Current States of Legislation and Regulation on CCS

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IEAGHG

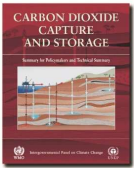
CCS Technical Workshop
Tokyo
16 January 2019

Why regulatory 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

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 (50 countries as of Oct 2018)
- Annual Meeting of the Contracted Parties. Annual meeting of Scientific Group.

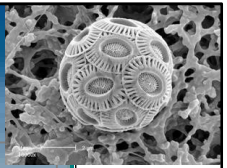
- How it works:
- Prohibition on dumping of all wastes, except for those listed in Annex 1, which need to be permitted under conditions in Annex 2.

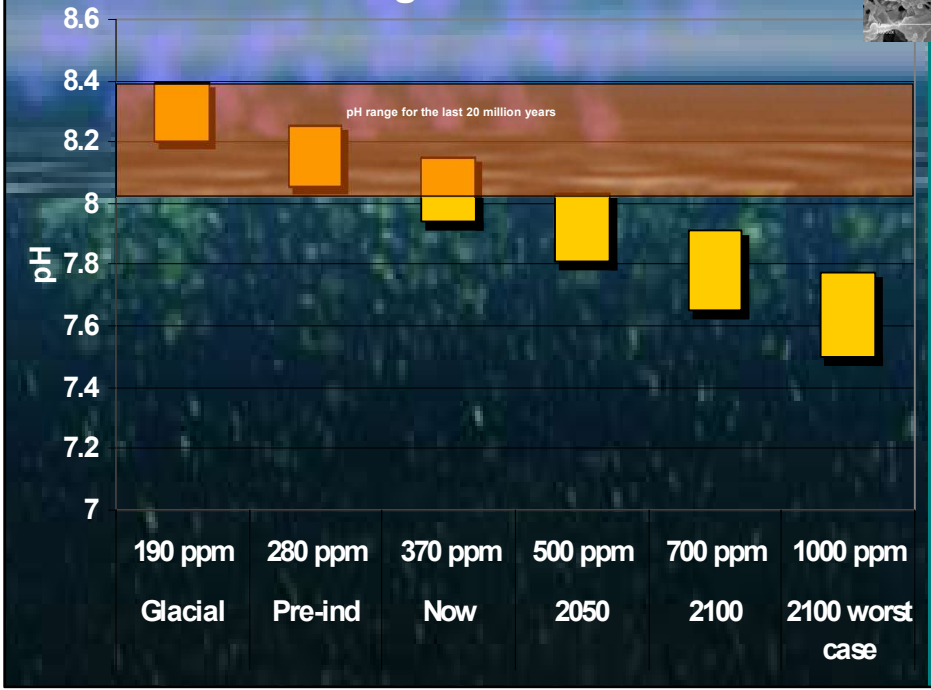
- Annex 1: dredged material; sewage sludge; fish waste; vessels and platforms; inert, inorganic geological material; organic material of natural origin; bulky items primarily comprising unharmful materials, from small islands with no access to waste disposal options

London Convention and Protocol and CCS

- Prohibited some CCS project configurations
- CO_2 Geological Storage Assessed by LC Scientific Group 2005/6
- 2006 - Risk Assessment Framework for CO_2
- **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_2 Specific Guidelines (2007)

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 – CO_2 Specific Guidelines

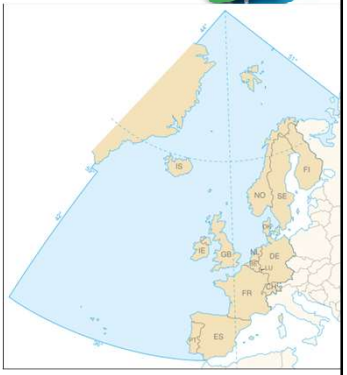
- "the CO2 stream, consisting of:
  1. *CO2;*
  2. *incidental associated substances derived from the source material and the capture and sequestration processes used:*
     - *.1 source- and process-derived substances; and*
     - *.2 added substances (i.e. substances added to the CO2 stream to enable 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.

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

In order to receive a permit must demonstrate:

- 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

London Protocol Transboundary

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."

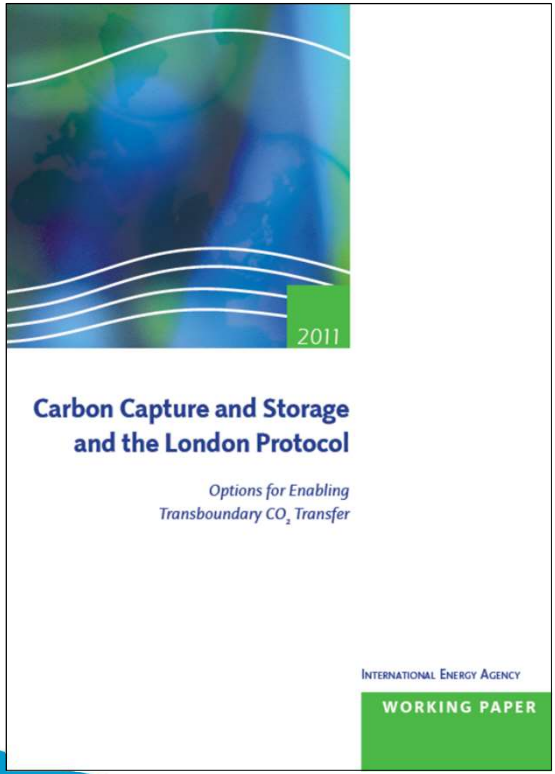
- Prohibits transboundary transport of CO_2 for geological storage
- 2009 LP4 (30 Oct) - Amendment to allow CO_2 for storage was adopted by vote.
- Article 6 , new para 2 : 'Export of CO_2 for disposal in accordance with Annex 1 may occur, provided an agreement or arrangement has been entered into by 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
- Transboundary movement of CO_2 streams after injection is not export in the sense of article 6, of the London Protocol.

London Protocol Transboundary

2018 Update

- 2012 - Revised CO_2 Specific Guidelines approved and adopted at LC-34,Oct29, London. Covering subsurface transboundary migration. Transboundary storage offshore now possible
- Transboundary movement of CO_2 streams after injection is not export in the sense of article 6, of the London Protocol
- 2013 - New 'Guidance on Export of CO_2 Streams for Disposal' approved to cover responsibilities for 'arrangements or agreements' for export
- All safeguards are now in place for transboundary CCS activity in the marine environment, including export.
- **But – 2009 Transboundary amendment for CO_2 export needs 33 countries to ratify in order to come into force. Only 5 so far (Norway, UK, NL, Iran, Finland), 1-2 more on way (Canada leading)**
- So export of CO_2 still not permitted for offshore storage

- Mr. Koji Sekimizu, Secretary-General of the International Maritime Organization, at the 2012 Annual Meeting (40th Anniversary of the London Convention)
- **"*The London Protocol currently is also the only global framework to regulate carbon capture and sequestration in sub-seabed geological formations……. However, it remains a serious concern that, to date, only two of the 43 London Protocol Parties have accepted the 2009 amendment, which is a long way from satisfying the entry-into-force requirements. The importance of securing its entry into force cannot be over-emphasized, if the threat of acidification of the oceans from climate change is to be minimized."***



Options:

1. Interpretative resolution
2. Provisional application
3. Subsequent agreement through an additional treaty
4. Modification of the operation of relevant aspects of the London Protocol between two or more contracting parties
5. Suspension of the operation of relevant aspects of the London Protocol between two or more contracting parties
6. Conducting CCS through non-contracting parties

IEA 2011

EU CCS Directive (1)

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

Enabling regulatory framework to ensure environmentally sound CCS

- Permits will be required for CCS – exploration and storage
- Follows IPCC GHG Guidelines and OSPAR
- Objective is permanent storage
- Ocean storage prohibited
- 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

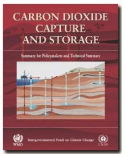
EU CCS Directive (2)

- After closure, responsibilities transfer to competent authority "when evidence indicates completely and permanently contained" and >20 yrs. **Evidence: conformity of monitored behaviour with modelled; absence of detectable leakage; evolving towards long-term stability.** Monitoring will continue but reduced to detect irregularities .
- Financial security – to Competent Authority to cover long-term monitoring for 30 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.
- Removes barriers in other Directives –Waste, Water, EIA, ELD, LCPD - Capture-ready
- **Reviewed in 2014 – Fit for Purpose**, no revisions, update Guidance Documents

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 installations
- If any leakage – surrender of allowances
- If leakage from storage suspected from monitoring under CCS Directive, then trigger ETS monitoring to quantify
- Monitoring and Reporting Guidelines for CCS
- Biomass and CCS ?

CCS in UNFCCC



- **2005 - IPCC SR on CCS**
- 2005– 2011 CCS in CDM?

- 2011 – CCS CDM Abu Dhabi workshop
- **2011 - COP-17 CCS in CDM**

- 2014 - ADP TEM on CCS – project focussed
- 2014 - COP-20 – CCS projects Side Event
- 2015 - COP-21 – CCS projects Side Event
- 2016 – COP-22 – CCS in Africa Side Event
- 2017 – COP-23 – CCS, Oceans and SIDS

Kyoto Protocol and CCS

- 2008 - 2012 (KP 1st Period)
- 2013 - 2020 (KP 2nd Period)
  - Developed country emission commitments
    - CCS included in KP Art 2.1
    - IPCC GHG Guidelines 2006 allows CCS to be reported
  - Clean Development Mechanism (CDM) – Policy mechanism for rewarding CO2 reduction in developing countries. Project-based carbon credits.
  - > 7,500 projects, 1,500 CERs (Mt CO2e)

Technical Workshop 2011

Abu Dhabi 7-8 Sep 2011

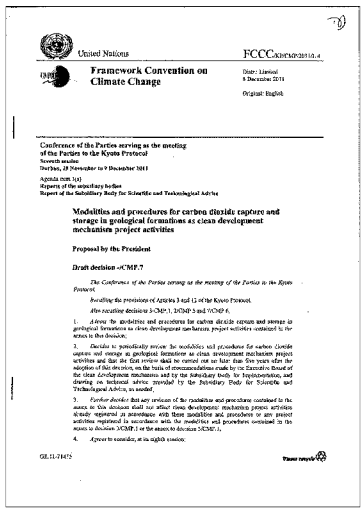
- Brought technical expertise to negotiators
- Technical experts on site selection; modelling; accounting; project boundaries; transboundary; risk assessment; environmental impacts; monitoring; liability (28 talks, several members of IEAGHG Networks).
- Results and experiences from real projects and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

Courtesy H.Olson, BEG, UT

CCS in COP-17, Durban

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

- **Agreed and adopted CCS Modalities and Procedures**



United Nations FCCC/KP/CMP/2011/L.4

Framework Convention on Climate Change

Date: 11revised 8 December 2011

Original: English

Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
Seventh session
Durban, 28 November to 9 December 2011

Agenda item 5(a)
Reports of the subsidiary bodies
Report of the Subsidiary Body for Scientific and Technological Advice

Modalities and procedures for carbon dioxide capture and storage in geological formations as clean development mechanism project activities

Proposal by the President

Draft decision -/CMP.7

The Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol,

Recalling the provisions of Articles 3 and 12 of the Kyoto Protocol,

Also recalling decisions 3/CMP.1, 2/CMP.3 and 9/CMP.6,

1. *Agrees* to modalities and procedures for carbon dioxide capture and storage in geological formations as clean development mechanism project activities contained in the annex to this decision;

2. *Decides* to periodically review the modalities and procedures for carbon dioxide capture and storage in geological formations as clean development mechanism project activities and that the first review shall be carried out no later than five years after the adoption of this decision, on the basis of recommendations made by the Executive Board of the clean development mechanism and by the subsidiary body for implementation, and drawing on technical advice provided by the Subsidiary Body for Scientific and Technological Advice, as needed;

3. *Further decides* that any revision of the modalities and procedures contained in the annex to this decision shall not affect clean development mechanism project activities already registered in accordance with those modalities and procedures or any project activities registered in accordance with the modalities and procedures contained in the annex to decision 3/CMP.1 or the annex to decision 2/CMP.3;

4. *Agrees* to consider, at its eighth session,

GE.11-71475

Please recycle

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 CO_2 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 – 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

US EPA Storage Regulation

- Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells – Final Rule
- Federal Register Vol. 75, No. 237 p77230. Dec 10, 2010

- Applies to wells to inject CO_2 for the purpose of long-term storage.
- Purpose of protecting underground sources of drinking water (USDWs).
- Establishes a new class of well for CCS, **Class VI**

- (Experimental use Class V, EOR and EGR use Class II)

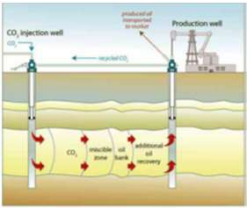
US EPA - Class VI

- Sets minimum technical criteria for:
  - Permitting
  - Geologic site characterization,
  - Area of review (AoR) – determined by pressure front, update every 5 years
  - Corrective action
  - Financial responsibility
  - Well construction, operation, mechanical integrity testing
  - Monitoring – monitoring plan reviewed every 5 years, to include CO_2 stream composition, well integrity, ground water quality, pressure, plume tracking, possible surface monitoring
  - Well plugging
  - Post injection site care (PISC), Site closure
  - PISC and monitoring for 50 years (unless alternative timescale approved based on non-endangerment to USDWs)

US EPA - GHG Emissions

- Mandatory Reporting of Greenhouse Gases: Injection and Geologic Sequestration of Carbon Dioxide - Final Rule
- Federal Register Vol. 75, p75060. Dec 1, 2010.
- Requirement to report GHG data to EPA annually
- Subpart RR - for geologic sequestration.
  - to develop and implement an EPA-approved site-specific monitoring, reporting and verification plan
  - to quantify and report the amount of CO_2 sequestered
  - to detect, quantify and report emissions from subsurface
  - This rule is complementary to and builds on UIC requirements.
- Subpart UU - requires GHG reporting from all other facilities that inject CO_2 underground for any reason, including EOR and EGR

US: Transition from CO_2-EOR to CO_2 Storage



Issues:

- Site characterization and CO_2 modelling
- Storage risk assessment – EOR has 1000s of wells
- Monitoring baseline measurements

➢ all required in advance for storage projects but not for CO_2-EOR projects

- Pore space access/ownership/leasing (which may end at the end of EOR operations)
- Additional monitoring to demonstrate storage permanence
- Post-closure monitoring and liability issues

Ref: EPA Memo 2015, CCP4 2016, SCCS Haszeldine 2015, CSLF 2017

ISO TC 265 - CCS

- Proposed by Canada. Technical Committee TC265 was approved by ISO members in 2011. Canadian Chair, Canada and China Secretariat. 16 participating countries, 11 observer countries, 6 Liaison orgs.
- Objective: **to prepare standards for the design, construction, operation, environmental planning and management, risk management, quantification, monitoring and verification, and related activities in CO2 capture, transportation, and geological storage.**
- Excluded: ocean storage of CO_2 by direct injection; mineral carbonation storage; industrial uses of CO_2 not related to CCS; and legal liability and permitting.

TC265 Working Groups and Outputs

- WG 1 Capture – Japan
- WG 2 Transport – Germany
- WG 3 Storage - Canada and Japan
- WG 4 Quantification and Verification – China and France
- WG 5 Cross-cutting issues – France and China
- WG 6 CO2-EOR – USA and Norway

Published ISO Standards on:

- Pipeline transport (ISO 27913:2016);
- Geological storage (ISO 27914:2017);
- Vocabulary (ISO 27917:2017)
- (4 more under development)

Published TR reports on:

- Capture systems (ISO 27912:2016);
- Quantification and verification (ISO 27915:20167)
- (2 more under development)

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
- CO_2 stream impurities determined by impacts on integrity

Development and application of regulation:

- Use the technical and scientific evidence base
- Learn from previous regulatory developments
- Benefit of having real projects to drive and test regulations
- Good communication between project and regulators, starting early as possible
- Be flexible in application of regulations so as to learn from doing and adapt to developments
- MMV plans should be risk-based and adaptive

ADM CCS Projects

- Archer Daniels Midland, Decatur, Illinois. Storage in Deep Saline Formation
- IBDP (0.3Mt pa from 2011)
  - Class I (2011), then Class VI (2014) – 10 year PISC, AoR 2 miles radius
- ICCS project (1Mt pa from 2017)
  - Class VI (2014) – 10 year PISC, AoR 2 miles radius
  - Subpart RR for GHG reporting (2017) – similar MRV as for Class VI

Shell's Quest CCS project

- **Quest, Shell, Alberta, Canada**
- H_2 Refining
- 1Mt CO_2 pa to DSF storage from 2015

- No CCS-specific regulation in place at outset
- Project worked in collaboration with regulators
- Alberta Energy Regulator Directive 65 "Application for a CO2 acid gas storage scheme"
- Carbon Sequestration Tenure Regulation requirements (only in existence 2011).
- MMV plan: to address D65 approval and Carbon Sequestration Tenure Regulation requirements. MMV plan for the operational phase submitted in January 2015 and approved in March 2015. Revisions - latest MMV plan was submitted in February 2017 and approved in May 2017.
- Post-injection site closure activities to last approx. 10 years – then transfer liability to Gov of Alberta
- Alberta Emission Offset System provides carbon credits

Sleipner and Snovit

- Sleipner 1Mt pa from offshore gas production processing to DSF since 1996
- Snovit 07Mt from LNG to offshore DSF since 2008

- Regulated under Norwegian Petroleum Law
- Re-permitted under EU CCS Directive 2016
- Existing MMV plan was sufficient
- Post-injection plan covred under Petroleum decommissioning plan

Sleipner
1Mt/y CO_2

Snohvit
0.7Mt/y CO_2

ROAD Project Storage Site

- P18-4 field - near-depleted gas field located approximately 20 km off the Dutch coast in the North Sea, originally proposed for ROAD project storage.
- Operator applied for a CO_2 storage permit to the Dutch authorities in 2011.
- EC gave positive 'Opinion' in Feb 2012.
- Storage permit for P18-4 was approved in September 2013.

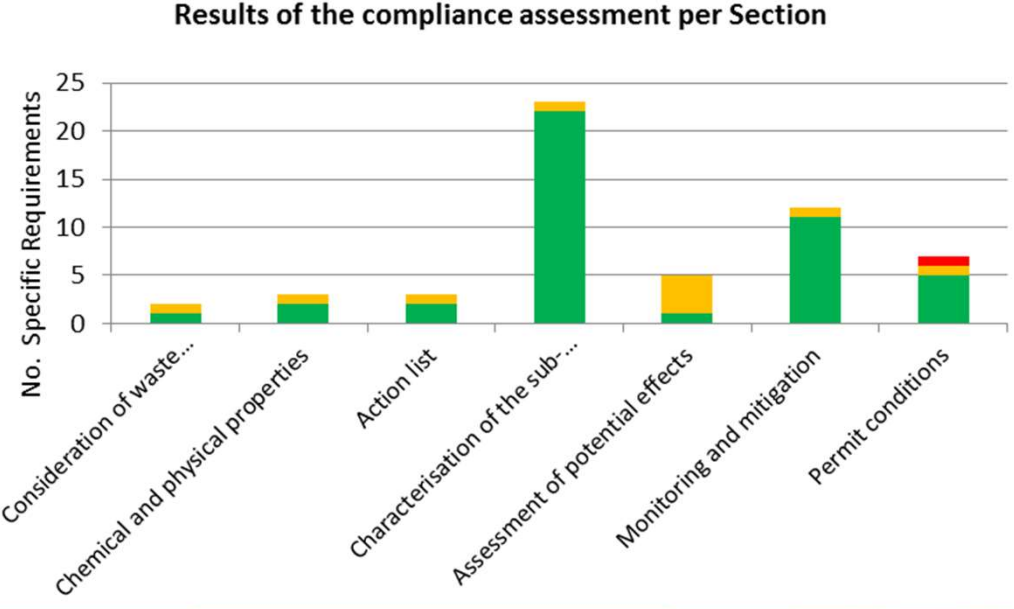
- However the project was postponed indefinitely due to economic constraints.

Comparison with London Protocol requirements

- EU CCS Directive ⇐ OSPAR CCS Amendment ⇐ London Protocol
- Objective: to assess to what extent the permit application complies with the London Protocol's 2012 Specific Guidelines, and therefore the 1996 London Protocol itself.
- Systematic cross-check of the 56 requirements of the Specific Guidelines against the contents of the application material provided by the operator to the National Authority. Approximately 1100 pages of material (some in Dutch).

CO_2 Specific Guidelines

- Around 56 requirements - generally qualitative rather than quantitative in nature:
  - Waste prevention audit / Waste management options
  - Chemical and physical properties (of CO_2 stream)
  - Action list (substances not allowed in CO_2 stream)
  - Site selection and characterisation
    - Characterization of the sub-seabed geological formation
    - Characterization of the marine area
    - Evaluation of potential exposure
  - Assessment of potential effects
    - Evaluation of potential effects
    - Risk assessment
    - **Impact hypothesis**
  - Monitoring and risk management
    - Monitoring and risk management
    - Mitigation or remediation plan
  - Permit and permit conditions


Results of the compliance assessment per Section
No. Specific Requirements
25
20
15
10
5
0
Consideration of waste...
Chemical and physical properties
Action list
Characterisation of the sub-...
Assessment of potential effects
Monitoring and mitigation
Permit conditions

Compliance – Partial

Para	Specific Guideline requirements	Evaluation
3.2.2	other disposal and/or sequestration options, e.g. land-based underground storage.	
4.2.3	toxicity, persistence, potential for bio-accumulation	
5.2	Development of a screening tool to assess the acceptability of CO_2 streams for disposal, based on the presence of incidental substances	
6.2.9	economic and operational feasibility	
7.6	Evaluation of potential effects on human health, living resources, amenities and other legitimate uses of the sea.	
7.8.1	Magnitude to which the release increase the concentration of the substance in the seawater, sediments or biota	
7.8.2	The degree to which the substance can produce adverse effects on the marine environment or human health	
7.11	Development of an impact hypothesis	
8.7.4	Monitoring marine communities (benthic and water column) to detect effects of CO_2 leakage	
9.2	Opportunities are provided for public review and participation	
9.4	Permits should be reviewed at regular intervals	

Recommendations in report

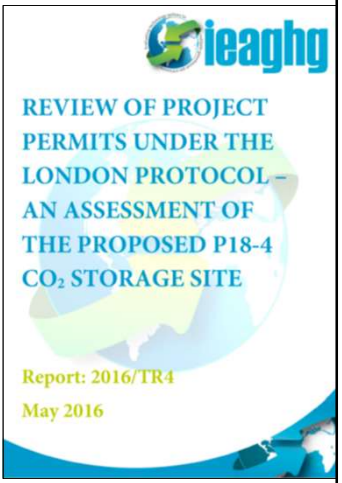
Recommendations to the National Authority

- A brief summary of conformance with the requirements of the 1996 London Protocol to be included in permit conditions.
- Applicant should be asked to provide information on effects of CO_2 leakage on the marine environment. Can be based on the outcomes of the risk assessment and/or from pre-existing information from a similarly indicative area.
- The applicant should be asked explicitly to conclude with an "Impact Hypothesis"
- If it has been decided not to develop an Action List this should be explicitly mentioned as part of the LP compliance summary recommended above.
- The National Authority should ensure that fixed intervals for permit review are explicitly mentioned in the permit conditions.

- **Recommendations to the London Protocol**
- Clarification on the economic and operational feasibility aspects in site-selection .
- Clarification could be sought on the extent and nature of public participation recommended.

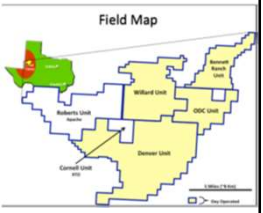
Conclusions

- Material submitted to National Authority was broadly sufficient to allow compliance assessment
- Compliance assessment indicates overall technical compliance with the CO2 Specific Guidelines
- Overall, this exercise demonstrated that the requirements of the CO_2 Specific Guidelines are relevant and achievable by national regulators and CCS projects, and that transparency of compliance assessment is possible in ensuring the protection of the marine environment.



CO_2-EOR Monitoring in USA

- Occidental's Denver Unit (Texas) CO_2 MRV Plan approved by EPA under Subpart RR (GHG reporting) (approved 2015)
- Using existing EOR infrastructure and injection pressure monitoring with additional data management for monitoring CO_2 behaviour
- H2S sensors and visual inspection for leakage detection
- Processed gases are metered
- Post-period reporting 2-3 years

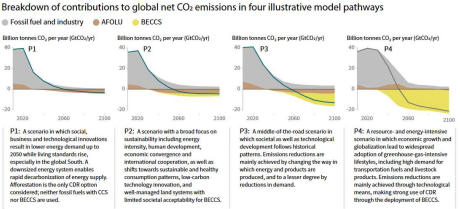


Similar EPA Subpart RR approvals for:

- Occidental's Hobbs Field, New Mexico (2017)
- Exxon's Shute Creek, Wyoming (2018)
- Core Energy's Northern Niagaran Pinnacle Reef, Michigan (2018)
- in context of Subpart RR MRV being discussed/proposed for 45Q proof of secure storage

IPCC 1.5 Special Report

- Impacts and pathways to achieving 1.5C by 2100, in context of increasing global response, sustainable development and poverty



- **"Removing BECCS and CCS from the portfolio of available options significantly raises mitigation costs."** (Chp 4.3)
- IEAGHG Note: IAMs typically assume Capture rate of 90% - this is a limiting factor for CCS deployment from IAMs later this century. Can be increased to 99% cost increase only ~ 5%
  - https://www.ipcc.ch/report/sr15/

Useful information sources and references

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

- Dixon, T, et al. *Legal and Regulatory Developments on CCS*. International Journal of Greenhouse Gas Control 40 (2015) 431–448 (IPCC SR Special Issue)
- Dixon, T, et al. *International Marine Regulation of CO2 Geological Storage*. Elsevier Energy Procedia 1 (2009) 4503-4510
- Dixon, T. et al. *Trials and Tribulations of Getting CCS in an ETS*. Elsevier Energy Procedia 1 (2009) 4443-4450
- Dixon, T. et al. *Getting Science and Technology into International Climate Policy: CCS in the UNFCCC*. Elsevier Energy Procedia 37 (2013) 7590-7595

Thank You

Any questions?

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