The status of CCS and issues surrounding CCS projects

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Financing CCS - May 28th 2008
Overview

- IEA Greenhouse Gas R&D Program
- Energy Demand and Global Warming
- Fossil Fuel Consumption and Carbon Lock-in
- CCS, its Role and Technology Status
- CCS Policy and Regulation
- Current and Future CCS Projects
- Next Steps in Financing CCS
IEA Greenhouse Gas R&D Programme

• A collaborative research programme involving governments, industry and other bodies founded in 1991
• Aim is to:
  
  Provide members with information on the role that technology can play in reducing greenhouse gas emissions.
• Funding approximately $2.5 million/year.
• Activities:- technical studies (>100), international research networks, facilitating and focussing R&D and demonstration activities
• Producing information that is:
  • Objective, trustworthy, independent
  • Policy relevant but NOT policy prescriptive
  • Reviewed by external Expert Reviewers
  • Subject to review of policy implications by members
WEO 2007 Reference Scenario: World Primary Energy Demand

Global demand grows by more than half over the next quarter of a century, with coal use rising most in absolute terms.
Half of the projected increase in emissions comes from new power stations, mainly using coal & mainly located in China & India.
How much energy is left in the world?

Sources: BP Statistical Review 2005; WEC Survey of Energy Resources 2001; Reasonably Assured Sources plus inferred resources to US$80/kg U 1/1/03 from OECD NEA & IAEA Uranium 2003; Resources, Production & Demand updated 2005; *energy equivalence of uranium assumed to be ~20,000 times that of coal

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Global warming

Global

Temperature anomaly (°C)

1900 1950 2000

North America

Temperature anomaly (°C)

1900 1950 2000

Europe

Temperature anomaly (°C)

1900 1950 2000

Asia

Temperature anomaly (°C)

1900 1950 2000

Africa

Temperature anomaly (°C)

1900 1950 2000

South America

Temperature anomaly (°C)

1900 1950 2000

Australia

Temperature anomaly (°C)

1900 1950 2000

Global

Temperature anomaly (°C)

1900 1950 2000

Global Land

Temperature anomaly (°C)

1900 1950 2000

Global Ocean

Temperature anomaly (°C)

1900 1950 2000

models using only natural forcings
models using both natural and anthropogenic forcings

observations

©IPCC 2007: WG1-AR4

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## Predicted Future Global Warming

### Characteristics of stabilization scenarios

<table>
<thead>
<tr>
<th>Stabilization level (ppm CO₂-eq)</th>
<th>Global mean temp. increase at equilibrium (ºC)</th>
<th>Year CO₂ needs to peak</th>
<th>Year CO₂ emissions back at 2000 level</th>
<th>Reduction in 2050 CO₂ emissions compared to 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>490 – 535</td>
<td>2.4 – 2.8</td>
<td>2000 - 2020</td>
<td>2000- 2040</td>
<td>-60 to -30</td>
</tr>
<tr>
<td>535 – 590</td>
<td>2.8 – 3.2</td>
<td>2010 - 2030</td>
<td>2020- 2060</td>
<td>-30 to +5</td>
</tr>
<tr>
<td>590 – 710</td>
<td>3.2 – 4.0</td>
<td>2020 - 2060</td>
<td>2050- 2100</td>
<td>+10 to +60</td>
</tr>
<tr>
<td>710 – 855</td>
<td>4.0 – 4.9</td>
<td>2050 - 2080</td>
<td></td>
<td>+25 to +85</td>
</tr>
<tr>
<td>855 – 1130</td>
<td>4.9 – 6.1</td>
<td>2060 - 2090</td>
<td></td>
<td>+90 to +140</td>
</tr>
</tbody>
</table>

- Mitigation efforts over the next 2-3 decades will have a large impact on opportunities to achieve lower stabilization levels

Source: IPCC 2007

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Carbon Lock-in - New and replacement fossil fueled power plants 2003-2030

Lifetime Carbon
Coal = 145 GtC
Gas = 63 GtC
Oil = 20 GtC

1,883
1,391
237

GW
World Energy Outlook 2007 summary

- Global energy system is on an *increasingly* unsustainable path
- China and India are transforming the global energy system by their sheer size
- Challenge for *all* countries is to achieve transition to a more secure, lower carbon energy system
- New policies now under consideration could make a major contribution

Next 10 years are critical

- The pace of capacity additions will be most rapid
- Technology will be “locked-in” for decades
- Growing tightness in oil & gas markets
CCS technology components
Maturity of CCS technology

- **Oxyfuel combustion**
- **Post-combustion**
- **Industrial separation**
- **Pre-combustion**
- **Transport**
- **Gas and oil fields**
- **Industrial utilization**
- **Saline formations**
- **Enhanced Oil Recovery**

**Mineral carbonation**

**Ocean storage**

**Research phase**

**Demonstration phase**

**Economically feasible under specific conditions**

**Mature market**

IPCC CCS 2005

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CCS in coal-fired power generation

Not all technologies at the same level of maturity.

After EPRI and others

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Role of CCS in climate change mitigation

- IPCC Special Report (2005) – CCS contributing between 15-55% of CO2 mitigation to 2100 and reduces mitigation costs by >30%

- IEA Technology Perspectives (2006) – CCS 20-28% of mitigation to 2050. Second only to energy efficiency.

- Stern Report (2006) – CCS ~10% mitigation by 2025, ~20% by 2050. Marginal mitigation costs without CCS increase by ~60%.

- EC (2008) – Cost of meeting climate change commitments to 2030 will be 40% higher if CCS is not included.
International Policy Developments

- International acceptance of CCS was seen as a major barrier to CCS deployment 2 years ago
- Situation has changed significantly in the last year
- Main International Environmental Treaty is the Kyoto Protocol
  - CCS accepted as a mitigation option in 2007
- Key International Marine Treaties, London Convention/OSPAR adopted amendments to allow CCS in sub sea geological structures
- EU Emissions Trading Scheme permits CCS with full acceptance planned from 2013
Development of CCS regulations

- **USA** – Existing Underground Injection Control programme for ground water protection adapted for pilot projects
  - Interstate Oil and Gas Compact Commission has developed recommendations for regulations for CO2 storage at a State Level
  - USEPA are developing Federal level regulations for CO2 storage
- **Australia**
  - Adapting Federal oil and gas laws, draft regulations for comment
  - State of Victoria has a consultation document for CCS, considering regulations
  - Queensland considering regulations
- **Canada**
  - Canada – acid gas injection and CO2-EOR already permitted in states like Alberta
  - Federal Task Force developing CCS regulations
- **Japan**
  - Adapted marine laws but has no oil and gas laws to adopt for CCS
  - Most existing laws cover; permitting, construction, operational and abandonment phases but NOT post closure
Current CO₂ Injection and Storage Projects

50 Acid Gas injection sites in North America

4 New CO₂-EOR Pilots in Canada

50 Acid Gas
Snohvit
Sleipner
K-12B

4 New CO₂-EOR Pilots in
Canada

Zama
Penn West
Weyburn
Mountaineer

West Pearl Queen

Frio

Mountaineer

70 CO₂-EOR projects in U.S.A.

Key
- Depleted Oil Field
- ECBM projects
- EOR projects
- Gas production Fields
- Saline aquifier

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Size matters!

Cumulative globally sequestered CO$_2$

Cumulative global need to sequester CO$_2$
Proposed Integrated CCS Projects

Total investment = $21.9 trillion (in $2006)

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CCS Commercialization

- Too few large scale demonstrations to accelerate deployment of CCS technologies
- This approach could result in risk of project failure
- High profile failures concerning CCS projects will result in a reluctance to invest in the deployment of CCS technologies
- We need a path forward to rapid commercialisation of CCS
Thank You!

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Recent Project Developments in US:

- Reconfigured FutureGen
- Hydrogen Energy – DF2
- USDOE Regional Carbon Sequestration Partnerships
  - 7 pilot to demonstration scale CCS projects
  - Storing between 1Mt and 5Mt of CO2
  - 21.9Mt stored total of CO2
  - Up to 5Mt CO2 stored/year total
Recent Project Developments in EU......

- **UK**
  - CCS demo – full scale, coal, post-combustion, offshore storage
- **Germany**
  - Ketzin - injection
  - RWE planning a 450 MWe coal fired IGCC project with on-shore storage
  - Vattenfall have built a 30 MW CO2 capture pilot plant
    - Plans to build a 300MW demonstration project in Germany
  - EON and Siemens – CO2 capture pilot plant
- **France**
  - Lacq Project. Total. 2008. Oxyfuel. 150kt - CO2 aquifer. 27km pipeline
- **Netherlands**
  - CO2 injection into K12B field
  - NUON _ IGCC CO2 capture