CO_2 Capture and Storage as a Climate Change Mitigation Option

Chair: Dr. Brian Flannery, ExxonMobil

IPIECA Side Event

Tuesday 7 November 2006, African Blackwood Tree

IPIECA in profile

IPIECA

- Founded 1974 - Global Membership: national & multinational petroleum companies / associations
  - Currently 28 companies, 14 associations
- UN Observer status
- Secretariat based in London
- Focus on key global issues:
  - Global Climate Change
  - Biodiversity
  - Social Responsibility
  - Oil Spill Preparedness & Response
  - Fuels and vehicles
  - Health

Climate Change Working Group (CCWG)

IPIECA

Established in 1988 its mission is to:

To provide reliable and timely information, issues analysis, education and involvement in international processes related to global climate change

IPIECA Work on Carbon Dioxide Capture and Geological Storage

2003:

- IPIECA CCS Workshop and Summary Report

2004:

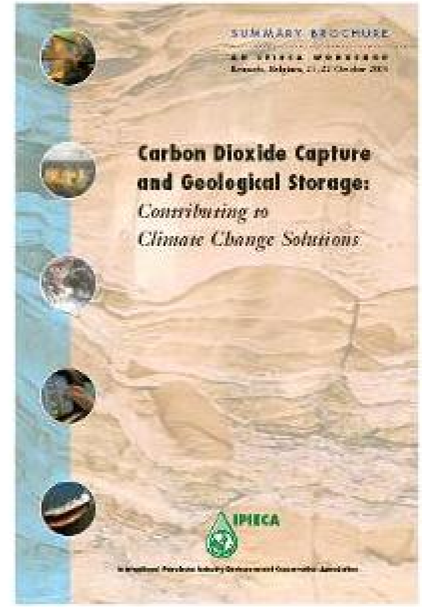
- Contribution to Preparation of the IPCC Special Report on CCS

2005:

- CCS Side-event at COP MOP-1, Montreal

2006:

- Petroleum Industry Roundtable: Policy and Regulatory Development
- Presentations at SBSTA CCS Workshop
- API / IPIECA Petroleum Industry Guidelines for CCS Emission Reduction Projects



A copy of the IPIECA CCS summary report available online through IPIECA website www.ipieca.org

This Session

- **Carbon Dioxide Capture and Geological Storage:**
  Contributing to Climate Change Solutions
  - Luke Warren, IPIECA
- **API / IPIECA Guidelines on Monitoring and Reporting Emission Reductions from CCS projects**
  - Frede Cappelen, Statoil
- **Policy and Regulatory Frameworks for CCS**
  - Arthur Lee, Chevron

Carbon Dioxide Capture and Geological Storage:
Contributing to Climate Change Solutions

Luke Warren, IPIECA

The Development-Climate Challenge

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- By 2030 energy use forecast to grow by 60%
  - Fossil fuels projected to remain dominant energy source
  - Meeting demand requires technology development & investment
- Affordable energy is a key factor to achieve economic & social development
  - 1.6 billion currently lack access to electricity
- Climate
  - Concerns over impacts of increased GHG emissions

Improved technology will be needed to meet the development-climate challenge.

Role of Technology in Providing for Energy Demand and Stabilizing CO_2 Concentration

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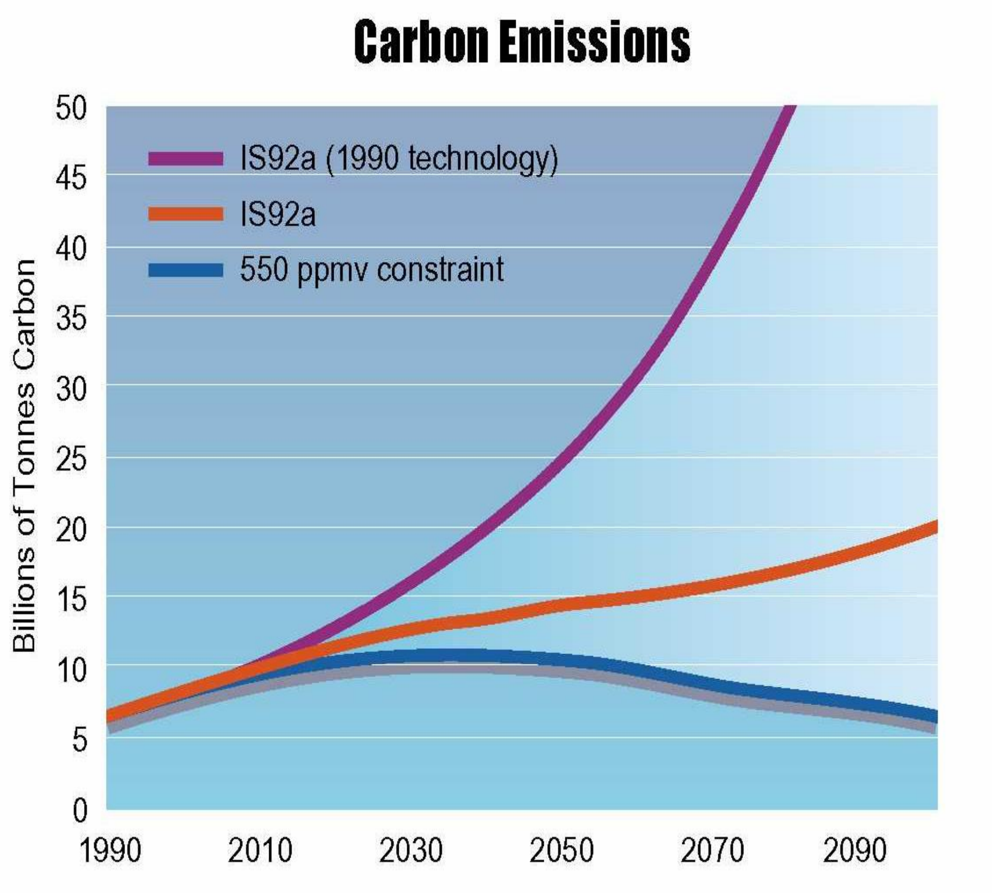

Edmonds, PNNL, 2003

Future CO_2 emissions:
No improvement in technology
No attempt to mitigate CO_2 emissions

Scenario for future CO_2 emissions:
No attempt to mitigate CO_2 emissions
Growth in developing countries

Emissions leading 550 ppm CO_2
•Assumed stabilization level

Role of Technology in Providing for Energy Demand and Stabilizing CO_2 Concentration

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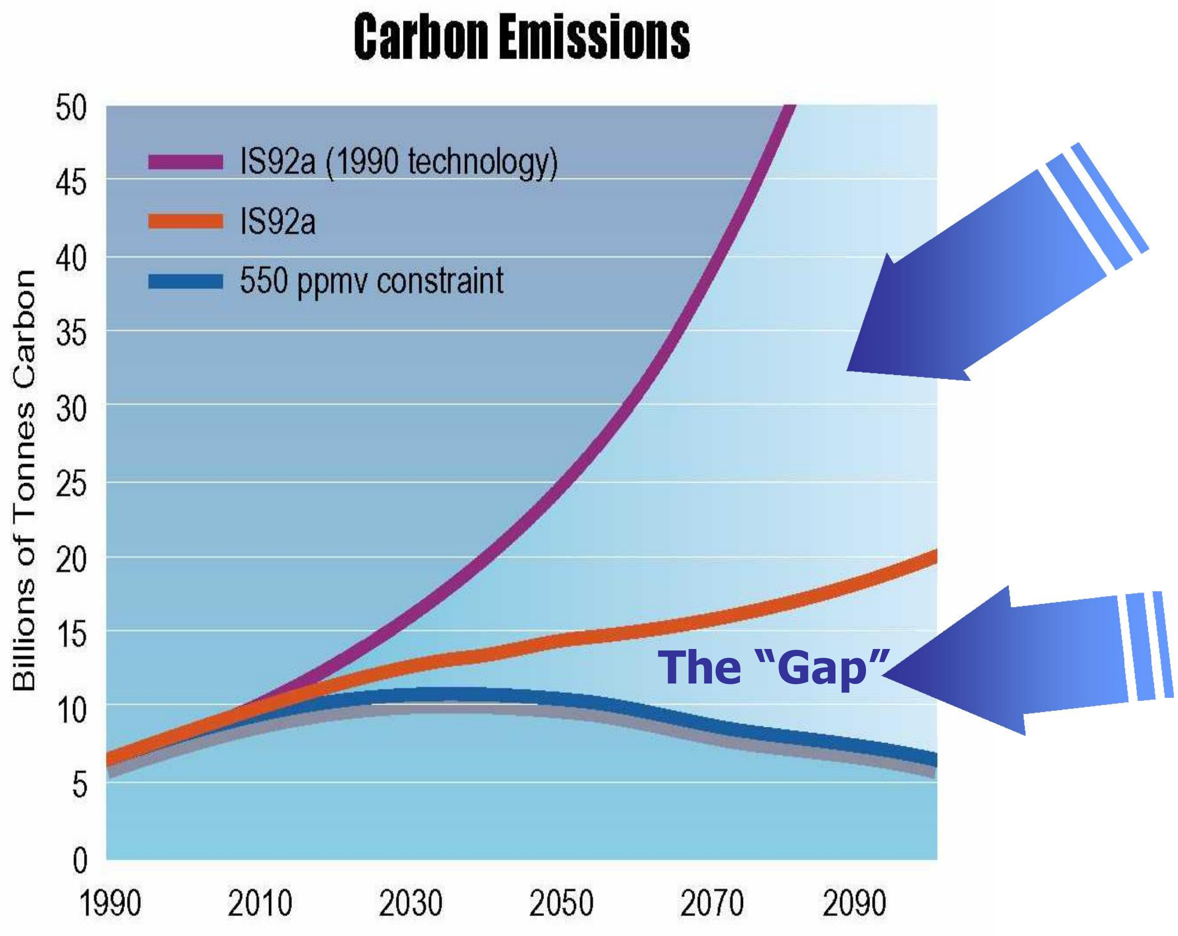

Edmonds, PNNL, 2003

<u>Assumed</u> Significant Advances In:

- Fossil Fuels
- Energy intensity
- Nuclear
- Renewables

<u>Gap technologies</u>

- **Carbon capture & storage**
    - **Adv. fossil**
- H_2 and Adv. Transportation
- Biotechnologies
    - Soils, Bioenergy, adv.
    - Biological energy

What is Carbon Dioxide Capture and Geological Storage?

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CCS is the capture of CO_2 from large stationary sources, its transportation to an appropriate injection site where it is pumped into underground geological formations

- Stationary sources responsible for large share of CO_2 emissions
  - Electricity provides ~40% of global CO_2 emissions
  - Capture of CO_2 from flue-gas using an amine absorbent at a cost of roughly 40 US$/t$CO_2$
  - Alternative methods: pre-combustion decarbonisation; combustion using oxygen instead of air or; separation using membranes, solid adsorbent cryogenics
- Captured CO_2 can be transported by high pressure pipelines or tankers to land-based or offshore geological sites
- Geological storage sites include depleted natural gas and oil fields, deep saline aquifers, and coal seams.

CO_2 Capture and Storage Technology for a Greenhouse Gas Constrained Future

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- Scope for CCS is large
  - Emissions from power production and industry = 63% of global CO_2 emissions
  - If shift to hydrogen or electricity for transportation's energy carrier, then scope could include another 25% of global CO_2 emissions
  - Allows coal to continue to contribute to energy in a GHG constrained world
- CCS adds costs and consumes energy leading to
  - increased cost of energy services; electricity generation costs estimated to increase by 0.01 – 0.05 US$ / kWh*
  - additional depletion of energy resources
- The current cost of CCS from power plants is roughly 40-60 US$/t$CO_2$
- In limited cases capture costs can be modest:
  - gas processing
  - production of some chemicals

  → **Case dependent**
- And in some limited cases CCS is economic:
  - enhanced oil recovery
  - acid gas disposal

  → **Opportunities for early experience**

*IPCC Special Report on Carbon Capture and Storage, 2005

CO_2 Capture and Storage Technology for a Greenhouse Gas Constrained Future cont.

- **In scenarios where atmospheric concentration stabilizes over the next century CCS can play a primary role:**
  - Assumes advances in technology
  - Assumes drivers from policy measures
  - Entails massive infrastructure addition rivalling that of current global energy system
- **Because of the large scale and cost, deployment of CCS, on a scale that affects global emissions would require many decades**
- **There are significant uncertainties in:**
  - policy measures to mitigate climate change
  - how technology will improve over the long-term
  - how CCS will stack up against other GHG mitigation options in the future

A portfolio of technology initiatives advancing not only CCS, but also other technology options is appropriate in this situation

Basis for Risk Management for an Expanded Role of Geological Storage of CO_2

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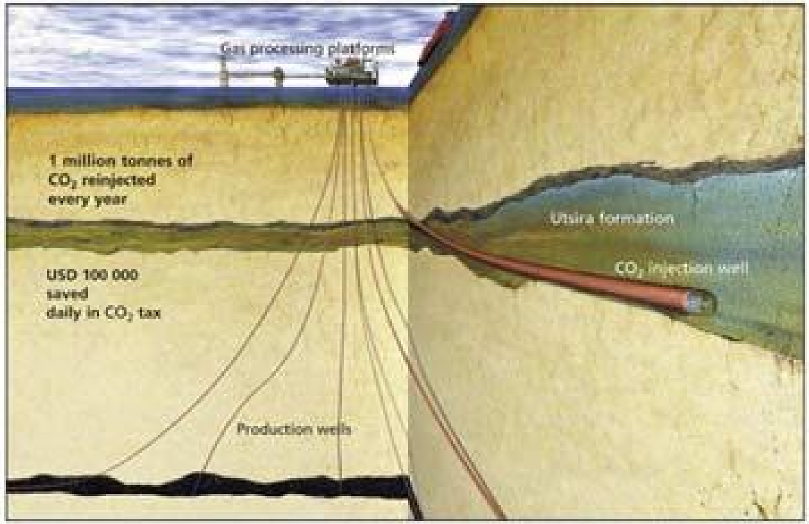
- **Science builds on over 30 years of industry experience**
  - enhanced oil recovery (EOR)
  - acid gas injection
  - CCS projects
- **Safety achieved by site selection and risk management systems that make use of information from:**
  - Site characterisation;
  - Operational monitoring;
  - Scientific understanding;
  - Engineering experience



- **Experience provides valuable information on the management of geological storage**
  - But fossil fuel emissions are several orders of magnitude greater
  - To avoid a substantial portion of global emissions would require CCS on much larger scale

Industry is confident that CCS can be practiced safely and effectively and we are prepared to work with others

Basis for Risk Management for an Expanded Role of Geological Storage of CO_2 cont.

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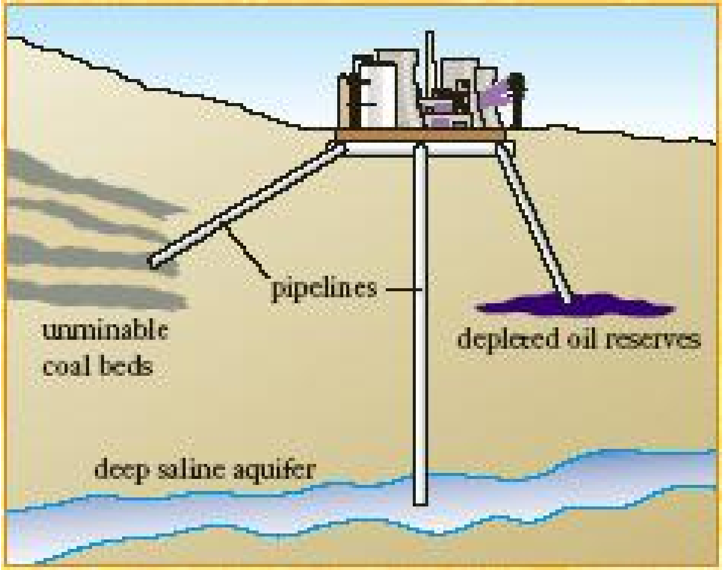
Geologic storage will require consideration of a broader range of geological settings than have been considered for EOR

Volume of pore-space beneath land and offshore ample in comparison to emissions of CO_2 from fossil fuels

- How much could effectively be used is an evolving question
- Depleted oil and gas fields might accept 920 $GtCO_2$ (45% of fossil fuel CO_2 emission to 2050)
- Deep aquifers form a class of sites that have much greater capacity (perhaps up to 500% of emissions to 2050)



Geological storage merits aggressive development and improvement

CO_2 Capture and Geological Storage – The Road Ahead

- A diverse set of initiatives by academia, governments and industry – the petroleum industry in particular – are improving the performance and prospects of CCS by:
  - Accumulating commercial experience with gas injection
  - Research initiatives to find lower-cost CCS technologies and improve understanding of risks
  - An increasing number of CCS projects worldwide to improve understanding through field experience
  - Assessment of the merits of CCS and how it rates against other technology options to provide valuable information for decisions and the basis for public acceptance
- These actions will improve and better define the prospects of CCS and its contribute to a potential solution to global climate change

Policy, Regulation and Public Perception: Opportunities and Barriers

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- Effective legal and regulatory frameworks facilitate good practices without forming unintended barriers for deployment of CCS
- Expanded use of CCS would be accompanied by reduction in costs, improvement in technology, improved understanding of risks and management, and raised public awareness
- A regulatory framework that encourages good practice and incorporates evolving understanding of risk and its management could promote these improvements
- Development of a sound regulatory and legal framework that will evolve with the evolution of CCS science and technology will be valuable if CCS is to be deployed on a global scale

Recent Developments: Accounting and Reporting of CCS Activities

IPCC 2006 Guidelines for National GHG Inventories

- Adopted at IPCC-25, Mauritius, April 2006
- Volume 2, Chapter 5: Carbon Dioxide Transport, Injection and Geological Storage
- Provides a methodology for inclusion of CCS activities in national GHG inventories

API / IPIECA Petroleum Industry Guidelines for Emission Reductions from Carbon Capture and Storage

- Framework for assessing emission reductions associated with CCS projects