



# **Carbon Dioxide Capture and Storage.**

## **International Legal and Regulatory Developments**

*Tim Dixon*

*IEA GHG R&D Programme*

*CCS MSc University Edinburgh 19 Feb 2010*

# IEA Greenhouse Gas R&D Programme



- A collaborative international research programme founded in 1991
- Aim: To provide information on the role that technology can play in reducing greenhouse gas emissions from use of fossil fuels.
- Producing information that is:
  - Objective, trustworthy, independent
  - Policy relevant but NOT policy prescriptive
  - Reviewed by external Expert Reviewers
- IEA GHG is an IEA Implementing Agreement in which the Participants contribute to a common fund to finance the activities.
- Activities: Studies and reports (>120); International Research Networks : Wells, Risk, Monitoring, Modelling, Oxy, Capture, Social Research, Solid Looping; Communications (GHGT conferences, IJGGC, etc); facilitating and focussing R&D and demonstration activities eg Weyburn



- Why developments started happening
- IPCC GHG Inventory Guidelines
- Marine Conventions
- EU Regulation and ETS
- UNFCCC
- Others
- Regulatory principles and learning
  
- Future work and opportunities.....

# Why developments started happening

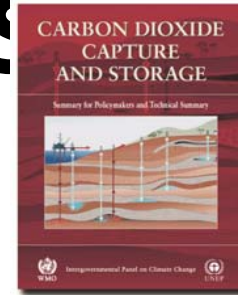


Role of CCS in climate change mitigation?

- IPCC Special Report (2005) – CCS contributing 15-55% of CO<sub>2</sub> mitigation to 2100
- G8 2005 recognised CCS at highest level, 5 initiatives
- 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%.

2004/5 Ocean acidification realisation

# IPCC Special Report on CCS (2005)



- “Observations from engineered and natural analogues as well as models suggest that the fraction retained in **appropriately selected and managed** geological reservoirs is very likely to exceed 99% over 100 years and is likely to exceed 99% over 1,000 years. ”
- “**For well-selected, designed and managed sites**, the vast majority of the CO<sub>2</sub> will gradually be immobilized by various trapping mechanisms and, in that case, could be retained for up to millions of years. Storage could become more secure over longer timescales. ”

# IPCC Guidelines for GHG Inventories



- Apr 2006
- Vol 2 Energy, Chp 5 - CO2 Transport, Injection and Geological Storage
- Each site will have different characteristics
- **Methodology**

Site characterisation – inc leakage pathways



Assessment of risk of leakage – simulation / modelling



Monitoring – monitoring plan



Reporting – inc CO2 inj and emissions from storage site

- For appropriately selected and managed sites, supports zero leakage assumption unless monitoring indicates otherwise

# IPCC Guidelines for GHG – cont



## Monitoring Plan

- Measurement of background fluxes of CO<sub>2</sub>
- Continuous measurement of CO<sub>2</sub> injected
- Monitoring of injection emissions
- Periodic monitoring of CO<sub>2</sub> distribution
- Monitoring of CO<sub>2</sub> fluxes to surface
  
- Post-injection monitoring – as above, linked to modelling, may be reduced or discontinued once CO<sub>2</sub> stabilises at its predicted long-term distribution
- Incorporate improvements in technologies and techniques over time

## Monitoring technologies – Annex 1

- Deep subsurface technologies
- Shallow subsurface technologies
- Surface / water technologies

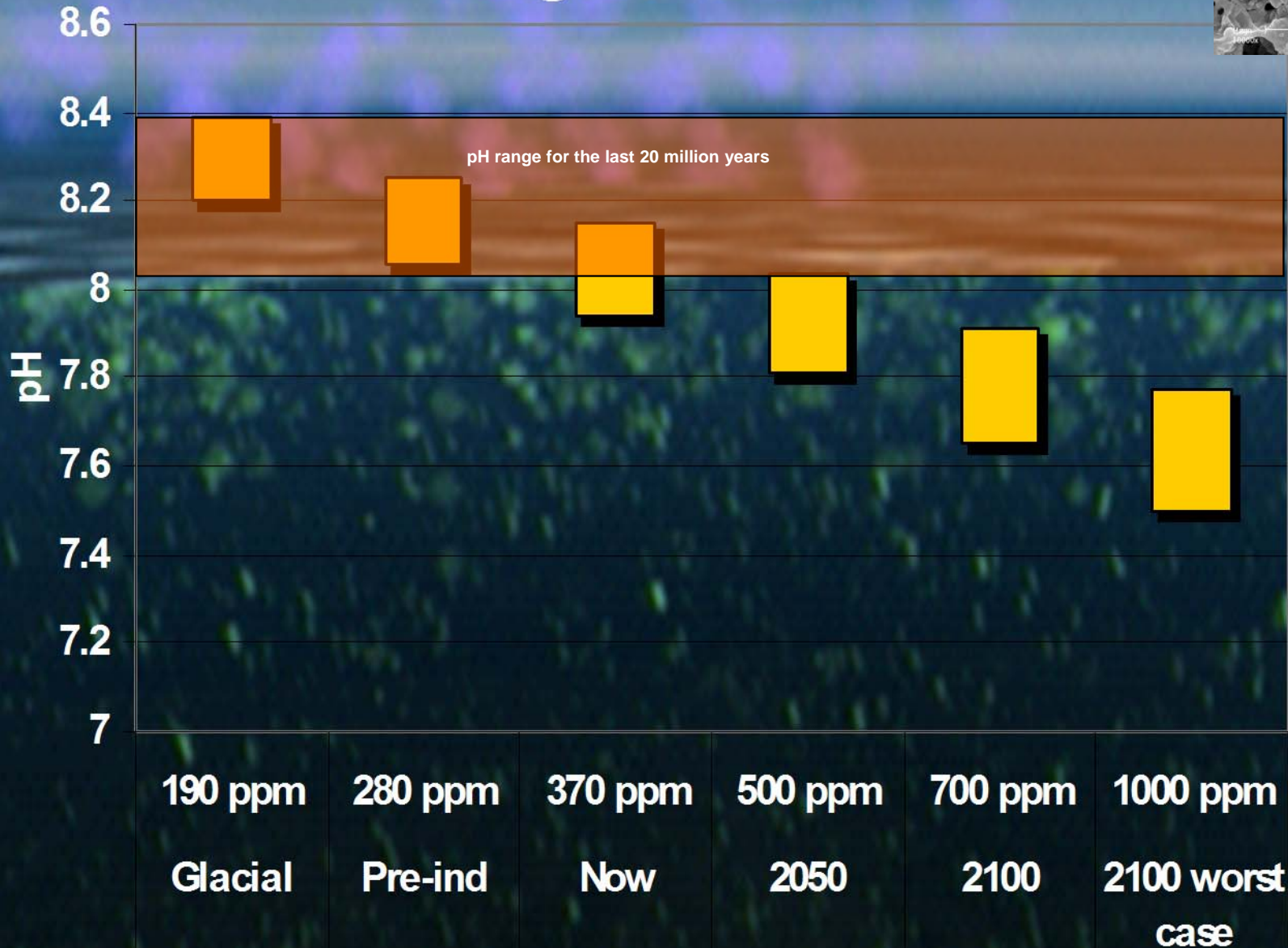
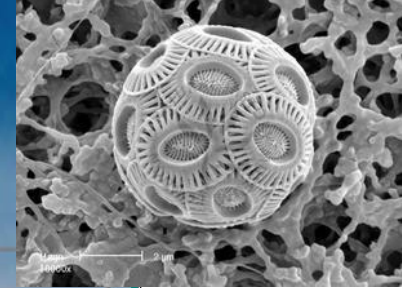
# London Convention and Protocol



- Marine Treaty - Global agreement regulating disposal of wastes and other matter at sea
- Convention 1972 (86 countries)
- Protocol 1996 – ratified March 2006 (39 countries as of Jan 2010)
- Prohibited some CCS project configurations
- CO<sub>2</sub> Geological Storage Assessed by LC Scientific Group 2005/6
- 2006 - Risk Assessment Framework for CO<sub>2</sub>
- To allow prohibited CCS configurations – **Protocol amendment adopted at 28th Consultative Meeting (LP1), 2 Nov 2006** - came into force 10 Feb 2007 to allow disposal in geological formations
- CO<sub>2</sub> Specific Guidelines



# Simulated and observed marine pH ranges till 2100



PML  
2005

# London Protocol Amendment



*Allowed to dispose of “CO<sub>2</sub> streams from CO<sub>2</sub> capture processes for sequestration”*

*“Carbon dioxide streams may only be considered for dumping, if:*

- 1 disposal is into a sub-seabed geological formation; and*
- 2 they consist overwhelmingly of carbon dioxide. They may contain incidental associated substances derived from the source material and the capture and sequestration processes used; and*
- 3 no wastes or other matter are added for the purpose of disposing of those wastes or other matter.”*

**LC 28/15 (6 Dec 2006) Annex6**

# London Protocol – CO<sub>2</sub> Specific Guidelines



*"the CO<sub>2</sub> stream, consisting of:*

- 1. CO<sub>2</sub>;*
- 2. incidental associated substances derived from the source material and the capture and sequestration processes used:*
  - .1 source- and process-derived substances; and*
  - .2 added substances (i.e. substances added to the CO<sub>2</sub> stream to enable or improve the capture and sequestration processes);*

*Acceptable concentrations of incidental associated substances should be related to their potential impacts on the integrity of the storage sites and relevant transport infrastructure and the risk they may pose to human health and the marine environment.*

**LC/SG 30/14 (Jul 2007) Annex 3.**

# Unresolved issue – Transboundary transport



## London Protocol Article 6

*“EXPORT OF WASTES OR OTHER MATTER*

*Contracting Parties shall not allow the export of wastes or other matter to other countries for dumping or incineration at sea.”*

- **Prohibits transboundary transport of CO<sub>2</sub> for geological storage**
- Working Group (Feb 08, Germany) – covering transport and subsurface migration - Agreed amendment Article 6 necessary – drafted.
- Annual meeting Oct08 considered further. Some against, some for. Agreed plenary statement to give a political message that *“LP should not create barrier to transboundary transport of CO<sub>2</sub> for CCS”*.
- Further Working Group in 2009 to take forward legal questions
- Amendment proposed by Norway Apr 09 for consideration at annual Consultative meeting in Oct 09

# CO<sub>2</sub> Transboundary Amendment to LP

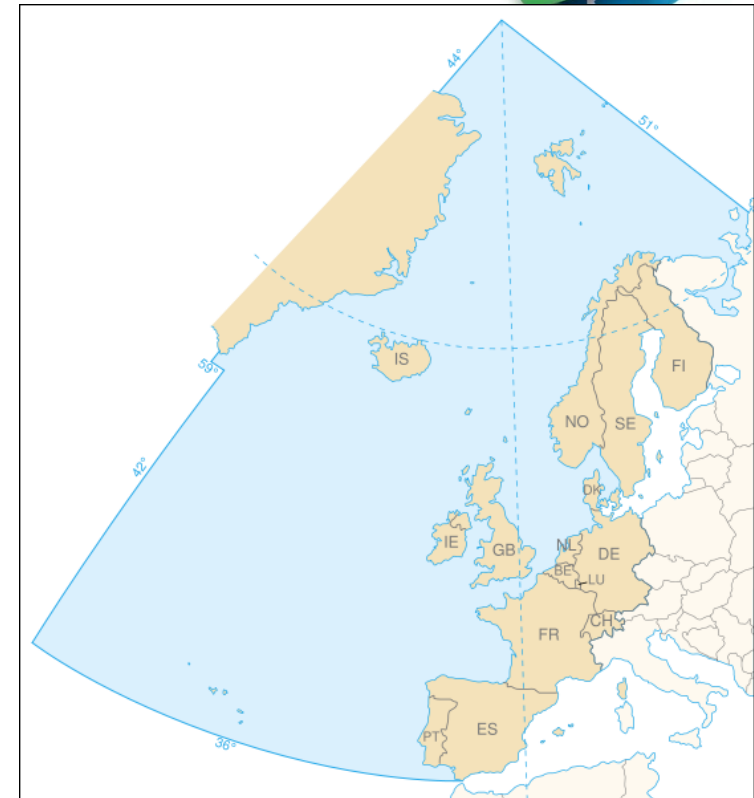


- LP4 30 Oct 2009 - Amendment was adopted by vote. 15-for, 1-no, 6-abst. Needed 2/3 majority voting (22 present). 2 against.
- Article 6 , new para 2. ***'Export of CO<sub>2</sub> for disposal in accordance with Annex 1 may occur, provided an agreement or arrangement has been entered into by countries concerned'***
- ***Agreement shall include : permitting responsibilities; for export to non-LP Parties provisions equivalent to LP's for issuing permits.***
- Working Group decided transboundary migration in geological formation is not export
- Request to Scientific Group to re-examine CO<sub>2</sub> Specific Guidelines wrt to transboundary migration
- To come into force needs ratification by two thirds all Parties (26)

# OSPAR



- Marine Convention for NE Atlantic, 1992
- 15 nations and EC
- Prohibited some CCS configurations
- Considered CCS and CO<sub>2</sub> impacts on seas
- To allow prohibited CCS configurations:
- Amendments (to Annexes II and III) for CO<sub>2</sub> storage adopted June 2007
- **Needs ratification by 7 Parties**
- **6 ratified** (as of March 2011)



- OSPAR Decision – requirement to use Guidelines when permitting, including risk assessment and management process
- OSPAR Guidelines for Risk Assessment and Management of Storage of CO<sub>2</sub> in Geological Formations – includes the Framework for Risk Assessment and Management (FRAM)

# London and OSPAR Guidelines for Risk Assessment and Management



- Scope – scenarios, boundaries
- Site selection and characterisation – physical, geological, chemical, biological
- Exposure assessment – characterisation CO2 stream, leakage pathways
- Effects assessment – sensitivity of species, communities, habitats, other users
- Risk characterisation – integrates exposure and effects - environmental impact, likelihood
- Risk management – incl. monitoring, mitigation

# EU Developments



***EC Communication on Sustainable Power Generation from Fossil Fuels (Jan 2007)***

***EU Spring Council 2007 - Action Plan for Energy Policy for Europe***

- Stimulate up to 12 CCS demonstrations by 2015
- Strengthen R&D and develop technical, economic and regulatory framework to bring environmentally-safe CCS to deployment by 2020



# EU CCS Directive and ETS Directive



Drafts launched 23 Jan 2008

Agreed 12 Dec EU Council and 16 Dec EP !

Adopted 6 April 2009, published 5 June 2009

# EU CCS Directive (1)



## **'Directive on the Geological Storage of Carbon Dioxide' 2009/31/EC**

Enabling regulatory framework to ensure environmentally sound CCS

- Follows IPCC GHG Guidelines and OSPAR
- Objective is permanent storage
- Ocean storage prohibited
- Permits will be required for CCS – exploration and storage
- Storage permit only if “no significant risk of leakage”
- Emphasis on site selection, characterisation, risk assessment, monitoring plan
- Corrective measures plan, and provisional post-closure plan

# EU CCS Directive (2)



- Permits - EC has right to review permit decisions – non-binding opinion
- Permits – review by authority after 5 years and then every 10 years
- CO<sub>2</sub> stream acceptance criteria - “overwhelmingly CO<sub>2</sub>” – may contain impurities, levels based on risk assessment of integrity – no wastes to be added
- Monitoring plans to include ETS monitoring. Update every 5yrs. Leakage triggers ETS monitoring.
- Reporting and inspections at least once a year

# EU CCS Directive (3)



- Financial security required from operator
- After closure, liability transfer to competent authority “when evidence indicates completely and permanently contained”. >20 yrs. EC will review. Monitoring will continue but reduced to detect irregularities .
- Financial security – from outset, to cover liabilities including closure, up to transfer of liability. Financial contribution to Competent Authority to cover long-term monitoring for 30 years
- Access to transport networks and storage, unless technical issue or lack capacity
- Removes barriers in other Directives – IPPC, Waste, Water, EIA, ELD, LCPD - Capture-ready

# EU CCS Directive (4)



- Capture-ready in LCPD
- Definition was based on IEA GHG report (TR2007/04) for IEA – G8
- > 300 MW, from date of CCS Directive:
  - Assessed availability of suitable storage sites
  - Assessed transport is technically and economically feasible
  - Assessed technical feasibility of retrofitting capture equipment
- If so, then leave space for capture equipment

# EU CCS Directive (5)



- Annex 1 - Site characterisation
  - Data collection
  - Static Simulation
  - Dynamic simulation - security characterisation (ie performance assessment)
  - Risk assessment
- Annex 2 – Monitoring plan criteria
  - Criteria, coverage, updating (non prescriptive on techniques or timescales)
- MS bring into force in 2yrs
- Review Directive in 2015 – include mandatory Emissions Performance Standards?

# EP proposed amendments to CCS Directive



Included:

- CO<sub>2</sub> stream >95% CO<sub>2</sub>, with no H<sub>2</sub>S or SO<sub>2</sub>
- Responsibility for storage sites post-closure to remain with operator for at least 50 years,
- Storage operators to pay into a fund to cover authorities' responsibilities after transfer, for all CO<sub>2</sub> stored ie an additional charge on CCS, level not indicated.
- EPS – 500 g kWh
- Exclude EOR

***These were not adopted***

# EC Guidance Documents



Drafts issued June 2010

- GD1 Storage Risk Assessment
- GD2 Storage site characterisation, CO2 stream composition, Monitoring, Corrective Measures
- GD3 Criteria for Transfer of Responsibility
- GD4 Financial Security (liabilities)



# EU Emissions Trading Scheme



**EU ETS 'Cap-and-trade' scheme. Phase I from Jan 2005 – Dec 2007.  
Phase II 2008-2012. Phase III 2013-2020**

Phase II - CCS via Article 24 'Opt-in'

- Article 24 – procedure for country to 'opt-in' to ETS an activity or installation or GHG not listed in ETS Directive
- Article 24 requires :
  - inclusion in country's National Allocation Plan;
  - project specific application by gov'n to EC, containing:-
  - activity/installation definition,
  - effects on market,
  - distortions of competition,
  - environmental integrity of ETS,
  - and specific MRG for the activity/installation



# ETS Directive

**Proposed 23 Jan 2008 - to strengthen, expand and improve the ETS from 2013. Now agreed.**

## CCS

- CCS fully included from 2013
  - Site and operation will need to comply with CCS Directive
  - Needs monitoring and reporting guidelines - underway
- No free allocation to CCS (same as electricity)
- Separate permitting of capture, transport and storage
- If any leakage – surrendering of allowances
- If leakage from storage suspected from monitoring under CCS Directive, then trigger ETS monitoring to quantify
- Biomass and CCS ?



# EU ETS Revised Monitoring and Reporting Guidelines (MRG) for Phase II

Measurement based. Boundaries specified.

## MRG for Capture

- Measure CO<sub>2</sub> transferred to transport, subtract from installation's calculated emissions

## MRG for Transport

- Measure CO<sub>2</sub> in and out (mass balance) – difference is leakage emission
- Or, emission factors for each component

## MRG for Injection and Storage

- Injection - Measure CO<sub>2</sub> received and injected to storage (mass balance) – difference is leakage emission
- Storage – leakage emissions to be measured.....

# EU ETS Revised MRG - 2



## Leakage emissions from storage

- Measurement based – based on monitoring
- Stepwise procedure based on IPCC GHG Guidelines = site characterisation and modelling + risk/performance assessment + monitoring plan + modify in light of operational results
- Monitoring to detect leakage (CCS Directive)
- If detected, calculate amount :
  - Identify and characterise leakage source and pathway
  - Apply range of measurement techniques to estimate flux
  - Flux duration – backdated to a reference point
  - Total leakage amount tCO<sub>2</sub> per day



# UNFCCC and CCS

## Four negotiating bodies relevant to CCS:

### UNFCCC:

- [COP – Conference of the Parties to the UNFCCC]
- AWG-LCA – Ad Hoc Working Group on Long-term Cooperative Action

### Kyoto Protocol:

- CMP – Conference of the Parties serving as a Meeting of the Parties to the Kyoto Protocol
- AWG-KP – Ad Hoc Working group on Further Commitments for Annex I Parties under the Kyoto Protocol (Post 2012)
- SBSTA – Subsidiary Body for Scientific and Technological Advice

# Kyoto Protocol and CCS



- 2008 - 2012 (Kyoto 1<sup>st</sup> Period)
  - Developed country emission commitments
    - CCS included in KP Art 2.1
    - IPCC GHG Guidelines 2006 allows CCS to be reported
  - CDM – Policy mechanism for rewarding CO<sub>2</sub> reduction in developing countries. Project-based carbon credits.
- Post 2012 – CDM ?

# Kyoto Protocol and CCS



## Considering CCS in CDM since CMP1 Montreal (2005)

- CDM Executive Board to consider new methodologies
- Under SBSTA:-
- Technical workshops (2006)
- Consideration of technical and policy Issues
- Submissions from Parties and NGOs – two synthesis reports (2007 and 2008)
- On agenda of every SBSTA meeting
- Decision due at CMP4 Poznan (Dec 08) – failed
- CMP request EB to look at implications
- **EB commission ‘Experts Report’**
- Decision due at CMP5 Copenhagen (Dec 09) – failed
- CMP6 Cancun .....

All CCS CDM reports and background <http://cdm.unfccc.int/about/ccs/index.html>



# Key issues of concern

## Included

- Timescales of benefits vs liability
- Impact on CDM market
- Scale and impacts of leakage
- Furthering use of fossil fuels – sustainable development
- Role of CCS in climate change mitigation

## Since CMP 5

- Non-permanence
- MRV
- Environmental impacts
- Project boundaries
- Liability
- Perverse outcomes
- Safety
- Insurance and compensation for leakage

Negotiations characterised by a few countries having strong views against CCS – but need unanimous agreement to progress



# 'Experts Report' to EB50 on Implications of CCS in CDM



Reviewed all previous work, and latest regulatory developments

## Conclusions:

- CCS compatible with current Modalities and Procedures
- Treat as stable long-term emission reductions - with appropriate site selection, risk management, liability, boundaries, monitoring.
- Treat CCS projects the same as other CDM project activities, and deliver fungible permanent CERs

# CCS in Cancun



## Decision CMP.16

- CCS is eligible provided that certain issues are addressed
- Issues include site selection, modelling, monitoring, risk assessment, liabilities (short and long-term)
- SBSTA to “elaborate” new “Modalities and Procedures” which address the issues

# CCS in Cancun



Decision CMP.16

Work programme for 2011:

- Submissions (by 21 Feb) and 'Synthesis report'
- Technical workshop (technical and legal expertise)
- UNFCCC to draft Modalities and Procedures for SBSTA 35 (Durban Dec 2011)

# AWG-KP and CCS



## Extension to the Kyoto Protocol (AWG-KP) (L.15/AWG-KP10)

- Should CCS be included in the CDM in the second commitment period of the Kyoto Protocol (2013 – c.2020)?

### Currently two options:

1. CCS shall not be eligible under CDM due to unresolved concerns
2. CCS shall be eligible under CDM in 2<sup>nd</sup> and subsequent periods
  - SBSTA to develop procedures to address outstanding issues
  - These to be adopted in Dec. 2010 or Dec. 2011

***Cancun outcomes: Agreement to achieve replacement agreement before KP ends.  
Continuation of mechanisms - CDM***

# UNFCCC and CCS: AWG LCA



- Nationally Appropriate Mitigation Actions (NAMAs)
- Technology Mechanism
  - Climate Technology Centre and Network
- Green Climate Fund
- All to be designed and operationalised



# Future Work

Work continues in all these areas at

- SBSTA 35, COP-17, CMP-7, Durban, December
- CCS CDM issues have wider effect on all mechanisms for CCS
- **General low level of understanding of CCS, hence concerns**
- General view - technical arguments can be addressed, a few countries block for other reasons, so needs decisions at Ministerial level

# Regulatory developments in other regions



## Australia

- Offshore using Petroleum and GHG Storage Act (2008)
- Onshore in Victoria, Queensland, WA

## USA

- US EPA have developed Federal level regulations “Draft Rule” for CO<sub>2</sub> storage (Jul08) and for Reporting of Emissions from Capture and Storage (2010)
- Interstate Oil and Gas Compact Commission developed recommendations for regulations for CO<sub>2</sub> storage at a State Level
- Individual state regulation (KS, LA, TX, WY, ND, MT, etc)

## Canada

- Canada – acid gas injection and CO<sub>2</sub>-EOR already permitted in states like Alberta
- Alberta CCS Amendments Act 2010

## Japan

- Adapted marine laws



# Regulatory lessons learnt

## Regulatory principles for CCS to ensure environmental integrity:

- Site-by-site assessment
- Risk assessment
- Site characterisation and simulation, supported by monitoring
- CO<sub>2</sub> stream impurities determined by impacts on integrity

## Development of regulation:

- Use the technical and scientific evidence base
- Learn from existing regulatory developments
- Benefit of having real projects to drive and test regulations



# Future work...



- National legislation and regulation for CCS
- Implementation and permitting
- Long term liability – treatment, criteria, scope, definitions etc
- Transboundary issues
- Monitoring performance – eg quantification of potential leakage, verification of stored CO<sub>2</sub>
- CO<sub>2</sub> purity standards across transmission networks
- And lots more

# Useful information sources



- IEA Regulatory Network <http://www.iea.org/ccs/legal/index.asp>
- (Model Regulatory Framework, Legal Review, Webinars)
- UCL Carbon Capture Legal Programme <http://www.ucl.ac.uk/cclp/>



# ieaghg

