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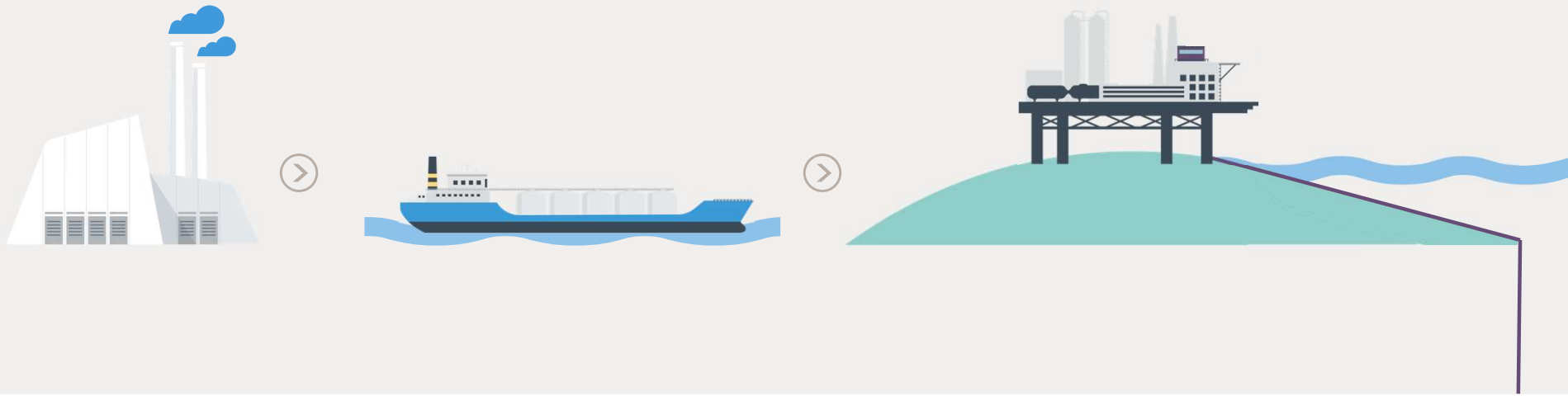
CCS at Ørsted

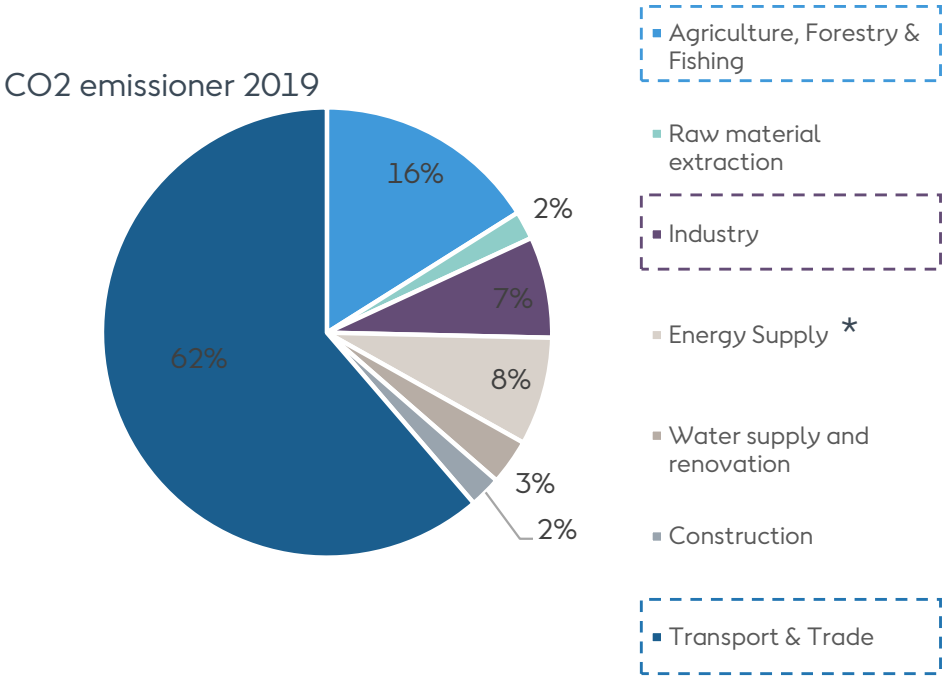
Bogi Bech Jensen
Head of Digitalisation & Technology



2024

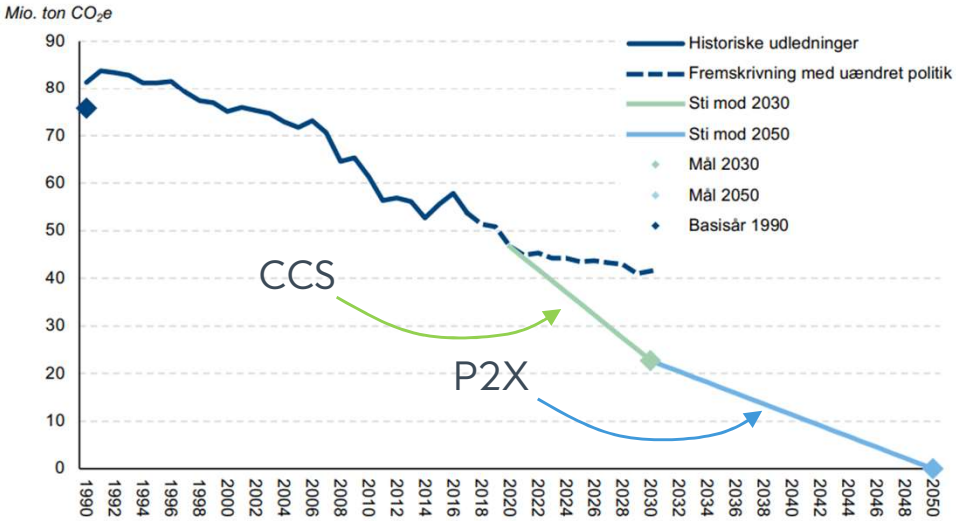
Our climate problem in a nutshell

Where are the largest remaining DK emissions?



The Danish government's route to climate neutrality

- In the long run, Denmark must reach 100% through PtX/CCU.
- CCS is necessary to reach 70% reduction in 2030



Source left: Statistikbanken.dk/drivhus
Source right: Klimarådet.
*Reduced with the phase-out of coal and natural gas

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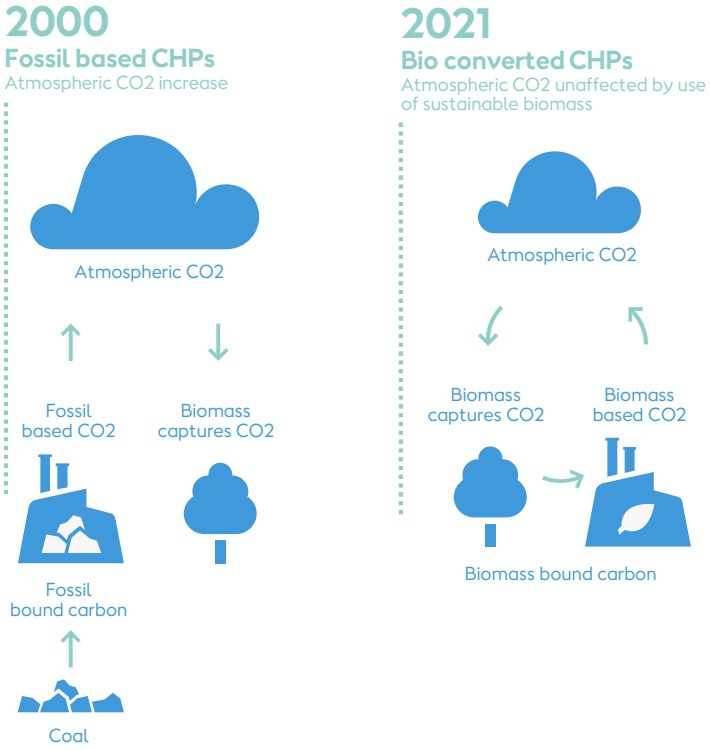
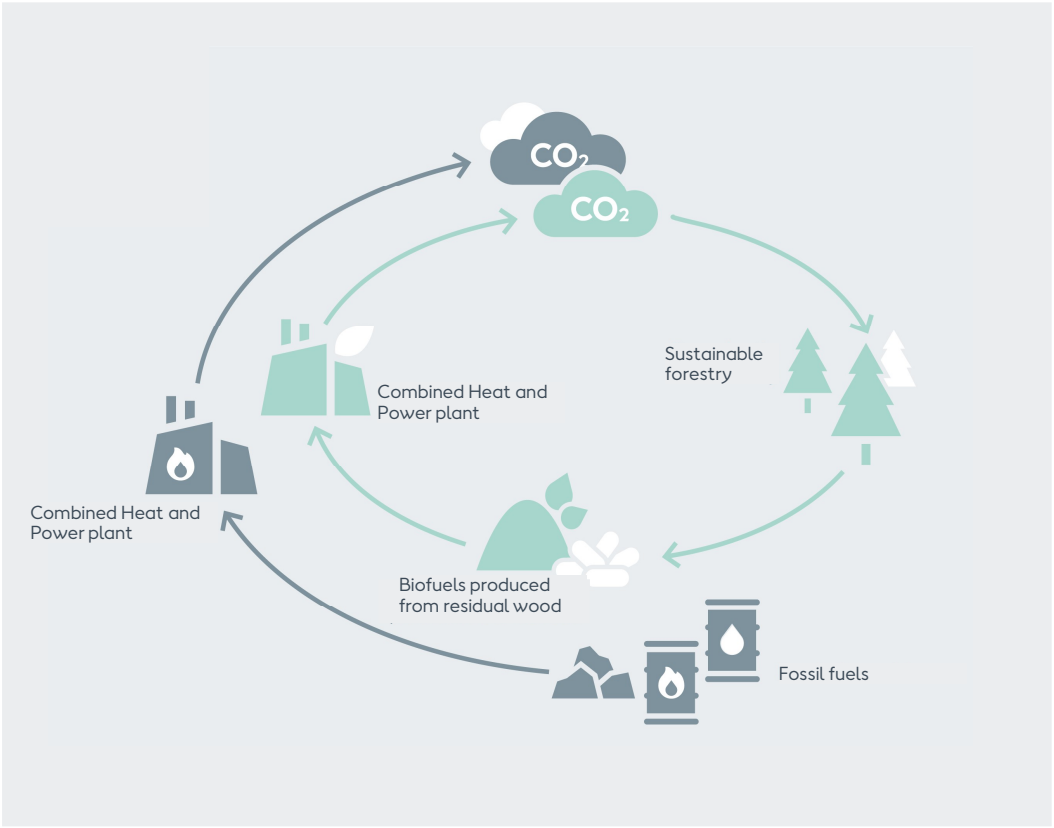
Bioenergy - a sustainability journey

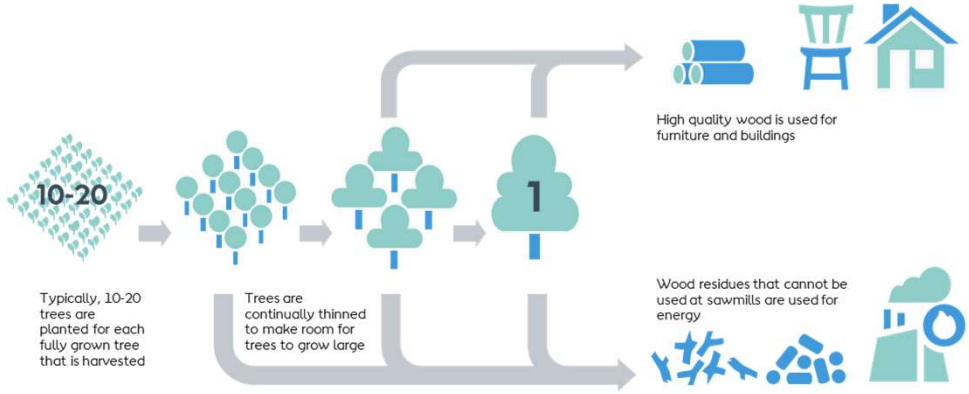
Ørsted's Bioenergy business has transformed from purely fossil to green combined heat and power production by converting the coal fired assets to sustainable biomass combustion[1]. Next step is electrical boilers and capturing CO2 from the combustion and either storing it or utilizing it to substitute fossil hydrocarbons

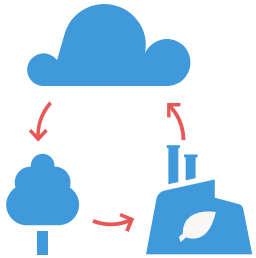


1 The Esbjerg Power Plant remains coal fired until taken out of operation in 2024

Transformation from coal to certified sustainable biomass







FSC
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PEFC™
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SBP
Sustainable Biomass Program

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Bioenergy - a sustainability journey

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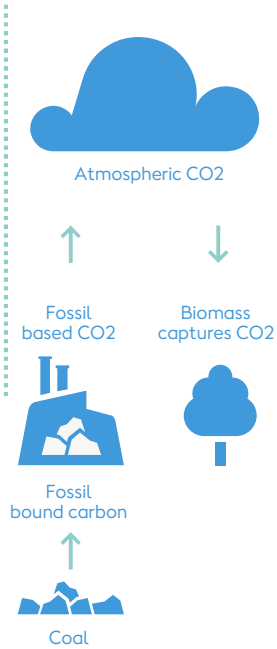
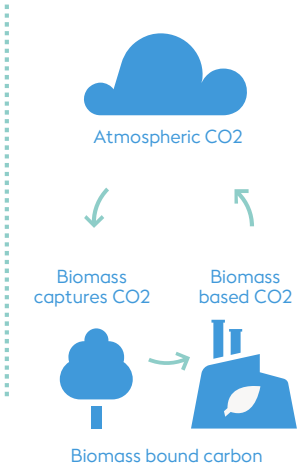
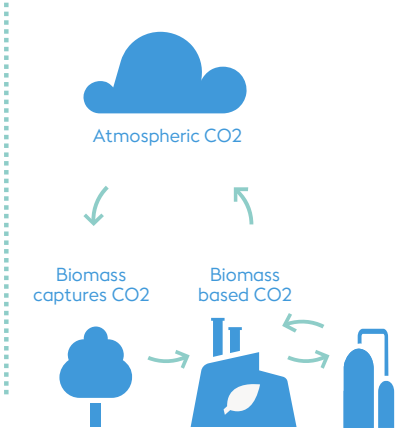
2000
Fossil based CHPs
Atmospheric CO2 increase



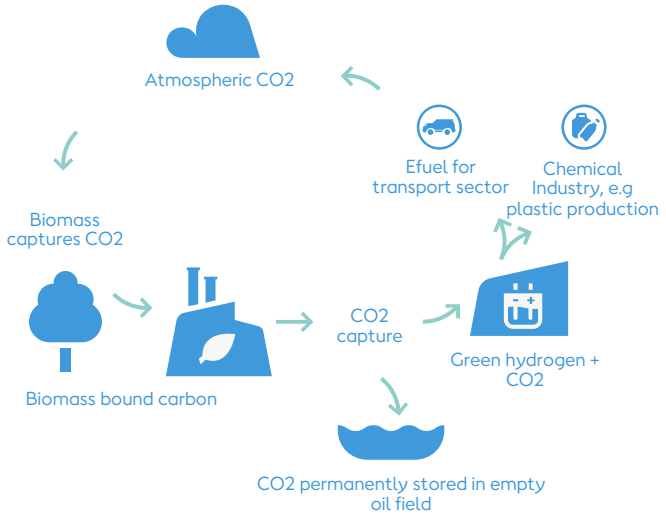
2021
Bio converted CHPs
Atmospheric CO2 unaffected by use of sustainable biomass



2023
Build-out electrical boilers

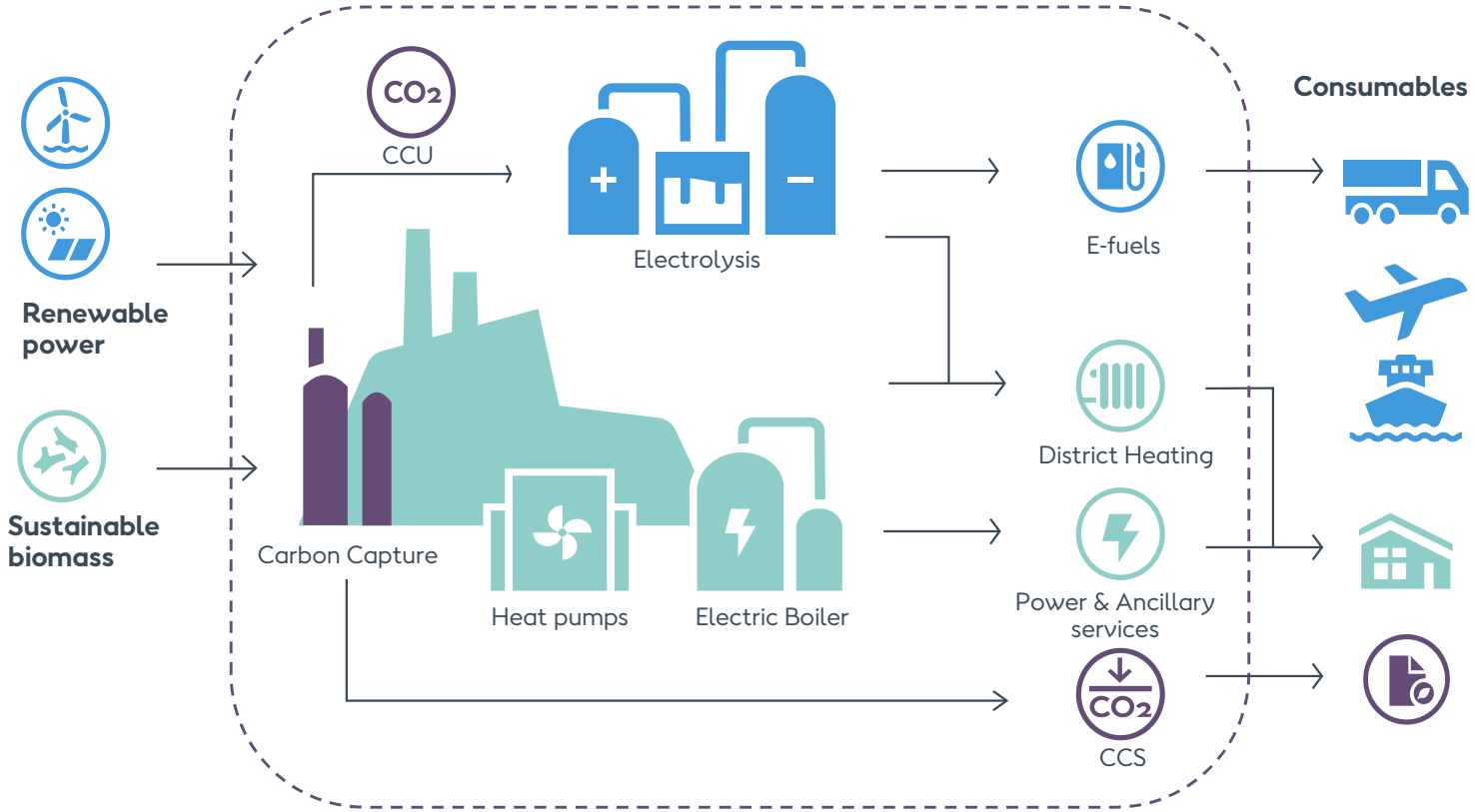


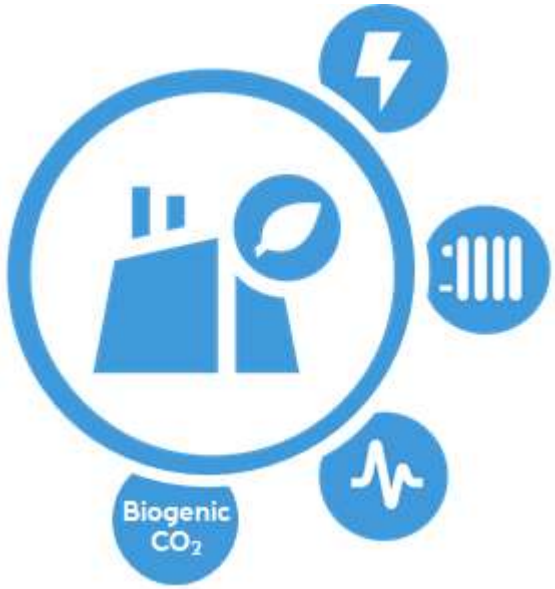
2025
Carbon Capture Utilization and Storage
Atmospheric CO2 reduced



1 The Esbjerg Power Plant remains coal fired until taken out of operation in 2024

A combined heat and power plant has the unique ability to integrate multiple technologies & optimise multiple value streams





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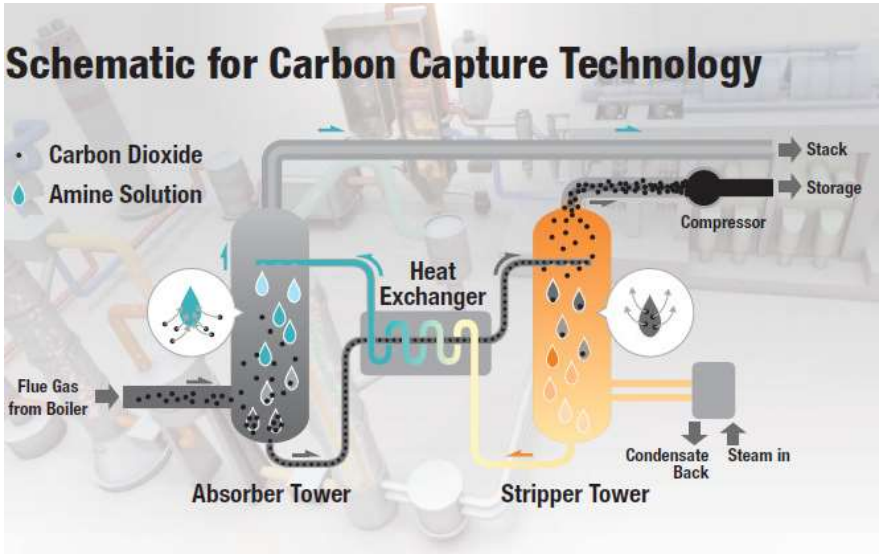
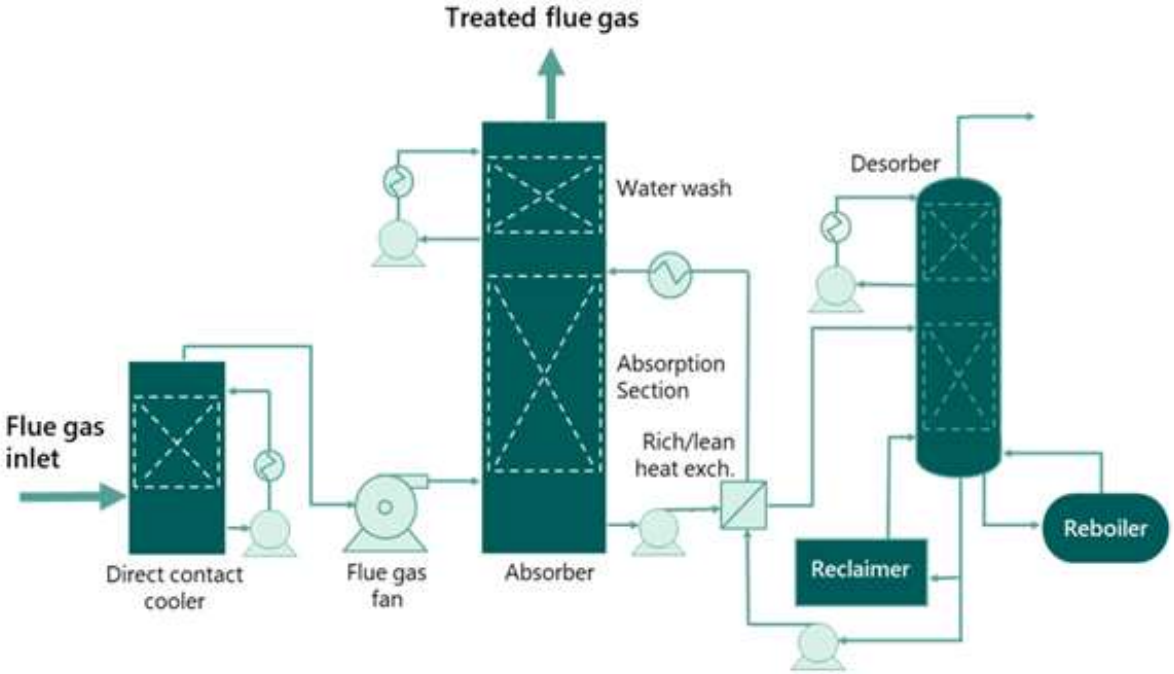
How carbon capture work





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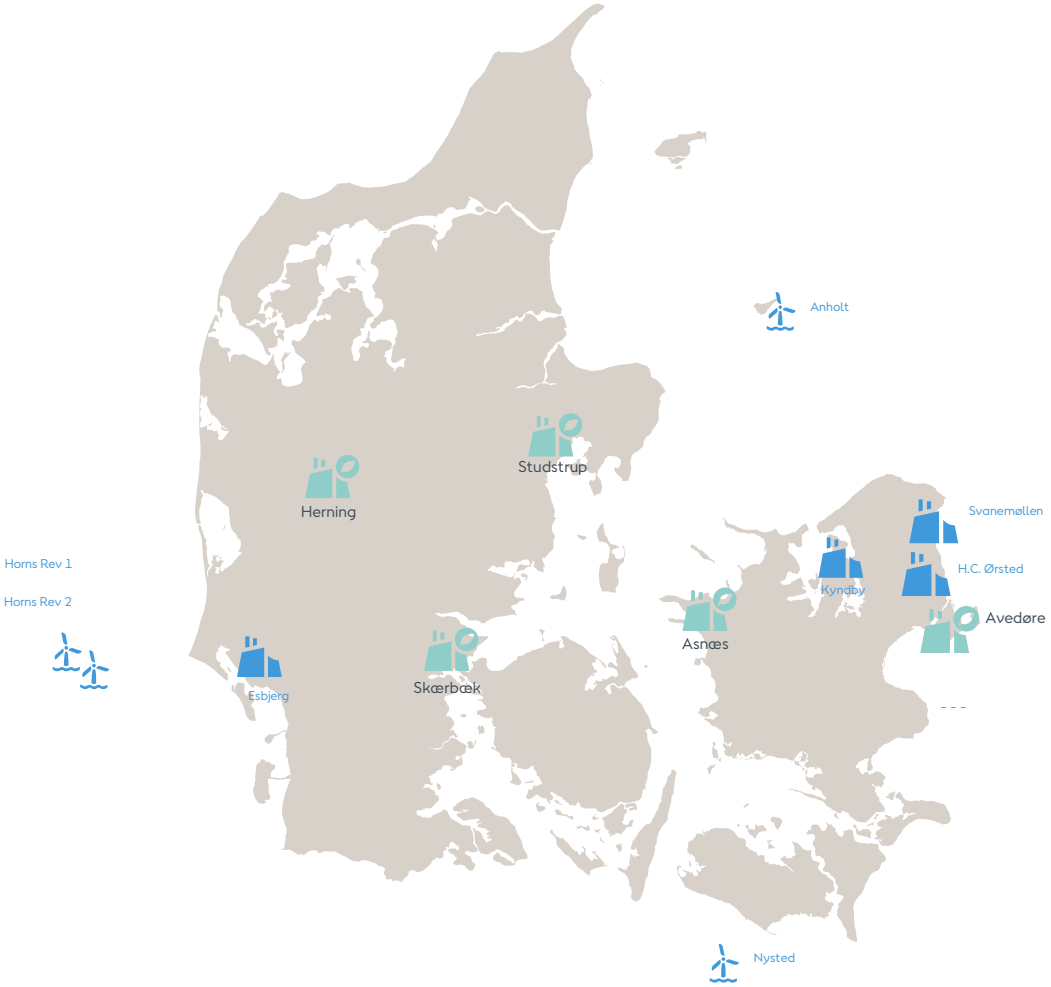
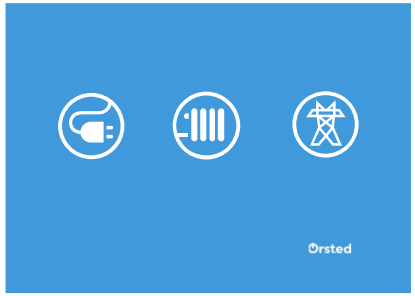
Introduction to Ørsted Bioenergy and our coming CCUS activities





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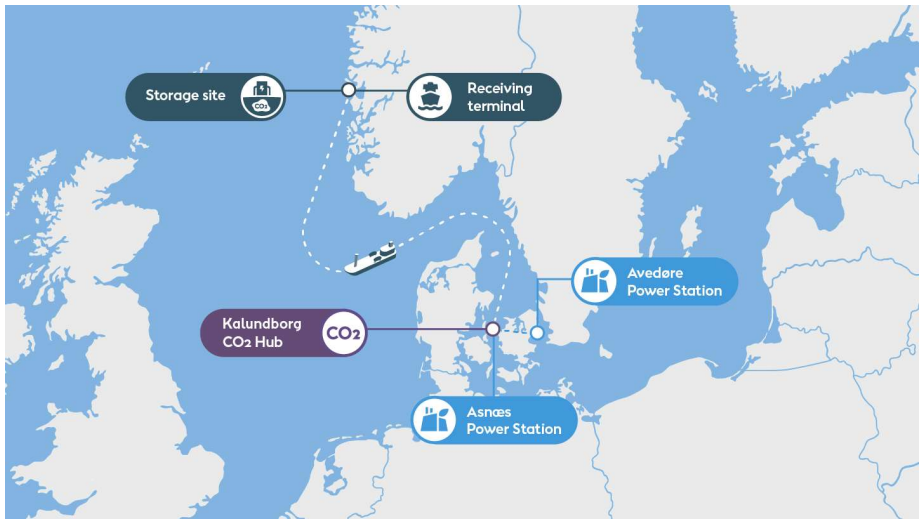
The Ørsted Kalundborg CO2 Hub establishes a key starting point for CO_2 infrastructure centrally in Denmark, capturing & storing 430,000 tonnes CO_2 annually

Location of assets



Key facts on Ørsted Kalundborg CO2 Hub

Project Scope

- Ørsted Kalundborg CO2 Hub will have a central role in the import and export biogenic CO_2
- Project is based on a portfolio of two-point sources to deliver the contracted CO_2 quantity of 430,000 tonnes annually:
  1. Asnæs Power Station with ~280,000 tonnes/annually
  2. Avedøre Power Station with ~150,000 tonnes/annually
- Commencement of operations end of 2025. Project execution initiated in June 2023
- The project establishes first-of-kind, large scale agreement with Microsoft for the offtake of carbon removal credits
- Subsidy contract with the Danish Energy Agency is for 20-year period.

Technical Scope

- Key technology provider: Aker Carbon Capture will deliver five Just Catch™ units to the CHP plants. The Just Catch™ standardised concept is a modular and configurable technical solution
- Reliable and cost-effective CO_2 streams from sustainable biomass-fired CHP plants
- Transportation of CO_2 from AVV to ASV via trucks – each with 34 tonnes CO_2 capacity. Truck solution offers cost and emission efficient solution, and built-in flexibility to change to pipeline
- Transport and permanent offshore geological storage of CO_2 is performed by Northern Lights.

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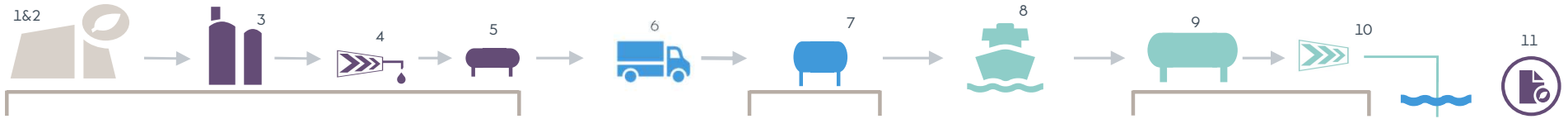
Our key partners in Ørsted Kalundborg CO2 Hub



Description

The solution is based on a concept with the two -point sources:

(1) Asnæs Power Station, wood chips boiler

(2) Avedøre Power Station, Straw Boiler

CO_2 is captured from five carbon capture modules (3) before it is liquefied by compression and cooling (4). The liquid CO_2 streams are joined in the shared intermediate storage and shipping terminal, awaiting transport (5)

Transportation of captured CO_2 from AVV to ASV via truck (6)

At the ASV terminal, the CO_2 is loaded to intermediate storage tanks (7)

Transport is performed by ship (8), at a rate consistent to the operation of the two CC units. Liquid CO_2 is delivered to onshore intermediate storage terminal (9) ahead of transfer and injection into offshore permanent geological reservoir (10)

Negative emission credits (11) from BECCS at ASV and AVV can be sold through bilateral offtake agreements and commodity trading platforms

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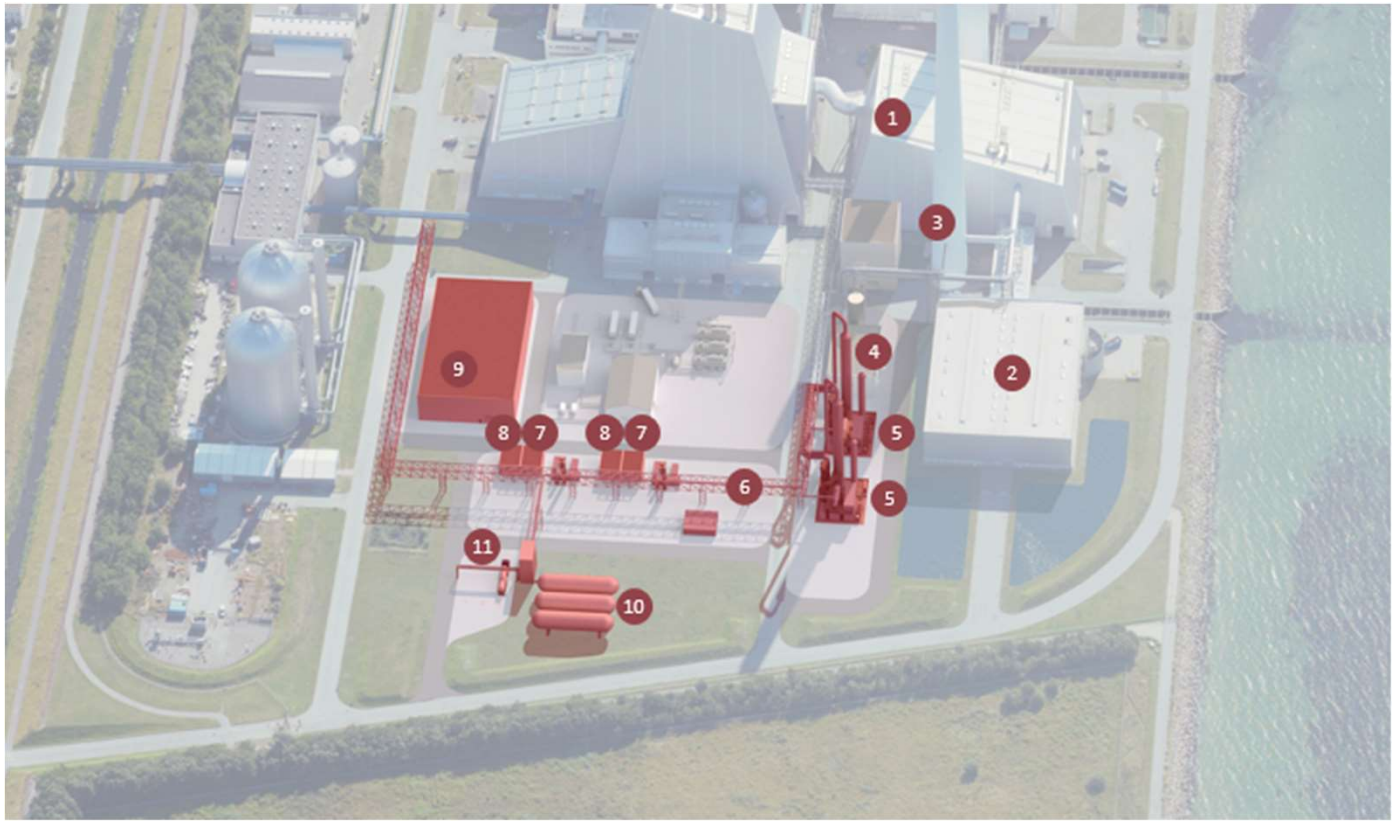
AKER CARBON CAPTURE

DSV

Northern Lights

Microsoft

Avedøre Power Station – project layout



1. Straw boiler
2. Straw storage and preparation building
3. Existing stack
4. Flue gas condenser
5. CO_2 capture
6. CO_2 pipe bridge
7. Compression plant
8. CO_2 purification and liquefaction plant
9. CW, district heating, heat pump
10. CO_2 storage (tank farm)
11. Liquid CO_2 filling station for truck trailers

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Asnæs Power Station – project layout

1. Wood chips boiler
2. Existing stack
3. Flue gas duct routing
4. Cooling water system
5. Electrical building B1
6. CO_2 capture (3 units)
7. Compression & Liquefaction plant (3 units)
8. Existing ASV2 stack
9. CO_2 storage (tank farm)
10. Liquid CO_2 import terminal (trucks)
11. Liquid CO_2 filling line
12. CO_2 ship loading terminal on pier

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Northern Lights transportation and storage concept

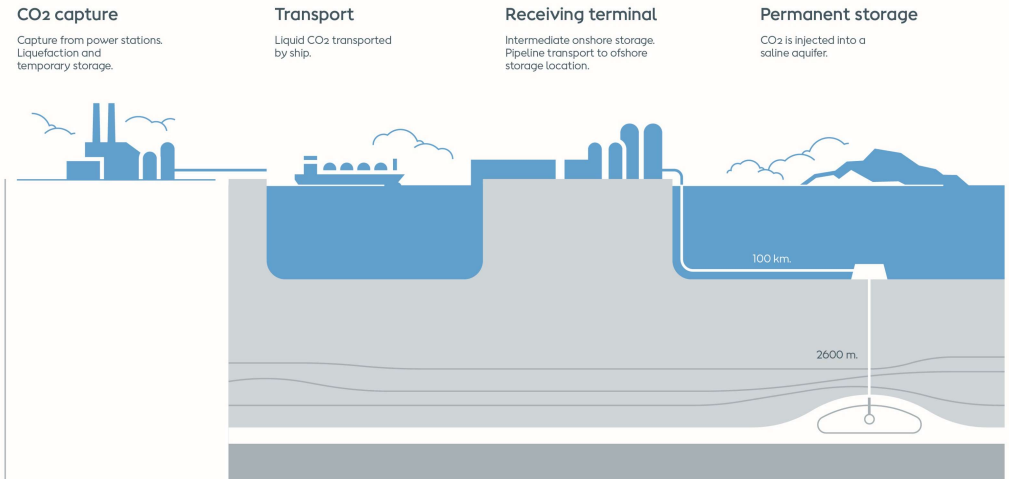
Northern Lights concept

- The CO_2 shipping and storage will be operated by the Northern Lights Joint Venture launched in 2021 to offer safe and permanent underground storage to industries from across Europe.
- Northern Lights is the transport and storage component of Longship project, the Norwegian Government's full-scale carbon capture and storage project launched in 2020.
- Northern Lights' ships have a capacity of 7,200 tonnes CO_2 per trip, where a round trip from ASV to storage and back to ASV takes approximately 5 days.
- The onshore terminal receives liquid CO_2 from multiple sources in North-western Europe.

Northern Lights

The CO_2 is transported to the terminal in Øygarden in western Norway before injected 2,600 meters under the seabed

The carbon capture storage value chain



Source: Northern Lights

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Let's create a world that runs entirely on green energy