

Velkommen til CCUS-alliancemøde 14. marts 2024

Velkomst

v. Kristian Jensen, Adm. Direktør,
Green Power Denmark

Dagsorden for CCUS-alliance møde d. 14. marts 2024

Lokation: Pressen, Vestergade 28, 1456 København K, i lokale "Salen".

Dato: 14. marts 2024, 15.00-17:00

Moderator: Finn Lauritzen, Axcelfuture

15.00-15.05 Velkomst v. Kristian Jensen, Adm. Direktør, Green Power Denmark

15.05-15.25 Den europæiske CCUS-strategi v. Johanna Fiksdahl, CCUS Policy Officer, DG Energy.

15.25-15.40 Etablering af en samlet CO2-infrastruktur – synergier mellem CCU og CCS v. Torben Franch, Regional low carbon fuels lead, DNV

15.40-16.00 Kassø-projektet: erhvervseffekter og eksportpotentialer v. Mathias Aarup Berg, Head of Regulatory Affairs, European Energy

16.00-16.20 Udkast til anbefalinger til dansk CCU-indsats – Kristian Jensen, Adm. Direktør, Green Power Denmark

16.20-16.55 Paneldebat om accelereret CCU-indsats:

Ulrik Stridbæk, Chef for Regulatory og Public Affairs, Ørsted

Lisbeth Sørensen, Business Opportunity Manager, Crossbridge

Charlotte Søndergren, Direktør for forsyningsstrategi og vind, HOFOR

Sara Westphal E. Neergaard, Director of Communication and Public Affairs, Denmark Norwegian

Jacob K. Clasen, Viceadm. Direktør, Danske Rederier

16.55-17.00 Eventuelt og øvrige arrangementer

Charlotte Larsen, DTU Offshore, invitation til kommende arrangement

Herefter byder Green Power Denmark på et glas bobler og lidt snacks

Den europæiske CCUS-strategi

v. Johanna Fiksdahl, CCUS Policy
Officer, DG Energy

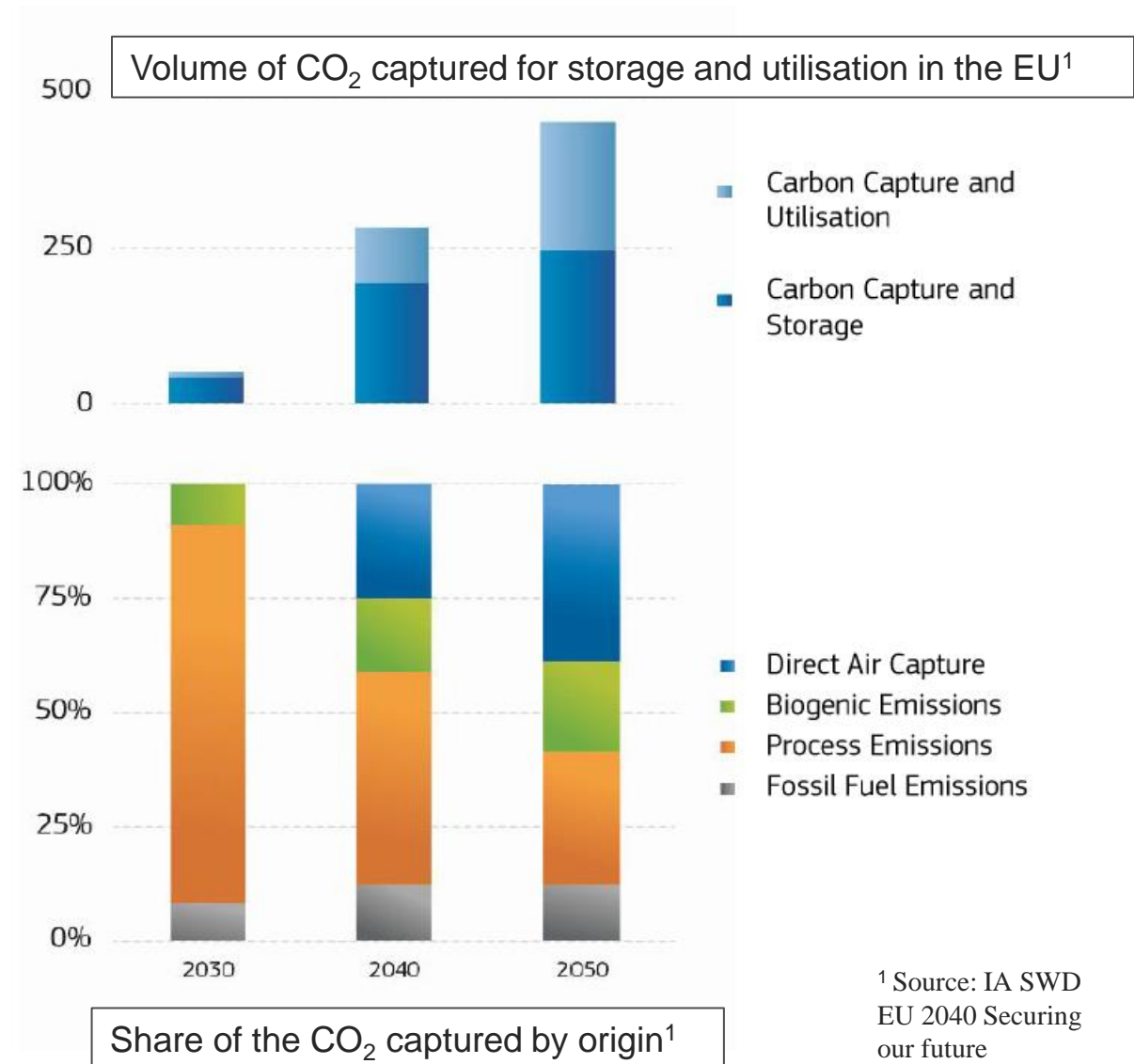


Towards an ambitious Industrial Carbon Management (ICM) for the EU

Johanna Fiksdahl, DG ENER

The 2040 Climate Target Communication

- ICM essential complement to mitigation that is necessary in the first place
- ICM key to reduce and manage carbon emissions in industrial processes
- Then, need for a shift towards biobased and air-captured CO₂ streams
- CO₂ capture needs:
 - 2030: ~50 Mtpa
 - 2040: ~280 Mtpa (~250 Mtpa for storage)
 - 2050: up to 450 Mtpa
- **EU today: 10 Mtpa capture projects supported by the Innovation Fund – no CO₂ storage site operational**



Industrial carbon management in Europe

EU Level

- NZIA: CCS as a strategic net-zero technology. 50 Mtpa storage target with investment obligation
- CCS Directive
- EU ETS + EU Innovation Fund
- RFNBOs and synthetic fuels
- Carbon Removal Certification Framework
- 14 CO₂ projects in the 1st PCI/PMI list under TEN-E: 5 awarded CEF
- CCUS Forum: plenary + WGs, new ones to be established for 2024

MS Level

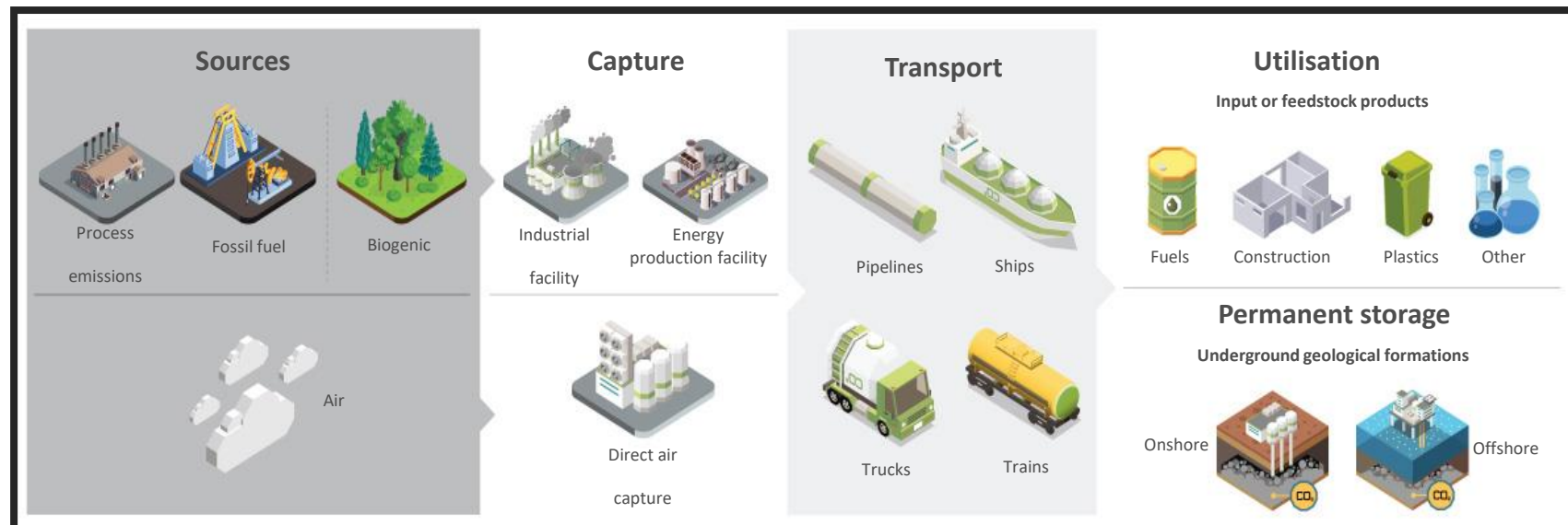
- 20 MS include ICM in NECPs
- 7 MS include ICM in Recovery and Resilience Plans
- DK, NL + NO w/ ICM subsidies and pioneering CO₂ storage
- FR, DE & AT developing ICM strategies

Three pathways and transport as key enabler

The strategy focuses on three main technological pathways:

- Capturing CO₂ emissions for storage (CCS)
- Removing CO₂ from the atmosphere (BioCCS and DACCS)
- Capturing CO₂ for utilisation (CCU)

CO₂ transport infrastructure = **key enabler** necessary to establish a fully-fledged CO₂ market in Europe.



Capturing and storing CO₂

Aim(s): Decarbonisation option for industry (ETS = incentive).

Challenge(s): No operational storage sites (NZIA), no storage market, limited bargaining power, lack of geological data, insufficient investments.



Commission will develop:

- **CO₂ demand aggregation platform** to match demand and supply for storage.
- **CO₂ Storage Atlas for the EEA** to identify several gigatonnes of investable geological storage capacities for 2040 and beyond
- **Guidance:** CO₂-specific value chain “leakage” risks, transfer of storage responsibility, and financial security requirements under CCS Directive.

Member States:

- support **Net Zero Strategic Projects** under NZIA.
- Facilitate **storage permits**
- Empower geological services to create **CO₂ Storage Atlas for investors.**

Removing CO₂ from the atmosphere

Aim(s): Support industrial carbon removals are key to EU climate neutrality.

Challenge(s): Not fully recognized by existing legislative framework, cost of carbon removals, different stages of maturity.



Commission will:

- **Assess overall objectives for carbon removals** in line with the 2040 climate ambition and the achievement of climate neutrality by 2050 and negative emissions thereafter.
- **Develop policy options and support mechanisms**, including if and how to account for them in the EU ETS.
- **Boost EU research, innovation and early-of-a-kind demonstration** for novel industrial technologies to remove CO₂ with resources under Horizon Europe and the ETS Innovation Fund.

CO₂ utilisation

Aim(s): Recognise CO₂ as a valuable resource, to replace fossil carbon with real climate benefits.

Challenge(s): Heterogeneity of CCU pathways, accounting framework not fit for all CCU purposes, no price incentive for some types of CCU.



Commission will:

- **Consider options for higher uptake** of sustainable carbon as a resource in industrial sectors.
- **Establish a coherent framework for the accounting of all industrial carbon management activities** to accurately reflect the climate benefits along their value chains.

CO₂ transport infrastructure

Aim(s): A single CO₂ market for Europe: non-discriminatory, open-access, transparent, multimodal, cross-border. Harmonisation and flexibility

Challenge(s): High upfront costs, complicated coordination across value chains, lack of business case.



Commission will:

- Initiate preparatory work for a possible future **CO2 transport regulatory package**.
- Work towards an EU-wide **CO₂ transport infrastructure planning mechanism**.
- Consider nominating **European coordinators** to support the early development of (cross-border) infrastructure projects.
- Develop **emissions accounting rules** in the context of the EU ETS.
- Work with the European standardisation bodies to establish minimum **standards for CO2 streams**.
- Promote through the International Maritime Organization the development of **guidelines on safe transportation of CO₂ by sea**.

Investments and funding

Status quo: Already a number of EU policies in place to support ICM:

- EU ETS + EU IF: 26 CCS/CCU projects, > 3.3 BNEUR
- PCI/PMI under TEN-E and CEF: 14 CO2 projects of which 5 awarded CEF

Aim(s): Support first-of-a-kind deployments in the EU.

Challenge(s): first-of-a-kind projects are costly but need to scale up the market.



Commission will:

- Work with MS, to make use of **JEF-IPCEI**, in the context of ICM.
- Consider **market-based funding mechanisms** (such as competitive bidding auctions as a service under the IF) for certain ICM technologies
- Engage with the **EIB** on financing of CCS and CCU projects.
- Announcing the assessment of **investment needs for ICM up to 2040 and 2050.**

Conclusion

Member States and the Commission need to work together to increase certainty for investors and to ensure real and quantifiable environmental benefits.

- **To reach climate neutrality by 2050 the EU needs a policy framework for industrial carbon management.**
- **The technological solutions to capture, transport, use and store CO₂ are available, but need to be deployed at scale, both avoid emissions in industry / energy production and to start removing CO₂ from the atmosphere.**
- **Theoretical geological CO₂ storage possibilities and CO₂ transport infrastructure need to become bankable climate solutions.**
- **Captured CO₂ is a valuable commodity that should be used.**

Etablering af en samlet CO2- infrastruktur – synergier mellem CCU og CCS

v. Torben Franch, Regional low
carbon fuels lead, DNV



WHEN TRUST MATTERS

Denmark as a European CO2 hub

CCUS Alliance meeting

Torben Franch

14 March 2024



About DNV

A global assurance and risk management company

160

years

~16,000

employees and associates

~100,000

customers

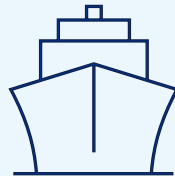
100+

countries

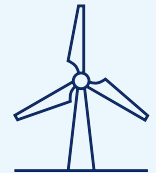
5%+

of revenue in R&D

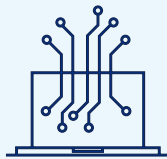
Ship and offshore
classification and advisory



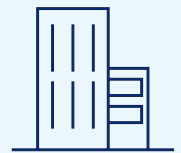
Energy advisory, certification,
verification, inspection and
monitoring



Software, cyber security,
platforms and
digital solutions



Management system
certification, supply chain and
product assurance



Introduction

Why Denmark as a CO2-hub?

For CO2hub Europe, DNV has analysed two scenarios for developing a Danish CO2 infrastructure.

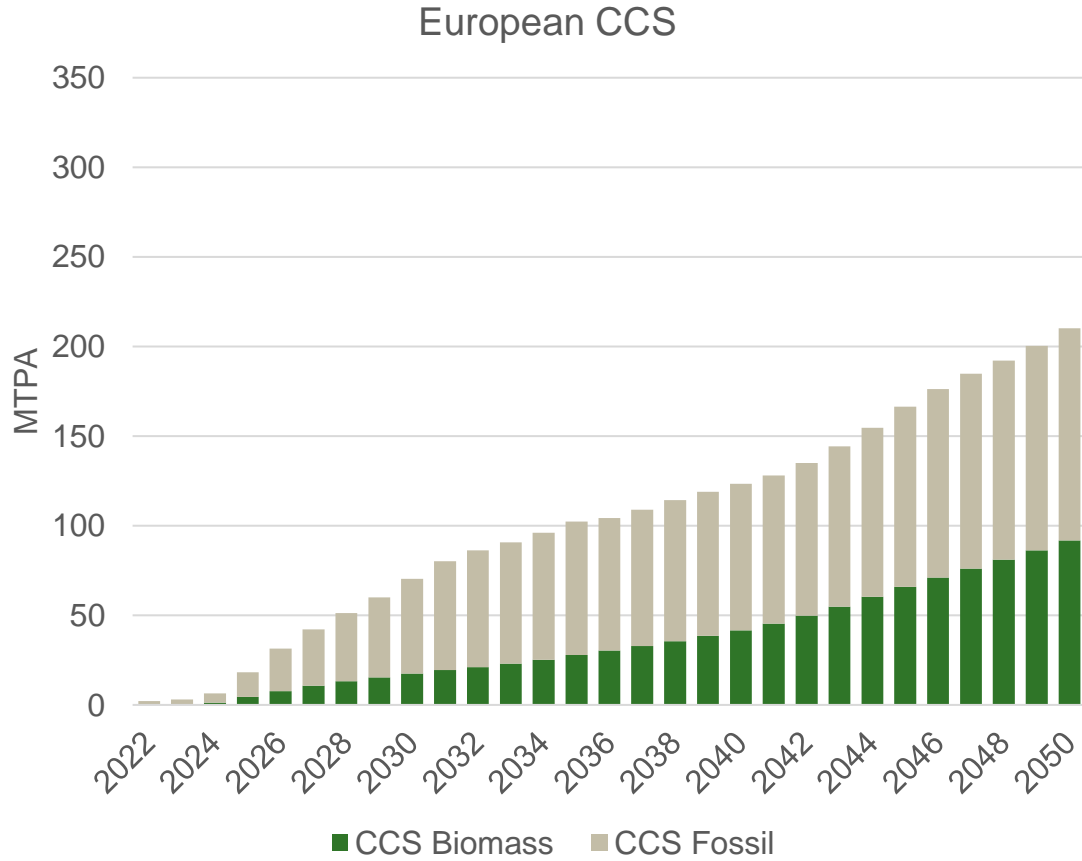
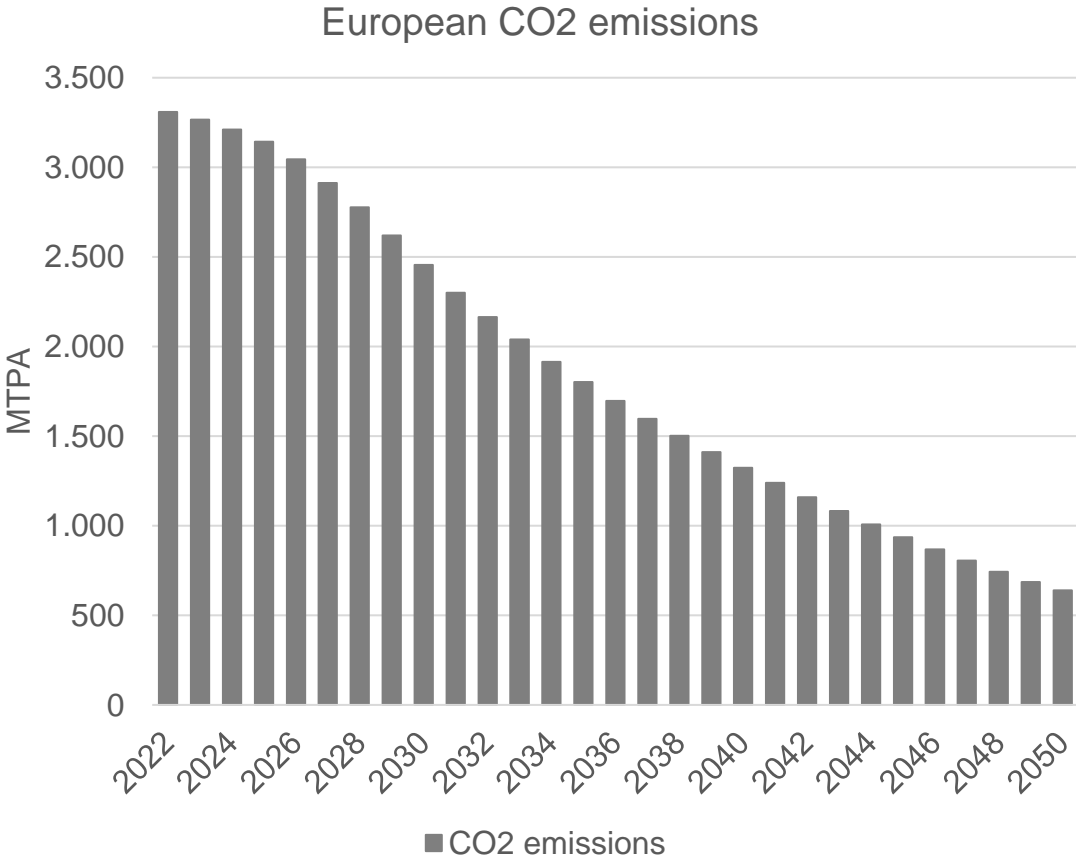
Why Denmark as a CO2 hub:

- CCS is part of strategy for reaching Danish and EU climate targets
- Good potential for CO2 storage sites
- Neighbouring countries need CO2 storage



European market for CCS

CCS is an important contribution to European CO2 neutrality but not a fix all



Source: DNV ETO 2023

Source: DNV ETO 2023

The report

Denmark as a European CO2 hub

The report maps and evaluates scenarios for the business potential of a CO2 storage industry in Denmark.

The report covers four main topics:

1. Market and Regulatory Review
2. Scenario Development
3. Cost Estimation
4. Cost-Benefit Analysis

Two main scenarios:

- “Each on their own” – an uncoordinated, project-by-project development
- “Build and they will join” – a coordinated, integrated development



“Each on their own”

Project-by-project development scenario

An uncoordinated project-by-project scenario based on current political incentives:

- Uncoordinated capture projects and storage projects
- Onshore storage development is expected to start later and take longer compared to the development of Danish capture projects

Positive results from the cost-benefit analysis gives positive results, but

- economic efficiency is lower than in the coordinated scenario
- captured Danish CO2 is exported and imported CO2 is stored in Danish storages

MTPA	Captured CO2	Imported CO2	Exported CO2	Injected CO2	Total
Ålborg	1	2.5	-0.5		3.0
Gassum				-3.0	-3.0
Esbjerg	0.3		-0.3		0.0
Kalundborg	0.5	3.0	-0.5		3.0
Havnsø				-3.0	-3.0
København	1.6		-1.6		0.0
Total	3.4	5.5	-2.9	-6.0	0.0



Source: Google Maps. Location of Ports has been applied manually.

“Build and they will Join”

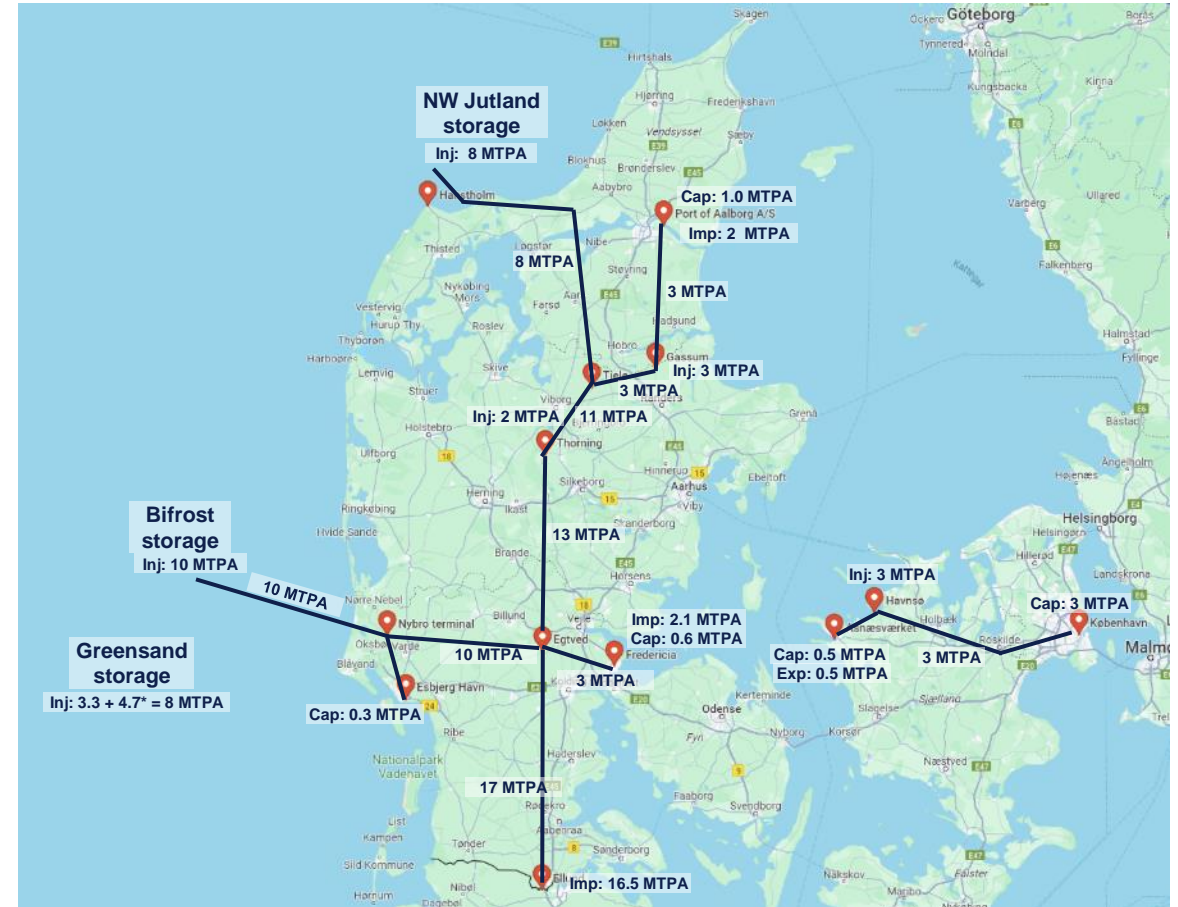
Coordinated scenario

Coordinated development of storage sites and backbone pipeline grid.

- Planned, built and in operation simultaneously - in a rough 2030 timeline.
- Pipeline infrastructure designed to facilitate the expected storage capacity and take into account domestic and imported CO2 volumes.

The coordinated scenario will probably require a degree of government participation and coordination and in return:

- Better economic efficiency and higher socio-economic value
- Better facilitation of Danish CCUS as CCS and PtX does not have to be co-located
- Captured Danish CO2 is stored in Danish storages and significant contribution to storage of CO2 emissions from neighbouring countries
- Investing in infrastructure instead of spending money on shipping



Source: Google Maps. Location of storage sites has been applied manually.

Main findings

What do the scenario outcomes show us?

1. Investments are significant but also potential benefits
2. Lead times and coordination of project planning across the value chain is key
3. Economies of scale and import volumes are vital to realise a substantial CCS-industry in Denmark and to effectively support CCU
4. If a backbone-based CCS-industry is developed, Denmark can have a competitive edge compared to other European countries developing CO₂ storage

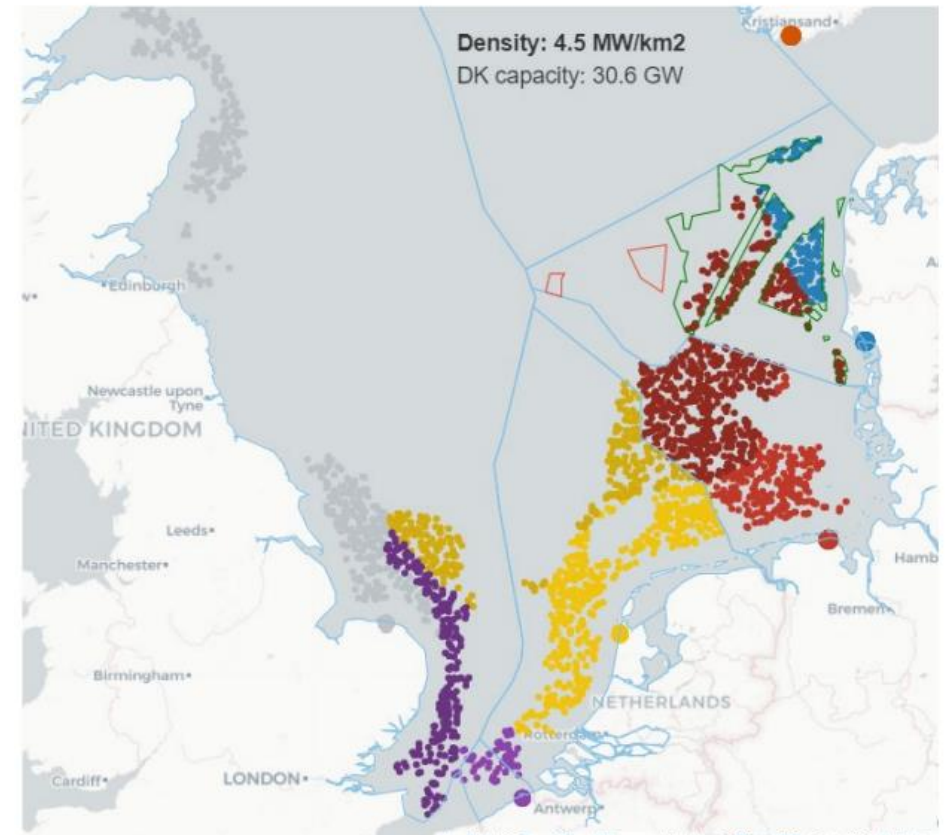


But it is also about CCU

Realising the Danish offshore wind potential

1. Denmark has a very significant potential for producing electricity from offshore wind
2. Building electric interconnectors are expensive and time consuming
3. The Danish hydrogen backbone is a key part of the infrastructure
4. And there is an opportunity producing eFuels such as eAmmonia, eMethanol and eSAF for maritime and aviation industries

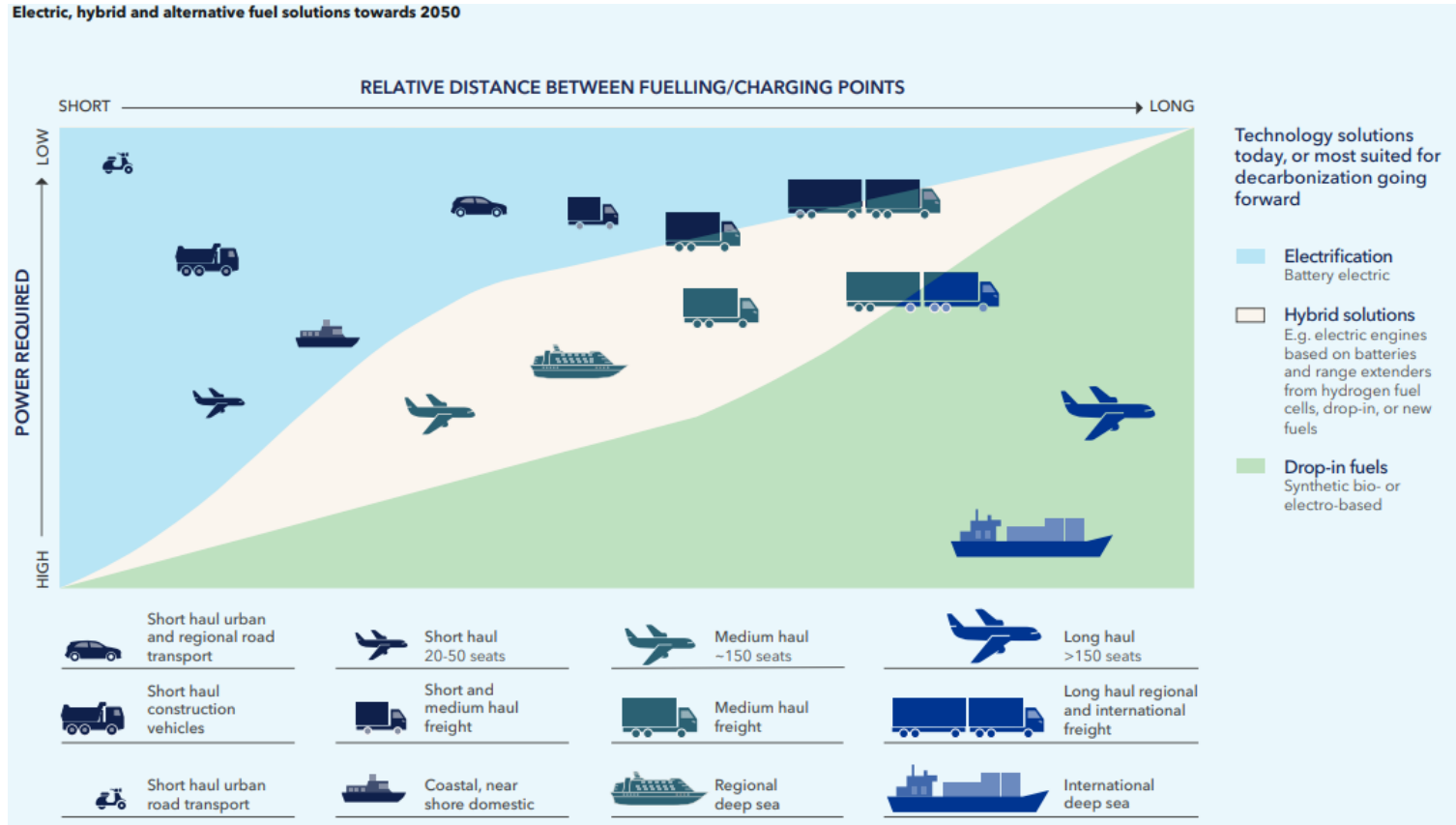
Chart 4: Scenario for cost-effective distribution of approx. 250 GW capacity



Source: Energistyrelsen (2022)

DNV ETO: Pathways to decarbonising transport

Electricity, hydrogen, then bio- and efuels



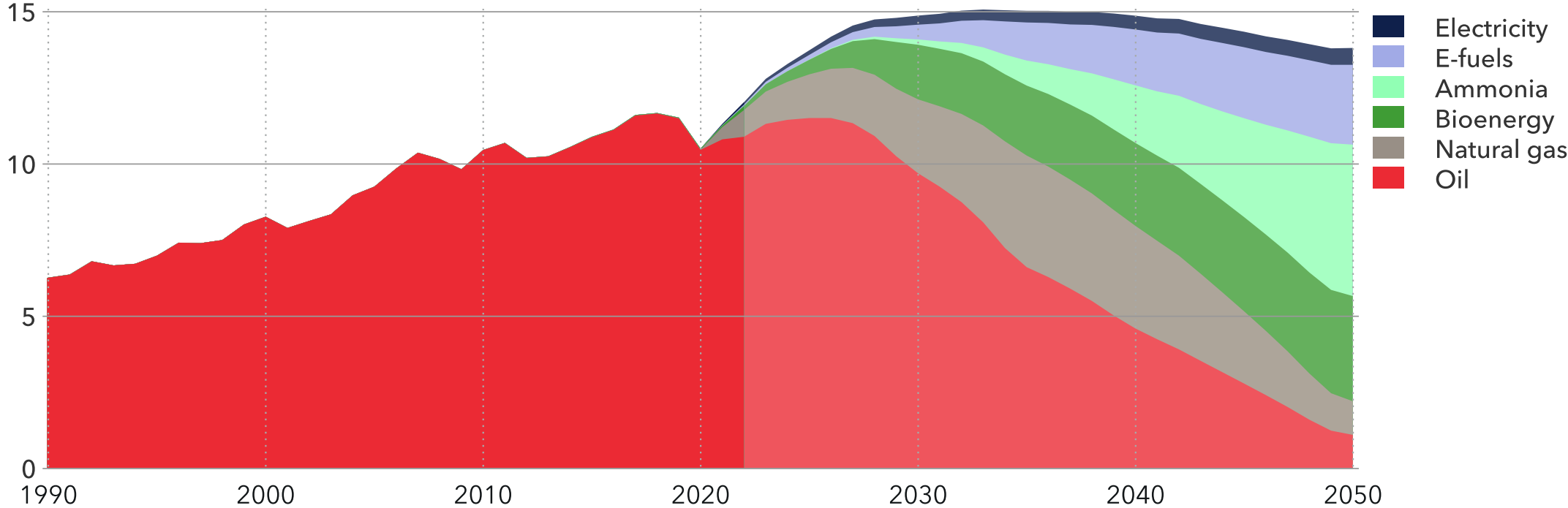
- Barriers to electrification:
 - One reason that not all energy use can be electrified is the low energy density of batteries
- If you require storing large amounts of energy, drop-in fuels offer a solution
 - Drop-in fuels have the same properties as conventional fuels and can be used in existing engines and infrastructure
 - Sustainable drop-in fuels can be made from biomass, waste or electricity+CO2 (e-fuels)

DNV Energy transition outlook 2023

The maritime fuel mix will change dramatically

World maritime subsector energy demand by carrier

Units: EJ/yr



Natural gas includes LNG and LPG. Historical data source: IEA WEB (2023)

Source: DNV, Energy Transition Outlook (2023)



EU regulation 2023

Driving decarbonization and uptake of sustainable fuels

Renewable energy directive (RED) emission and renewable target (2023):

- Binding target of 42,5% of all energy in 2030 from renewable sources

RED binding target for the transport sector:

- 14.5% reduction in GHG emissions by 2030 or at least 29% renewable energy in the fuel mix
- Sub target of 5.5% energy from advanced biofuels (non-food) or RFNBO* (at least 1% RFNBO)

RED binding target for industry:

- 42% of hydrogen (current use) must be RFNBO by 2030 (60% in 2035)



Aviation

Blending mandates on **fuel suppliers** for sustainable aviation fuels (SAF) and renewable fuels of non-biological origin (RFNBO):

2025: 2% SAF
2030: 6% (0.7% RFNBO)
2035: 20% (5% RFNBO)
2040: 34% (8% RFNBO)
2045: 42% (11% RFNBO)
2050: 70% (28% RFNBO)



Maritime

GHG reduction requirements on vessel operators:

2025: 2%
2030: 6%
2035: 14.5%
2040: 31%
2045: 62%
2050: 80%

From 2024, Shipping is part of ETS mechanism

*RFNBO = Renewable Fuels of Non-Biological Feedstock (= hydrogen, ammonia and e-fuels from renewable electricity)

Early adopters:

Shipping operators looking for biomethanol and eMethanol

When one shipowner turned, the marine market turned towards methanol

Ship & Bunker
CMA CGM Moves Ahead of Maersk on Methanol Powered Ship Orders
by Ship & Bunker News Team
Wednesday, April 12, 2023

CONTAINER NEWS
COSCO places orders for 12 methanol-powered giant ships
October 31, 2022

Brookes Bell
HMM Orders Nine Methanol-Fuelled Containerships

TradeWinds
Evergreen follows Maersk with \$4bn methanol container ship push, despite fuel bill fears
21 April 2023 10:52 GMT | UPDATED: 22 April 2023 14:24 GMT

OFFSHORE ENERGY
X-Press Feeders orders six methanol dual-fuel boxships
June 6, 2022, by Jasmina Ovicina Mandic
Eastaway, a member of the X-Press Feeders Group, has ordered six 1,250 TEU containerships, fitted with dual-fuel engines capable of operating on conventional fuel and methanol.

Source: MAN Energy Systems (2023)

In conclusion: Combining CCS and CCU

1. CO2 infrastructure can facilitate development of a Danish CCS industry
2. Realising potential for CCU will probably require CO2 certification and mass balancing
3. CCS and CCU possibly require support regimes. Make sure that CCS does not get in the way of CCU



Thank you for your attention!

Reach out for further details and discussions

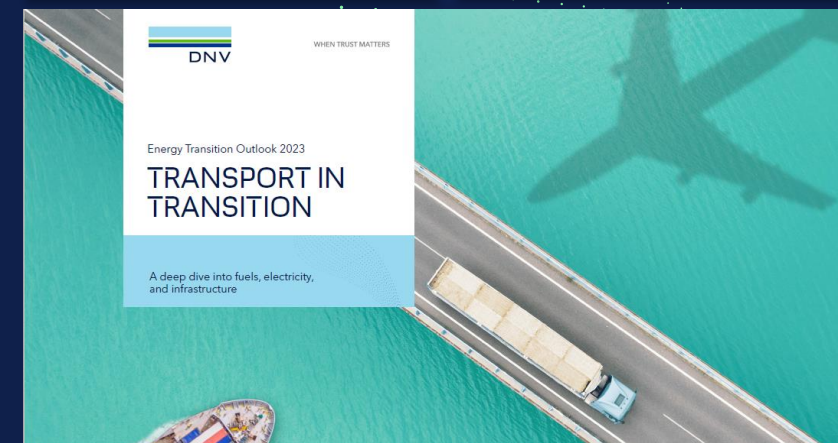
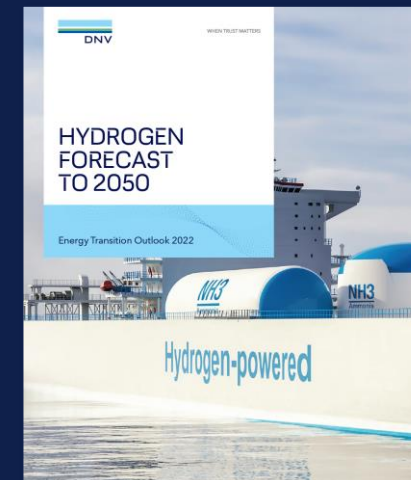
Torben Franch

Regional low-carbon fuels lead
Energy Systems Northern Europe

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Tel: +45 41 820 320

www.dnv.com



Kassø-projektet: erhvervseffekter og eksportpotentialer

v. Mathias Aarup Berg, Head of Regulatory Affairs, European Energy

14. marts, 2024

Kassø: Erhvervseffekter og eksportpotentialer

Mathias Aarup Berg – Head of Regulatory Affairs



Kassø Power-to-X-anlæg

- European Energys første – og **verdens største** – storskala e-metanol-anlæg idriftsættes i 2024
- Anlægget kan producere op til **42.000 tons e-metanol** (50 mio. liter) om året, når det er i fuld produktion
- Produktionen er afsat til **Maersk, Lego** og **Novo Nordisk**, der erstatter henholdsvis skibsbrændstof og fossil metanol.
- Brugen af e-metanol fra Kassø vil **reducere udledning af fossil CO2** med op til 80.000 tons

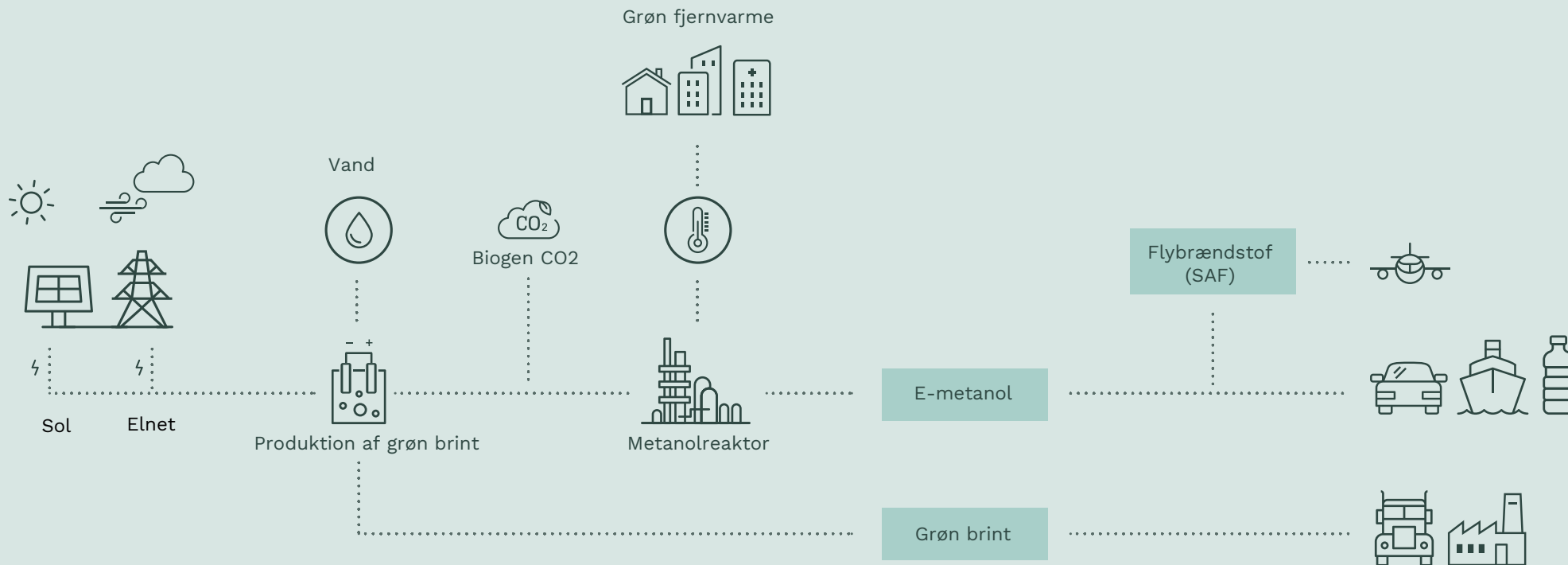


novo nordisk®



EUROPEAN
ENERGY

Fremstilling af e-metanol på Kassø Power-to-X-anlæg



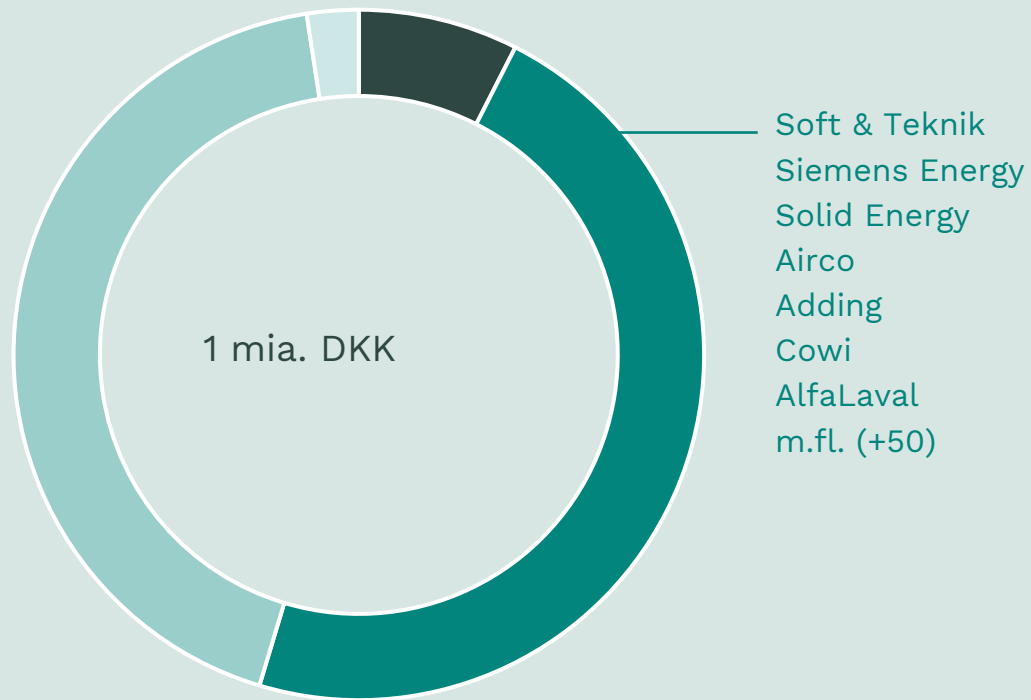
Konstruktionen af anlægget startede i maj 2023, og siden er det gået stærkt...



Et e-metanolanlæg er en milliardinvestering

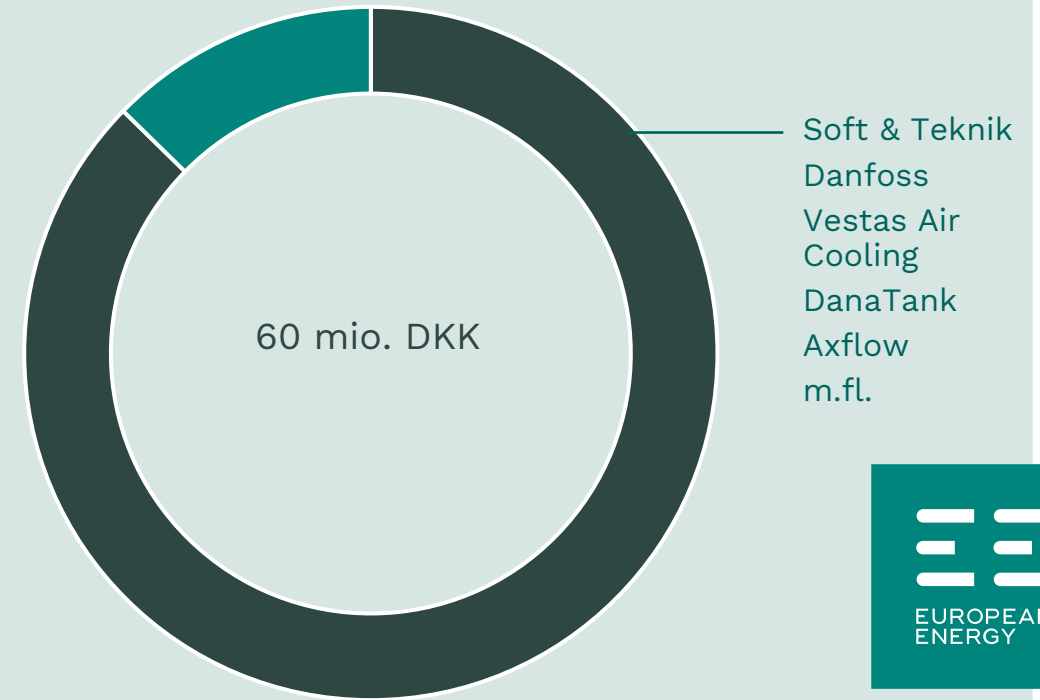
European Energy prioriterer lokale, danske og europæiske leverandører

Leverandører til Kassø Power-to-X



■ Lokale ■ Danmark ■ EU (inkl. UK) ■ Uden for EU

Leverandører til CO2-fangstanlæg ved Tønder Biogas



■ Danmark ■ EU



Jobskabelse og lokale arbejdspladser

+100

Over **100**
fuldtidsmedarbejdere i
anlægsfasen, hvoraf
halvdelen er lokale



Et hav af
underleverandører til
service på anlægget,
transport af e-metanol,
drift af havneterminal
etc.

+60

Mange af European
Energys **60**
medarbejdere inden for
Power-to-X er aktivt
involveret i projektet og
får støtte fra eksterne
rådgivere



+30

Op til **30**
fuldtidsmedarbejdere vil
stå for den løbende
drift, når anlægget er
færdigt



Kassø er grundstenen for fremtidige anlæg – i Danmark og resten af verden

DANMARK

2 projekter under opførelse

- E-metanolanlæg ved Kassø, Aabenraa
- Brintanlæg ved Måde, Esbjerg

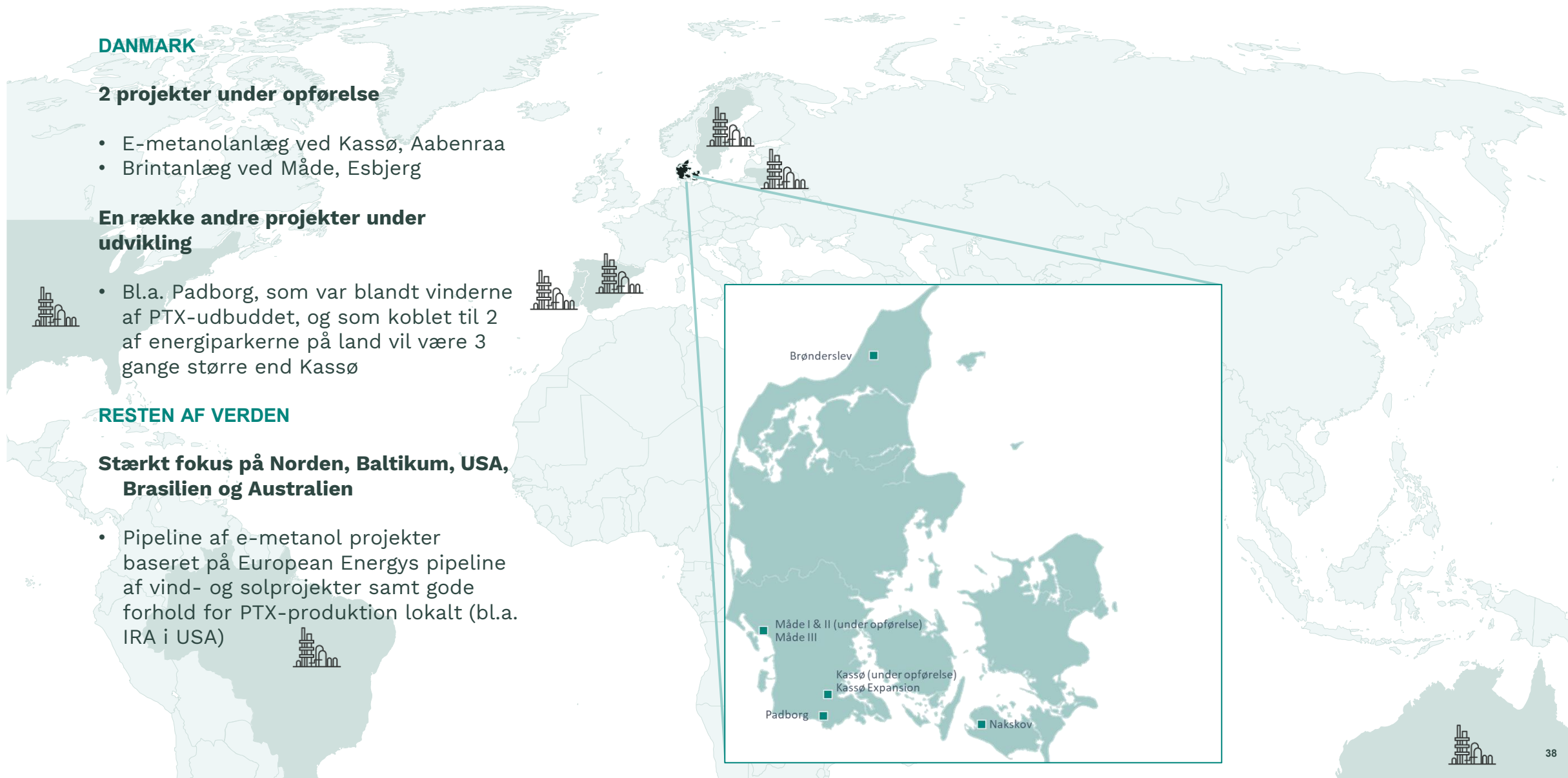
En række andre projekter under udvikling

- Bl.a. Padborg, som var blandt vinderne af PTX-udbuddet, og som koblet til 2 af energiparkerne på land vil være 3 gange større end Kassø

RESTEN AF VERDEN

Stærkt fokus på Norden, Baltikum, USA, Brasilien og Australien

- Pipeline af e-metanol projekter baseret på European Energys pipeline af vind- og solprojekter samt gode forhold for PTX-produktion lokalt (bl.a. IRA i USA)



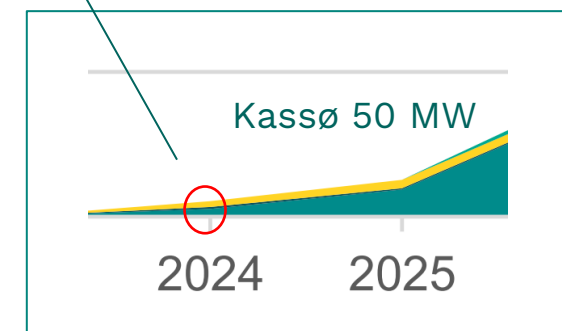
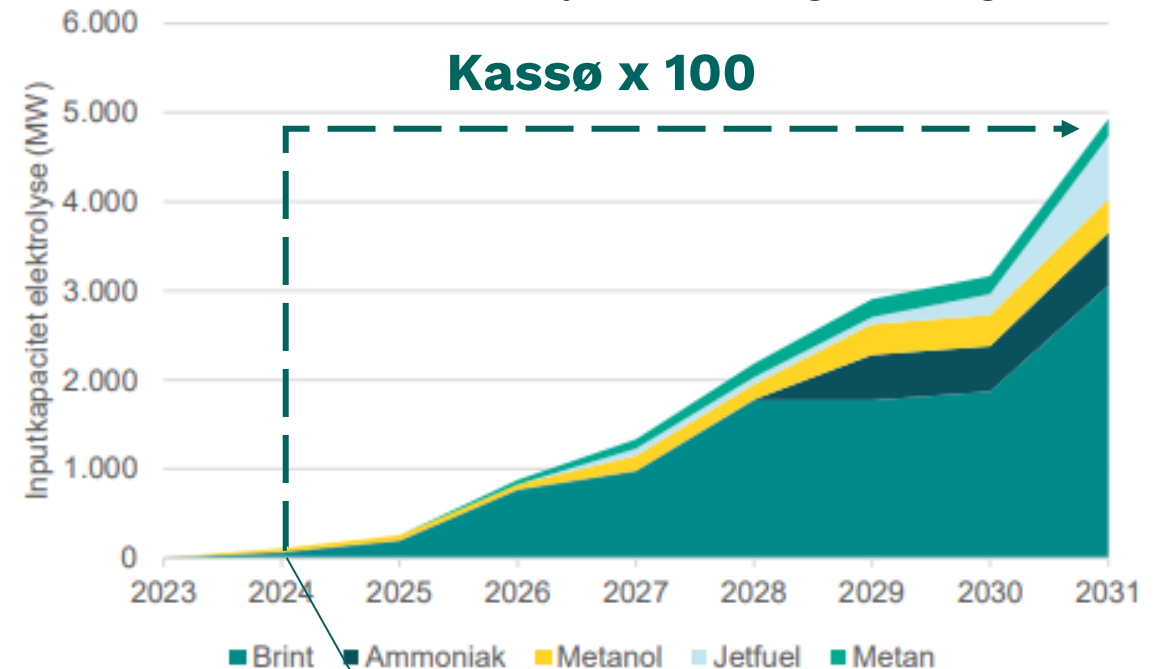
De første skridt i PtX-industrialiseringen er taget – og næste skridt skal følge hurtigt efter

- Kassø er et lille stort skridt i industrialiseringen
- National målsætning fra PtX-aftale om 4-6GW elektrolysekapacitet i 2030 kræver:

Kassø X 100

- Vi er allerede kommet godt fra start, men rammevilkår og støtte skal sikre acceleration af PtX-produktion i Danmark via:
 - Brintinfrastruktur
 - PtX-udbuddet vol. 2 (Auction-as-a-service i EU Hydrogen Bank)
 - Ensartet myndighedsbehandling med de rette kompetencer og ressourcer

Kilde: ENS analyseforudsætninger til Energinet 2023



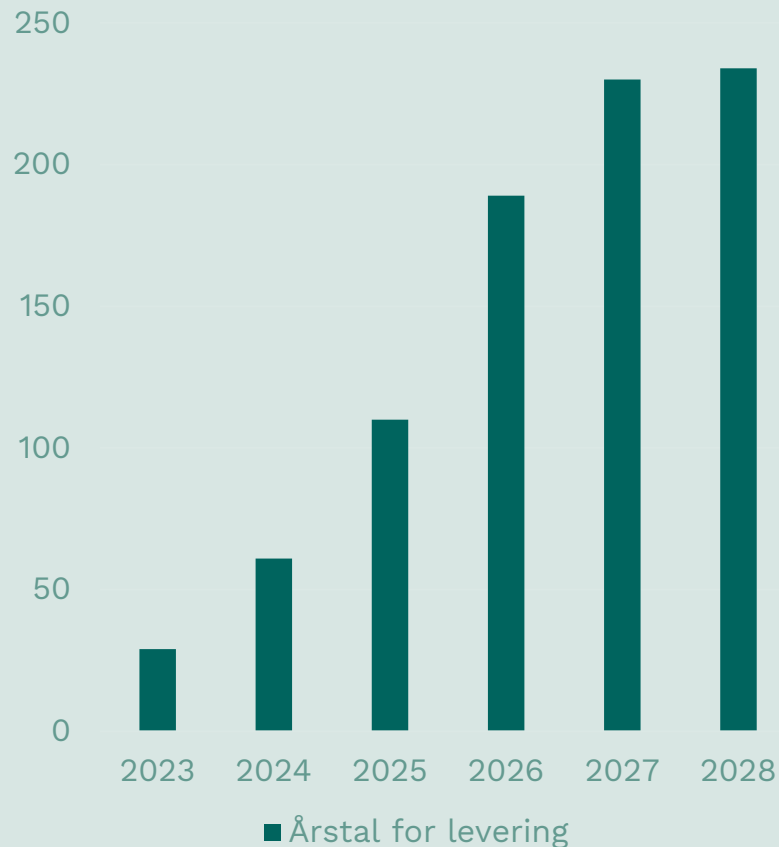
Global efterspørgsel skaber danske eksportmuligheder



EUROPEAN
ENERGY

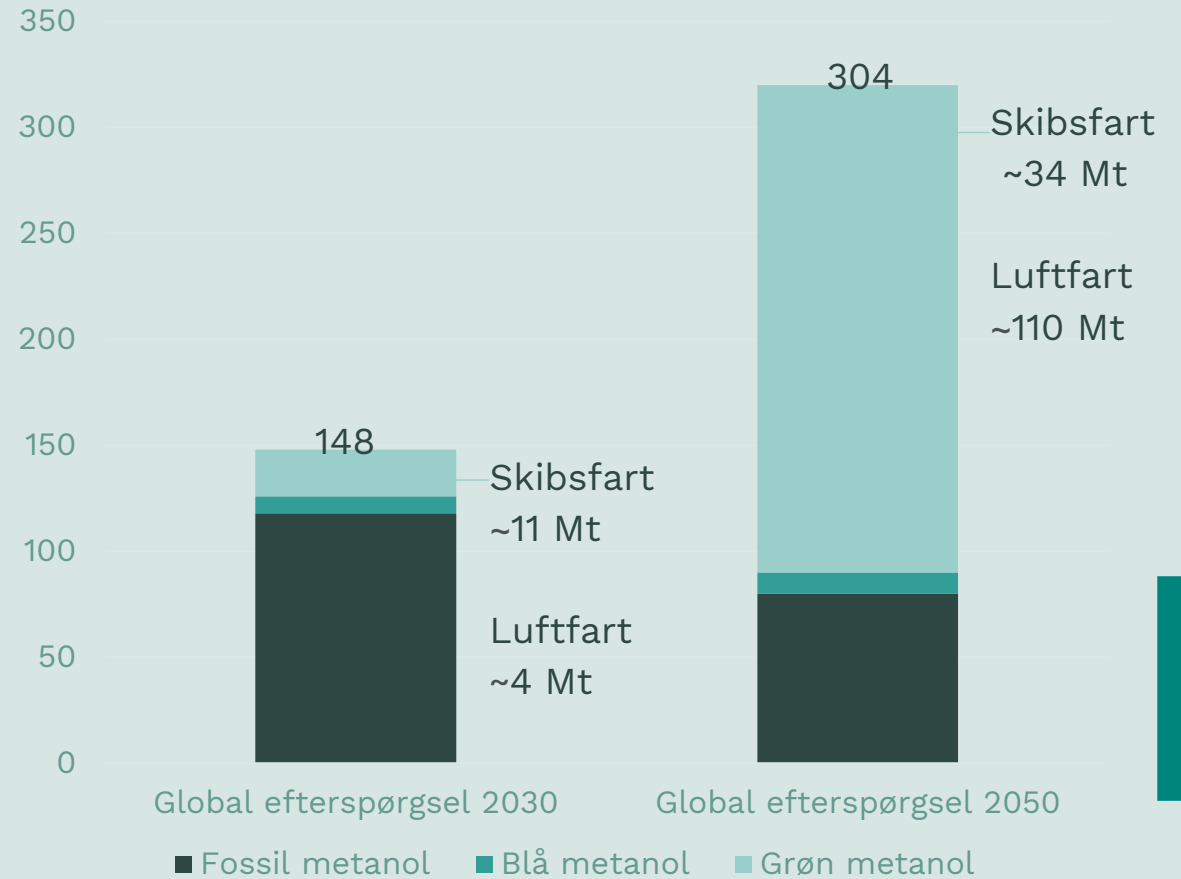
Alene i shippingindustrien vil behovet for e-metanol stige støt

Globale ordrer på metanoldrevne containerskibe



Kilde: DNV Alternative Fuels Insight 2023

Forventet global efterspørgsel på metanol (Mt/år)



Kilde: McKinsey 2023



Vi skal op i skala!

Nordeuropas største solcellepark
forsyner Kassø Power-to-X-anlæg
med grøn strøm til at producere
42.000 tons e-metanol årligt ...

... det svarer til den mængde, som 3-4
af Mærsk's første grønne
containerskibe sejler på årligt



Danmark kan imødekomme global efterspørgsel

- ✓ Vi har store mængder **grøn strøm** – og får endnu mere gennem havvindsudbud og energiparker på land
 - VE-andel i elnettet på over 90% inden for få år
- ✓ Vi har **biogene punktkilder**
 - Biogasproduktion udleder biogen CO₂, som ved hjælp af carbon capture-teknologier kan bruges i Power-to-X
 - Biogas er en kilde til CO₂ i meget høj koncentration og dermed nemt og energieffektivt at fange
- ✓ Vi har et **økosystem** af eksperter fra universiteter, teknologileverandører og tradition for sektorkobling
 - En know-how til gavn for indenlandsk produktion og eksport af dansk Power-to-X-teknologi

= **En helt unik styrkeposition**



An aerial night photograph of an industrial facility, likely a power plant or refinery, illuminated by its own lights. The facility features several large buildings, a tall distillation column, and numerous storage tanks. A parking lot filled with vehicles is visible on the left. The background shows a vast landscape under a sunset sky with a warm orange and red glow.

Tak for jeres
opmærksomhed!

Udkast til anbefalinger til dansk CCU-indsats

v. Kristian Jensen, Adm. Direktør,
Green Power Denmark

Paneldebat om accelereret CCU-indsats i Danmark

Ulrik Stridbæk, Chef for Regulatory og Public Affairs, Ørsted

Lisbeth Sørensen, Business Opportunity Manager, Crossbridge

Charlotte Søndergren, Direktør for forsyningsstrategi og vind, HOFOR

Sara Westphal E. Neergaard, Director of Communication and Public Affairs, Denmark Norwegian

Jacob K. Clasen, Viceadm. Direktør, Danske Rederier



We operate safely or not at all

Kort om Crossbridge Energy

- 🌱 **Crossbridge Energy er verdens andet mest energieffektive raffinaderi og garant for storskalaproduktion af brændstoffer**
- 🌱 **Crossbridge Energy spiller i dag en vigtig samfundsrolle, hvor vi er medvirkende til at sikre den nationale forsyningsikkerhed**
- 🌱 **Crossbridge Energy har infrastrukturen og kompetencerne til at levere på den grønne omstilling**

Eventuelt og øvrige arrangementer

DTU Offshore - CCS conference – 2024

CO₂ storage in Denmark – Risks and Uncertainties

Storage of CO₂ is a key part of Denmark’s road towards negative emissions in 2050 and at the same time Denmark has an ambition of becoming a CO₂ storage hub for Europe. The technologies behind the storage of CO₂ are mature, however, there are remaining risks and uncertainties when it comes to implementation. This conference will focus on the risks/uncertainties associated with CO₂ storage in Denmark, looking at both offshore and onshore storage sites. The risks and uncertainties which will be addressed are covering a wide range of issues from lack of high-quality data.

Confirmed speakers (more to come):



June 4th 2024 at Rungstedgaard

Netværk og et glas bobler