non-CO_2 GHG Experts

Dina Kruger and Francisco de la Chesnaye, USEPA
Paul Freund and John Gale, IEA Greenhouse Gas R&D Programme

Methane & N_2O

Ann Gardiner, Judith Bates, AEA Technology
Casey Delhotal, Dina Kruger, Elizabeth Scheehle, USEPA
Chris Hendriks, Niklas Hoehne, Ecofys

Fluorinated (HGWP) Gases

Jochen Harnish, Ecofys, Germany
Deborah Ottinger and Dave Godwin, USEPA

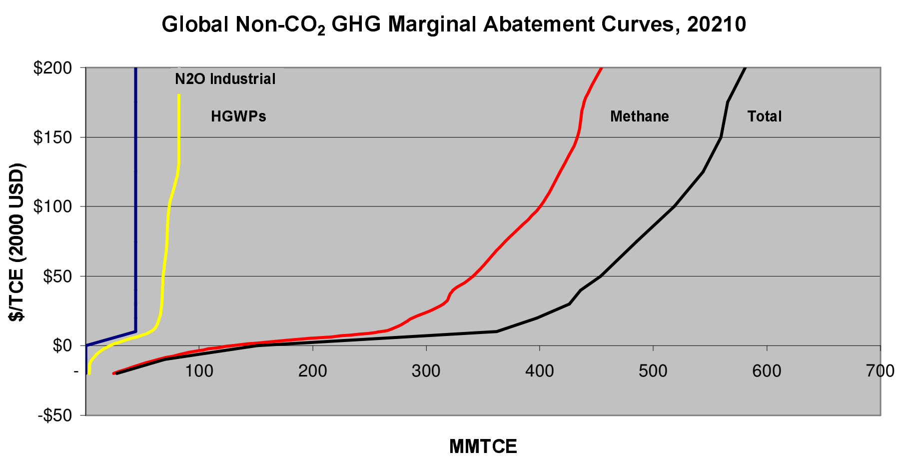
EC DG EV

Sinks (Terrestrial Sequestration)

Bruce McCarl, Texas A&M
Ken Andrasko, USEPA & Jayant Sathaye, LBNL
Roger Sedjo, RFF & Brent Sohngen, Ohio State Univ
Ron Sands, PNNL-JGCRI

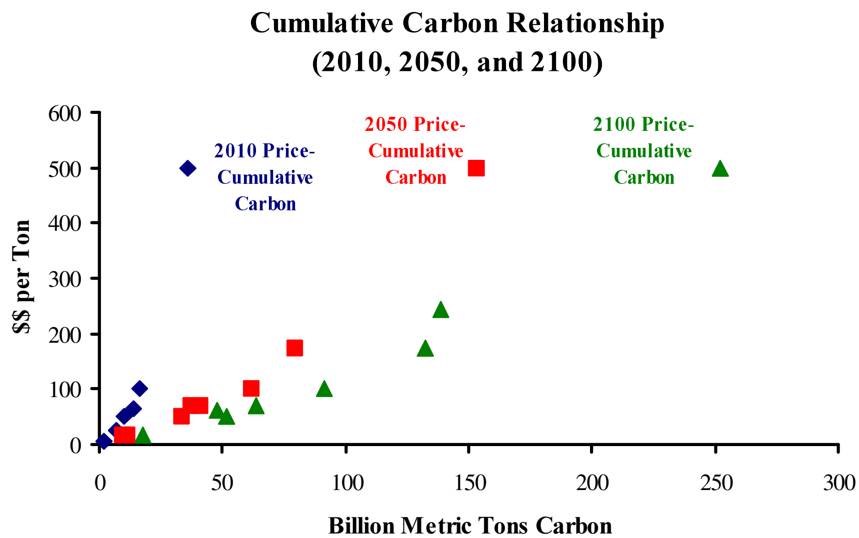
EMF 21 Working Group Objectives

1) Conduct a new comprehensive, multi-gas policy assessment to improve the understanding of the affects of including non-CO_2 GHGs (NCGGs) and sinks (terrestrial sequestration) into short- and long-term mitigation policies. Answer the question: *How important are NCGGs & Sinks in climate policies?*.
2) Advance the state-of-the-art in integrated assessment / economic modeling
3) Strengthen collaboration between NCGG and Sinks experts and modeling teams
4) Publish the results as a special journal issue



Source: EMF 21 Study

Global Potential Sequestration



Source: Brent Sohngen , OSU

Approaches to combine / integrate non-CO_2 GHG MACs with Energy Models

1. **Quick and Simple – Off-line addition**

   MAC results in $/TCE and cumulative reductions can be added to the supply curves from an energy model results in a spreadsheet to obtain one, total GHG abatement supply curve. From this, both price and quantity results can be obtained for different emission caps, target price, or both.

2. **Inclusion of reduced form equations from MACs**

   For both the MACs and the energy model supply curves, reduced form equations (regressions) can be developed. These can be used separately or added and then solved for specific energy or quantities.

3. **Endogenous non-CO2 MACs or cost parameters into energy model**

   Deconstructing the non-energy MACs to their appropriate sector or sub-sector cost identities and emission reduction potentials which are then used to modify the GHG emission coefficient in the energy model's production functions

4. **Incorporate abatement and mitigation options directly into models just as those for CO_2 reductions**

EMF 21 Priority Scenarios:

1) Modeler's Reference

2) Kyoto Protocol

As defined in the Kyoto Protocol with the Marrakesh Accords and the US following its GHG intensity policy. The scenario is a multigas mitigation case only.

Time frame: 2008 to 2012 with policy announcements starting in 2002. Results reported for 2010. Modelers should assume countries have the same targets in the second commitment period (2013 to 2017), if required for modeling.

Emission targets: As defined in the protocol for all GHGs.

GWPs: As defined in protocol, i.e.,. 100-yr GWP from the IPCC Second Assessment Report.

Country Participation: Those in protocol with an additional 100 MMTCE from CDM. Limit sinks in CDM to 30 MMTCE.

3. New Long-term, CO_2-only Stabilization Scenario

This scenario will be compared to the modeler's reference and # 4 to evaluate the significance of multigas mitigation (including sinks).

Climate Change / Emissions Target:

a) For long-term models: *With CO_2-only mitigation*, Stabilize radiative forcing at 4.5 Wm^{-2} relative to pre-Industrial times by 2150. This corresponds to an equilibrium temperature of 3.0°C, for a 2.5°C per CO_2 doubling climate sensitivity. (Some models may want to also evaluate sensitivities ±). From 2100 to 2150, the radiative forcing from non-CO_2 GHGs (NCGGs) should be held constant at the 2100 level.

b) For short-term models requiring emissions targets, global total emissions for all GHGs (based on 100-yr GWPs) will be provided that match the stabilization target in (a). Corresponding model reference emissions also will be provided.

3. New Long-term, CO_2-only Stabilization Scenario-continued

Time frame: 2000 to 2100. From 2002 to 2012, the Kyoto Protocol is *NOT* in reference scenario, to be consistent with #2 above. Reporting is now changed to every decade from 2000 to 2100.

Emission targets: Based on meeting the stabilization target at lowest global cost with participating countries as defined below. For the long-term models, emission targets can be endogenously calculated. For the short-term models, emission targets can be derived from global total GHG budget as provided above in (b).

GWPs: For some models, these are endogenously calculated. For others, modeling teams should use 100-yr GWPs from the IPCC Second Assessment Report.

Country Participation: All countries and regions starting in 2013. This would establish the global, least-cost trajectory to achieve the specified stabilization target. Any contraction in participation would show a divergence from the least-cost trajectory.

4. New Long-term, Multigas Stabilization Scenario

This scenario should include as many NCGG and sinks mitigation options as available in a model to meet the specified radiative forcing stabilization target.

Climate Change / Emissions Target:

a) For long-term models: *With Multigas mitigation*, Stabilize radiative forcing at 4.5 Wm^{-2} relative to pre-Industrial times by 2150. This corresponds to an equilibrium temperature of 3.0°C, for a 2.5°C per CO_2 doubling climate sensitivity. (Some models may want to also evaluate sensitivities ±). From 2100 to 2150, the radiative forcing from non-CO_2 GHG (NCGG) *does not need* to held constant at the 2100 level.

b) For short-term models requiring emissions targets, global total emissions for all GHGs (based on 100-yr GWPs) will be provided that match the stabilization target in (a). Corresponding model reference emissions also will be provided.

All other aspects of the scenario are the same as #3.

Rate of Change, Cost-minimizing Scenarios: 5 & 6

As above, two cases should be run and compared against each other and the reference scenario:

5. Achieved through CO_2 mitigation only
6. Achieved through multigas mitigation.

Climate Change / Emissions Target:

a) For models with a climate module: Hold global mean temperature change to an average decadal rate of 0.20ºC over the period 2000 to 2050 and then for the period 2051 to 2100. Modelers may adjust the periods over which to average the rate target.
b) For the other models, this scenario is only required if modeling results are available from which to calculate global total emissions.

Time frame: same as described in # 3.

Emission targets: same process as in # 3.

GWPs: same process as in # 3.

Country Participation: same as in #3.

EMF 21 Sinks Subgroup

- Conduct comparison of land use data across models, both climate economic and Ag/Forestry.
- Compare key drivers and dynamics in future use and expansion of land for agriculture, forestry, & biofuels.
- Evaluate paired prices in models, i.e., timber-carbon, agriculture-carbon, biofuels-carbon.
- How does all this affect competition for land use in the reference and mitigation scenarios ?
- How do we match up the sinks mitigation scenarios with the climate scenarios ?
- How best to incorporate the results from the sinks models into the climate economic models and how to handle the price & quantity interactions?

EMF 21 Subgroup on Stabilization Targets

Will evaluate multiple *long-term* stabilization scenarios

Modeling teams will use their own reference case

Key analytical issues:

- What constitutes a multigas stabilization scenario ? Stabilize concentrations, radiative forcing, temperature change, etc.?
- Should multigas stabilization still be defined in CO_2 concentration equivalents ? (The 100ppm CO_2 for other gases)
- How to handle NCGG ?
- How to handle sinks ?
- How to handle short-term, regional agents, e.g., BC/OC, O_3 ?
- What is the appropriate disaggregation of results across regions?
- How to best report results ?

EMF 21 Progress & Schedule

√ January 2002. Maastricht, Netherlands. EMF & Non-CO_2 GHG Network Meeting. NGCC-3 Conference.

√ May 2002. University of Maryland at College Park. EMF & Joint Global Change Research Institute.

√ October 2002. NCGG data posted to EMF website.

√ December 2002. Washington, DC. EMF meeting.

√ May 19-21, 2003. Copenhagen, Denmark. EMF & Copenhagen Economics.

º Interim: Complete non-CO_2 Agriculture and Sinks data. Additional mutigas stabilization runs.

º December 2003 (or January 2004). Stanford University. Concluding EMF 21 Meeting.

º 2004. Complete study and submit manuscripts for publication.

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