

# Transnational CCS Value Chain Developments



**Tim Dixon**

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**2024 FECM / NETL Carbon Management Research Project Review Meeting**

**Pittsburgh**

**6 August 2024**

# Technology Collaboration Programme

by **iea**

## DISCLAIMER

### Who are we?

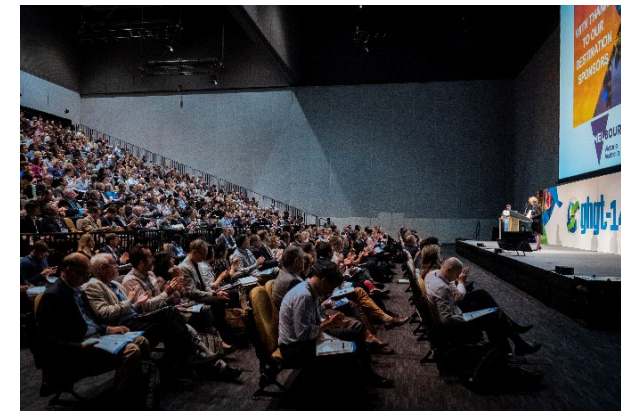
Our internationally recognised name is the IEA Greenhouse Gas R&D Programme (IEAGHG). We are a Technology Collaboration Programme (TCP) and are a part of the International Energy Agency's (IEA's) Energy Technology Network.

### Disclaimer

The IEA Greenhouse Gas R&D Programme (IEAGHG) is organised under the auspices of the International Energy Agency (IEA) but is functionally and legally autonomous. Views, findings and publications of the IEA Greenhouse Gas R&D Programme do not necessarily represent the views or policies of the IEA Secretariat or its individual member countries.



- Established in 1991. 38 Member countries and organisations
- Funds research into development and deployment of CCS technologies
- Technical Reports >400 reports published on all aspects of CCUS
- International Expert Networks: Risk Management; Monitoring; Modelling; Environmental Research; High Temperature Solid Looping; Costs; Social Research; Offshore CCS (with UT)
- Conferences
  - GHGT conferences (the largest global conference on CCS)
    - GHGT16 – 23-27 Oct 2022, Lyon France.
    - **GHGT17 – 20-24 Oct 2024, Calgary**
  - PCCC conferences – PCCC7, NETL Pittsburgh, 25-27 Sep 2023
  - Negative CO<sub>2</sub> Emissions conference – 17-20 June 2024 Oxford
- International CCS Summer Schools





Input to WPFE



United Nations  
Framework Convention on  
Climate Change

UNFCCC CCS Side Events at COP20, 21,  
22, 23, 24, 25, 26, 27, 28



CSLF Technical Group  
IEAGHG inputs



CCUS Initiative  
IEAGHG inputs



London Convention:  
Regular updates on CCS:  
ROAD permit assessment, Offshore workshops  
**CO<sub>2</sub> Export Resolution 2019**

[ieaghg.org](http://ieaghg.org)

## Knowledge Transfer



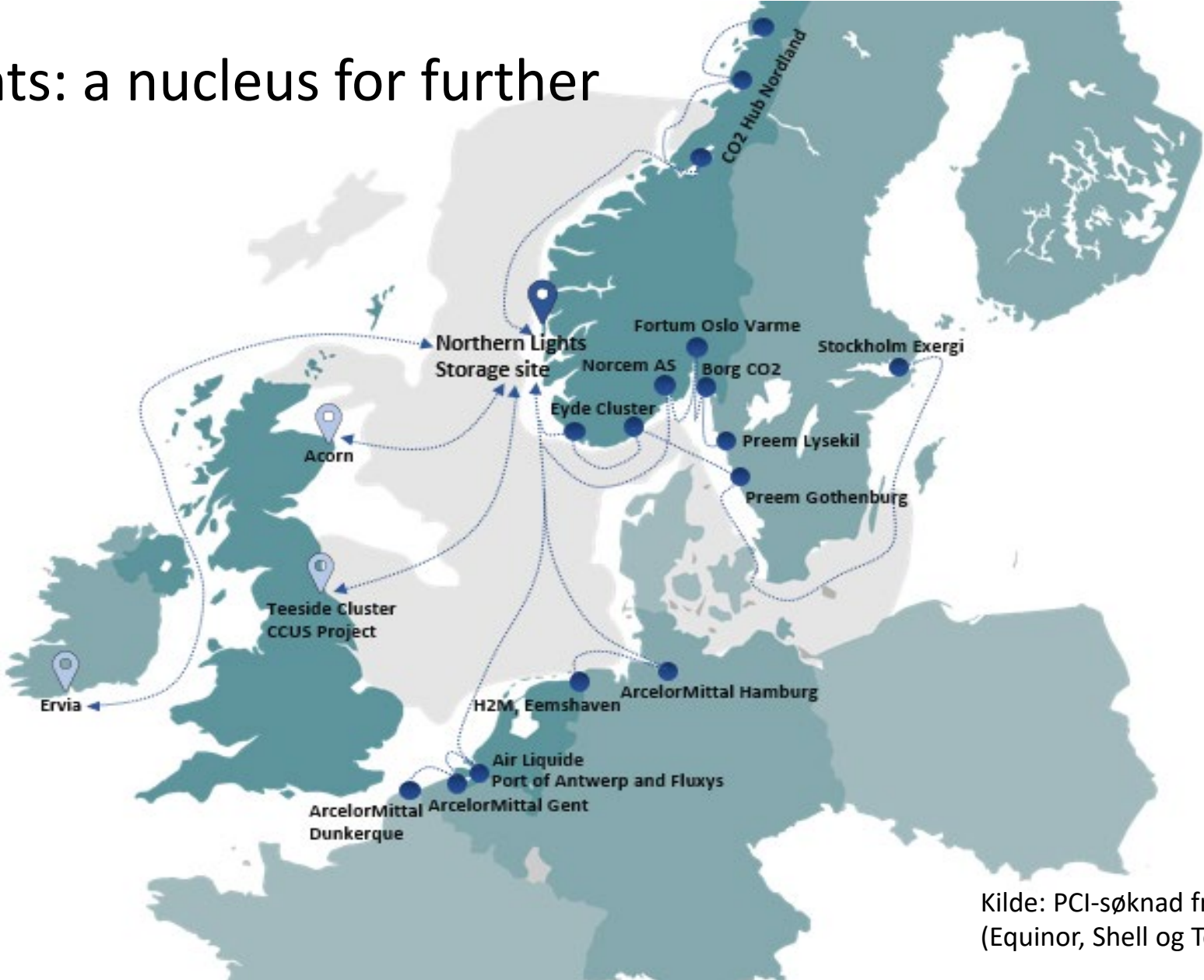
Expert Reviewers,  
Accredited Observer  
**AR6 reviews**  
AR6 – 98 comments  
provided



ISO TC-265  
IEAGHG inputs



# Northern Lights: a nucleus for further growth

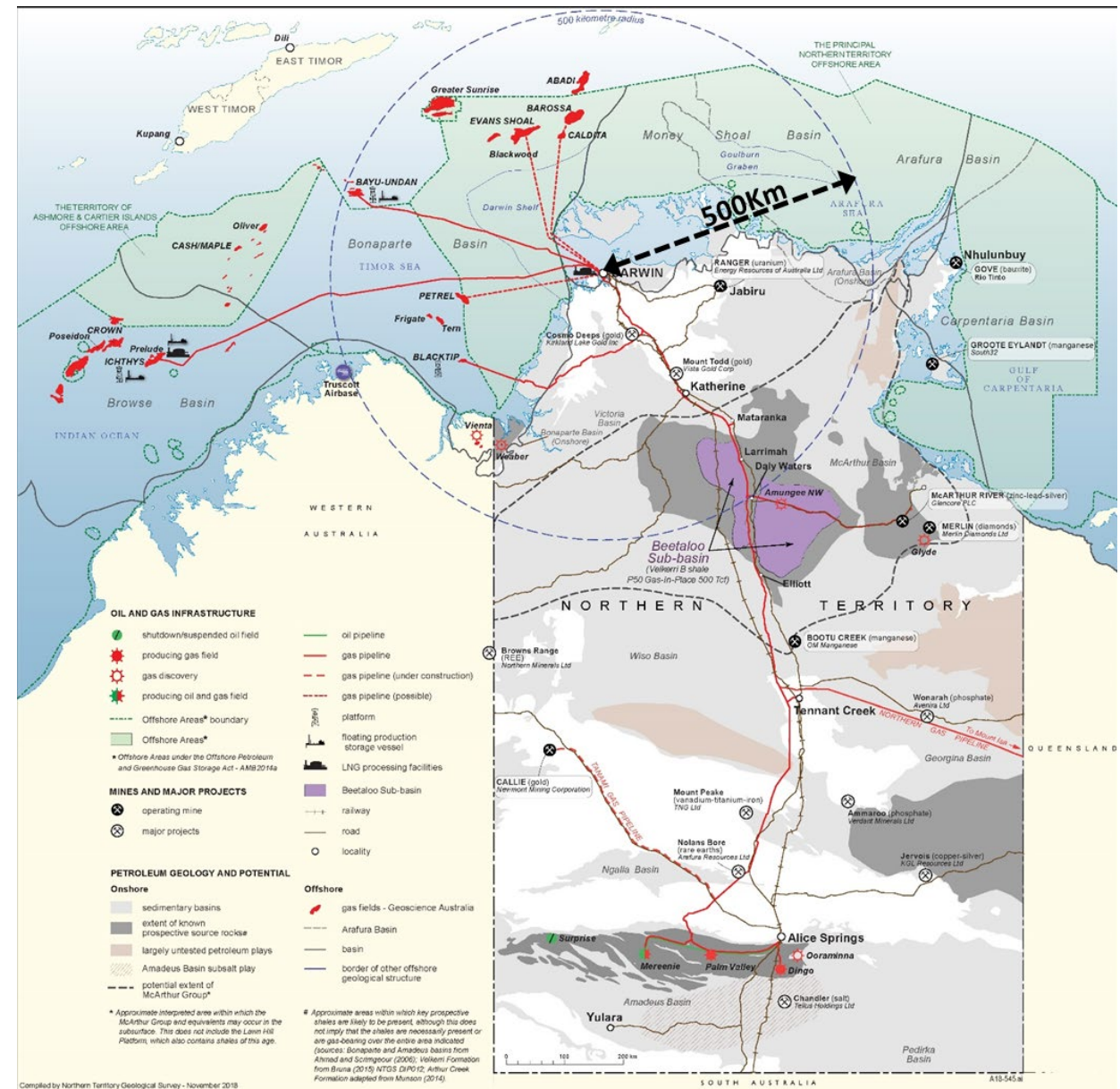


Kilde: PCI-søknad fra Northern Lights (Equinor, Shell og Total)

# Bayu-Undan field and potential storage overview

## BU gas condensate field:

- Location: Offshore Timor-Leste
- Water depth: 80-100 m
- Operator: SANTOS LTD (and TIMOR GAP from 2024)
- Discovery: 1995
- Start Production: 2004
- Expected end-of-field life: 2025



# London Convention and London Protocol



- Marine Treaties - Global agreements regulating disposal of wastes and other matter at sea
- London Convention 1972 (87 countries)
- London Protocol 1996 – ratified March 2006 (54 countries as of Sep 2023) is the more modern treaty
- Annual Meeting of the Contracted Parties + Annual meeting of Scientific Group.
  
- **London Protocol** – 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 unharmed materials, from small islands with no access to waste disposal options

# London Protocol and CCS



- Prohibited some CCS project configurations
- CO<sub>2</sub> Geological Storage Assessed by LC Scientific Group 2005/6
- 2006 - Risk Assessment and Management 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 sub-seabed geological formations
- **CO<sub>2</sub> Specific Guidelines (2007)** - to guide assessment and permitting



# 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<sub>2</sub> for geological storage**
- **2009 LP4 (30 Oct 2009) - Amendment proposed by Norway to allow export of CO<sub>2</sub> for storage was adopted by vote.**
- 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 then provisions equivalent to LP’s for issuing permits.
- **But, to come into force needs ratification by acceptance by two thirds all Parties - Only Norway, UK, Netherlands, Iran, Finland and Estonia accepted in 10 years (Oct 2019)**

# London Protocol CO<sub>2</sub> Export

- LC41 and LP14 meeting at IMO London, 7<sup>th</sup>-11<sup>th</sup> October 2019
- **Netherlands and Norway proposal to LP14 for “Provisional Application” of export amendment.**
- Drafting Group formed at LP14.
- IEAGHG supported with Information Paper 2019-IP11, and evidence-base in plenary with paper LC41/INF3
- **Success! – Resolution for Provisional Application adopted 11 Oct 2019**



# Resolution LP.5(14) on the Provisional Application of the 2009 Amendment to Article 6 of the London Protocol

Approved on 11 October 2019 . 2 pages of preamble then the operative clauses as follows:

- **1. DECIDES to allow for the provisional application of the 2009 amendment pending its entry into force by those Contracting Parties which have deposited a declaration on provisional application of the 2009 amendment;**
- *2. INVITES Contracting Parties to deposit with the Depositary a declaration on provisional application of the 2009 amendment of the London Protocol pending its entry into force;*
- *3. FURTHER RECALLS the obligation to notify the Depositary of agreements or arrangements mentioned in article 6, paragraph 2 of the London Protocol (as amended by resolution LP.3(4));*
- *4. AFFIRMS that the export of carbon dioxide under the provisional application of article 6 of the London Protocol (as amended by resolution LP.3(4)), and in compliance with the requirements of paragraph 2 of the article (as amended by resolution LP.3(4)) will not be in breach of article 6 as in force at the time of the export; and*
- *5. URGES Contracting Parties to consider accepting the amendment to article 6 of the London Protocol adopted through resolution LP.3(4).*

# London Protocol Transboundary Guidance

## CO<sub>2</sub> Specific Guidelines - revised 1 Nov 2012 for transboundary

1.10 In the case of transboundary sub-seabed geological formations that could be used by more than one country or where sub-seabed geological formations are located in areas where there is the potential for transboundary movement of CO<sub>2</sub> streams after injection **the Contracting Party where the injection occurs should be responsible for the implementation of these Specific Guidelines.**

# London Protocol Transboundary Guidance

## Arrangements or Agreements for Export (2013) - 1

**“Guidance on the Implementation of Article 6.2 on the Export of CO<sub>2</sub> Streams for Disposal in Sub-seabed Geological Formations for the purpose of Sequestration” . LC 35/15 Annex 6. 2013**

- This new Guidance was adopted at the Annual Meeting on 18 October 2013, for use when the export amendment comes into force.
- *“Export of CO<sub>2</sub> ....provided an agreement or arrangement has been entered into by countries concerned”*
- Definitions: “agreement” as a legally binding agreement between States, whereas an “arrangement” between refers to something non-binding, such as a memorandum of understanding”
- Allocation of permitting responsibilities between exporting and receiving countries must be confirmed in advance of export, and notified to the IMO.

# London Protocol Transboundary Guidance

## Arrangements or Agreements for Export - 2

**“Guidance on the Implementation of Article 6.2 on the Export of CO<sub>2</sub> Streams for Disposal in Sub-seabed Geological Formations for the purpose of Sequestration” . LC 35/15 Annex 6. 2013**

- Both Parties have to issue permits to meet LP requirements
- Exporting Party to characterize CO<sub>2</sub> stream and share data with receiving Party
- Receiving Party to characterize storage site, assess potential effects, verify monitoring and risk management, and share data with receiving Party
- *“flexibility given between the two States as to the content of their agreement or arrangement, it must be consistent with both the Protocol's provisions and those of applicable international law”*
- *“The optimal roles and responsibilities may become apparent as practical situations are negotiated over time, including which information is best supplied by which party to the transaction. Furthermore, it is likely that developing a final agreement or arrangement will involve a good deal of back and forth cooperation between two Contracting Parties”*

# London Protocol Transboundary Guidance

## Arrangements or Agreements for Export - 3

“Guidance on the Implementation of Article 6.2 on the Export of CO<sub>2</sub> Streams for Disposal in Sub-seabed Geological Formations for the purpose of Sequestration” . LC 35/15 Annex 6. 2013

- Exports to non-Contracting Parties - full responsibility of the Contracting Party to ensure ***“that the provisions of the agreement or arrangement must at a minimum be equivalent to those contained in the Protocol – including those relating to the issuing of permits and permit condition”*** . This is the means of ensuring the same level of environmental protection is provided for a non-Party storing a Party’s CO<sub>2</sub>.
- In the case of a breach of an agreement or arrangement by a non-Contracting Party, the Contracting Party should ***“engage in consultations to rectify”*** . In the case of a ***“significant ongoing breach”*** the Contracting Party is required to ***“terminate the export”***



IEAGHG Technical Review  
2021-TR02  
April 2021

# Exporting CO<sub>2</sub> for Offshore Storage – The London Protocol’s Export Amendment and Associated Guidelines and Guidance

IEA GREENHOUSE GAS R&D PROGRAMME

- Report describes the background, details and requirements of the provisional application of the CCS export amendment
- Includes the revised “CO<sub>2</sub> Specific Guidelines” (2012)
- Includes the “Guidance on Implementation of Article 6.2 on the Export of CO<sub>2</sub> Streams....” (2013), covering the “Agreements or Arrangements” of responsibilities between Parties



# Resolution LP.5(14) on the Provisional Application of the 2009 Amendment to Article 6 of the London Protocol (2019)

## Update :-

- Declarations of Provisional Application received by IMO (Apr 2024) from **Norway, Netherlands, Denmark, Korea, Belgium, Sweden, UK, Switzerland**
- “Agreements or Arrangements” (as needed by the 2009 Export Amendment) :-1<sup>st</sup> Arrangement received by IMO: Denmark-Belgium MoU (Sep 2022)
- **European Commission Analysis paper – CCS Directive acts as an “Arrangement”**
- First export – Belgium to Denmark for Greensands test injection (early 2023)
- In 2024 Arrangements by Denmark-France MoU, Netherlands-Norway MoU
- 2009 Export amendment needs acceptance by two thirds all Parties ie 36/53
- Norway, UK, Netherlands, Iran, Finland, Estonia, Korea, Sweden, Denmark, Belgium, Switzerland = 11 total (Apr 2024)

**MEMORANDUM OF UNDERSTANDING (MoU)**  
**BETWEEN**  
**THE MINISTER FOR ENVIRONMENT OF THE FLEMISH REGION**  
**AND**  
**THE FEDERAL MINISTER FOR THE NORTH SEA OF BELGIUM**  
**AND**  
**THE MINISTER FOR CLIMATE, ENERGY AND UTILITIES OF DENMARK**  
**ON CROSS BORDER TRANSPORTATION OF CO<sub>2</sub> WITH THE PURPOSE OF**  
**PERMANENT GEOLOGICAL STORAGE**

The Minister for Environment of the Flemish Region, the Federal Minister for the North Sea of Belgium, and the Minister for Climate, Energy and Utilities of Denmark (hereinafter referred to individually as a "Participant" and collectively as the "Participants");

Bearing in mind the MoU between the Participants on cooperation on carbon capture utilisation and storage (CCUS), particularly section 2b on the intent of the Participants to consider and prepare a bilateral agreement or arrangement between the Participants enabling cross-border transportation and storage of CO<sub>2</sub>;

Have reached the following understanding:

*Section 1 – Scope*

This MoU is an arrangement in the sense of Article 6 paragraph 2 of the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972, as amended by Resolution LP. 3(4). Any definitions used should be understood as they are understood in the context of the London Protocol and applicable European Union law.

This MoU applies to cross border transportation of CO<sub>2</sub> between the Participants with the purpose of permanent geological storage.

*Section 2 – Allocation of permits*

The Participants recognise that all necessary permit responsibilities will be allocated to the relevant authorities of each Participant's country in accordance with the London Protocol. A non-exhaustive list of relevant permitting authorities are as follows;

For Denmark:

- The Danish Energy Agency (Energistyrelsen) is responsible for the issuance of CO<sub>2</sub> storage permits as well as ETS permits:

Danish Energy Agency (Energistyrelsen)  
Carsten Niebuhrs Gade 43  
1577 København V

Tlf: 33 92 67 00  
[ens@ens.dk](mailto:ens@ens.dk)

Danish Energy Agency (Energistyrelsen), Esbjerg  
Niels Bohrs Vej 8D  
6700 Esbjerg

Tlf: 33 92 67 00  
[ens@ens.dk](mailto:ens@ens.dk)

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For Belgium:

- Provincial Executive(s) of the Provincial Council(s) are responsible for the issuance of (amongst other) ETS permits. ETS permits are issued based on an obligatory advice issued by the Flemish Energy and Climate Agency (Vlaams Energie- en Klimaatagentschap), which is also responsible for the implementation of ETS.

Flemish Energy and Climate Agency (Vlaams Energie- en Klimaatagentschap)  
Koning Albert II-laan 20, box 17  
1000 Brussels

Tlf 32 2 553 46 00  
veka@vlaanderen.be

- The Flemish government is responsible for the issuance of CO<sub>2</sub> storage permits.
- The Belgian federal maritime authorities are responsible for determining the technical rules and regulations a seagoing vessel has to comply with when shipping CO<sub>2</sub>.

#### *Section 3 – Arrangements of the Participants*

This MoU does not create any rights and obligations under international law and does not impose any financial obligations on the Participants.

Each Participant intends to conduct the cooperation under this MoU subject to all applicable laws and regulations.

#### *Section 4 – Amendment procedures and mutual understanding*

This MoU may be amended at any time by jointly written consent of the Participants.

At any time, the Participants will consult, at the request of any of them, on any matter relating to this MoU, in the spirit of cooperation, good faith and mutual trust, to resolve quickly any difficulties or misunderstanding that may arise.

The Participants will convene to evaluate the MoU at least once a year, unless they decide not to convene by jointly written consent. The Participants will convene alternatively in Copenhagen and Brussels, or in any other place decided upon by the Participants by jointly written consent.

*Paul E*

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*g*

*Section 5 – Final provisions*

This MoU will come into effect upon signature and upon the date of entry into force of the declaration of provisional application of the 2009 Amendment, in accordance with the national rules of both Participants.

This MoU may be terminated by either Participant giving twelve (12) month's written notice to the other Participant. The termination of this MoU will not affect any on-going activities under this MoU, unless otherwise decided by the Participants.

Signed in duplicate in Copenhagen and Brussels on the 26th of September 2022 each in the English language.

*For the Flemish Region:*

*The Minister of Justice and Enforcement,  
Environment, Energy and Tourism*



*Zuhel Demir*

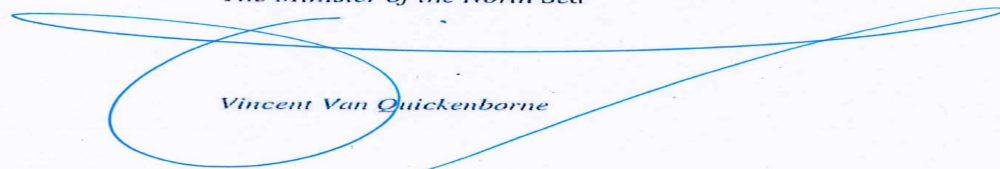
*The Minister for Climate, Energy and Utilities of  
Denmark*



*Dan Jørgensen*

*For the Federal Government:*

*The Minister of the North Sea*



*Vincent Van Quickenborne*

# London Convention/Protocol Scientific Group meeting SG47

London, 15-19 April 2024

## CCS

- Update from Correspondence Group, led by Japan and Australia, on sharing offshore permitting experiences using the CO<sub>2</sub> Specific Guidelines (2012).
- Greenpeace and ACOPS concerns about CCS used instead of reducing emissions and lack of experience with aspects of CCS including monitoring for leaks
- IEAGHG provided an update, including on 6<sup>th</sup> Offshore Workshop, and addressed concerns.
- SG47 Science Day on 18 April on CCS Permitting experiences. IEAGHG presented Scene-setter and global updates on offshore CCS.

## Marine Geoengineering

- Lots of activity and concerns – prohibition except for research which is permitted under London Protocol

# 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 Inventories



## Reporting of cross-border CCS operations - 4 scenarios:

**Scenario 1.** CO<sub>2</sub> may be captured in one country, Country A, and exported for storage in a different country, Country B.

Country A should report the amount of CO<sub>2</sub> captured, any emissions from transport and/or temporary storage that takes place in Country A, and the amount of CO<sub>2</sub> exported to Country B.

Country B should report the amount of CO<sub>2</sub> imported, any emissions from transport and/or temporary storage (that takes place in Country B), and any emissions from injection and geological storage sites.

# IPCC Guidelines for GHG Inventories



## Reporting of cross-border CCS operations - 4 scenarios:

**Scenario 2.** CO<sub>2</sub> is injected in one country, Country A, and migrates from the storage site and leaks in a different country, Country B.

Country A is responsible for reporting the emissions from the geological storage site. If such leakage is anticipated based on site characterization and modelling, Country A should make an arrangement with Country B to ensure that appropriate standards for long-term storage and monitoring and/or estimation of emissions are applied.



# IPCC Guidelines for GHG Inventories



## Reporting of cross-border CCS operations - 4 scenarios:

**Scenario 3.** More than one country utilizes a common storage site.

The country where the geological storage takes place is responsible for reporting emissions from that site. If the emissions occur outside of that country, they are still responsible for reporting those emissions

# IPCC Guidelines for GHG Inventories



## Reporting of cross-border CCS operations - 4 scenarios:

**Scenario 4.** Storage site occurs in more than one country.

Countries concerned should make an arrangement whereby each reports an agreed fraction of the total emissions.

# COP26 Glasgow



## Paris Agreement Article 6 – International Cooperation

- Article 6.2 relates to emissions trading between countries (ITMOs and OIMPs)
- Article 6.4 creates a new project-orientated crediting mechanism (like a new CDM).
- These set up frameworks for carbon markets to work in support of the Paris Agreement, will assist both countries and companies to achieve higher ambitions, and should be beneficial for multinational CCS projects. Both have provisions to ensure their integrity such as ‘corresponding adjustments’ to ensure no double-counting should take place.
- **Both are overall technology neutral, implicitly including CCS, explicitly including “removals” as well as “reductions”.**
- In both in 6.2 and 6.4 Decisions, they ask Supervisory Body and SBSTA to produce further recommendations, for example around emissions avoidance, and on removals.

# Article 6.4 Recommendations on Removals (2023)

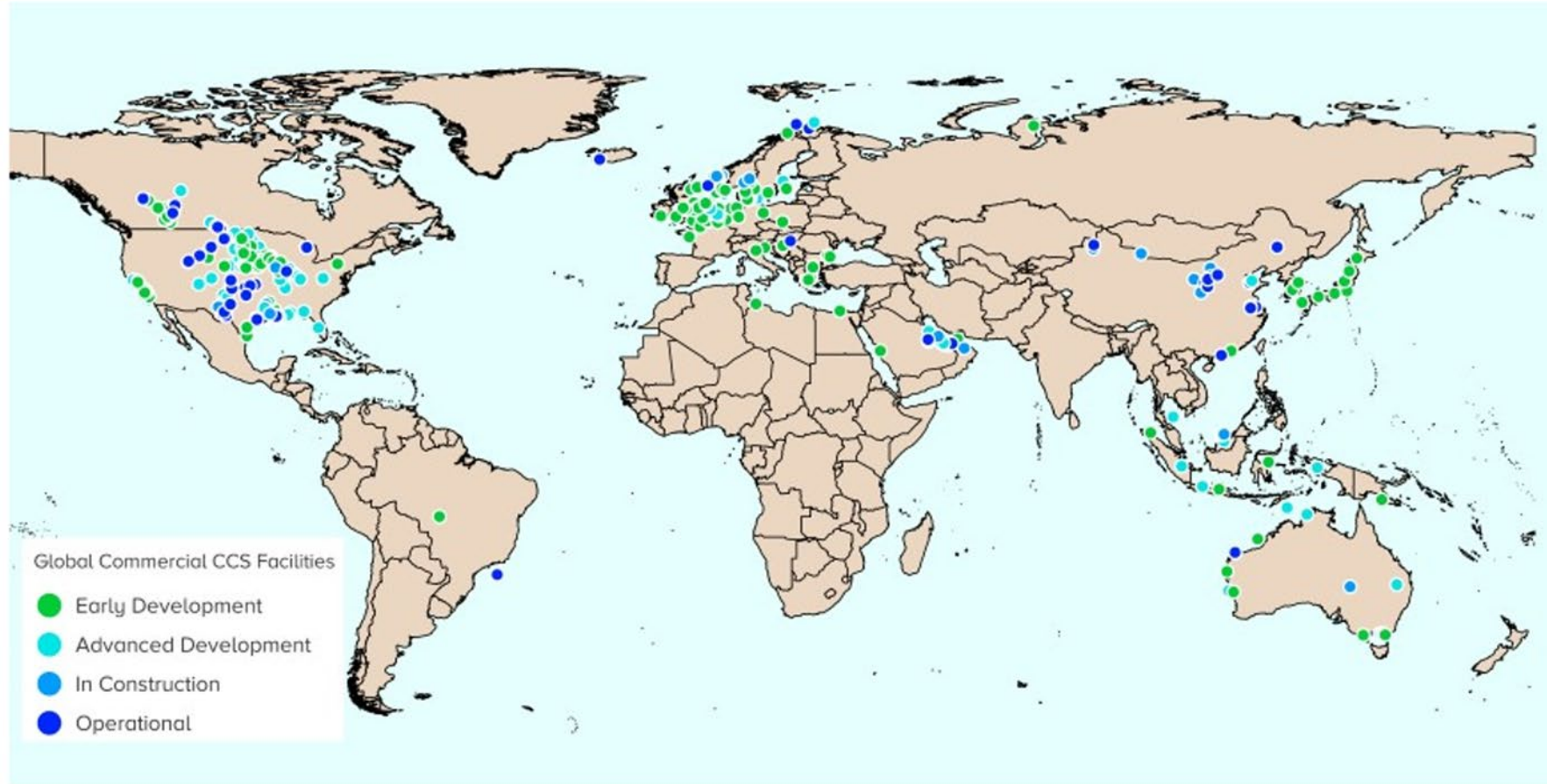
- Removal of CO<sub>2</sub> from atmosphere and durably storing in geological, terrestrial or ocean reservoirs, or in products – produce units of A6.4 ERs
- Requirements:
  - Monitoring methodologies
  - Avoidance of negative environmental and social impacts
  - Post-crediting – monitoring, reporting, remediation of reversals
  - Risk assessment for reversals
  - Reversal Risk Buffer pool (can opt-out for projects with negligible reversal risk)
  - Post reversal actions
    - Full monitoring report
    - Corrective actions
    - Cancellation of 6.4 ERs – either direct (by project participant or can be sovereign guarantee) or using Buffer Pool
- **But Parties failed to approve at COP28 Dubai** 6.4 recommendations on Methodologies and on Removals
  - further work on A6.4 for consideration/approval at COP29



## Paris Agreement Article 6 – International Cooperation

- Article 6.2 relates to emissions trading between countries (ITMOs and OIMPs)
  - operationalised via bilateral agreements between countries
- Article 6.4 creates a new project-orientated crediting mechanism (like a new CDM)
  - not operationalised – Supervisory Body revisiting Removals, may merge with standard methodology

# GLOBAL CCS FACILITIES - 2023



41 Facilities in operation

26 Facilities in construction

325 Facilities in development

**102%**  
year-on-year increase in  
number of CCS facilities  
in development pipeline.

\*Includes Navigator Heartland Greenway network

# Useful information sources and references

For London Protocol : [Carbon Capture and Sequestration \(imo.org\)](https://www.imo.org)

IEA Handbook on Legal and Regulatory Frameworks (July 2022) [Legal and Regulatory Frameworks for CCUS – Analysis – IEA](#)

Dixon T and Birchenough A. *-Exporting CO<sub>2</sub> for Offshore Storage – The London Protocol’s Export Amendment*. GHGT-15. March (2021), SSRN and IEAGHG Report 2021-TR02

Dixon, T, Havercroft, I. and McCoy, S. *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 CO<sub>2</sub> Geological Storage*. Elsevier Energy Procedia 1 (2009) 4503-4510

[ANGEA carbon accreditation study](#)

[SEACA III Workshop - 27-28 August, Kuala Lumpur \(GCCSI\)](#)

# Thank You

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