STATUS ON CCS IN DENMARK

15 SEPTEMBER 2022

AGENDA

- 13:00-13:10 Welcome
  Dan Jørgensen, Minister for Climate, Energy and Utilities

- 13:10-13:30 Denmark in a global CCS perspective
  Guloren Turan, General Manager, Global CCS Institute

- 13:30-14:00 Overview: status on implementation and the road ahead + Q&A
  Anders Hoffmann, Deputy Permanent Secretary, Ministry of Climate, Energy and Utilities

- 14:00-14:20 Update on seismic data gathering and potential storage sites + Q&A
  Nina Skaarup, Head of Department, Geological Surveys of Denmark and Greenland (GEUS)

- 14:20-14:30 Final remarks
  Anders Hoffmann, Deputy Permanent Secretary Ministry of Climate, Energy and Utilities

Welcome

Dan Jørgensen, Minister for Climate, Energy and Utilities

Denmark in a global CCS perspective

Guloren Turan, General Manager, Global CCS Institute

SEPTEMBER 2022

DENMARK IN A GLOBAL CCS PERSPECTIVE

GULOREN TURAN
GENERAL MANAGER, GLOBAL CCS INSTITUTE

GLOBAL CCS INSTITUTE

THE GLOBAL CCS INSTITUTE

Accelerating the deployment of CCS for a net-zero emissions future.

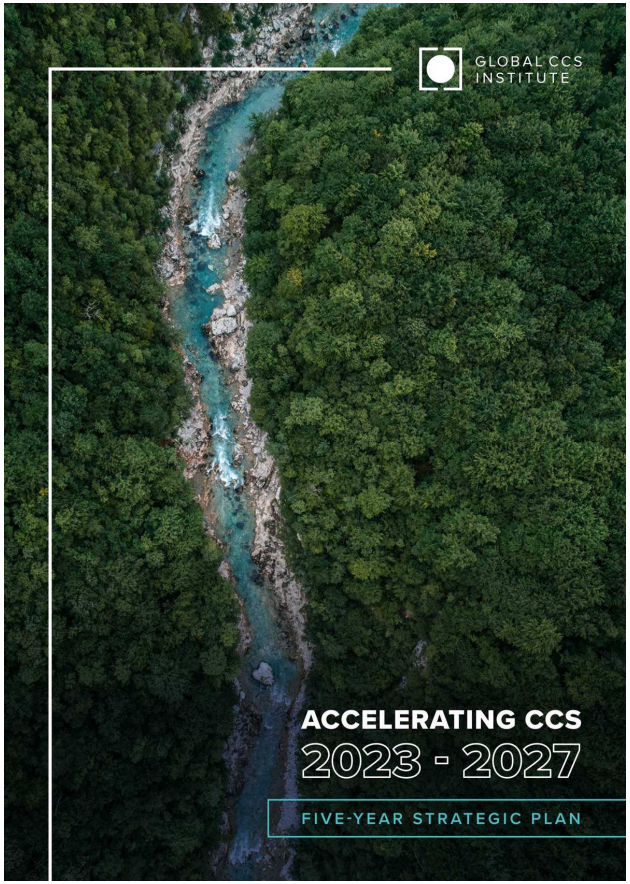
WHO WE ARE

International CCS think tank with offices around the world.

Over 150 members across governments, global corporations, private corporations, private companies, research bodies and NGOs, all NGOs, all committed to a net-zero future.

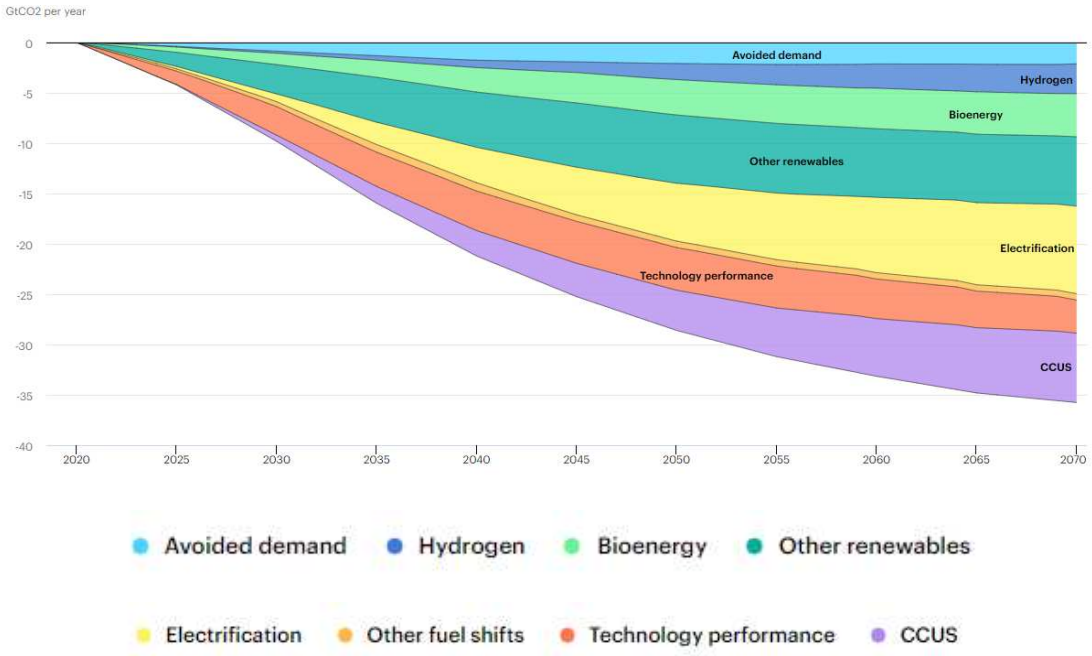
WHAT WE DO

Fact-based influential advocacy, catalytic thought leadership, authoritative knowledge sharing.



WHY CCS?

- Scientific consensus that CCS is necessary to achieve our climate goals.
- Three of four IPCC illustrative pathways require CCS.
- IEA suggests up to 15% of global emissions could be abated through CCS.



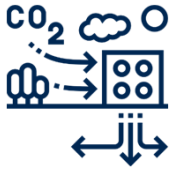
IEA 2020: Energy Technology Perspectives 2020

CCS: REACHING NET-ZERO AND DRIVING THE LOW-CARBON ECONOMY

Achieving deep decarbonisation in hard-to-abate industry.

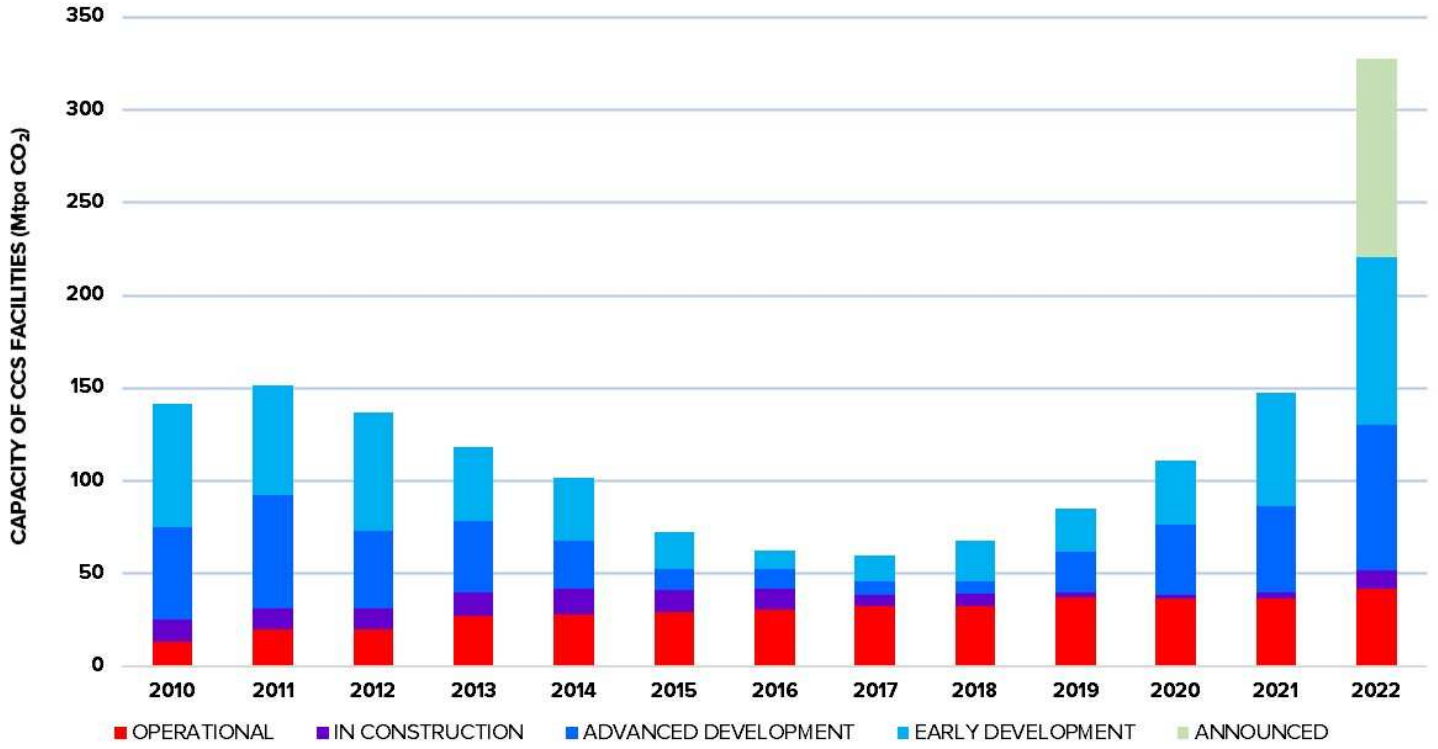
Enabling the production of low-carbon hydrogen at scale.

Providing low carbon dispatchable power.

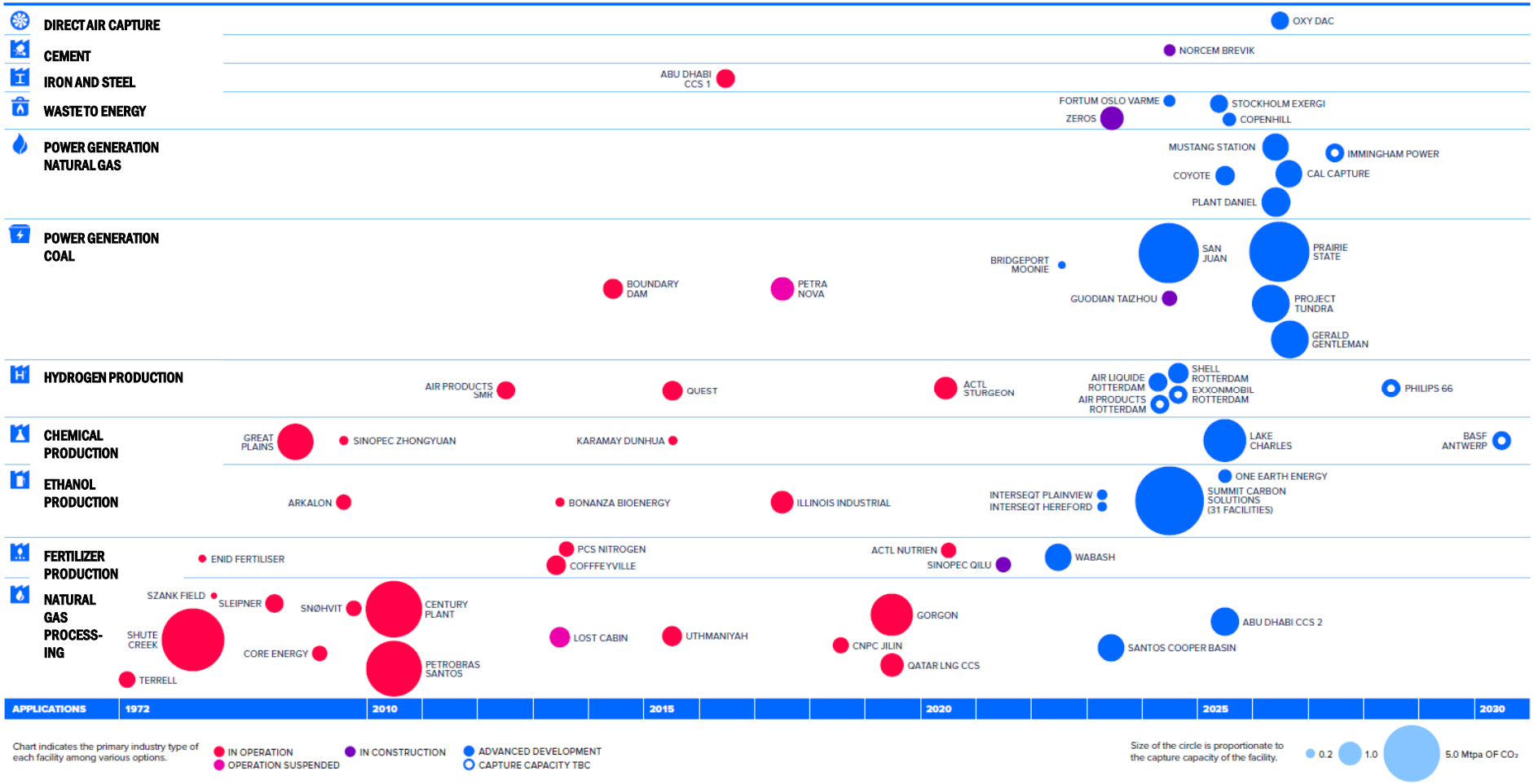


Delivering negative emissions.

THE GLOBAL STATUS OF CCS



INCREASING DIVERSITY OF CCS APPLICATIONS



DRIVERS OF CCS MOMENTUM

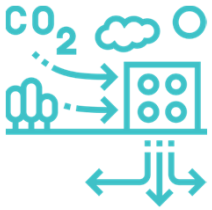
Strengthening policy support for CCS

Emergence of Strategic Business Partnerships

Net Zero Commitments

Blue Hydrogen Projects

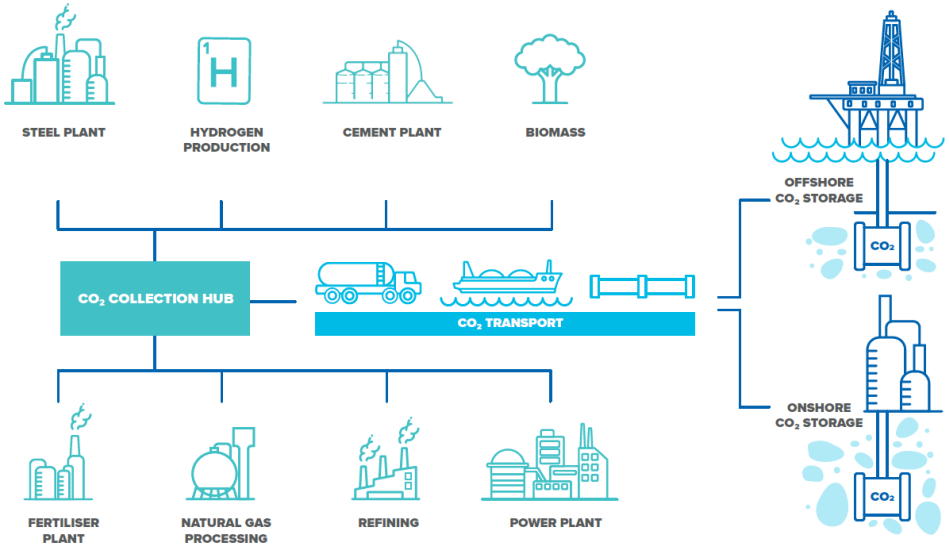
Rise of CCS Networks



Technology-based Carbon Dioxide Removal

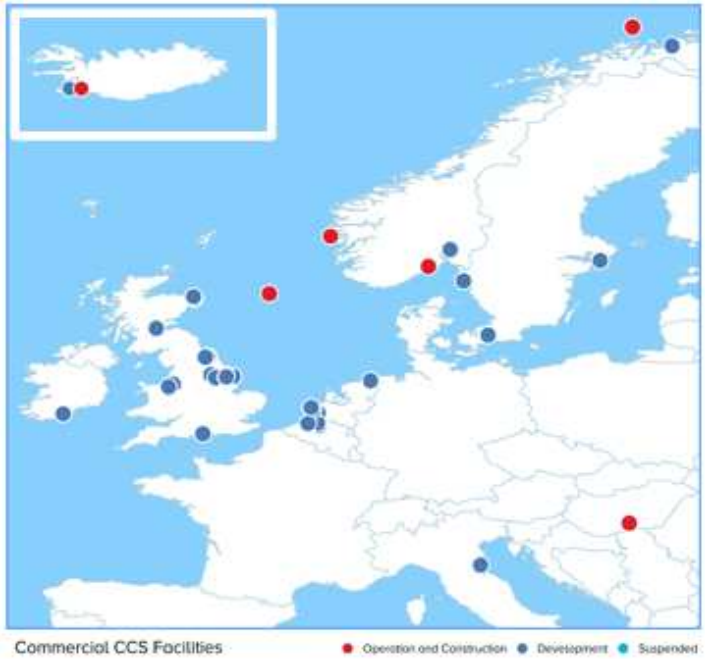
THE CONTINUED RISE OF CCS NETWORKS

- Networks continue to emerge as the preferred deployment method.
- Multiple industrial point sources of CO_2 connected to a CO_2 transport and storage network.
- Access to large geological storage resources with the capacity to store CO_2 from industrial sources for decades.
- Economies of scale deliver lower unit-costs for CO_2 storage.
- Synergies between multiple CO_2 sources and the storage operator reduce cross chain risks and support commercial viability.



CCS DEVELOPMENTS IN EUROPE

- More than 30 commercial facilities in various stages of development across Europe.
- Legislative proposals to introduce regulatory mechanisms for CCS in the EU underway.
- EU Innovation Fund to invest in 11 CCS and CCU projects, supplemented by individual member state policies.
- Denmark allocated around €5 bn for CCS projects
- Dutch Government allocated €2bn SDE++subsidy to capture facilities in the Port of Rotterdam network.



6 commercial projects operating or in construction.

32+ projects in development (not including announcements).

DENMARK AND CCUS

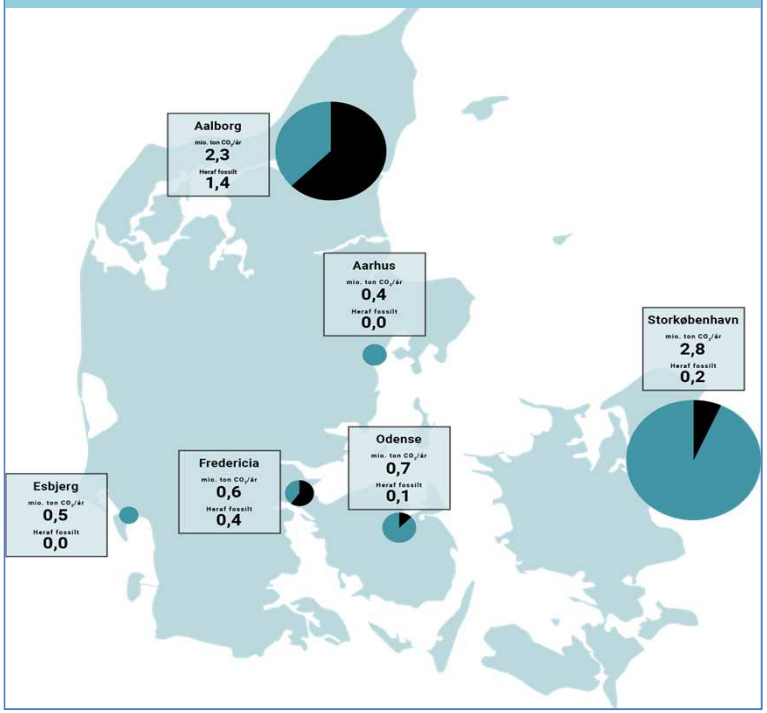
- Denmark is one of the most progressive countries when it comes to addressing climate change.
  - Denmark set its long-term goal of becoming a carbon neutral society by 2050 in 2011.
  - The Danish Climate Agreement: 70 % reduction in GHG emissions by 2030 and climate neutrality by 2050

- Denmark is looking to deploy CCUS as a part of its portfolio of climate measures.
  - It will invest €5 billion in CCUS over the coming decade through various government programs
  - Projects Greensand, Bifrost, ARC and others in the works…

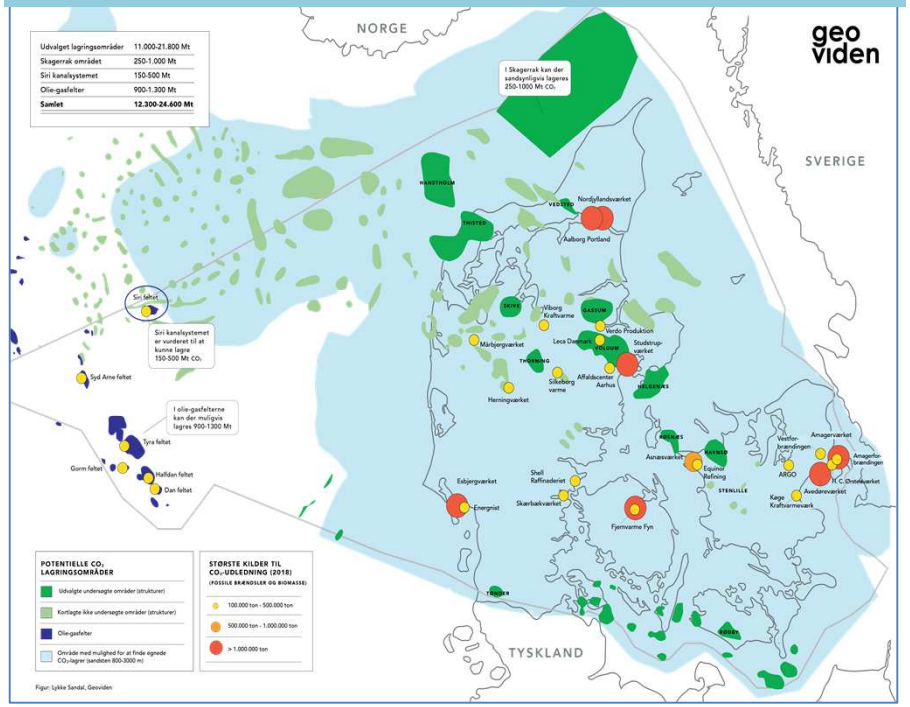
- CCUS has broad political support.
  - Cross party support in parliament, also from municipalities
  - Close engagement with all stakeholders is key

DENMARK: CAPTURE VS. STORAGE SOURCES

Main capture sources



Storage resources



Source: Klima-, Energi- og Forsyningsministeriet

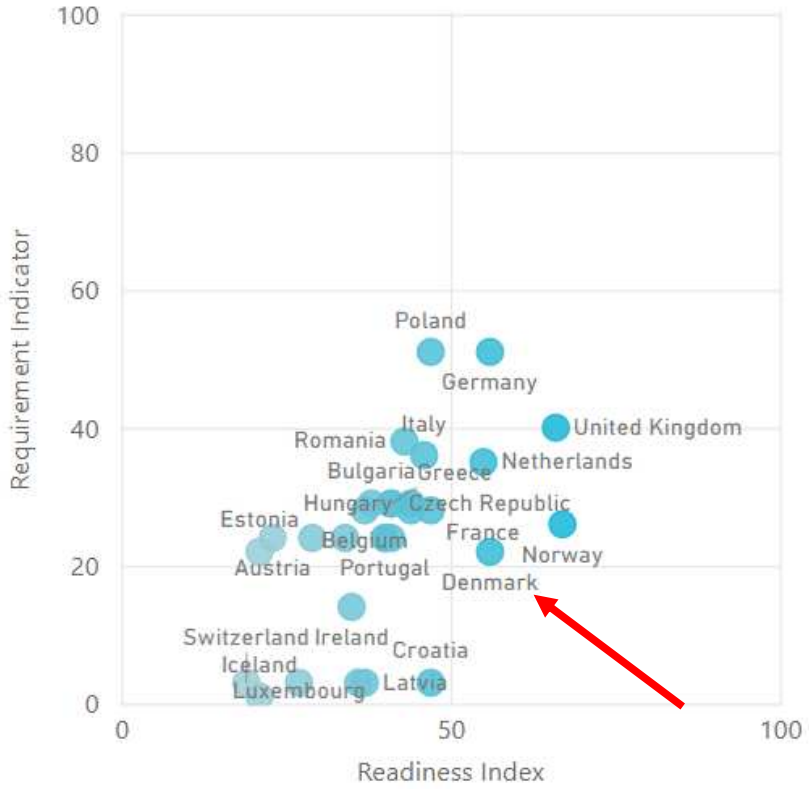
CCS READINESS AND REQUIREMENT INDICES

- First created by the Global CCS Institute in 2015
- CCS readiness indicator ranks over 50 countries for their attractiveness for investment and deployment
- Index is composed of 3 main categories
  - Endowment of storage resources and state of knowledge about those resources,
  - Each country's policy environment
  - Each country's legal and regulatory framework of relevance to CCS

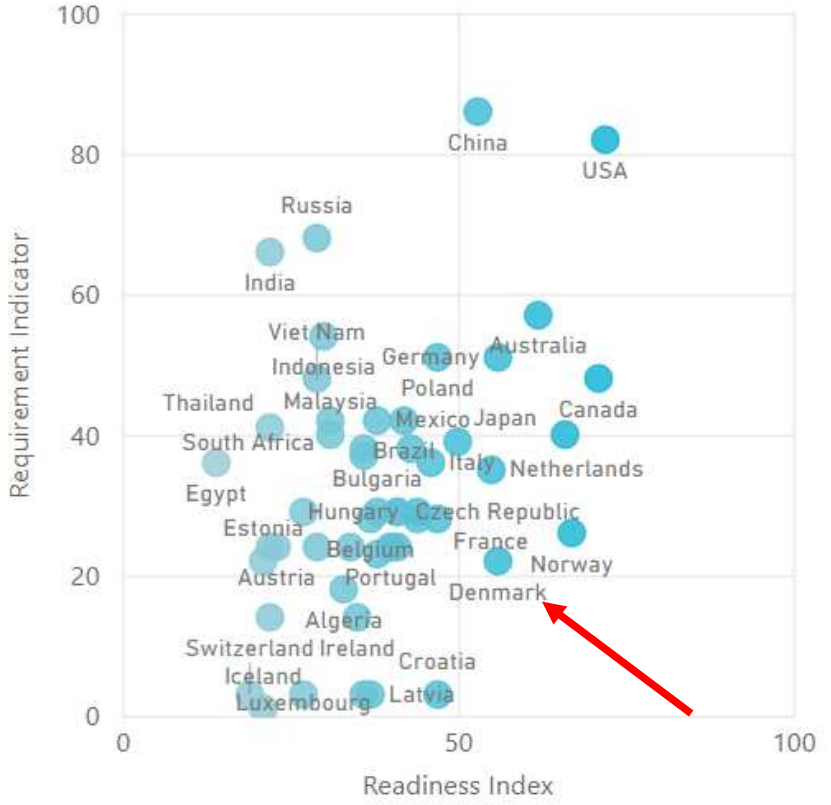
- CCS requirement indicator is relative index based on a country's share of fossil fuel production and consumption
  - Big consumer or exporters of fossil fuels rank high in this indicator (e.g. US and China)

CCS READINESS INDEX - DENMARK

Europe



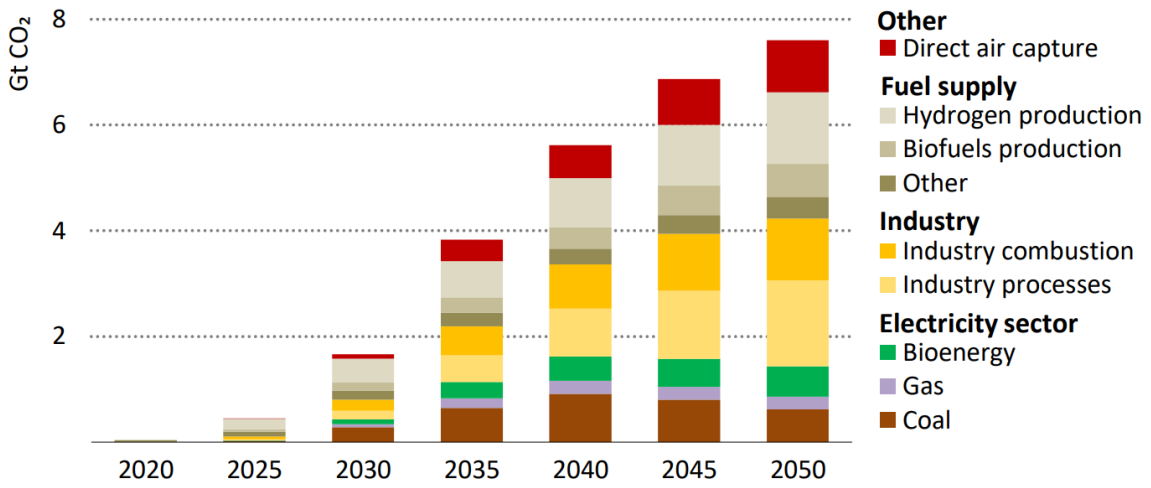
Global



Source: Global CCS Institute, https://co2re.co/ccsreadiness

CCS ACCELERATION NEEDED

- According to IEA SDS, by 2050 7.6 $GtCO_2$ captured per year, including 2.4 Gt removal from BECCS and DACCS.
- CCUS across diverse sectors and increasingly important to industry.
- Stronger policy to incentivise rapid CCS investment is required.



REALISING CCS AT SCALE GLOBALLY

Define the role of CCS and CDR in meeting national climate strategies and plans, set and communicate targets.

Create a long-term, high value on the storage of CO_2.

Support the identification and appraisal of geological storage resources.

Develop specific CCS laws and regulations.

Identify opportunities for CCS networks and facilitate the establishment of transport and storage infrastructure.

Enable investment in CCS through appropriate policy and market mechanisms.

THANK YOU

GLOBAL CCS INSTITUTE

Overview: status on implementation and the road ahead

Anders Hoffmann, Deputy Permanent Secretary,
Ministry of Climate, Energy and Utilities

STATUS ON CCS IN DENMARK

Political agreements:

- Agreement to make CCS legal and allocate 16,6 billion DKK (2,2 billion EUR) in June 2020.
- Agreement to make import/export of CO2 legal, to make DK a European hub for CCS, and to roll out CCS on market terms in the long run in CCS strategy from 30 June 2021 and 14 Dec. 2021.
- Agreement in finance act of 2022 to allocate 2,6 billion DKK (0,4 billion EUR) to achieve negative emissions.
- Agreement on state co-ownership of storage permits + pilot project in Stenlille June 21, 2022.
- Agreement on green taxation reform for industry etc. of June 24, 2022. 19.5 billion DKK (2,6 bill. EUR) to CCS.

Legislation:

- Speedier and less extensive approval process for storage pilot projects in the North Sea entered into force on 1 July 2022.
- Exempting storage and transport of CO2 from the prohibitions against dumping in the Marine Environment Act entered into force 1 August 2022.

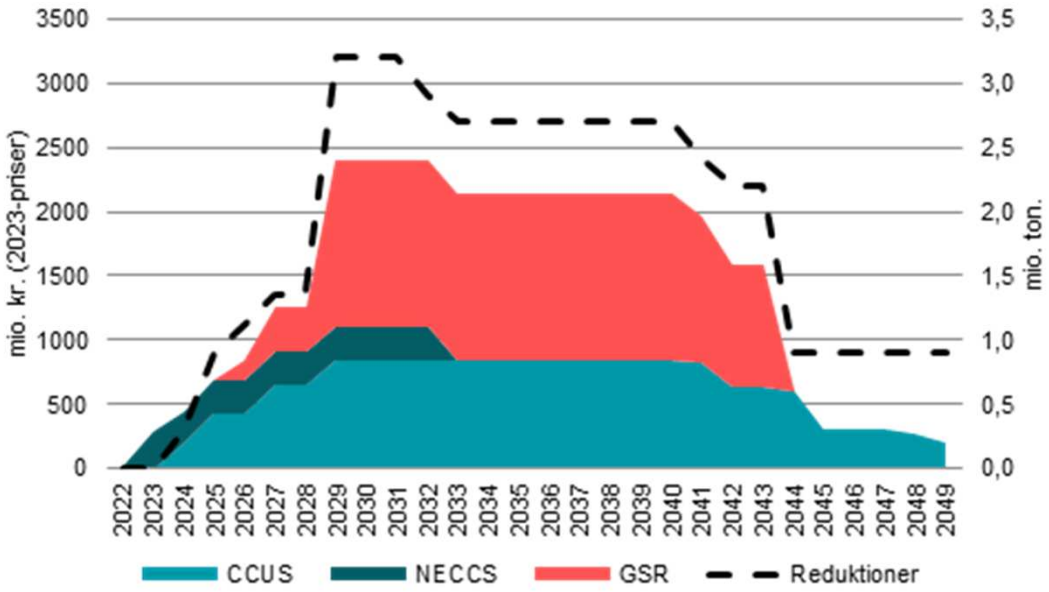
Implementation:

- Denmark's first tender for CO2 storage permits: per 15 August 2022 opening for permit applications until 1st of October 2022 for exploration and storage of CO2 in a delimited area in the Danish part of the North Sea.
- Prequalification of three organizations in the first round of the CCUS funds.
- GEUS has begun seismic preliminary studies of possible storage structures on land and near the coast and Danish Energy Authority has started the Environmental Impact assessment.
- MoU on CCUS with the Netherlands + Belgium with the aim of promoting CCUS.

Overall:

- Total funding for CC(U)S of approx. 38.7 billion DKK (approx. 5,2 bill. EUR) in 2023 prices.
- Total expected reduction estimate from CC(U)S of DKK 3.2 million. tonnes of CO2 annually from 2030.

OVERVIEW OF FUNDS



OVERVIEW OF FUNDS

Table 1
Comparison of subsidy schemes for CCS

	CCUS	NECCS	GSR
Eligible for funding	Negative emissions and reductions from technological flue gas processes	Negative emissions from technological processes.	Negative emissions and reductions from technological processes, agricultural sector excluded
Eligible sources of CO2	Fossil and biogenic	Biogenic (including DACCS)	Fossil and biogenic (including DACCS)
Contract period	Up to 20 years per contract w/ opt-out option w/ retention penalty	Up to 8 years per contract w/ opt-out option (limited retention penalty)	Up to 15 years per contract w/ opt-out option (limited retention penalty)
Pre-financing	No	Yes	No
First reduction year	2025/26	2024/25	2026/27
Support period	2024-2049	2023-2032	2026-2043
Budget (2023-prices)	16,6 mia. kr.	2,6 mia. kr.	19,5 mia. kr.

Projects

- GEUS: storage potential of the saline aquifers in the Danish part of the North Sea is enormous + great potential onshore and nearshore.

- Off-shore storage projects under development in depleted oil- and gas fields + NEW demo project on land:

- Project Greensand:
  - INEOS consortium (Maersk Drilling, GEUS, Wintershall DEA etc.)
  - Storage capacity of 0,5-1,5 mio. ton CO_2 /y in 2025 and 4-8 mio. ton CO_2 /y in 2030.

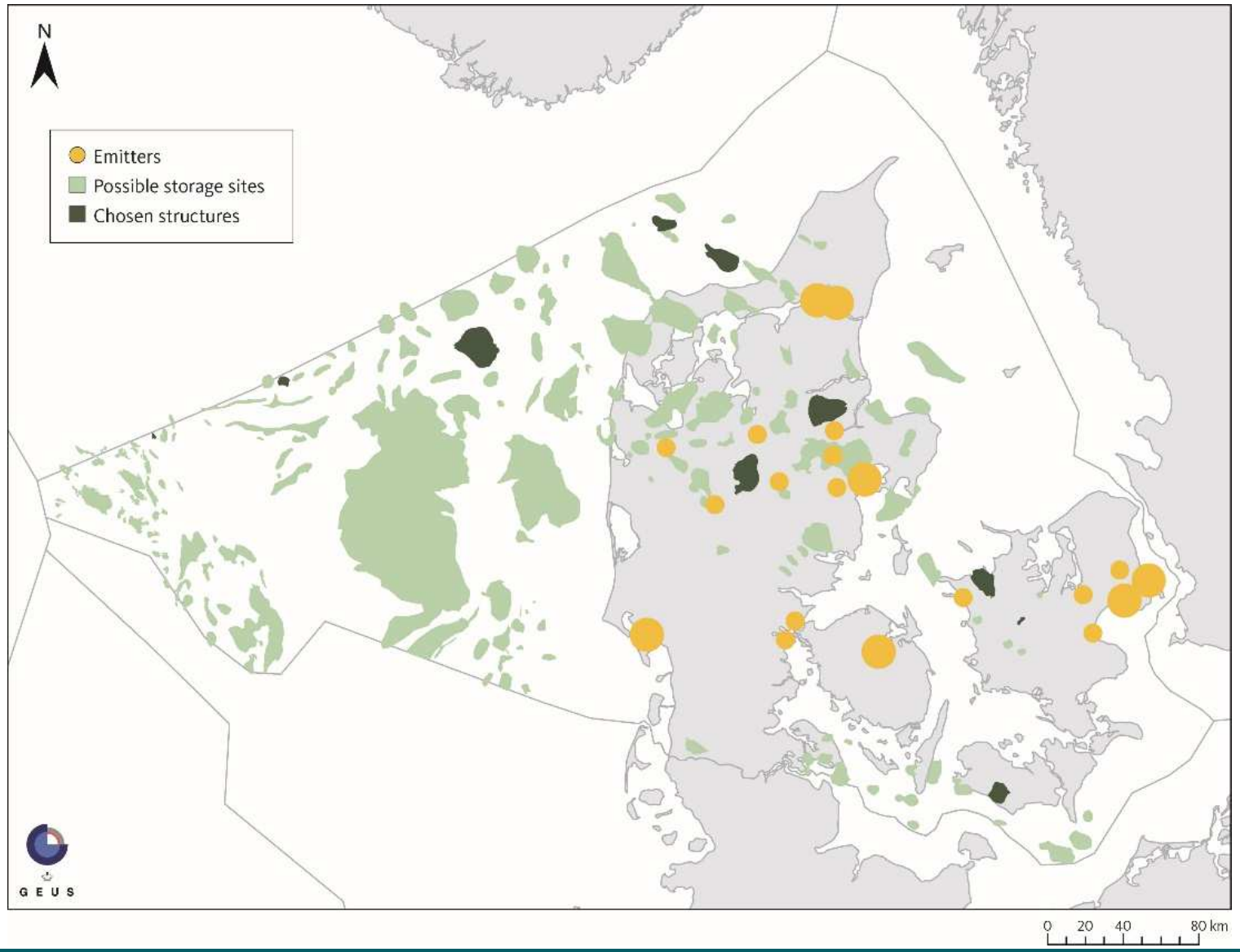
- Project Bifrost:
  - TotalEnergies consortium (Noreco, Nordsøfonden, Ørsted, DTU etc.)
  - Storage capacity of 3 mio. ton CO_2 /y in 2027 and a long term potential of 16 mio. ton CO_2/y.

- Stenlille demo project
  - Storage capacity of 0,5 mio. ton CO_2 /y in 2025, total potential of 2,5 mio. ton.

OVERVIEW OF POTENTIAL CO2 STORAGE SITES – PHASE 1

Site	Municipality	Type	GEUS planning starts	GEUS conducting seismic survey	GEUS repport	Danish Energy Agency conducting EIA
Gassum	Mariagerfjord og Randers	Onshore	Aug. 2022	Feb. 2023	Oct. 2023	Started, expected to finish end 2023
Havnsø	Kalundborg	Onshore	March 2022	Aug. 2022	April 2023	Started, expected to finish end 2023
Inez	-	Nearshore	Not necessary, structure mature enough	-	-	Started, expected to finish end 2023
Jammerbugt	-	Nearshore	Aug. 2022	April 2023	Jan. 2024	Started, expected to finish end 2023
Lisa	-	Nearshore	Not necessary, structure mature enough	-	-	Started, expected to finish end 2023
Rødby	Lolland	Onshore	Oct. 2022	Late spring 2023	Spring 2024	Started, expected to finish end 2023
Stenlille	Sorø	Onshore	Aug. 2021	Feb. 2022	Oct. 2022	Started, expected to finish end 2023
Thorning	Ikast-Brande, Silkeborg, Viborg	Onshore	Oct 2022	August 2023	Spring 2024	Started, expected to finish end 2023

Note: Timeline subject to change, and dependent on dialogue with relevant municipalities.


N
Emitters
Possible storage sites
Chosen structures
GEUS
0 20 40 80 km

PROCESS: ENVIRONMENTAL IMPACT ASSESSMENT

- 1st public phase is expected to begin at the end of October 2022
- Consultation of other authorities is expected to begin at the end of March 2023
- 2nd public phase is expected to begin in June 2023
- Entire process expected to be finished end 2023.

NEXT STEPS

Transport:

- First bilateral arrangement on transportation expected soon
- Recommendations from 6 cluster collaborations on CCUS infrastructure expected on 2nd of January 2023
- Allocation of pipeline responsibilities
- CO2 transportation legislation

Storage:

- First tender permit round for on shore and near shore storage sites expected to take place soon after EIA has ended.

Funding schemes:

- Negative emissions funding scheme expected to be announced end 2022
- Winner of first phase of the CCUS fund expected to be announced primo 2023

Questions?

Update on seismic data gathering and potential storage sites

Nina Skaarup, Head of Department,
Geological Surveys of Denmark and Greenland (GEUS)

CO_2 is stored in a closed structure

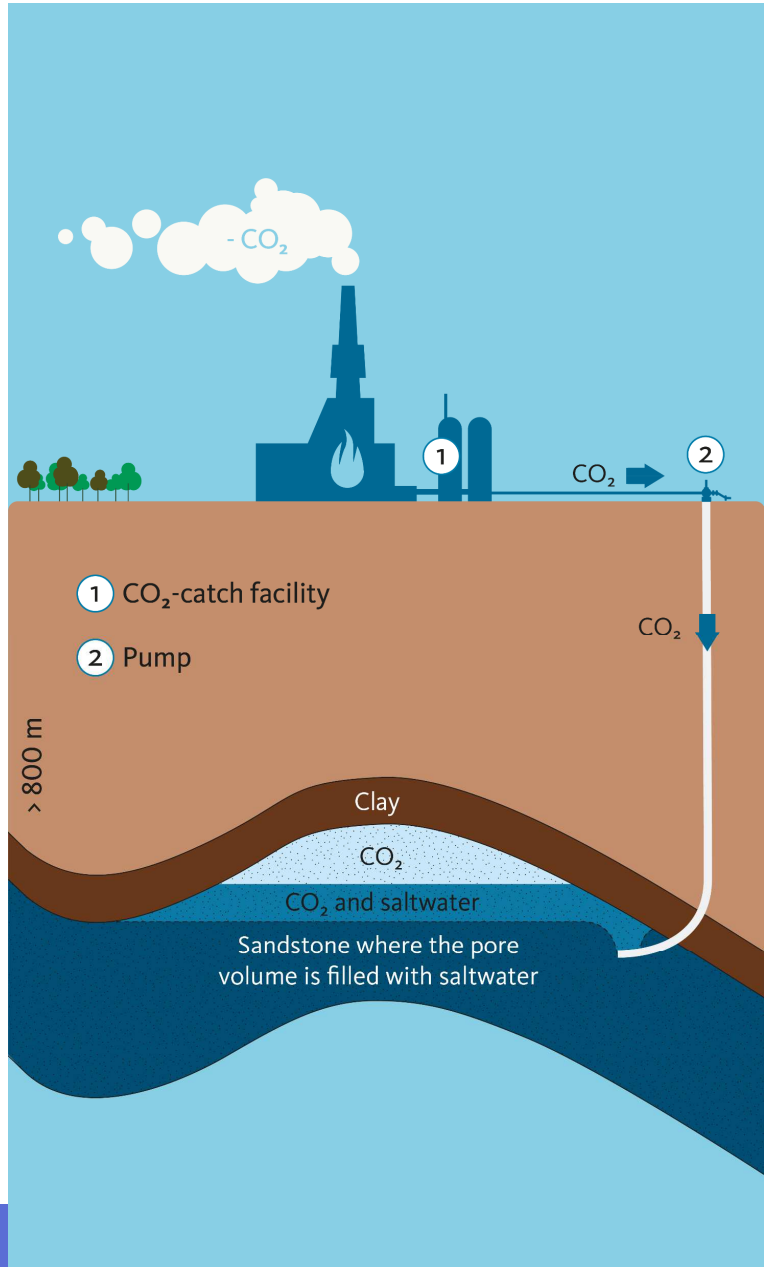
CO_2 is pumped through a pipe at least 800 meters into the underground – into a sandlayer.

Here, CO_2 is distributed in the small pore spaces, deep in the subsoil.

Ideal areas in the underground are e.g. places where thick layers of sandstone are found in a closed dome structure.

The sandstone must lie at a depth of at least 800 meters and have many connected pore spaces.

Above there must be a thick layer (a lid or seal) of impermeable rocks such as clay stone, so that CO_2 remains in the reservoir/sandstone.



Example of survey

The seismic survey takes place on the roads marked in blue on the map in the Havnsø area in northern Sealand.

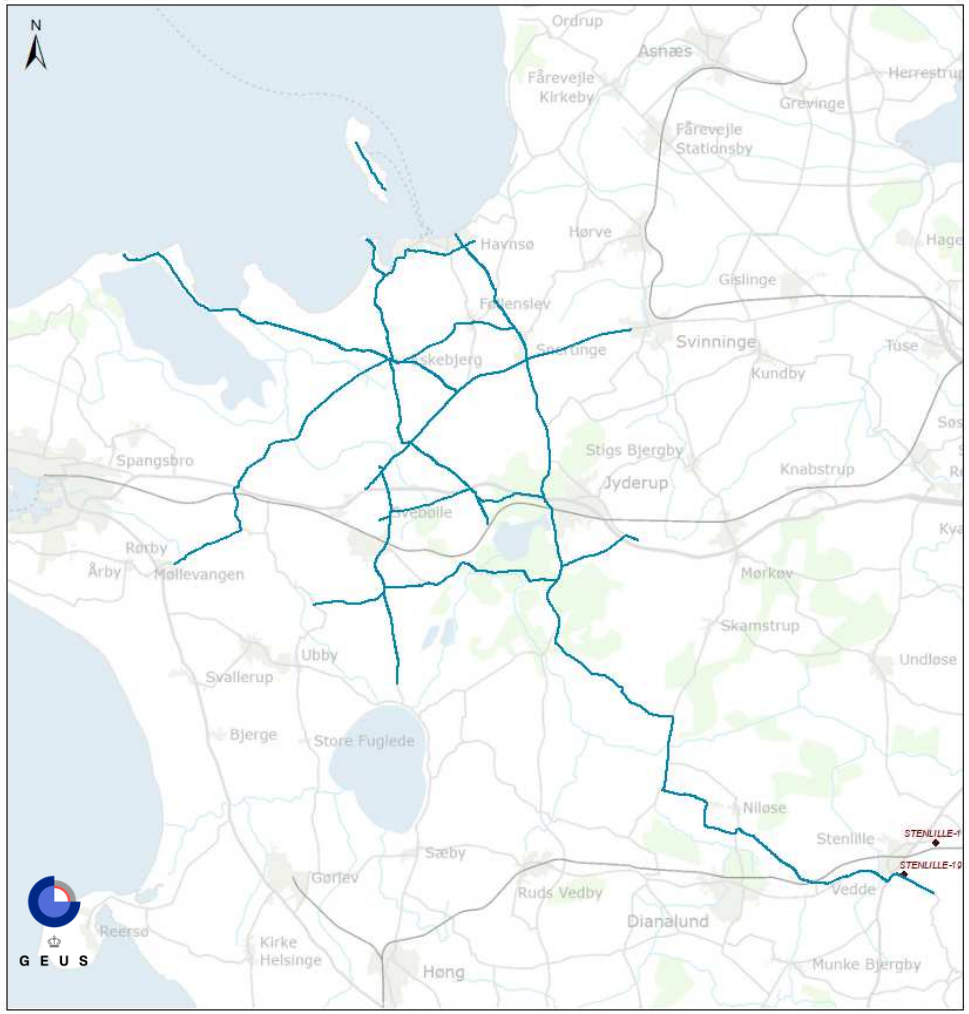
Starts at Stenlille in August 2022 and ends in October 2022.

Moves approx. 2 km per day along the blue lines on the map.

Take into account the traffic as much as possible.

There are done huge efforts to guide the public traffic, and to avoid roadblocks as much as possibly.

A detailed map can be seen on the website:
kortlink.dk/2fx69



Planned collection lines over Havnsø structure

Data collection

- vibrations are reflected from the subsurface

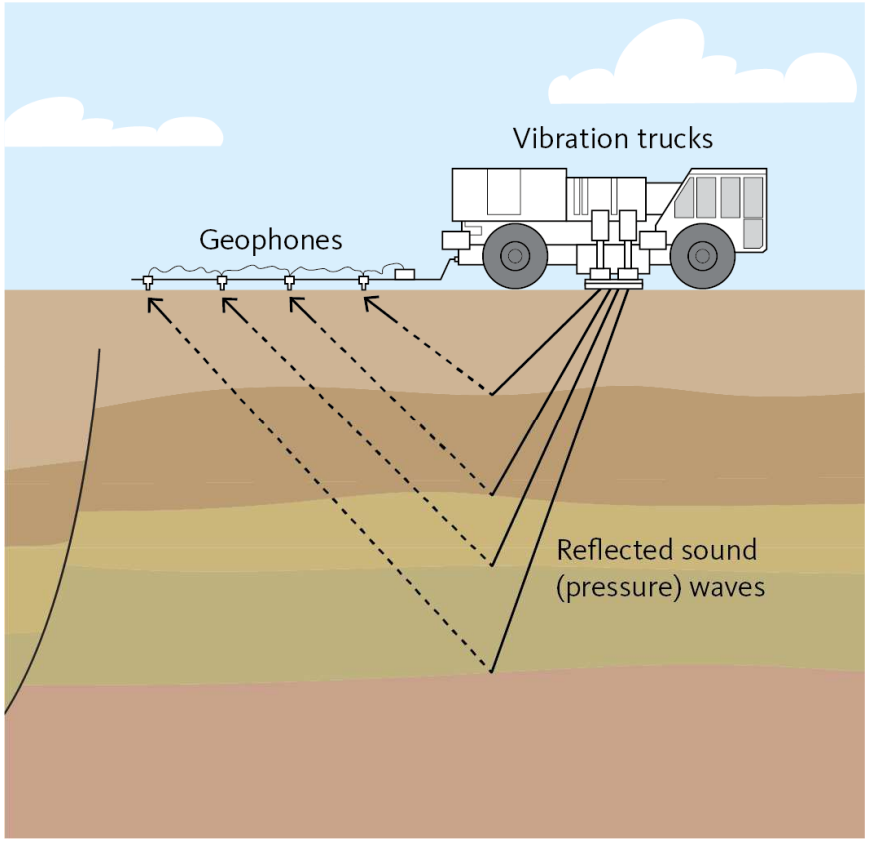
Two mini-trucks transmit small seismic vibrations, which are reflected by the layers of the subsoil and picked up by geophones – a form of microphones on and by the road.

Three short periods of vibration are emitted for every ten meters. Each period lasts approx. 16 seconds from low to higher frequency.

The vibrations can initially, at a low frequency close to the source, be felt in the ground, like a hum or like a truck passing by.

Uppsala University leads the collection with the assistance of students from universities in Copenhagen and Uppsala.

Highly sensitive monitoring equipment ensures that the vibrations are kept below the limit values defined by the German standard DIM 4150-3.

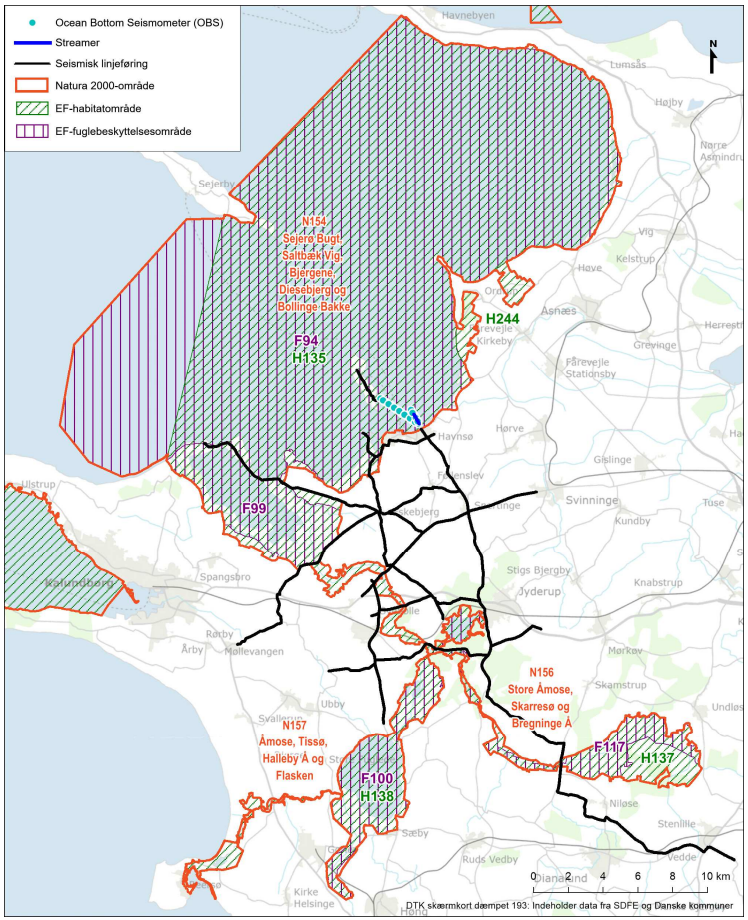


Equipment

Wireless geophone (sound/vibration recorder)

Sensitive measuring equipment ensures that the vibrations do not exceed the limit value

Respect for nature



The study takes into account the nature in the area – and runs e.g. only on the roads, and not on fields or parks, etc.

COWI has made an environmental impact assessment that reviews the protected species in the affected habitats.

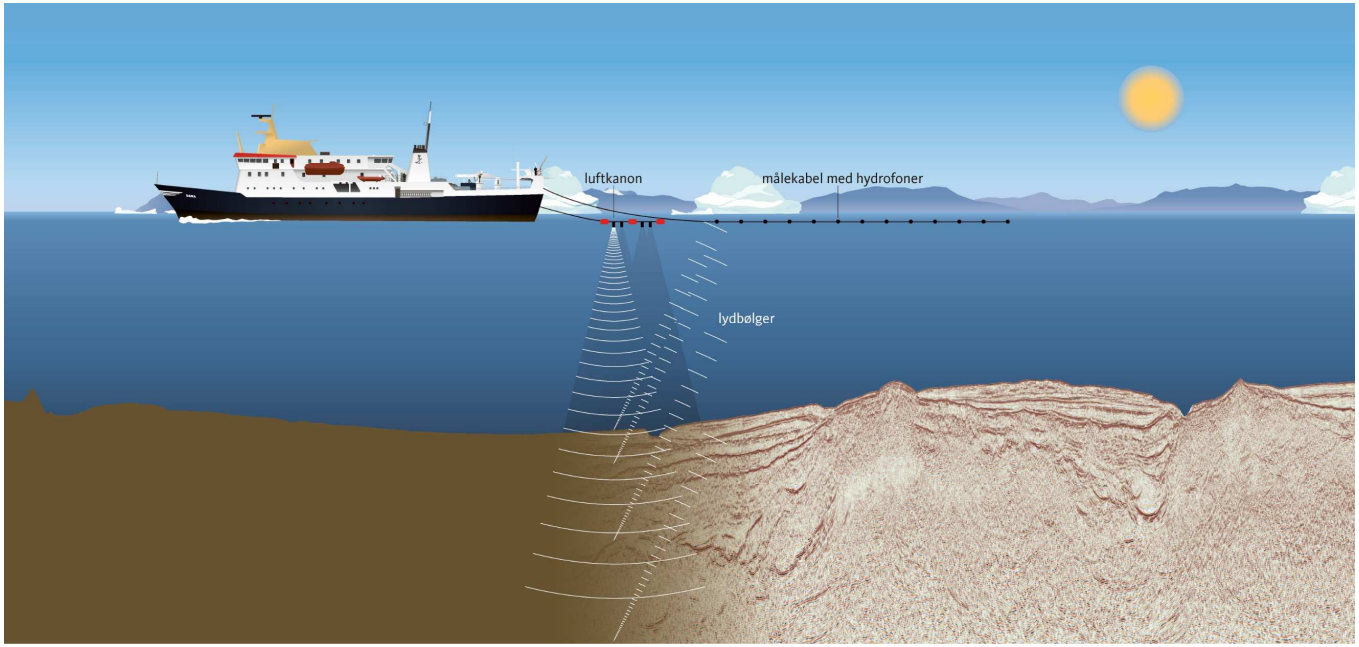
The conclusion for the Havnsø area is that the survey will not cause a significant impact on species and nature types in the Natura 2000 areas.

The assessment must be approved by the Danish Energy Agency.

Data collection
- vibrations are reflected from the subsurface

At sea, pressure waves are transmitted by a ship and hydrophones – microphones on the water – pick up the seismic signals reflected by the various layers in the subsurface

Aarhus University will take part in the data collection together with the German research institute BGR and the new Faroese research vessel Jakup Sverri from the Havstovan Institute.



Final remarks

Anders Hoffmann, Deputy Permanent Secretary,
Ministry of Climate, Energy and Utilities