Climate Stabilization Scenarios:
New Integrated Assessment Approaches for IPCC AR5 and Recent IIASA Scenarios

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Scenarios:

- Provide a framework for decision making which illuminates the impact associated with alternative courses of action
- Facilitate the interpretation of possible future states
- Include elements that cannot be formally modeled
- Aimed at challenging prevailing mind sets
Proximate and Ultimate Drivers

Proximate Drivers
- Population
- Economy
- Technology
- Governance

Ultimate Drivers
- Values and Needs
- Knowledge and Understanding
- Power Structure
- Culture

Source: Paul Raskin, 2002
Urbanization

Source: Grübler, 2007
Education

Source: Lutz, 2007
Democratization

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Source: Modelski, 2002

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Global Mean Temperatures are Rising


<table>
<thead>
<tr>
<th>Period</th>
<th>Rate</th>
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<tr>
<td>50</td>
<td>0.128±0.026</td>
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<tr>
<td>100</td>
<td>0.074±0.018</td>
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Years °/decade
...and with financial woes spreading to the "real economy"...
Global Population Projections

World Population (post SRES, non intervention, n=64)

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Surface Temperature Change
AOGCM projections for illustrative SRES scenarios

A2: 2020-2029
A2: 2090-2099
B1: 2020-2029
B1: 2090-2099

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)
Vulnerability of Key Sectors

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)
Long-Term Stabilization Profiles

A2

B1

\( \approx \$100/\text{tCO}_2 \)

Historical emissions

Stabilisation level
RCP Stabilization Profiles
Initial Scenarios
4 RCPs – few stabilization targets (3)
All modeling groups

Sensitivity Scenarios with specific research focus
Selected group of models for each topic
- Baseline Uncertainty
- Interim-targets and Overshoot
- Limited regional participation
- Technology (e.g., limited portfolio)
- ??...

Climate and ESS Models
Baseline and stabilization climate projections
Carbon fluxes and other feedbacks

Source: After Keywan Riahi, 2006
Intended uses and limits

Intended uses
- Input to CMs
- To facilitate pattern scaling
- To explore ranges of socioeconomic conditions
- To explore climate implications of spatial forcing patterns

Limits
- Not forecasts or absolute bounds
- Not policy prescriptive
- Socioeconomics underlying each RCP are not unique; and, across RCPs, are not a set
GHG Emissions and Concentrations from IAMs

- Greenhouse gases: CO₂, CH₄, N₂O, CFCs, HFC’s, PFC’s, SF₆
- Emissions of chemically active gases: CO, NOₓ, NH₄, VOCs
- Derived GHG’s: tropospheric O₃
- Emissions of aerosols: SO₂, BC, OC
- Land use and land cover
2.6 W/m² or 2.9 W/m²?

Which scenario for the low (<3W/m²) RCP?

Noordwijkerhout debate over what it means to be “compatible with the full range of stabilization, mitigation, and baseline emissions scenarios available in the current literature”
Proposed Extensions to 2300!

- **RCP8.5**: fix emissions at 2100 levels, derive concentrations

- **RCP 4.5 / 6.0**: fix concentrations, derive consistent emissions

- **RCP2.6/2.9**:
  - Fix emissions at 2100 levels, derive consistent concentrations
  - Other 2.9 option: allow emissions to fall to zero or negative, and fix

- Land-use: scale cropland and pasture land with population (current proposal); or hold constant (alternative)

- For ESM data, harmonize the unique IAM extended emissions and concentration data with a single climate model (e.g. MAGICC)
### International IAM Consortium

**Facilitate the coordination of scenario development efforts**

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<thead>
<tr>
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<th><strong>National Institute for Environmental Studies (NIES)</strong></th>
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2009
Timeline for New Scenarios

- **Product 1:** RCPs delivered to CMC
- **Product 2:** RCP-based CMC ensemble runs
- **Product 3:** New IAM Scenarios
- **Product 4:** Story Lines
- **Product 5:** Integration of CMC Ensembles with New IAM Scenarios Available

**Timeline:**
- **Fall 2007:** Preparatory Phase
- **Fall 2008:** Parallel Phase
- **Fall 2010:** Integration Phase
- **Spring 2012:** Publication Lag
- **Spring 2013:**

Source: Moss et al., 2007

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RCP Database

- Central data repository to share information and to provide easy access to the data
- Interactive & web-based “working environment”
  - detailed comparisons between RCPs and base year inventory data
  - quick data visualization
  - help to understand major data differences (e.g. identify definitional issues across RCPs)
- At the moment limited access, since all data is preliminary
- Plan to make the database publicly accessible for data dissemination once the data is final
2007 Special Issue of Technological Forecasting and Social Change Journal (Nakicenovic and Riahi, eds., 2007):
http://www.sciencedirect.com/science/journal/00401625

Web-based database:
http://www.iiasa.ac.at/Research/ENE/GGIDB_index.html
Carbon-Free Energy in A2r

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Carbon-Free Energy in B1

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GHG emissions in A2r

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GHG emissions in B1

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2009
Energy Investments in A2r

![Graph showing energy investments in A2r with different scenarios and CO2 levels.](Image)
Energy Investments in B1

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Integrated Assessment Framework

Scenario Storyline
- Economic development
- Demographic change
- Technological change
- Policies

Global and Regional Scenarios
- Population
- Economy

Downscaling Tools
Spatially explicit and national scenarios

DIMA
Forest Management Model

AEZ-BLS
Agricultural Modeling Framework

ClIMATE and ACIDIFICATION IMPACT MODELS

MESSAGE-MACRO
Systems Engineering / Macro-Economic Modeling Framework (all GHGs and all sectors)

Emissions

National, regional & spatially explicit socio-economic drivers

Spatially explicit socio-economic drivers

Consistency of land-cover changes
(spatially explicit maps of agricultural, urban, and forest land)

Endogenous Climate Model

Drivers for land-use related non-CO2 emissions

Emissions & Abatement Costs

Agricultural bioenergy potentials and costs

Carbon and biomass price

Potential and costs of forest bioenergy and sinks

Consistency of land-cover changes

National Policy Models (GAINS)
Determinants of Demand

Scenario Drivers

Demographic-Energy Linkages

Scenario Overview

Downscaling

Linkages Energy – Agriculture - Forestry

Forests

Agriculture

Energy Scenarios and Technology Portfolios

Policy Synergies & Co-benefits

NATIONAL POLICIES

IMPACTS
Global GDP Density

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Global Bioenergy Land

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B1: Arable land
B1: Bioenergy, 2070
GJ / ha
- 0 - 1
- 1 - 20
- 20 - 50
- 50 - 100
- 100 - 250
- 250 - 380
Energy and Food Land Conflicts

Source: R. Doornbosch, et al., 2008
...accounting for one-third of total international bank financing

Bank lending to energy-sector and total bank lending to emerging markets

$ billions

Total bank lending

Energy sector bank lending

Source: World Bank, 2009

*As of September
Towards a more Sustainable Future

- The magnitude of the change required in the global energy system will be huge.
- The challenge is to find a way forward that addresses simultaneously climate change, security and equity issues.
- Paradigm change is needed: radical improvements in energy end-use efficiency, new renewables, advanced nuclear and carbon capture and storage.
- Needs to be globally integrated but with maximum support of countries and local levels.
- In the best spirit of science: fact-based and peer-reviewed.
Confronting the Challenges of Energy for Sustainable Development: The Role of Scientific and Technical Analysis

IIASA
International Institute for Applied Systems Analysis
and its international partners present

www.GlobalEnergyAssessment.org
Towards a more Sustainable Future

- The magnitude of the change required is huge.

- The challenge is to find a way forward that addresses all the issues simultaneously.

- A paradigm shift is needed: energy end-use efficiency, new renewables, and, if concerns can be resolved, carbon capture and storage and nuclear.