Through the IPCC lens – what we need for a reasonable assessment

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The Structure of the IPCC

- IPCC Plenary
  - IPCC Bureau
    - Working Group I: The Physical Science Basis
    - Working Group II: Climate Change Impacts, Adaptation and Vulnerability
    - Working Group III: Mitigation of Climate Change
    - Task Force on National Greenhouse Gas Inventories
  - Authors, Contributors, Reviewers
Demand for energy services is increasing

GHG emissions resulting from the provision of energy services contribute significantly to the increase in atmospheric GHG concentrations.
AR5: Exploring the whole solution space

Population
Pop

Per capita production
GDP / Pop

Energy intensity
E / GDP

Non-fossil energy
Carbon intensity
CO₂ / E

CO₂ capture at plant (CCS)
CO₂ released
CO₂(A)/CO₂

CO₂ emissions

Carbon cycle
CDR

Radiative forcing
SRM

Ecosystem impacts, incl. ocean acidification

Temperature change

Impacts
Adaptation

Other GHG emissions
Non-CO₂ mitigation

Edenhofer/Seyboth 2012
One important component of the solution space

http://srren.ipcc-wg3.de/report
The assessment process of IPCC
Economic growth drives global emissions

![Graph showing CO₂ emissions trends with labels for Population, Energy Intensity, GDP per Capita, Carbon Intensity, and Change in CO₂ over the years from 1971 to 2008.](image)
Conventional reserves alone exceed 1000 Gt CO2

SRREN IPCC 2011
Current energy system is dominated by fossil fuels

SRREN, IPCC (2011)

Shares of different energy carriers in total primary energy supply in 2008

- Gas: 22.1%
- Oil: 34.6%
- Coal: 28.4%
- Nuclear Energy: 2.0%
- RE: 12.9%
- Bioenergy: 10.2%
- Modern bioenergy: 4%
- Traditional biomass: 6%
- Direct Solar Energy: 0.1%
- Ocean Energy: 0.002%
- Wind Energy: 0.2%
- Hydropower: 2.3%
- Geothermal Energy: 0.1%
RE growth rate accelerating in recent years

150 GW of new RE power plant capacity was built in 2008-2009.

This equals 50% of all power plants built during that period.
Technical potential of renewable energy

IPCC SRREN 2011
... some technologies are competitive today

SRREN, Edenhofer et al. (2011)
The role of technologies

Costs of renewable energy technologies shrinking
Objectives of AR5 Scenario Process

Explore adaptation and mitigation options

Explore benefits, costs, and risks of adaptation and mitigation

\[ \Delta(2^\circ/3^\circ), \Delta(3^\circ/4^\circ) \] policies:
Consistent understanding of costs of impacts and of mitigating impacts

Establish smallest common denominator between both communities
AR5 WG III Outline

I: Introduction
1. Introductory Chapter

II: Framing Issues
2. Integrated Risk and Uncertainty Assessment of Climate Change Response Policies
3. Social, Economic and Ethical Concepts and Methods
4. Sustainable Development and Equity
5. Drivers, Trends and Mitigation
6. Assessing Transformation Pathways
7. Energy Systems
8. Transport
9. Buildings
10. Industry
11. Agriculture, Forestry and Other Land Use (AFOLU)
12. Human Settlements, Infrastructure and Spatial Planning

III: Pathways for Mitigating Climate Change
13. International Cooperation: Agreements and Instruments
14. Regional Development and Cooperation
15. National and Sub-national Policies and Institutions
16. Cross-cutting Investment and Finance Issues

IV: Assessment of Policies, Institutions and Finance
The Scientific Arena

Table 3.10: Properties of emissions pathways for alternative ranges of CO₂ and CO₂-eq stabilization targets. Post-TAR stabilization scenarios in the scenario database (see also Sections 3.2 and 3.3); data source: after Nakicenovic et al., 2006 and Hanaoka et al., 2006

<table>
<thead>
<tr>
<th>Class</th>
<th>Anthropogenic addition to radiative forcing at stabilization (W/m²)</th>
<th>Multi-gas concentration level (ppmv CO₂-eq)</th>
<th>Stabilization level for CO₂ only, consistent with multi-gas level (ppmv CO₂)</th>
<th>Number of scenario studies</th>
<th>Global mean temperature C increase above pre-industrial at equilibrium, using best estimate of climate sensitivity</th>
<th>Likely range of global mean temperature C increase above pre-industrial at equilibrium</th>
<th>Peaking year for CO₂ emissions</th>
<th>Change in global emissions in 2050 (% of 2000 emissions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2.5-3.0</td>
<td>445-490</td>
<td>350-400</td>
<td>6</td>
<td>2.0-2.4</td>
<td>1.4-3.6</td>
<td>2000-2015</td>
<td>-85 to -50</td>
</tr>
<tr>
<td>II</td>
<td>3.0-3.5</td>
<td>490-535</td>
<td>400-440</td>
<td>16</td>
<td>2.4-2.8</td>
<td>1.6-4.2</td>
<td>2000-2020</td>
<td>-60 to -30</td>
</tr>
<tr>
<td>III</td>
<td>3.5-4.0</td>
<td>535-590</td>
<td>440-485</td>
<td>21</td>
<td>2.8-3.2</td>
<td>1.9-4.9</td>
<td>2010-2030</td>
<td>-30 to +5</td>
</tr>
<tr>
<td>IV</td>
<td>4.0-5.0</td>
<td>590-710</td>
<td>485-570</td>
<td>118</td>
<td>3.2-4.0</td>
<td>2.2-6.1</td>
<td>2020-2060</td>
<td>+10 to +60</td>
</tr>
<tr>
<td>V</td>
<td>5.0-6.0</td>
<td>710-855</td>
<td>570-660</td>
<td>9</td>
<td>4.0-4.9</td>
<td>2.7-7.3</td>
<td>2050-2080</td>
<td>+25 to +85</td>
</tr>
<tr>
<td>VI</td>
<td>6.0-7.5</td>
<td>855-1130</td>
<td>660-790</td>
<td>5</td>
<td>4.9-6.1</td>
<td>3.2-8.5</td>
<td>2060-2090</td>
<td>+90 to +140</td>
</tr>
</tbody>
</table>

Notes:
a. Warming for each stabilization class is calculated based on the variation of climate sensitivity between 2°C – 4.5°C, which corresponds to the likely range of climate sensitivity as defined by Meehl et al. (2007, Chapter 10).
b. Ranges correspond to the 70% percentile of the post-TAR scenario distribution.
c. ‘Best estimate’ refers to the most likely value of climate sensitivity, i.e. the mode (see Meehl et al. (2007, Chapter 10) and Table 3.9)

Only 6 scenarios from 3 models in the lowest category...

Fisher et al. (2007), AR4
Low Stabilization Scenarios Beyond AR4

- …but already many more available for AR5
- Exploration of RCP3-PD within the scenario process

Knopf/Luderer/Edenhofer (2011)

~20 scenarios

Negative emissions

Knopf/Luderer/Edenhofer (2011)
Implications for the Scenario Process

WG I
Extreme events
Sea level rise

WG II
Differential impacts:
\[ \Delta(2^\circ C/3^\circ C) \]
\[ \Delta(3^\circ C/4^\circ C) \]

WG III
Differential mitigation costs:
\[ \Delta(2^\circ C/3^\circ C) \]
\[ \Delta(3^\circ C/4^\circ C) \]

Iteration

Complete picture of impact and mitigation costs for policy relevance

\[ \Delta(2^\circ/3^\circ), \Delta(3^\circ/4^\circ) \]

Policies
Global RE Primary Energy Supply from 164 Long-Term Scenarios versus Fossil and Industrial CO$_2$ Emissions

SRREN, Edenhofer et al. (2011)
Global RE Primary Energy Supply from 164 Long-Term Scenarios versus Fossil and Industrial CO2 Emissions

SRREN, Edenhofer et al. (2011)
Global RE Primary Energy Supply from 164 Long-Term Scenarios versus Fossil and Industrial CO2 Emissions

SRREN SPM, Figure SPM.9

CO2 Emissions from Fossil Fuels and Industrial Processes [Gt CO2/yr]
Potential Role of Renewables

**Bioenergy**

- Maximum
- 75th
- Median
- 25th
- Minimum
- Baselines
- Cat. III + IV (440 - 660 ppm)
- Cat. I + II (<440 ppm)
- Deployment Level 2008

**Direct Solar Energy**

**Geothermal Energy**

**Hydropower**

**Wind Energy**

*CO₂ Concentration Targets*

- Bioenergy Supply is Accounted for Prior to Conversion
- Primary Energy Supply is Accounted for Based on Secondary Energy Produced
Exploring the feasibility frontier in „2nd best Worlds”

Unavailability of technologies
Fragmented carbon markets
1st best World

Stringency of the mitigation target

Restrictions in implementing climate policies (2nd best)

Socio-economic baseline assumptions

Baseline #1
Baseline #2
Baseline #3
Baseline #4
Baseline #5

Knopf et al. 2011
Costs of mitigation

Costs hinge critically on:
- The stabilization target
- The biomass potential
- The availability of technologies, RE and CCS in particular
The Pragmatic Science/Policy Interface

- While pursuing certain ends, unintended side-effects may require the reevaluation of means and ends
- Relies on continuous iteration between policy and science
There is always more than one way…