Long-Term Technology Pathways to Stabilization of Greenhouse Gas Concentrations

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Aspen, CO
Topics

• The IPCC 4\textsuperscript{th} Assessment Report

• The Technology CCT

• How to move forward?
The Origins of Cross-Cutting Themes

- TWENTIETH SESSION of the IPCC
- Paris, 19-21 February 2003
- Preparations For The Fourth Assessment Report
- Created the new function of Cross-Cutting Theme “Anchors”
Cross-Cutting Themes (CCT)

Purpose: “To facilitate and improve cross Working Group co-operation and to achieve better integration and consistent treatment of key issues throughout the AR4.”
## Cross-Cutting Themes (CCT)

<table>
<thead>
<tr>
<th>CCT</th>
<th>Lead WG</th>
<th>Anchors</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Risk and Uncertainty</td>
<td>WG1</td>
<td>Manning, Petit</td>
<td>USA, France</td>
</tr>
<tr>
<td>2. Regional Integration.</td>
<td>WG1</td>
<td>Giorgi, Carter (Anchor 3)</td>
<td>Italy, Finland</td>
</tr>
<tr>
<td>3. Water</td>
<td>WG2</td>
<td>Kundze wicz, Mata</td>
<td>Poland, Venezuela</td>
</tr>
<tr>
<td>4. Key Vulnerabilities (including UNFCCC Art. 2 Issues)</td>
<td>WG2</td>
<td>Schneider, Semenov, Patwardhan</td>
<td>USA, Russia, India</td>
</tr>
<tr>
<td>5. Adaptation &amp; Mitigation</td>
<td>WG3</td>
<td>Grubb, Huq</td>
<td>UK, Bangladesh</td>
</tr>
<tr>
<td>6. Sustainable development</td>
<td>WG3</td>
<td>Srivastava, Heller</td>
<td>India, USA</td>
</tr>
<tr>
<td>7. Technology</td>
<td>WG3</td>
<td>Edmonds, Mirera</td>
<td>USA, Brazil</td>
</tr>
</tbody>
</table>
Timing of the Fourth Assessment Report

The Fourth Assessment Report (AR4) to be completed in 2007;

Working Group reports and, if it is decided to prepare one, the Synthesis Report, would be sequenced such that the

- Working Group I report finalized first quarter of 2007,
- Working Group II mid-2007
- Working Group III mid-2007 and
- The Synthesis Report last quarter of 2007;
The IPCC Working Groups in the Fourth Assessment Report

► Working Group I
  ● Assesses the scientific aspects of the climate system and climate change.

► Working Group II
  ● Assesses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adapting to it.

► Working Group III
  ● Assesses options for limiting greenhouse gas emissions and otherwise mitigating climate change.
The Technology CCT

For the purposes of the technology cross-cut theme (CCT), we will refer to technology as the broad set of processes covering know-how, experience and equipment, used by humans to produce services and transform resources.

(Not just devices.)
## Technology in the Three WGs

Table 1: Overview of sectors for which technology plays a role that may be addressed in the AR4 and the IPCC working group with which they may be expected to be associated.

<table>
<thead>
<tr>
<th>Sectors</th>
<th>WG1</th>
<th>WG2</th>
<th>WG3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Buildings</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2 Industry</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Transportation</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>4 Power</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5 Refining</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>6 Fossil Fuel Supply</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>7 Biomass Supply</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>8 Nuclear Supply</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Hydro, Solar &amp; Wind Supply</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Energy transmission &amp; storage</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>11 CC&amp;D</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Terrestrial Sequestration</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>13 Agriculture</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>14 Livestock</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>15 Forestry</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>16 Hydrologic Systems</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 Coastal zones</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>18 Health</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>19 Geoengineering</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>20 Monitoring and Verification</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
Technology Components and Systems

Technology exists at both the component and system levels.

- E.g. Hydrogen systems require components from …
  - Transportation
  - Buildings and Industry
  - Refining
  - Carbon capture and disposal

- E.g. commercial biomass requires components from
  - Agriculture
  - Refining
  - Transportation
## Technology Characteristics

### Table 3: Technology Characteristics

1. Technology description, system boundaries
2. System connections, interactions with other technologies. What for example, is assumed about institutions and infrastructure? Are there resource limitations. Are the resource limitations amenable to technological change? Are there deployment limitations associated with intermittency?
3. Output (units) per scale unit
4. Output Emissions of greenhouse gases per unit output
5. Output Emissions of non-GHG’s and other pollutants per unit output
6. Health and safety issues per unit output
7. Production Inputs: capital (common discount rate)
8. Production Inputs: labor (education requirements?)
9. Production Inputs: energy (form, common price)
10. Production Inputs: water
11. Production Inputs: land, other resources, exotic metals
12. Climate Interaction: Temperature
13. Climate Interaction: Precipitation
14. Climate Interaction: Direct CO₂ effect
15. Other Issues: Health and safety issues per unit output
Technological Characterization

Resources

- Oil
- Gas
- Coal
- Wind
- Solar
- Geologic carbon repositories
- Etc.

Resources
- Reserves
- Economic
- Non-economic
Technological Characterization

Importance of Scale

Characteristics that are trivial for small scale may be extremely important for large scales.

- Commercial biomass
- H₂ vehicles
Table 3 does not focus on cost

- Cost is derived from the relationship between prices for inputs and outputs and production relationships.
- Standardization of prices and interest rates could facilitate comparison of costs.

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# Technology Characteristics

## Table 4: Three Periods of Technology Characterization

<table>
<thead>
<tr>
<th>Period</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present average practice</td>
<td>Regional variation</td>
</tr>
<tr>
<td>Present best practice</td>
<td></td>
</tr>
<tr>
<td>2020 Technology development</td>
<td>With uncertainty as it appears in the literature</td>
</tr>
<tr>
<td>2050 Technology potential</td>
<td></td>
</tr>
<tr>
<td>Long term potential</td>
<td></td>
</tr>
</tbody>
</table>
Technological and Time

Basic Research

1. Curiosity driven
2. Motivated by potential use
Technological and Time

1. Applied research
2. Learning
3. Scale economies
4. Adaptation of technologies from
   - related sectors and
   - regions
5. Serendipity
Technological and Time

Rate of change

Role of existing capital stocks and capital stock turnover.
What can an anchor contribute to an assessment?
- Anchors do not write the technology sections.
- The anchor’s role is one of coordinator and facilitator.

Creating a common vocabulary?
- Common system boundaries
- Common boundary conditions
- Common characteristics

Distinguishing between components and systems—how to generate useful information?