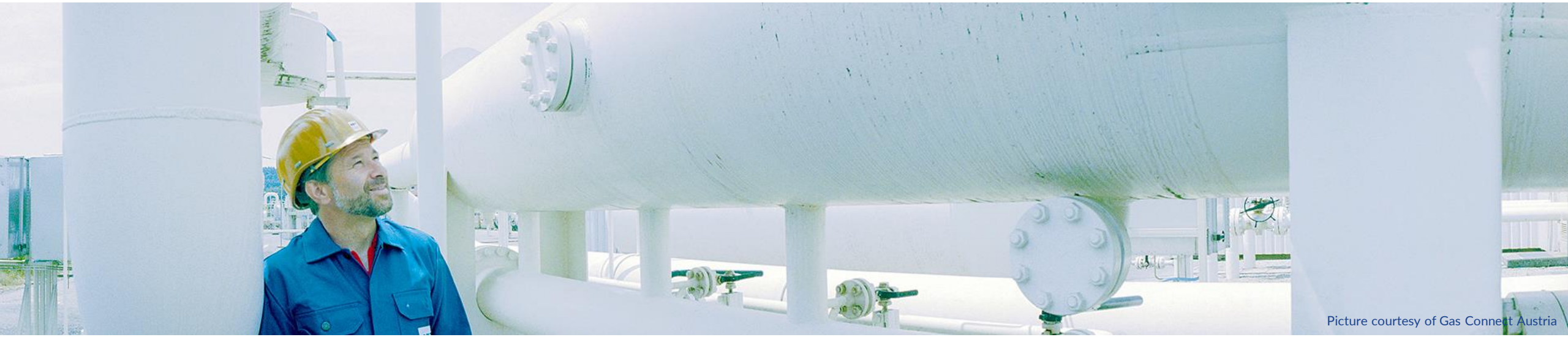
05 May 2023



Picture courtesy of Gas Connect Austria

10th meeting of Advisory Panel for Future Gas Grids

Meeting on 5 May 2023

ENTSOG

Introduction

Welcome

Copenhagen School of Energy Infrastructure (CSEI)

Agenda

	Description	Time
1.	**Introduction and welcome by Piotr Kuś**	11:00-11:05
2.	**CCUS Forum – presentation on the work and next steps of WG CO2 infrastructure**	11:05-11:20
3.	**Session on NetZero Industry Act – CCUS, CO2 transport and storage**	11:20-12:55
4.	**Summary and next meeting**	12:55 – 13:00
5.	**Closure of meeting**	13:00

CCUS Forum – presentation on the work and next steps of WG CO2 infrastructure

Update on the work and next steps of WG CO2 infrastructure

Caterina De Matteis

Senior Policy Manager

IOGP

Status of CCUS Forum WG CO2 infrastructure

Caterina De Matteis, IOGP Europe

Co-chair WG CO2 Infrastructure

Overview of CCUS Forum Working Groups

CCUS Forum - stakeholder consultation platform aiming at knowledge and best practice sharing

WG Consultation on the Strategic Vision Communication

Lead by European Commission

Scope
EU Communication on Strategic Vision

Objective
Inform and consult stakeholders in the development of the Communication

WG Infrastructure

Co-Chairs: IOGP Europe, ZEP, Bellona

Scope
Storage, transport (not capture)

Objectives
- Recommendations for regulatory framework
- Input to review of CO2 Storage Directive Guidance Documents (study conducted by DNV)
- Input to COM studies on CO2 infrastructure
- Subgroup dealing with technical specs and standards

Deliverable
Full report June 2023

WG Industrial Partnership

Co-Chairs: European Lime Assoc., ZEP, Cembureau

Scope
Industrial clusters

Objective
Define scope and objectives of a CCUS Alliance

Deliverable
Issue paper (Jan 2023) for

WG Public awareness

Co-chairs: EPG, ERCST, Fraunhofer ISI

Scope
CCUS

Objectives
- Raise public awareness and acceptance
- Prepare the public consultation on the CCUS Communication

Deliverable
Issue paper

Working Group CO2 Infrastructure

- Key objective: to provide recommendations to the EC on how to sustainably develop and deploy European CO2 transport and storage infrastructure
- Issue paper *Towards a European cross-border CO2 transport and storage infrastructure* presented at 2nd CCS Forum
- Forum's conclusions pointed out the importance of unrestricted, cross-border third-party access to CO2 transport and storage infrastructure and of harmonisation of technical
- Follow-up from CCUS Forum meeting (2023 activities):
  - Develop a Report based on the Issue paper including recommendations for the CO2 infrastructure
  - Establishing an expert Group on specifications for CO_2 transport
  - Consultation platform for Commission ongoing studies on CO2 infrastructure and CCS Directive review

Issue paper – key principles

- There is an urgent need for a fit-for-purpose EU regulatory framework for CO2 transport infrastructure, focused on the development of non-discriminatory, open access and multimodal CO2 transport infrastructure without barriers to early investment
- There is a need for standardisation of CO2 specifications, addressing the different technologies and segments of the CCUS value chain, including ship-based CCS
- The commercial deployment of CCUS depends on contracts between entities operating along the CCUS value chain, such as emitters, transport companies, and storage and utilisation operators which calls for a proper allocation of liabilities across the CO2 value chain
- The successful deployment of CCUS at scale will depend on the ability to put in place contracts which balance risks and rewards between the business entities along the CCUS value chain and de-risk the needed investments.
- Risk-sharing and transfer of liabilities between the storage developers and the regulatory authorities is key to support project development.

Key regulatory issues – CO2 transport

- Location cannot be a barrier – access to infrastructures needs to reflect different transport modalities
- Onshore transportation:
  - Pipeline transport: clear-cut regulation
  - What kind of regulation for other modalities (ship, barge, train and truck)?
  - Exemption from regulation for ongoing projects/ specific projects (island projects)?

- Offshore transportation – how to deal with:
  - Infrastructure operated jointly with the storage operators
  - Offshore pipelines leading to multiple storage sites

Key regulatory issues – CO2 storage

- Storage development is a complex activity involving several phases
- Characteristics of different storage sites (depleted fields and saline acquifer) needs to be considered
- Permitting and licensing can take up to 10 years – important to define how the process can be accelerated:
  - Synergies and potential mutual relevance of the EU Hydrocarbons Licensing Directive
- Important to enable access to information: it would be useful to develop an EU Storage Atlas
- Risk sharing and transfer of liabilities: aspects to be addressed in the CCS Directive Guidance documents reviews
- Access to storage – to be based on negotiated terms with storage operators?

Key regulatory issues – Operating and planning

- Deployment of new CO2 transport corridors and networks to benefit from integrated planning and consultation processes in a similar way to those established for the gas, electricity and hydrogen sectors
- Need for an entity incorporating emitters, transport providers and utilisation and storage operators in order to enable coordinated CO2 infrastructure planning, network design, and facilitate cross-border cooperation
  - This entity could address regulatory and permitting barriers and promote relevant standardisation across the value chain, including on CO2 quality specifications and shipping of CO2
- Planning and investment in infrastructure could be also supported at regional level:
  - market makers, sitting between industrial CO_2 sources and CO_2 users and storers to coordinate development and take responsibility for risks

Commercial models and funding

- CCUS value chains typically include multiple separate business entities: industry emitting, capturing and processing CO2, infrastructure operators transporting CO2 operators managing interim storage (e.g. ports), entities aggregating CO2 flows from multiple emitters, CO2 storage operators and CO2 users
- Successful deployment of CCUS at scale will depend on the ability to put in place commercial solutions that balances risk and reward along the full CCUS value chain,
- Main commercial risks: and :
  - price risks linked with CO2 price variation in the EU ETS→ potentially to be de-risked through CCfDs
  - volume risks: mismatch of CO2 needed →de-risking mechanisms with external bodies before concluding
- Funding mechanism to address commercial risks along the value chain → important of coherent and coordinated funds and between the EU and Member States

WG CO2 Infrastructure - next steps

- Full report to be finalised by the end of May and presented at the next WG meeting (date tbc)
- Stakeholders will have opportunity to share comments
- To join the WG ENER-CCUSFORUM@ec.europa.eu
- For further input, ideas, and interest to participate in expert group on standards (wg.co2infrastructure@gmail.com)

Session on NetZero Industry Act – CCUS, CO2 transport and storage

NetZero Industry Act – CCUS, CO2 transport and storage

Chris Bolesta
CCUS Policy Lead
DG ENER

Anne-Katrine Wisen
Business Developer
Gas Storage Denmark

François-Régis Mouton
Regional Director Europe
IOGP

Thijs De Vries
Program Manager CCUS
Gasunie

Per Sandberg
Senior Adviser
Equinor Low Carbon Solutions

David Nevicato
CCUS Director
TotalEnergies

Moderator

Piotr Kuś
General Director
ENTSOG

Introductory Remarks

Chris Bolesta

CCUS Policy Lead

DG ENER, European Commission

Introductory Remarks

Anne-Katrine Wisen

Business Developer

Gas Storage Denmark

GAS STORAGE DENMARK

ENTSO-G ADVISORY PANEL FOR FUTURE GAS GRIDS (CO2)

ON-SHORE CO_2-STORAGE

05. MAY 2023

Anne-Katrine Wisén / aws@gasstorage.dk / +45 2349 4742

WITH A FOUNDATION OF POLITICAL SUPPORT WE WILL STORE CO2 IN STENLILLE FROM 2026

GSD GAS STORAGE DENMARK

Experience

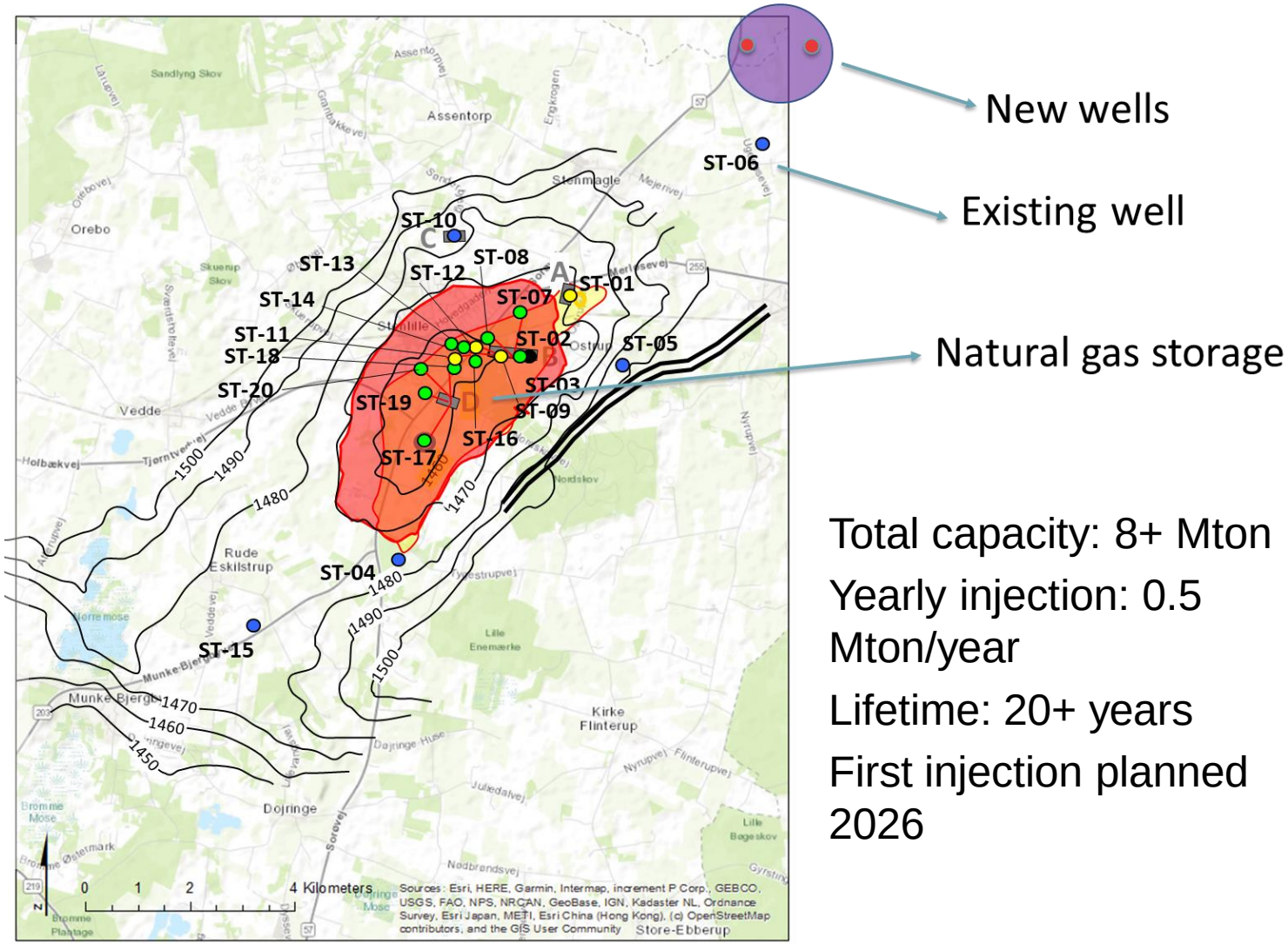
More than 30 years of operation, with safety, monitoring, communication and good relations with neighbours

Speed

Existing infrastructure and organisation enables relatively fast establishing of large-scale operation

Acceleration

With the pilot project, GSD can activily work together with partners in the industry to reduce risk, optimise setup, and improve timelines for CCS projects in Denmark in general



Total capacity: 8+ Mton

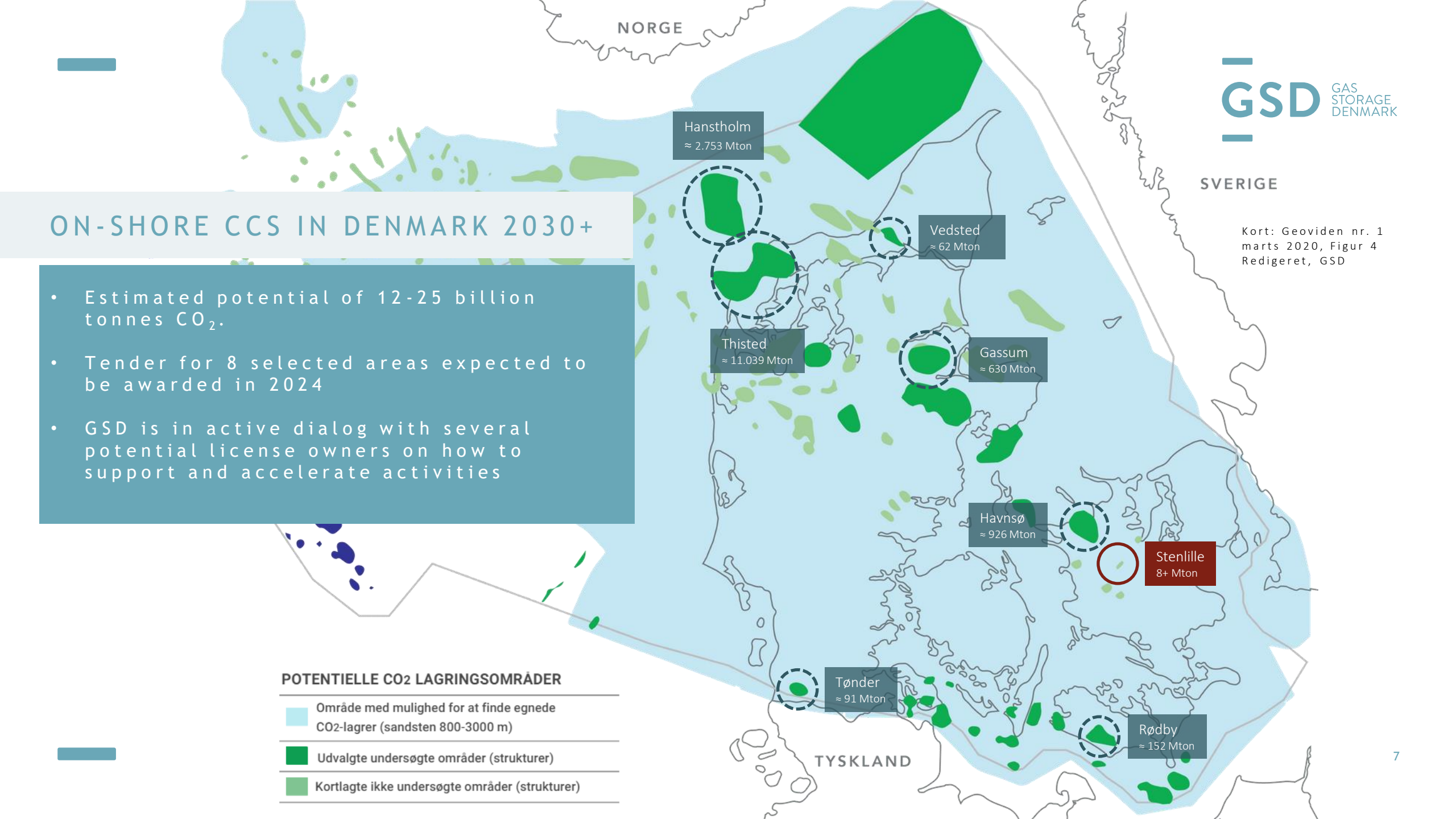
Yearly injection: 0.5 Mton/year

Lifetime: 20+ years

First injection planned 2026

ON-SHORE CCS IN DENMARK 2030+

- Estimated potential of 12-25 billion tonnes CO_2.
- Tender for 8 selected areas expected to be awarded in 2024
- GSD is in active dialog with several potential license owners on how to support and accelerate activities



GSD GAS STORAGE DENMARK

Kort: Geoviden nr. 1 marts 2020, Figur 4 Redigeret, GSD

Introductory Remarks

François-Régis Mouton

Regional Director Europe

IOGP

International Association of Oil & Gas Producers

Net Zero Industry Act

IOGP Europe position on the CO_2 storage contribution obligation

François-Régis Mouton

5th May 2023

CCUS in Europe *(available on www.iogpeurope.org)*

Overview of existing and planned CCUS facilities in Europe

AUSTRIA
1. Vienna Green CO_2*

BELGIUM
1. Leilac 1
2. Antwerp@C*
3. Carbon Connect Delta
4. Steelanol
5. C4U
6. North-CCU-Hub
7. Power-to-Methanol Antwerp BV
8. Kairos@C*
9. H2BE*

BULGARIA
1. ANRAV[€]

CROATIA
1. Petrokemija Kutina
2. Bio-Refinery Project
3. CCGeo[€]
4. **CO_2 EOR Project Croatia**

DENMARK
1. Greensand*
2. C4: Carbon Capture Cluster Copenhagen
3. Bifrost*

FINLAND
1. SHARC[€]

FRANCE
1. DMX Demonstration in Dunkirk*
2. Pycasso*
3. K6[€]
4. CalCC[€]
5. **Cryocap**
6. D'Artagnan

GERMANY
1. H2morrow*
2. Leilac 2
3. BlueHyNow*
4. OXYFUEL100 (subproject of Westkuste100)
5. H2GE Rostock*

GREECE
1. Prinos CCS
2. RECODE

ICELAND
1. **Orca**
2. **Silverstone**[€]
3. Coda Terminal[€]

ITALY
1. CCS Ravenna Hub*
2. Cleankerk

THE NETHERLANDS
1. Porthos*
2. Aramis*
3. H2M*
4. H-Vision*
5. Twence*
6. **AVR-Duiven**
7. AZUR*
8. L10 CCS

NORWAY
1. **Sleipner CO_2 Storage***
2. Longship (including Northern Lights)*
3. Barents Blue*
4. Norsk e-fuel
5. Borg CO_2*
6. **Snøhvit CO_2 Storage***
7. Smeaheia*

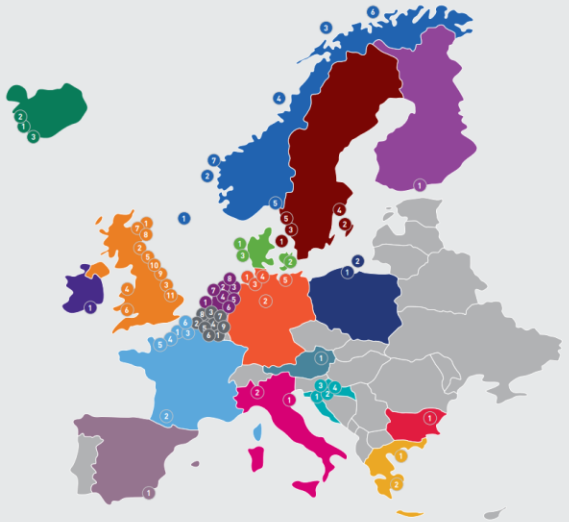
POLAND
1. Poland - EU CCS Interconnector
2. Go4ECOPlanet[€]

REPUBLIC OF IRELAND
1. Ervia Cork CCS

SPAIN
1. ECCO2

SWEDEN
1. Preem CCS*
2. Slite CCS
3. CinfraCap
4. BECCS@STHLM[€]
5. Project AIR[€]

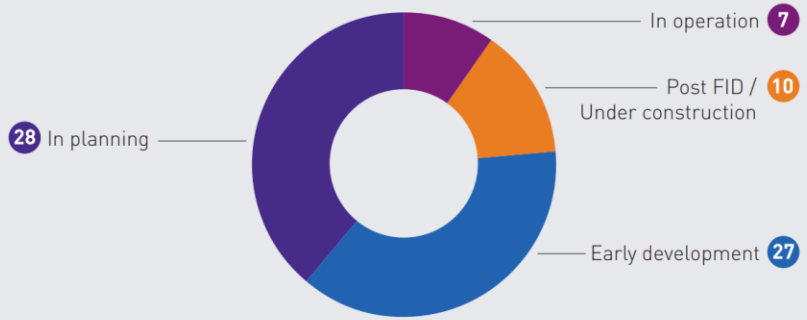
UK
1. Acorn*
2. Caledonia Clean Energy
3. Zero Carbon Humber*
4. HyNet*
5. Net Zero Teesside*
6. South Wales Industrial Cluster
7. Peterhead CCS Power Station*
8. Acorn CO_2 SAPLING*
9. Northern Endurance Partnership*
10. H2Teeside*
11. H2H Saltend*



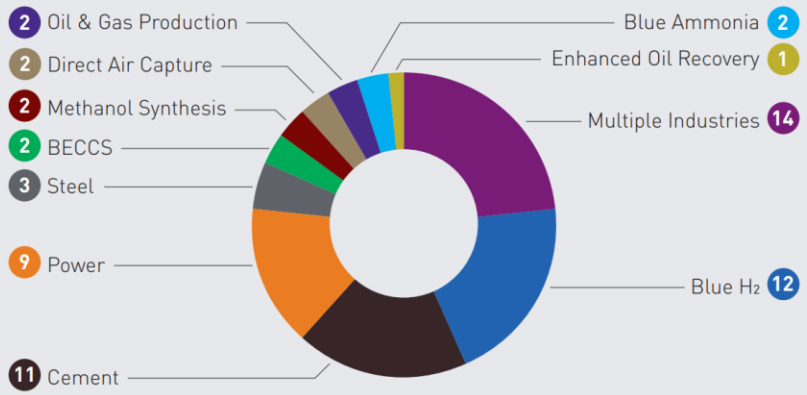
* Project where IOGP Members are involved
€ EU Innovation Fund (11 selected, **4 awarded**)
Projects listed in **bold** are in operation

Total number of projects: **72**
Around 80 $MtCO_2$/yr stored by 2030

Status of CCUS projects



Type of CO_2 capture projects

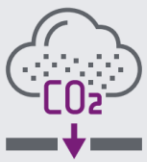


Key numbers

72 CCUS PROJECTS

18 COUNTRIES IN EUROPE have CCUS projects

80 MT CO_2/YEAR could be stored by 2030



- **7** in operation
- **6** with PCI status
- **11** supported by EU Innovation Fund
- **29** cross border
- **42** clusters
- **43** with offshore storage

International Association of Oil & Gas Producers

CO2 storage projects in Europe

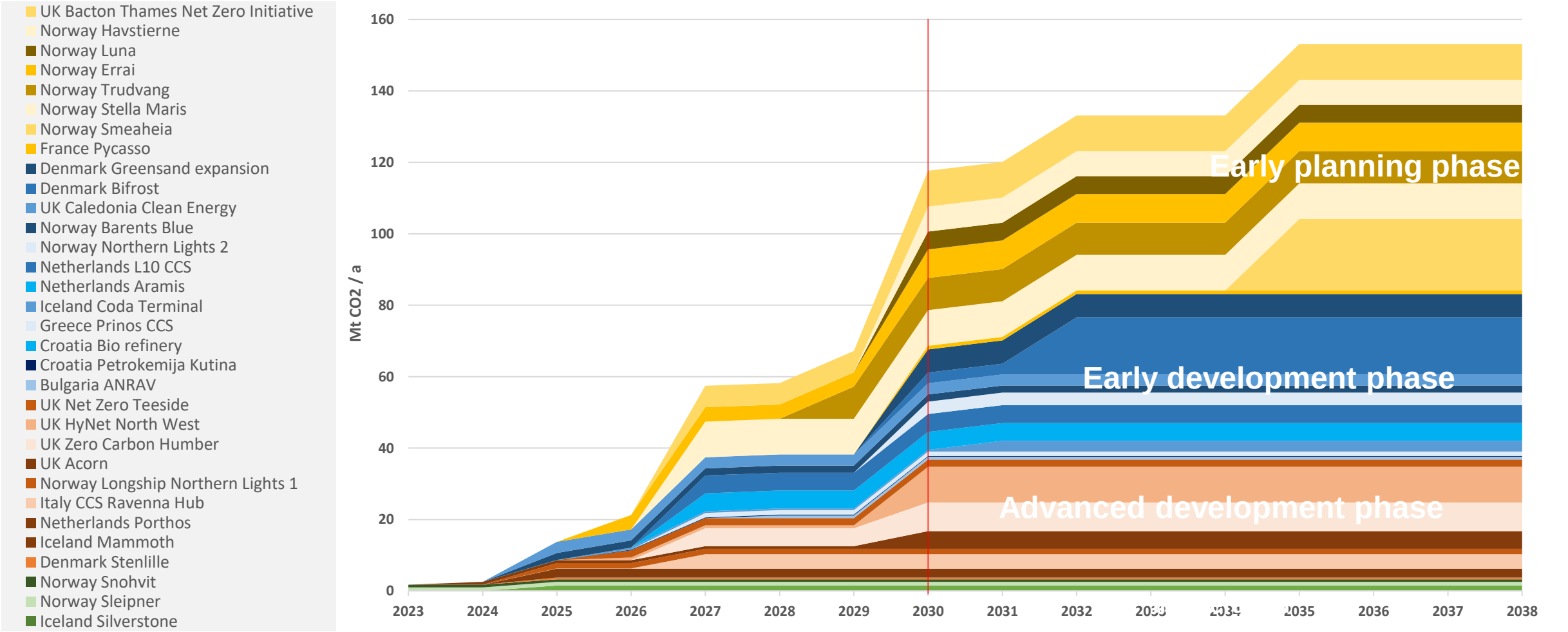
Classification according to development status

Project development status		
	Category	**Categorization criteria***
	In Operation	• Operation start-up (even if in pilot phase)
	Advanced Development (Design Phase, Appraisal & Contracting Phase, Construction Phase)	• FID taken • FEED study ongoing or completed • Under construction
	Early Development (Characterization & Appraisal Phase)	• Feasibility study ongoing or completed • Joint Development Agreement (JDA) signed • Environmental Impact Assessment ongoing or completed • Received sum funding or Pre-Feed study ongoing or completed
	Early planning **(**Screening Phase)	• MoU • Pre-feasibility study (ongoing or completed)

*) If none of the below criteria is met, then the project is not classified to any category

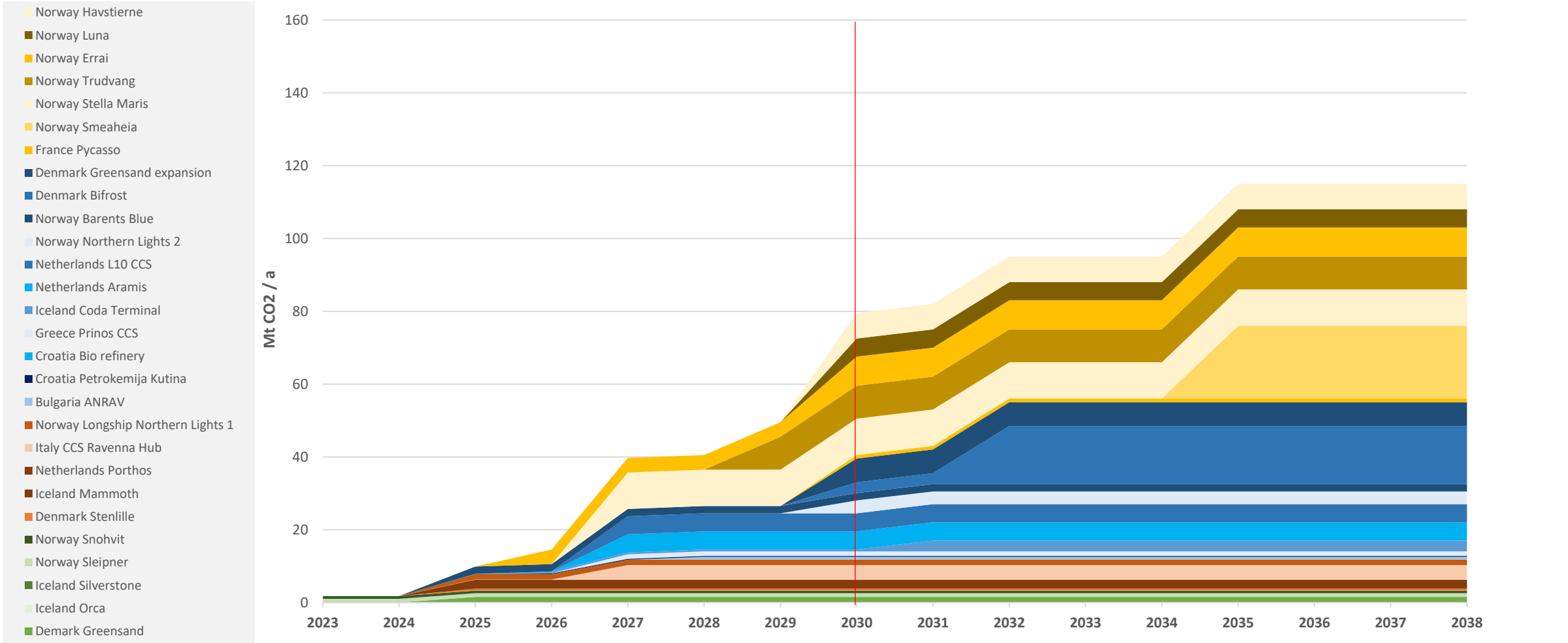
International Association of Oil & Gas Producers

CO2 storage injection capacity in EU, Norway, UK, Iceland



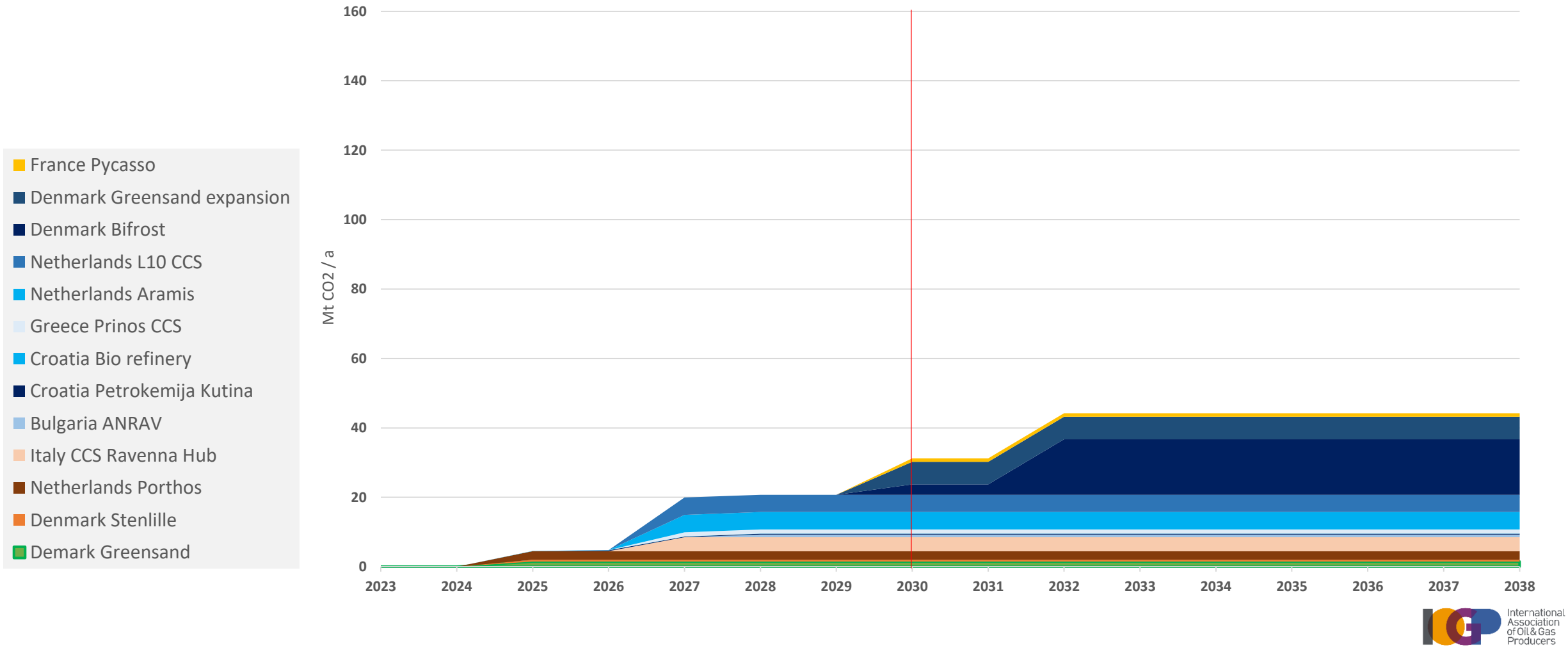
International Association of Oil & Gas Producers

CO2 storage injection capacity in EU, Norway & Iceland



International Association of Oil & Gas Producers

CO2 storage injection capacity in EU



International Association of Oil & Gas Producers

CO2 storage injection capacities by 2030

	Capacity MtCO2/a by 2030		
Projects	**EU + NOR + UK + Iceland**	**EU + NOR + Iceland**	**EU**
In operation	**3.25** (5 projects)	**3.2** (5 projects)	**1.5** (1 project)
In operation + in advanced development	**37** (14 projects)	**12** (10 projects)	**10** (4 projects)
In operation + in advanced & early development	**68** (24 projects)	**39** (19 projects)	**30** (11 projects)
In operation + in advanced & early development + early planning	**120** (32 projects)	**80** (26 projects)	**30** (12 projects)

International Association of Oil & Gas Producers

IOGP position (1)

IOGP welcomes the recognition of CCS as ‘strategic net-zero projects’ and thus an enabler of the energy transition

The proposed 50 Mt CO_2 injection capacity objective and the EU CCUS Forum work is a welcome **commitment from policy makers to develop and implement the needed frameworks**

This is crucial to enable and support the establishment of CCS value chains in Europe

International Association of Oil & Gas Producers

IOGP position (1b)

However, it will be challenging for the industry to achieve the capacity objective by 2030 as CCS projects depend on factors partially outside the control of the obligated companies

Several storage projects exist in the EU with indicative start-up by 2030, **but only two of them are authorized under the CCS Directive** (these projects will only allow for an aggregated planned CO_2 injection capacity of **3.8** MtCO2 p.a. by 2030)

Most projects are in very early project screening phases; even if they were to receive needed permits and funding within the next years, it will depend on multiple **external factors** to become operational by 2030

IOGP position (2)

CO_2 storage developments are **complex projects and depend on many factors outside the control of project developers**

They can take over 10 years - even if all project phases are managed within minimum periods, project durations under 5 years from project inception to injection start-up are not achievable

More **policy support is needed** than requiring hydrocarbon license holders only to make storage capacity available:

IOGP position (2b)

All entities along the CCS value chains need to have viable and sustainable business cases with signed agreements underpinning investments and defining their locations, capacities, and timing.

Stranded CO2 storage assets across Europe must be avoided.

Further **discussion is needed regarding requirements which need to be met** enabling entities to meet the 2030 target date, and regarding **reasonable criteria which justify an extension of the target date**

IOGP Europe proposes to organise **workshops with the industry and authorities** to establish increased understanding of the possible roadmaps to the envisaged 50 Mt storage capacity objective.

International Association of Oil & Gas Producers

Amendment Proposals

- A) Ensure CO2 storage capacity is built in conjunction with integrated CCS value chains; avoid stranded investments

- B) Require assessment by Competent Authorities whether project requirements can be met by 2030

- C) EU and Member State measures to facilitate timely and coordinated reachability of 50 MtCO2 storage objective

International Association of Oil & Gas Producers

For more information please contact:

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Introductory Remarks

Thijs De Vries

Program Manager CCUS

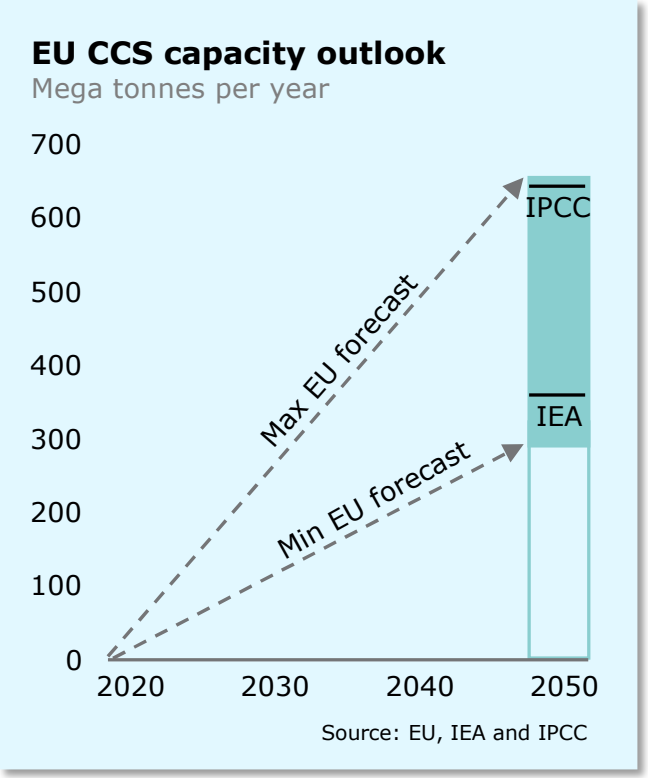
Gasunie

ENTSOG Advisory Panel for Future

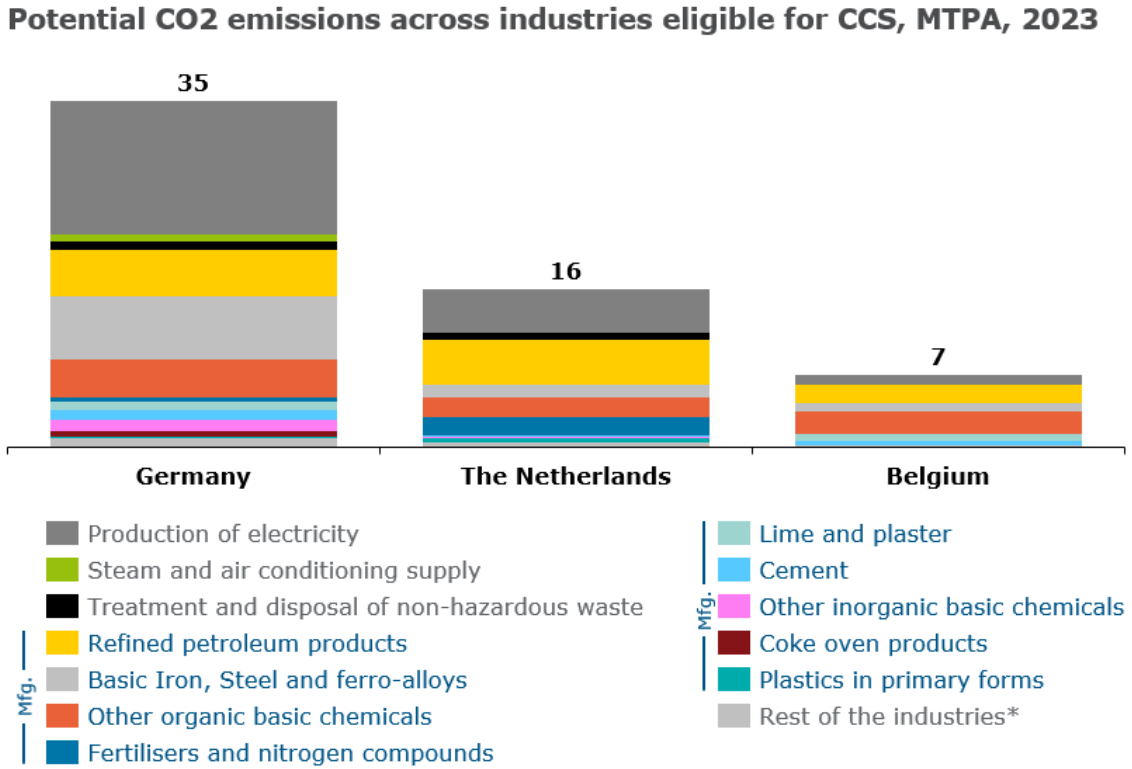
Gas Grids
CCUS/CO2 transport

Thijs de Vries
Program Manager CCS/CCU
Gasunie

CCS plays a key role in mitigating climate change; without it the Netherlands and EU will not be able to meet CO2 reduction targets for 2030 and 2050.



Market analysis covering current major industrial clusters in Germany, Belgium and the Netherlands ~60 MTPA of CO_2 is potentially available for CCS in the Netherlands. There is a large gap in infrastructure project development.



*Source: Gasunie internal study

The future European regulatory framework should support the development of the necessary infrastructure and fair and efficient access.

1. **Centralised and clear coordination of transport, terminal and storage infrastructure** in order to avoid unnecessary, inefficient and disconnected regional infrastructure; to **promote investments in infrastructure and favouring cooperation** among the value chain with a role for TSO's/public parties to facilitate timely and efficient transport infrastructure development.

2. A regulatory framework that secures **open-access and non-discrimination** supporting a fair level playing field for emitters from different sectors.

3. A European vision on **cross-border CCUS** and an **enabling European regulatory framework**.

4. **Identification of European infrastructure potential** to support hard-to-abate industries in decarbonisation using CCUS and identifying business opportunities for Gasunie at the same time. The InterCO2nnect study will also help in this regard.

Introductory Remarks

Per Sandberg

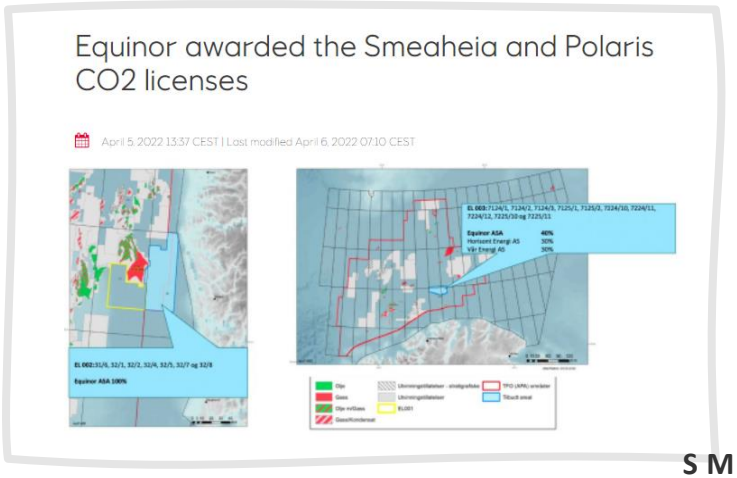
Senior Adviser

Equinor Low Carbon Solutions

Introductory remarks at Advisory Panel for Future Gas Grids
ENTSOG
5 May 2023

By Dr Per Sandberg
Senior advisor, Low Carbon Solutions, Equinor
prsa@equinor.com

CCS scale up- building on 26 years of operational experience and Northern Lights

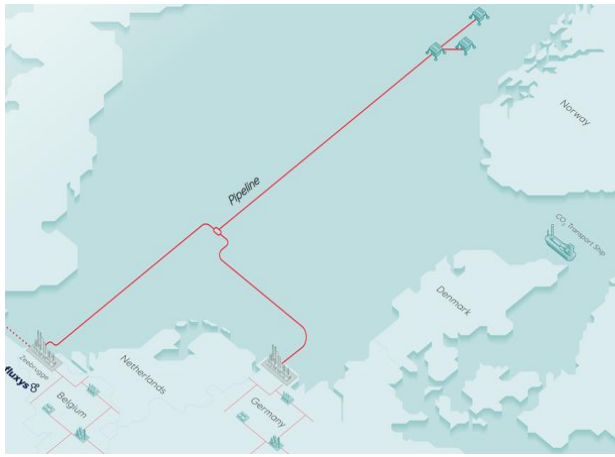


15-30 Mtpa

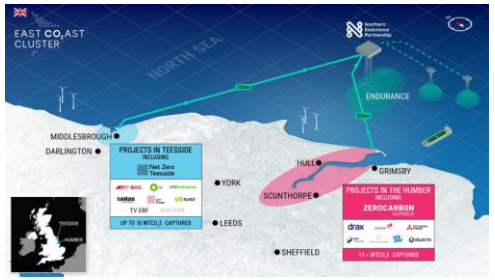
CO_2 transport and storage capacity by 2035

Equinor share

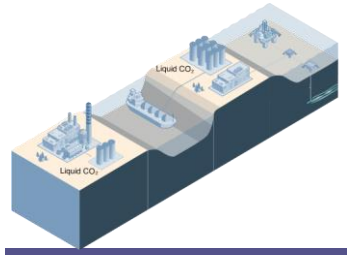
SMEAHEIA



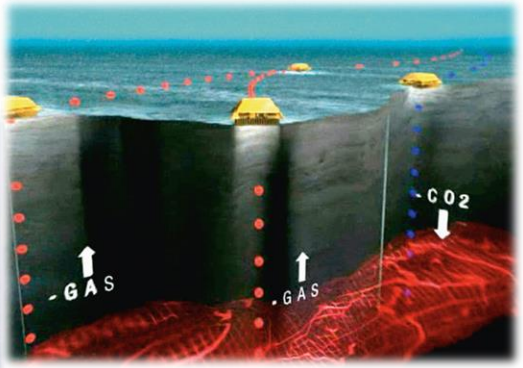
EAST COAST CLUSTER



NORTHERN LIGHTS



SNØHVIT



SLEIPNER

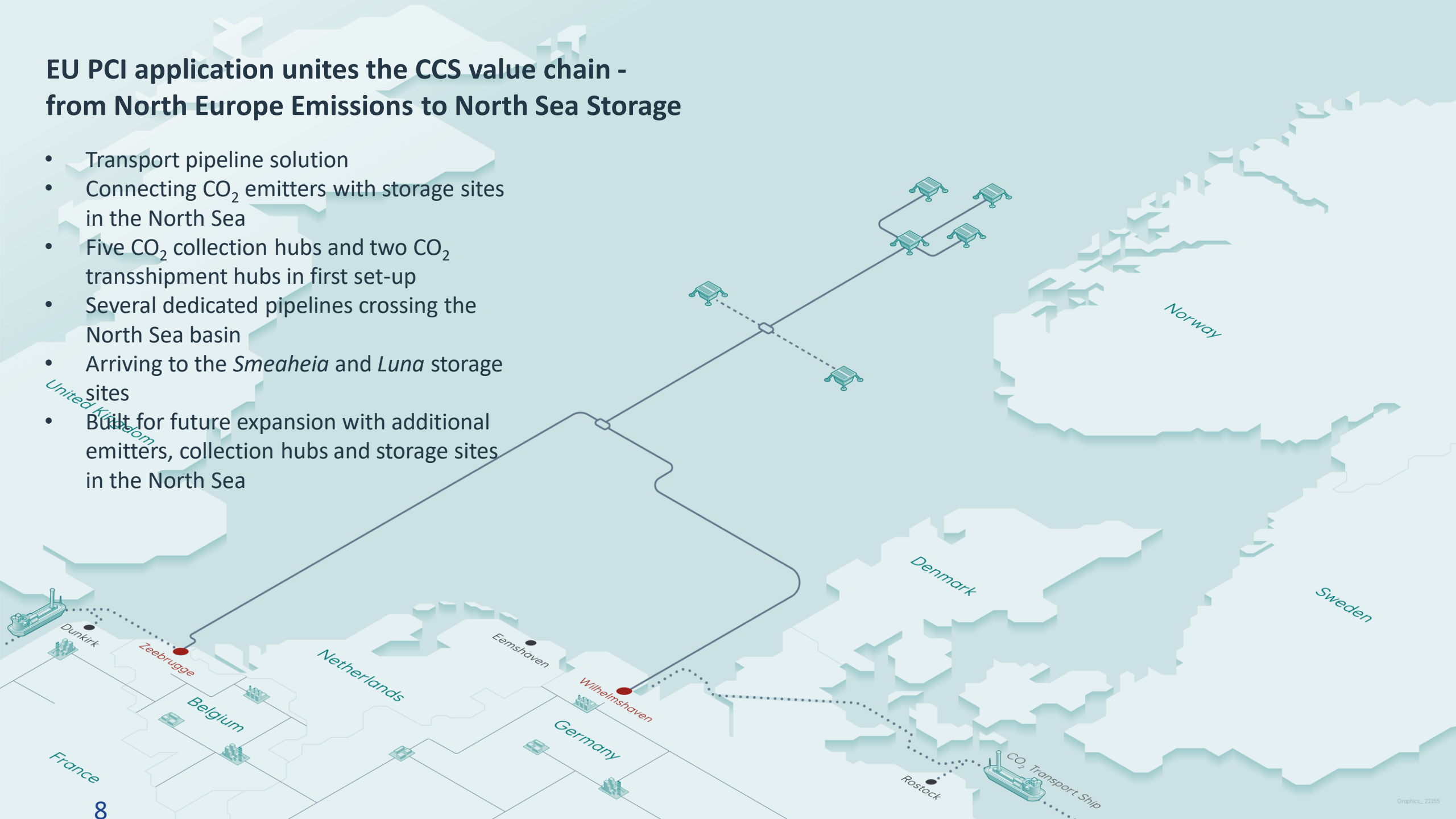
Costing Down by Scaling Up

Northern Lights – Market opener

Operation experience – technology works!

EU PCI application unites the CCS value chain - from North Europe Emissions to North Sea Storage

- Transport pipeline solution
- Connecting CO_2 emitters with storage sites in the North Sea
- Five CO_2 collection hubs and two CO_2 transshipment hubs in first set-up
- Several dedicated pipelines crossing the North Sea basin
- Arriving to the *Smeaheia* and *Luna* storage sites
- Built for future expansion with additional emitters, collection hubs and storage sites in the North Sea



Candidate PCI ‘EU2NSEA

Net Zero Industry Act - Equinor's initial position

11 April 2023

Input sent to European Parliament rapporteur MEP Ehler

- **Support inclusion** of CCS as a strategic net-zero technology
- **Support faster permitting-granting** processes and one-stop shops
- Stress that **value chain approach** for CCS is required to solve "coordination failure"
  - Matching ambitions and incentives for capture, transport, storage.
- Recommend that entities are allowed to meet their obligations through agreements with storage **developers with licenses granted under CCS Directive**
- Requirement on O&G entities should be **conditional to** CO2 storage exploration **licenses being granted** by Member States
- Consequences of producer obligation must be further explored

Introductory Remarks

David Nevicato

CCUS Strategy, Markets and Advocacy Director

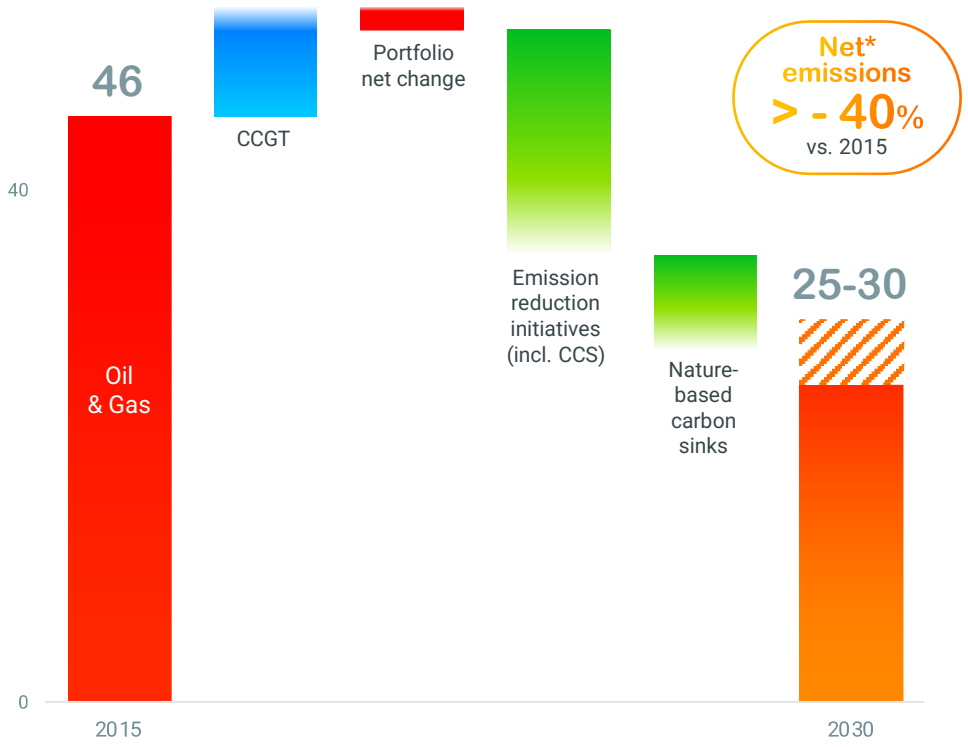
TotalEnergies

Reducing Emissions

Scope 1+2: reducing CO2 emissions by 2030

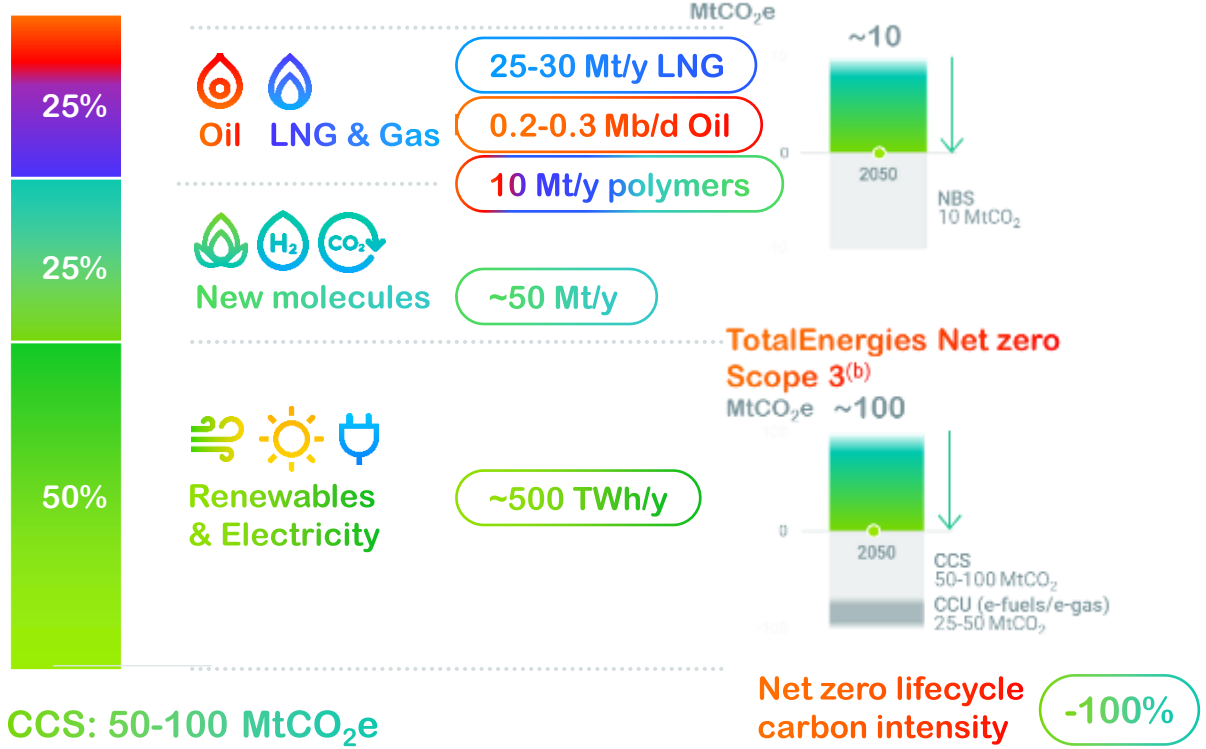
Scope 1+2 from operated facilities

Mt CO_2e



A vision for a Net Zero company by 2050

energy production & sales

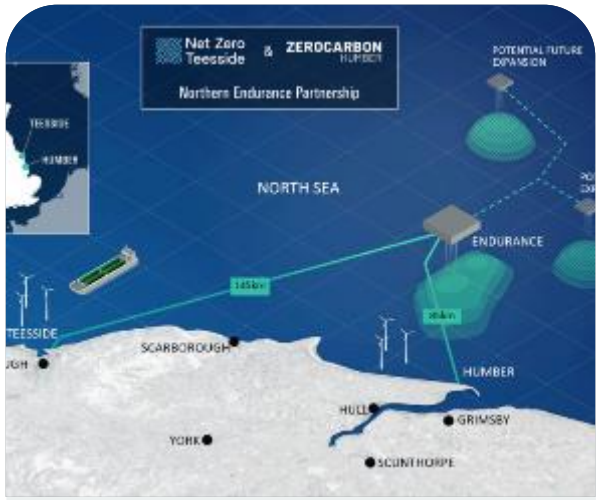


Investing in CO_2 storage services for our customers

Norway

Northern Lights (TotalEnergies 33%)

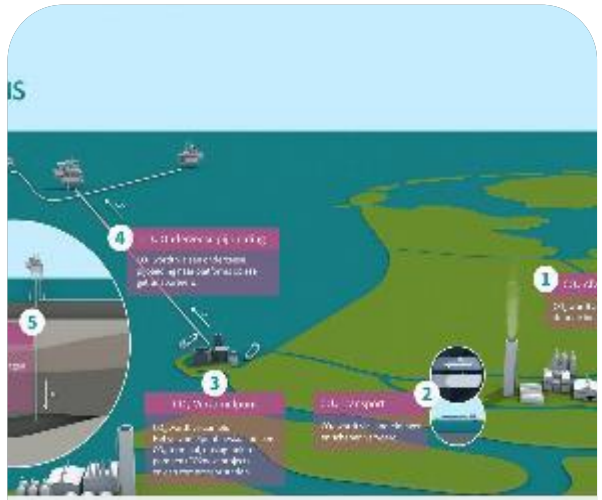
- Phase 1 (FID 2020)
  Up to **1.5 $MtCO_2$/y** by 2025
- Phase 2
  Capacity expansion to
  5 $MtCO_2$/y by 2026



UK

Northern Endurance Partnership NEP (TotalEnergies 10%)

- Onshore and offshore infrastructure
  for storage in the Endurance reservoir,
  a large-scale saline aquifer
  - **4 $MtCO_2$/y** by 2027
  - > 400 $MtCO_2$ storage capacity



Netherlands

Aramis (TotalEnergies 25%); CO2 storage (TotalEnergies 60%, op.)

- Aramis project
  - Onshore CO_2 multimodal terminal and transport infrastructure to off. storage
  - **> 5 $MtCO_2$/y** transport capacity from 2027 (Ph. 1)
- Operated storage: **2.5 $MtCO^2$**/y (Ph. 1) to 8 MtCO2/y in 2030

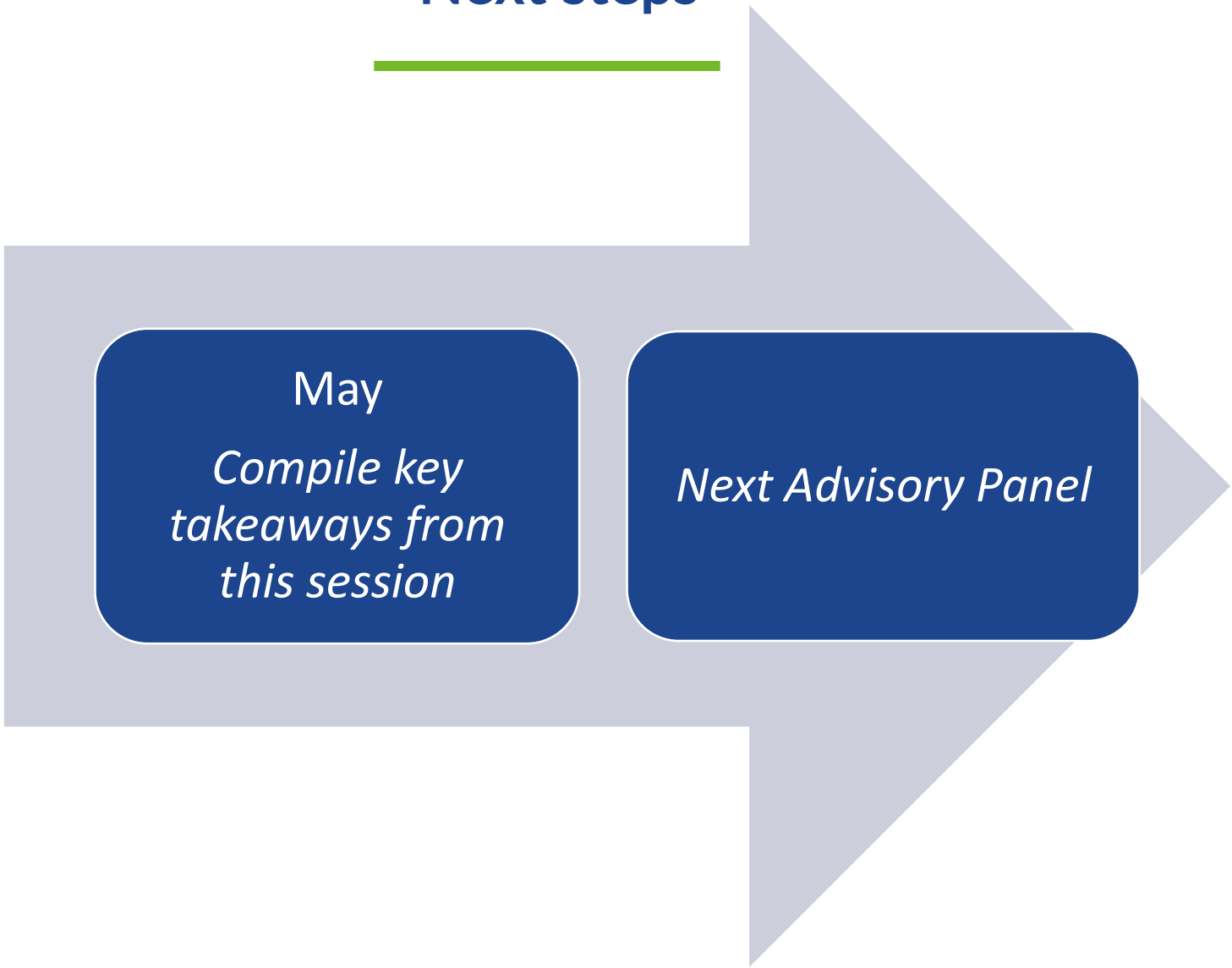
Denmark

Bifrost (TotalEnergies 80%, op.)

- Operational by 2030, targeting **5 $MtCO_2$/y** storage potential
- Pipeline sourcing from Germany
- Shipping sourcing from countries on Baltic Sea (Poland, Sweden…)

Summary and next steps

Next steps


May
Compile key takeaways from this session
Next Advisory Panel

Thank you for your attention

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