



Carbon Dioxide Capture and Storage - International Legal and Regulatory Developments and Carbon Accounting

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IEA Greenhouse Gas R&D Programme (IEAGHG)

- 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.
- Focus is on carbon dioxide capture and storage



- Why developments started happening
- IPCC GHG Inventory Guidelines
- Marine Conventions
- EU Regulation and ETS
- UNFCCC
- Others
- Regulatory principles and learning
- Unresolved issues
- Other new technologies

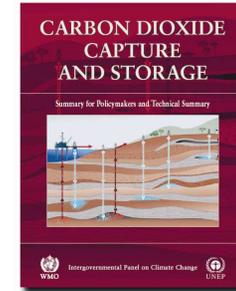
Why developments started happening



Role of CCS in climate change mitigation?

- IPCC Special Report (2005) – CCS contributing 15-55% of CO₂ 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 CO₂ 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 CO₂
- Continuous measurement of CO₂ injected
- Monitoring of injection emissions
- Periodic monitoring of CO₂ distribution
- Monitoring of CO₂ fluxes to surface

- Post-injection monitoring – as above, linked to modelling, may be reduced or discontinued once CO₂ 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 (87 countries)
- Protocol 1996 – ratified March 2006 (42 countries as of Feb 2013)
- How it works:
- Prohibition on dumping of all wastes, except for those listed in Annex 1, which need to be permitted under conditions in Annex 2

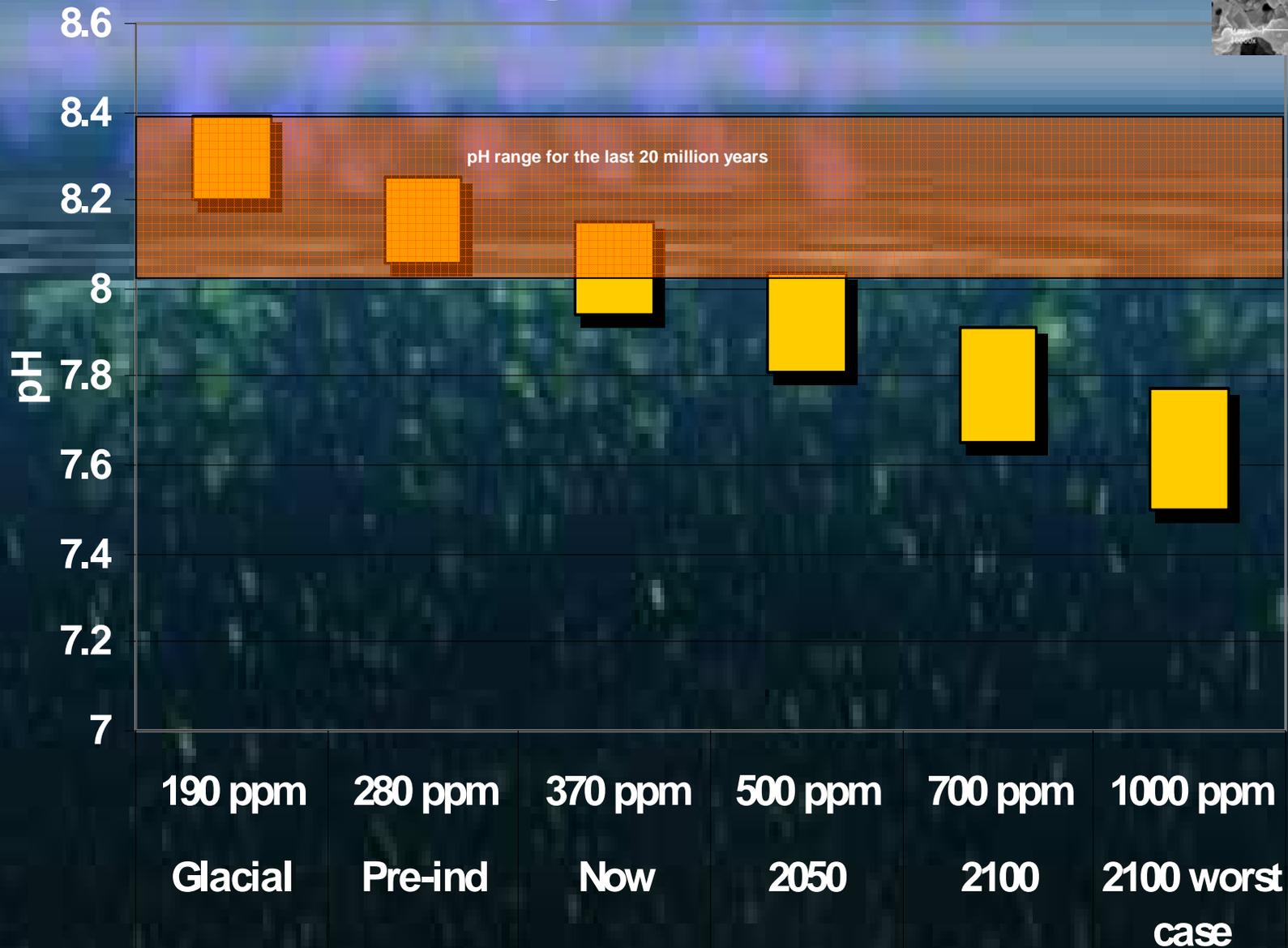
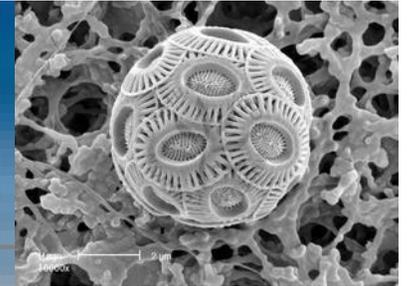
Annex 1: dredged material; sewage sludge; fish waste; vessels and platforms; inert, inorganic geological material; organic material of natural origin; bulky items primarily comprising unarmful materials, from small islands with no access to waste disposal options

London Convention and Protocol and CCS



- Prohibited some CCS project configurations
- CO₂ Geological Storage Assessed by LC Scientific Group 2005/6
- 2006 - Risk Assessment Framework for CO₂
- 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
- CO₂ Specific Guidelines

Simulated and observed marine pH ranges till 2100



PML
2005

London Protocol Amendment



Allowed to dispose of “ CO2 streams from CO2 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 – CO₂ Specific Guidelines



”the CO₂ stream, consisting of:

- 1. CO₂;*
- 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 CO₂ 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.

LP 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 CO₂ for geological storage**
- 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 CO₂ 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.***
- To come into force needs ratification by two thirds all Parties (27)

London Convention

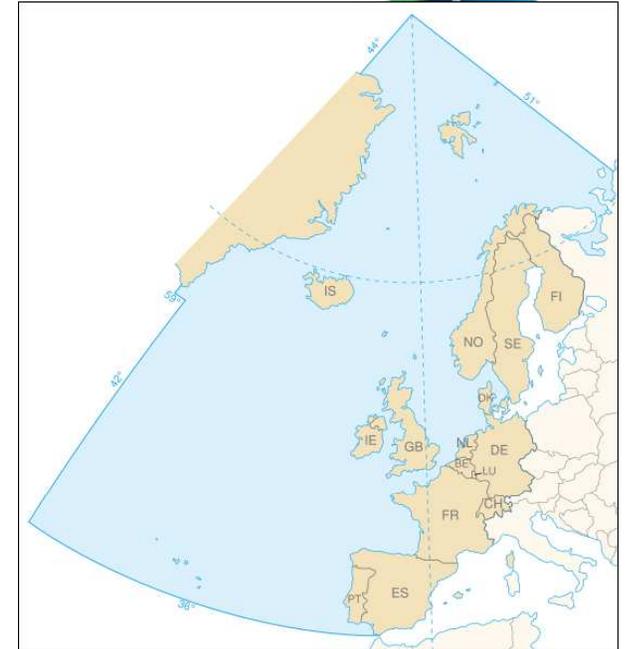


- Transboundary amendment in 2009 to allow CO₂ export. Needs 27 countries to ratify to come into force. Only 2 so far, 2 more on way.
- Work ongoing to revise the Specific Guidelines to take into account transboundary activities (export and migration)
- Stalled in 2011. Progress made in SG-35 (May 2012). WG chaired by Korea. IEA participated. 2 new documents:
 - Revised CO₂ Specific Guidelines prepared covering subsurface transboundary migration
 - Draft guidelines prepared for "Development and implementation of arrangements or agreements for export" – separating out permitting responsibilities and standards from Specific Guidelines
- **Revised CO₂ Specific Guidelines approved and adopted at LC-34, Oct 29, London**
- **Transboundary storage offshore now possible**
- Ongoing work on 'arrangements or agreements for export' guidelines

OSPAR



- Marine Convention for NE Atlantic, 1992
- 15 nations and EC
- Prohibited some CCS configurations
- Considered CCS and CO2 impacts
- To allow prohibited CCS configurations:
- Amendments (to Annexes II and III) for CO2 storage adopted June 2007
- Needed ratification by 7 Parties (8 ratified as of Oct 2011)
- **Amendments came into force July 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 CO2 in Geological Formations – includes the Framework for Risk Assessment and Management (FRAM)
- OSPAR Decision to prohibit ocean storage

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



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

CCS Directive (and ETS Directive) drafts launched 23 Jan 2008

Agreed 12 Dec 2008 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
- CO₂ stream acceptance criteria - “overwhelmingly CO₂” – 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 to transpose in 2yrs, by Jun 2011 (8 have as of Feb 2012)**
- Review Directive in 2015 – include mandatory Emissions Performance Standards?

EC Guidance Documents



Issued May 2011

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

http://ec.europa.eu/clima/policies/lowcarbon/ccs/implementation/documentation_en.htm

EU Emissions Trading Scheme



- **EU ETS ‘Cap-and-trade’ scheme. Phase I from 2005 – 2007. Phase II 2008-2012. Phase III 2013-2020**
Phase II - CCS via Article 24 ‘Opt-in’
- **New ETS Directive June 2009 - to strengthen, expand and improve the ETS from 2013.**
- CCS fully included from 2013
 - Site and operation will need to comply with CCS Directive
- 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 ?

UNFCCC and CCS



Six negotiating bodies relevant to CCS:

UNFCCC:

- COP – Conference of the Parties to the UNFCCC (194 Parties)
- AWG-LCA – Ad Hoc Working Group on Long-term Cooperative Action
- ADP – Ad Hoc Working Group Durban Platform for Enhanced Action

Kyoto Protocol:

- CMP – Conference of the Parties serving as a Meeting of the Parties to the Kyoto Protocol (192 Parties, 37 ‘developed’ countries)
- 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 1st 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 CO₂ 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/COP16 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 consensus to progress

CMP7/COP16, 2010, 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 develop new “Modalities and Procedures” which address the issues

Work programme for 2011:

- Submissions and ‘Synthesis report’
- Technical workshop (technical and legal expertise)
- UNFCCC to draft Modalities and Procedures for SBSTA 35 (Durban Dec 2011)
- IEAGHG: Research Networks addressed Cancun issues

Technical Workshop 2011



Abu Dhabi 7-8 Sep 2011

- Brought technical expertise to negotiators
- Technical experts on site selection; modelling; accounting; project boundaries; transboundary; risk assessment; environmental impacts; monitoring; liability (28 talks, several members of IEAGHG Networks).
- Results and experiences from real projects and natural systems, to support modelling and risk assessments
- Good Q&As from CCS negotiators and others



Courtesy H.Olson, BEG, UT

Technical Workshop 2011



Abu Dhabi 7-8 Sep 2011

Outcomes:

- Number of issues of concern shrunk considerably
- Liability remained as genuine concern – part technical, part policy issue
- UNFCCC produced draft Modalities and Procedures (M&Ps) drawing upon workshop and synthesis report, 20 pages of detail, the basis for negotiations in Durban



CMP7/COP17 Durban, Negotiations on CCS CDM



- Over 32 hours of formal negotiations





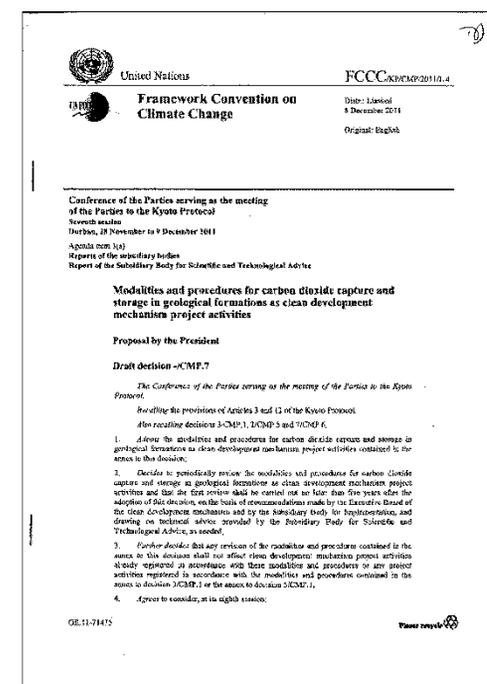
CCS in COP-17, Durban

Decision CMP#.7 (final draft was FCCC/KP/CMP/2011/L.4)

- **Agreed and adopted CCS Modalities and Procedures**
- Review within 5 years
- Transboundary left to resolve

Two unresolved issues:

- Transboundary CCS
- Global reserve of CERs
- Consideration by SBSTA, draft decision to CMP-8
- **CMP-8 Doha - both 'parked' until SBSTA 45 (2016)**



Modalities & Procedures for CCS in CDM



CDM Modalities and Procedures (M&Ps)

- Apply mutatis mutandis (use existing as much as possible) with the addition of the CCS-specific M&Ps

Definitions:

- Seepage – transfer of CO₂ ultimately to atmosphere or ocean
- Net reversal of storage – seepage exceeds emission reductions during operational period, or seepage after project close



M&Ps - Requirements



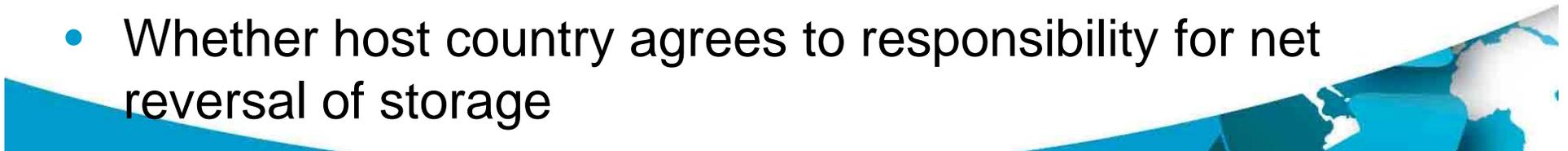
DOEs – CCS expertise

Participation Requirements

- Host to establish regulations to control and permit CCS. To include site selection and characterisation, storage rights, redress for affected entities, remediation, liability.

Validation by DOEs

- Site characterisation, risk and safety assessment, environmental and socio-economic assessment, liability provisions, financial provision.
- Host country has to agree to financial provision and liability
- Whether host country agrees to responsibility for net reversal of storage



M&Ps - Liability



- **Treatment of local liability** - *health, safety, environmental impacts*
 - Participation requirement; host party establish national laws and regulations that address local liability
- Liable entity identified for each phase of project lifecycle
 - Project participants liable from operation phase until transfer of liability
 - Transfer of liability to host party after monitoring period ends (20 yrs after crediting period)
- **Treatment of climate liability** - *obligations to surrender allowances for "net reversal of storage"*
 - Any CO₂ seepage results in retirement of credits equivalent to seepage emissions
 - Host party has 2 options;
 - Ultimate responsibility resides with the host party
 - Ultimate responsibility resides with developed country using the credits, i.e. a buyer liability.

M&Ps – Provisions



- **Financial provisions**

- Project participants establish financial provision ahead of project proceeding
- Host party agrees to the financial provision
 - Appears to provide the flexibility to choose the most appropriate instruments

- **CER Reserve Account**

- 5% of issued CERs held in reserve account for the purpose of accounting for “net reversal of storage”
- CERs released once the last certification report has been received, i.e. at least 20 years after crediting period



M&Ps – Project Closure



- CDM project closure when monitoring stops
- Monitoring stops when:
 - Not less than 20 years after last CDM crediting period
 - No seepage observed in previous 10 years
 - All available evidence from observations and modelling indicates CO₂ will be completely isolated from the atmosphere in the long-term
 - History matching of modelling and monitoring
 - Modelling confirms no future seepage expected
- Enables transfer of liability to host party
- Enables final certification report, which triggers release of CERs from Reserve Account to project participants



Significance of CCS M&Ps from Durban



- **Allows CCS to be CDM project activity and earn CERs**
- Create incentives / signal for CCS in developing countries
 - ▶ CDM key international mechanism supporting low-C technology in developing countries
- Legitimises CCS as valid technology for developing countries
- Establishes precedence-setting regulatory framework for CCS funded under international mechanisms



Durban Platform for Enhanced Action



- **New negotiating process established (AWG on the Durban Platform for Enhanced Action);**
- Recognises that current emission pledges inadequate $<2^{\circ}\text{C}$
- Process to develop “protocol, another legal instrument or outcome...with legal force” for all Parties
- Timeline;
 - ▶ Process to completed no later than 2015
 - ▶ Implemented by 2020



courtesy of IISD/Earth
Negotiations Bulletin

Durban COP17/CMP7 and Doha COP18/CMP8 Outcomes



- **AWG KP: Parties agreed to have Kyoto Protocol 2nd Commitment period**
 - 2nd Commitment period commences 1st January 2013 and ends 31 December 2020
 - Continued project-based mechanisms (CDM)
- **AWG LCA:**
- New Market Mechanism to be developed
- Technology Mechanism
- Green Climate Fund



courtesy of
IISD/Earth
Negotiations Bulletin

Regulatory lessons learnt from CCS



Regulatory principles for CCS to ensure environmental integrity:

- Site-by-site assessment
- Risk assessment
- Site characterisation and simulation, supported by monitoring
- CO₂ 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 for CCS...



- 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 CO₂
- CO₂ purity standards across transmission networks
- And lots more

Unresolved issue – Transboundary CCS



- **London Convention and Protocol**
- Transboundary amendment (2009) to allow CO₂ export. Needs 27 countries to ratify to come into force. Only 2 so far, 2 more on way.
- IEA legal report on Options for Enabling Transboundary CO₂ Transfer before LP amendment ratification, using *1969 Vienna Convention on the Law of Treaties* :
 - Option 1: Interpretative resolution
 - Option 2: Provisional application
 - Option 3: Subsequent agreement through an additional treaty
 - Option 4: Modification of the operation of relevant aspects of the London Protocol as between two or more contracting parties
 - Option 5: Suspension of the operation of relevant aspects of the London Protocol as between two or more contracting parties
 - Option 6: Conducting CCS through non-contracting parties

Transboundary CCS

UNFCCC



- *Durban left two unresolved issues:*
 - Transboundary CCS activities
 - Global Reserve of CERs (credits)
- *SBSTA-36 Bonn (May 2012) – some progress on Transboundary, no progress on Global Reserve*
 - UNFCCC administration processes in place for projects to apply
 - Technical paper by UNFCCC on transboundary and Global Res
 - Submissions – Australia and EU
- *CDM Executive Board's Working Group on CCS established*
- *COP-18/CMP-8/SBSTA-37 at Doha (Nov 26-Dec 8) – to consider with a view to a decision at CMP8.*

Transboundary CCS UNFCCC



UNFCCC Technical Paper 'Transboundary CCS Project Activities' TP/2012/9

- Relevant international frameworks
- Scenarios
 - Capture in A and storage in B
 - Capture in A and storage in A and B
 - Capture in A and B and storage in A and B
 - Capture in A, transport through C, storage in B
- *Doesn't cover*
 - *Capture in A and storage in A and unintentional migration into B and seepage in B (IPCC Scenario 2)*
 - *Capture in A and storage in A and unintentional migration into international waters (and seepage in B) – CBD Geoengineering*
 - *London Convention 2012 LC34 outcomes*

Transboundary CCS UNFCCC



- SBSTA 37, Doha 2012
- SBSTA/2012/ L.21
- “The SBSTA agreed to recommend to CMP that the issue of eligibility of transboundary CCS project activities under the CDM and the establishment of a global reserve of certified emission reduction units for CCS project activities be considered by the SBSTA at its forty-fifth session.
- The SBSTA also agreed that while transboundary CCS project activities would merit inclusion under the CDM, more practical experience of CCS project activities in the CDM would be beneficial.”



Other new technologies...?



Ocean Fertilisation and other Geo-engineering in the London Convention and Protocol



- Ocean fertilization: the intentional introduction of nutrients such as iron to the ocean to stimulate phytoplankton. Iron is often the limiting nutrient for their growth. Phytoplankton growth results in increased CO₂ removal from the atmosphere for their photosynthesis.
- Geo-engineering: Marine geo-engineering means a deliberate intervention in the marine environment with the purpose of manipulating natural processes, including to counteract anthropogenic climate change and/or its impacts, and that has the potential for widespread, long-lasting or severe effects.

Ocean Fertilisation and other Geo-engineering in the London Convention and Protocol



- 2007. Consideration by the LC Scientific Group – statement of concern “*knowledge about the effectiveness and potential environmental impactswas insufficient to justify large-scale operations*”
- 2008 **Ocean Fertilisation Resolution** “*given the present state of knowledge, ocean fertilization activities other than legitimate scientific research should not be allowed*”
- 2010. Developed an ‘**Assessment Framework**’ (2010) under which scientific research could be permitted
- 2012. “*The Parties... express grave concern regarding the deliberate ocean fertilization activity that was recently reported to have been carried out in July of 2012 in waters off the Canadian west coast. This activity, involved the deliberate introduction into surface waters of 100 metric tonnes of iron sulfate. The Parties recognize the actions of the Government of Canada in investigating this incident.*”
- 2012. Considering expanding to regulation of all marine geo-engineering activities – Option proposed, ongoing

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/> and <http://www.globalccsinstitute.com/networks/cclp>
- UNFCCC Durban
http://unfccc.int/meetings/durban_nov_2011/meeting/6245.php
- UNFCCC Doha
<http://unfccc.int/2860.php#decisions>
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Thank you