A Nordic BECCS value chain

Carbon Capture 2022

Teams 24 May 2022

Mats Fredriksson TDI FB Equinor

Agenda

- Equinor
- Negative emissions
- Carbon capture
- Transportation &Storage
- BECCS and BECCU

A leading company in the energy transition

Why we are changing

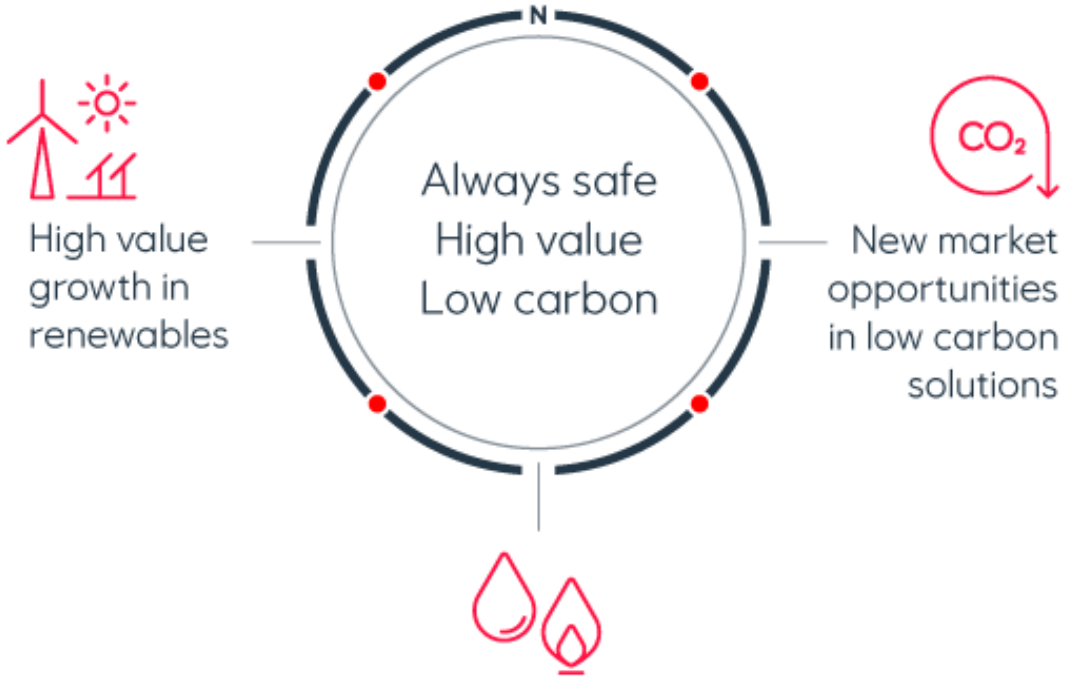
Creating value through the energy transition

Net-zero ambition gives new industry opportunities

Technology excellence and innovation define winners

Market dynamics set margins under pressure

Accelerating our transition



High value growth in renewables

New market opportunities in low carbon solutions

Optimised oil and gas portfolio

How we will get there - together

Safe and secure operations

Guided by our values

Building on competencies and capabilities

Together as one team – engaging partners and society

Facts and figures 2021

4.397

Billion USD
adjusted earnings as of Q4 2021

>21,000

Employees

30

Countries

2.079

Million barrels
of oil equivalent per day

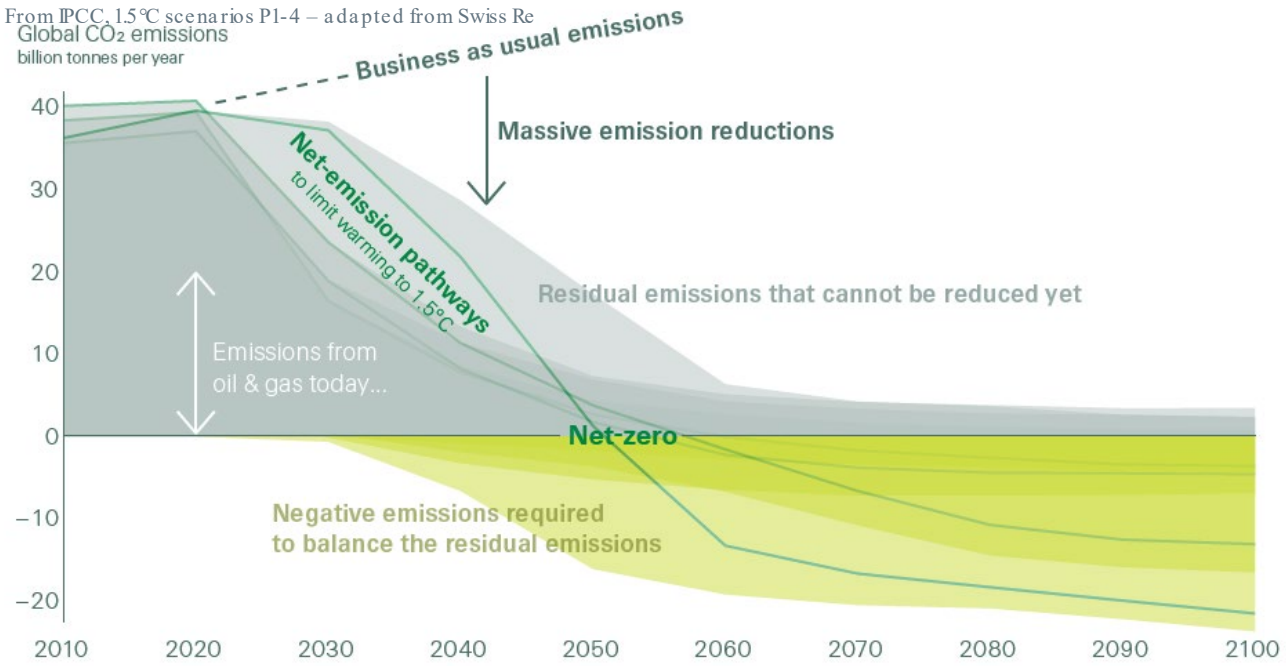
1,562

GWh
Renewable energy equity production

In February 2022, Equinor announced its intention to exit its business activities in Russia

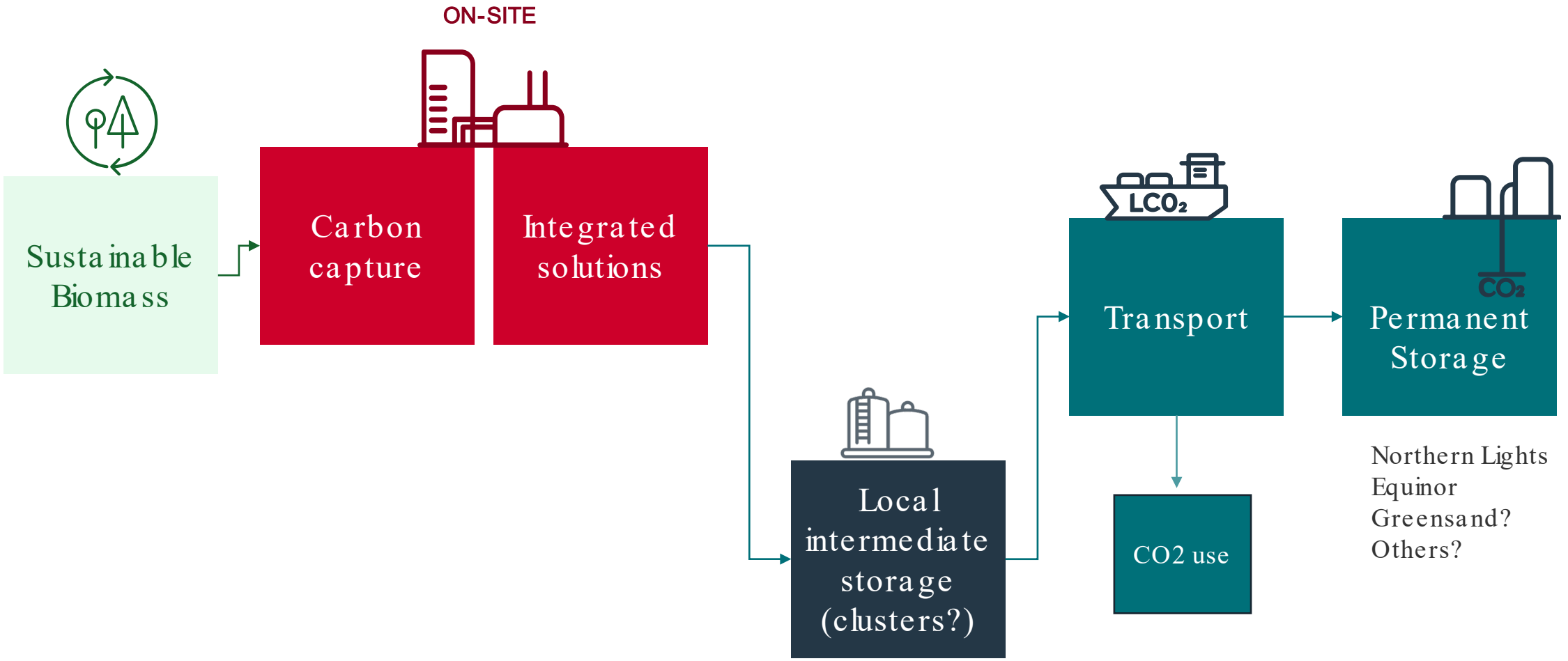
The world needs negative emissions to achieve global climate ambitions.

From IPCC, 1.5°C scenarios P1-4 – adapted from Swiss Re



- Emission reductions require complete overhaul of all emitting industries.
- Removals offset hard-to-abate emissions and historical accumulations.
- IPCC estimates a need for **5-10Gtpa** of carbon removal by 2050

BECCS – physical value chain



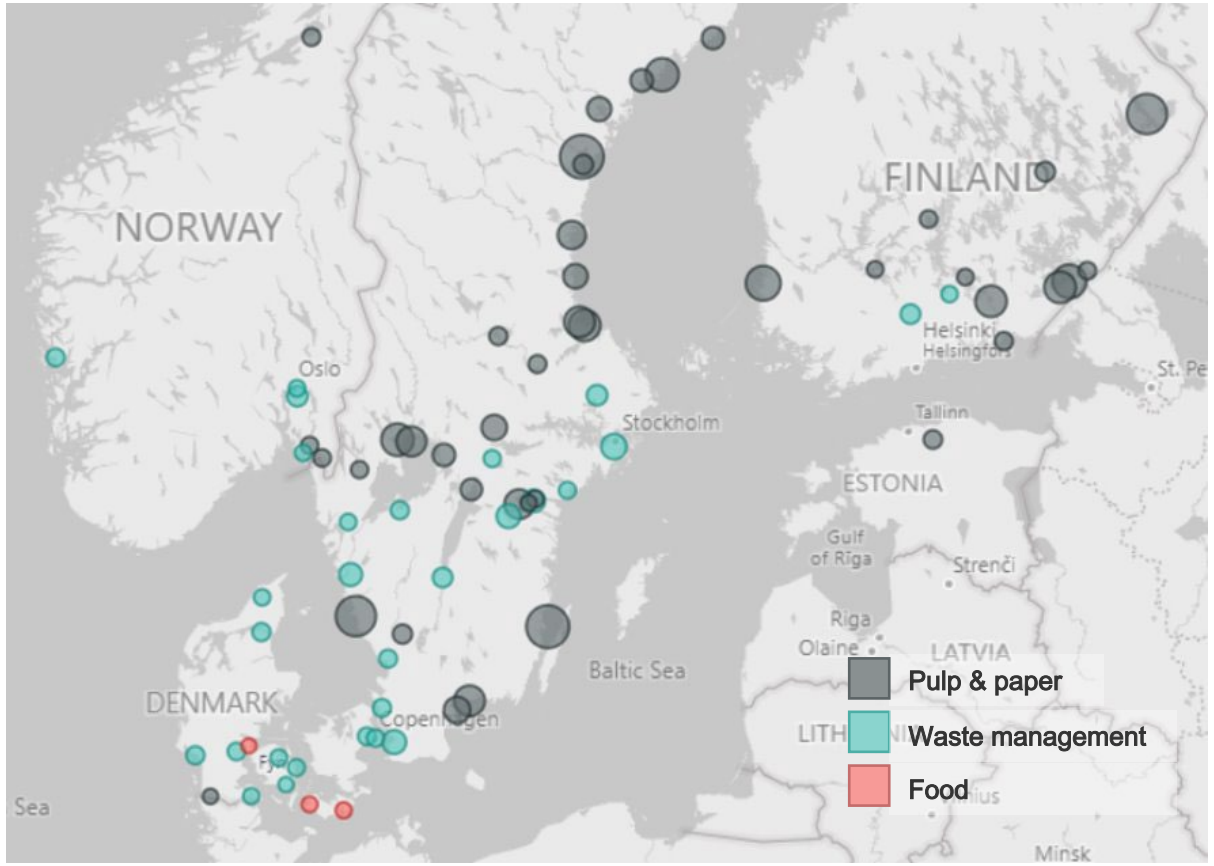
CO2 removal in Nordics & Baltics

Available in industrial volumes

Potential >50 Mtpa of bio-CO2

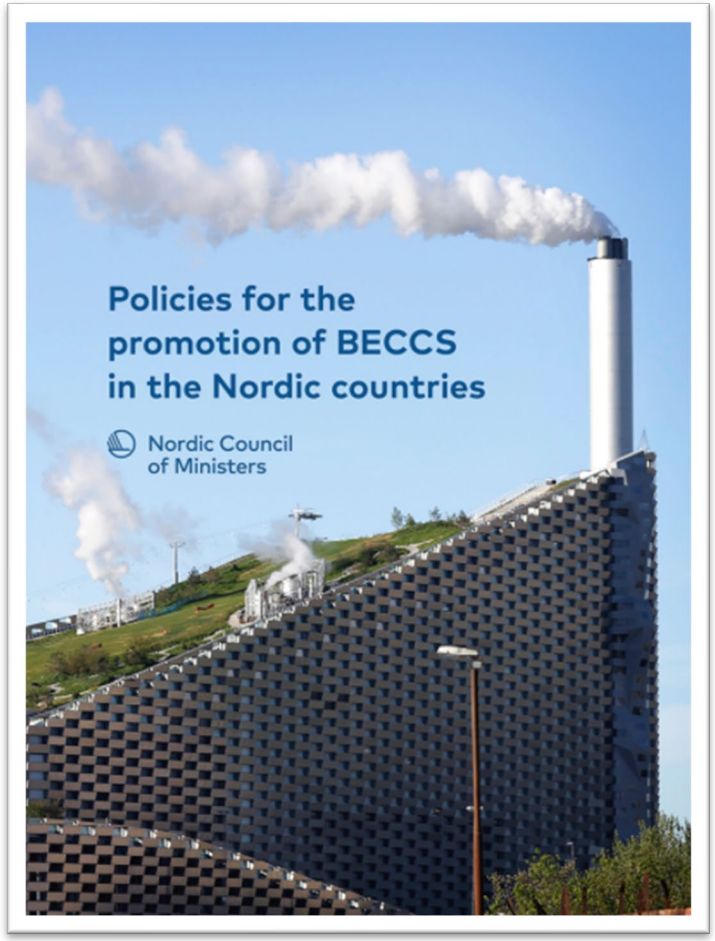
Success criteria for rapid success at scale:

- Biomass industry grasps the BECCS opportunity
- Governments kick-start markets
- Companies source innovative funding for negative emissions
- Storage providers develop capacity rapidly
- Nordic collaboration



Nordic Council of Ministers: Promoting BECCS in the Nordic countries

The Nordic Council of Ministers report



The 2019 Helsinki Declaration on Nordic Carbon Neutrality

- The Prime Ministers declare that Finland, Iceland, Sweden, Norway and Denmark want **to lead by example** and intensify cooperation, including **on removing CO2 from the atmosphere**.
- The **important role of** CO2 capture and storage (**CCS**), including **BECCS** technologies as well as the importance of resolving remaining technical challenges, and **developing business models** for their implementation.

BECCS purposes

1. Offset residual emissions in hard-to-abate sectors (e.g., agriculture, shipping, heavy road transport)
2. Contribute to net negative emissions on a global level, which are likely to be required since the emissions will probably overshoot what is compatible with the Paris Agreement.

- BECCS - major technology for CO2 removal (CDR) in the vast majority of scenarios achieving the Paris Agreement

Shaping the European future of CCS and clean hydrogen

Competitive edge founded on experience, infrastructure and customers.

15-30 MTPA

CO_2 transport and storage capacity by 2035

>25%

CO_2 transport and storage market share in Europe by 2035

3-5 MAJOR INDUSTRIAL CLUSTERS

Clean hydrogen projects by 2035

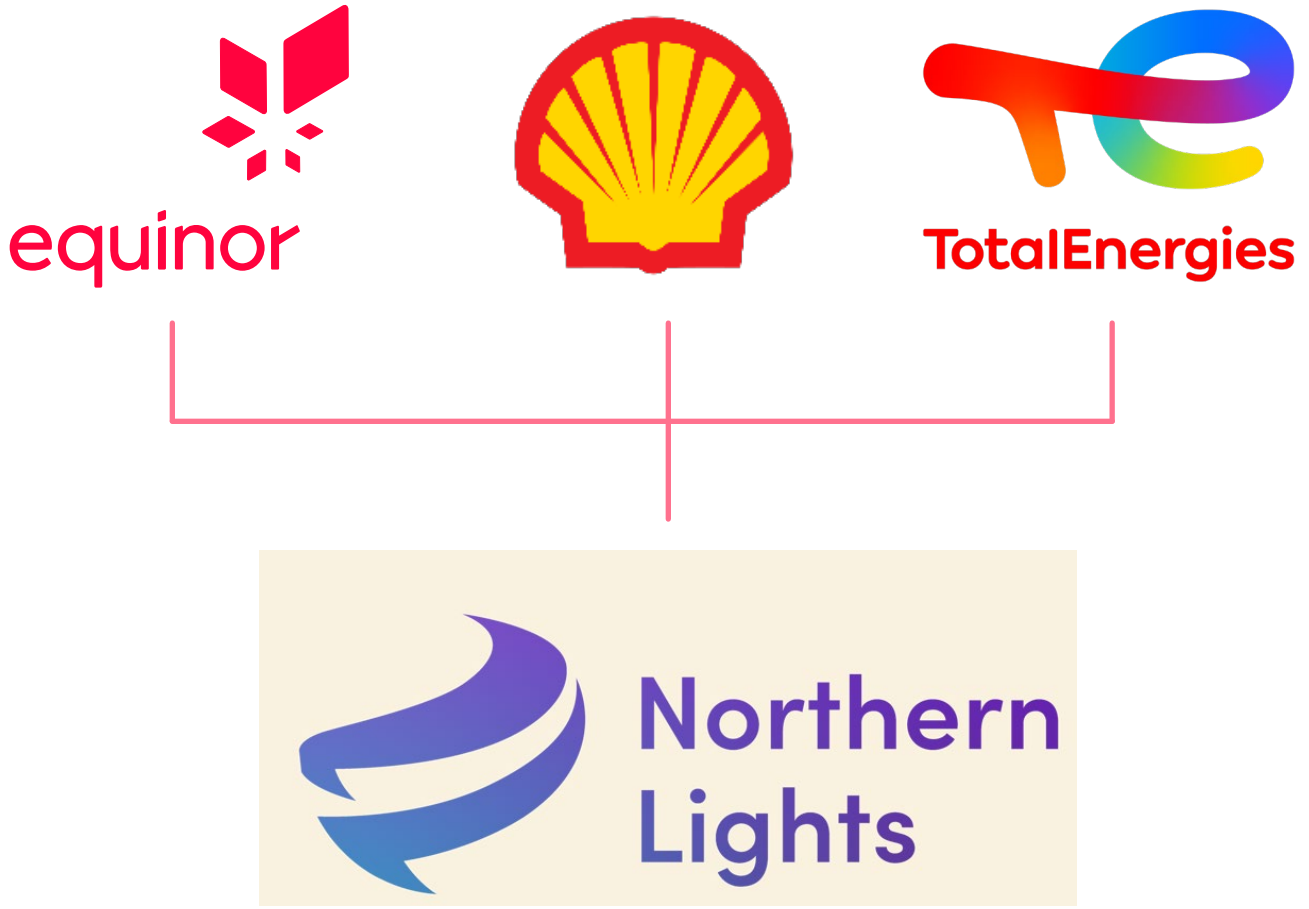
>10%

Clean hydrogen market share in Europe by 2035

Equinor share

Northern Lights Joint Venture

- June 7th 2021 the Northern Lights JV was formally established
- The JV is owned by Equinor, Shell and TotalEnergies
- JV employees are seconded from the owner companies, aiming to employ dedicated staff in the future
- Service agreements are in place with the owner companies for parts of the scope



Northern lights

World's first third party CO_2 storage

1.5 MTPA

CO_2 volumes phase 1

100% share

5 MTPA

CO_2 volumes including phase 2

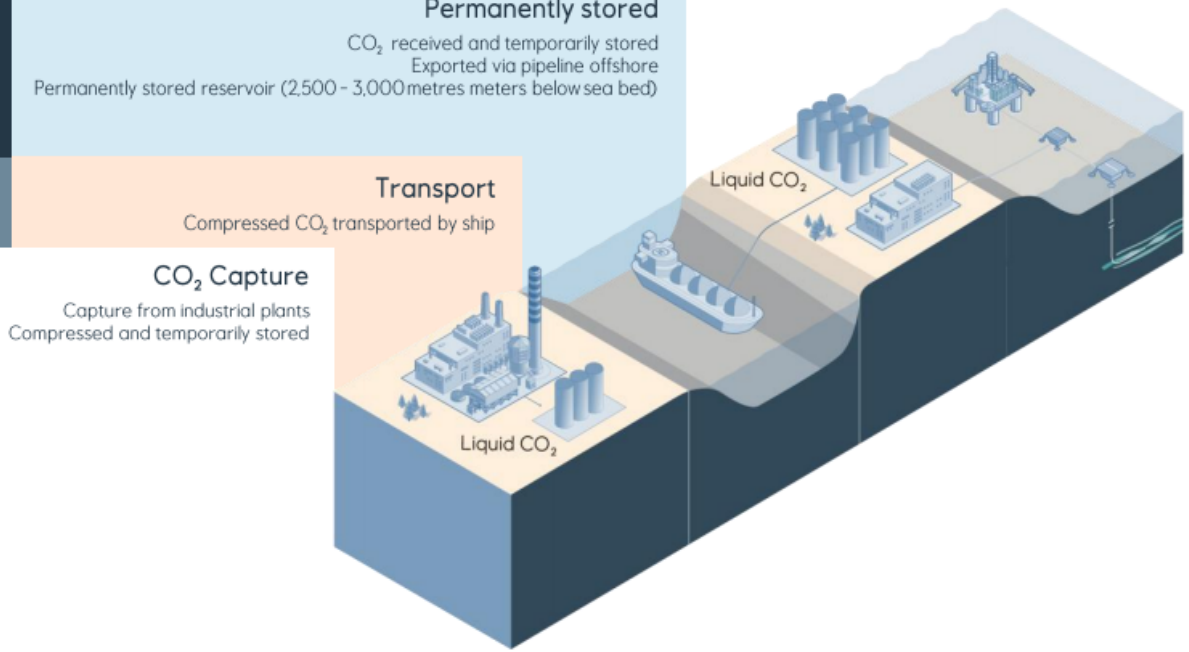
100% share

2024

Start-up, phase 1

2025-27

Start-up, phase 2



- Large scale CO_2 transportation and storage on NCS
- Interest from > 50 potential customers
- Joint venture with Total and Shell
- Funding from Norwegian government
- Capture sites eligible for EU innovation funding


Northern Lights
LCO2 CARRIER

CO_2 ship transport

Cargo Systems for CO_2

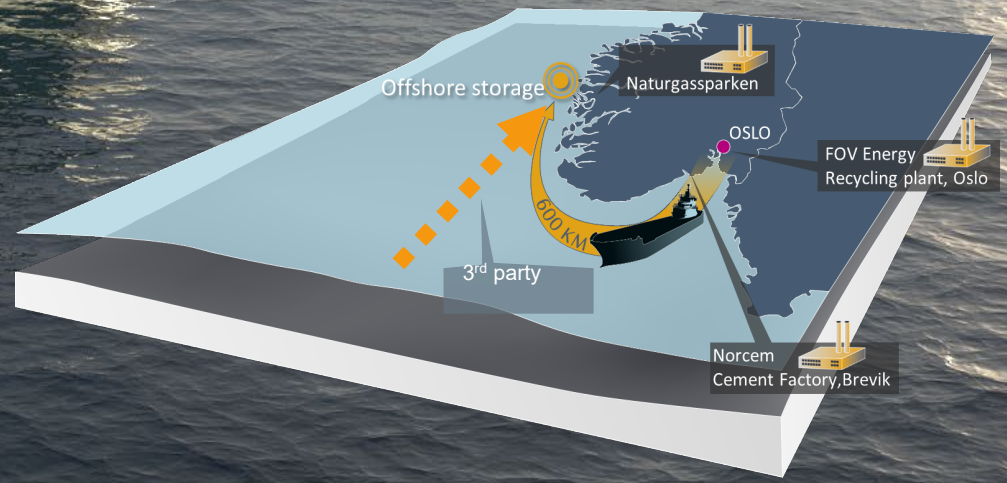
- 2 ships x 7500 m3 capacity initially
- Cargo at 13-15 barg (approx. -26°C)
- Offloading @ max 800 m3/hr
- Evaluating future ship sizes up to 15 000 m3

'LPG standard' design

- Proven concept

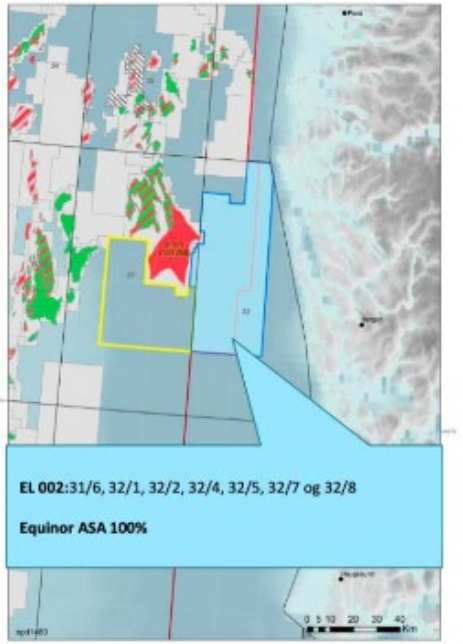
Emission reduction measures

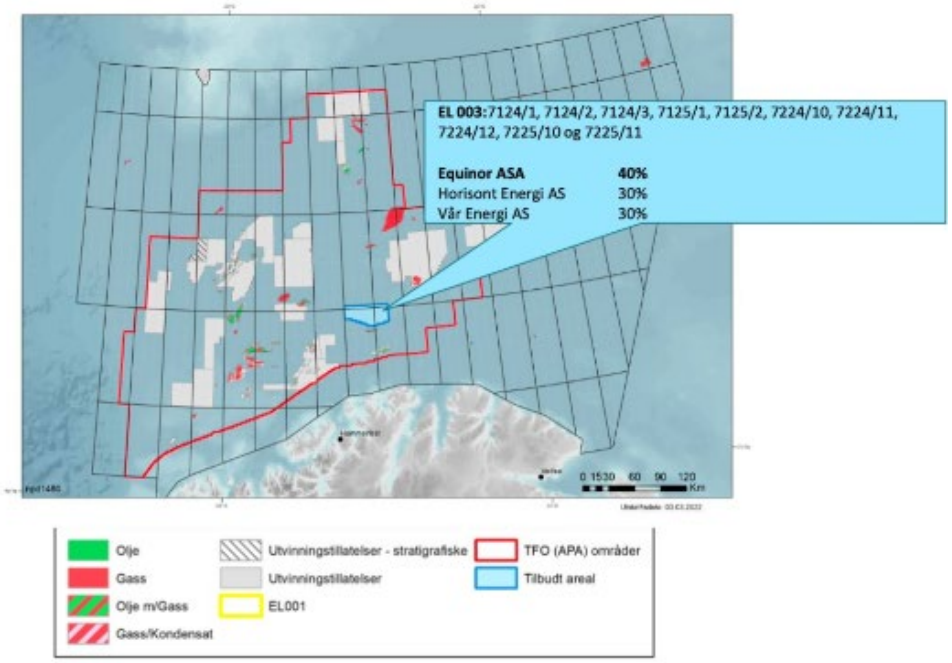
- LNG dual fuel combustion
- Air lubrication
- Rotor sails
- Shore power



Equinor awarded the Smeaheia and Polaris CO2 licenses

By Sverre Olden Mala - 05 Apr 2022 13:50



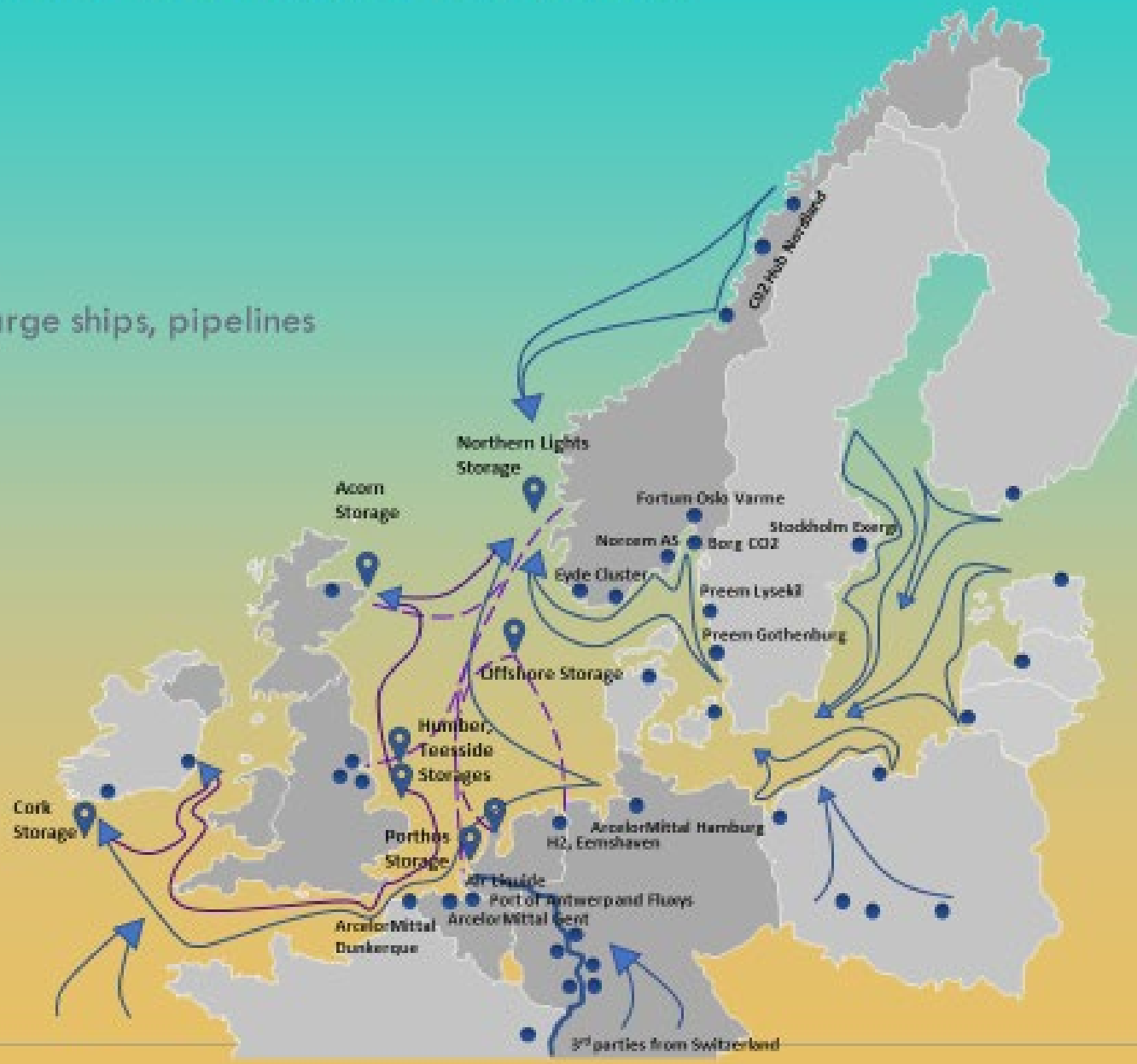


In its application, Equinor has submitted plans to develop the CO2 storage capacity in Smeaheia at 20 million tonnes annually, which entails a sharp increase in the capacity to store CO2 on a commercial basis on the Norwegian continental shelf.

Equinor awarded the Smeaheia and Polaris CO2 licenses
Equinor has been awarded the operatorships for the development of the CO2 storages Smeaheia in the North Sea and Polaris in the Barents Sea . The two licenses are important building blocks for developing the Norwegian continental shelf into a leading province for CO2 storage in Europe.

Future: A European infrastructure for CO2 removal

- CO2 from many industries and countries
- Logistics by hubs, intermediate storage, small ships, large ships, pipelines
- Storage across the continent
- Reducing emissions from hard to abate industry
- Enabling new industry
  - Large scale, clean hydrogen
  - Negative emissions through BECCS and DAC

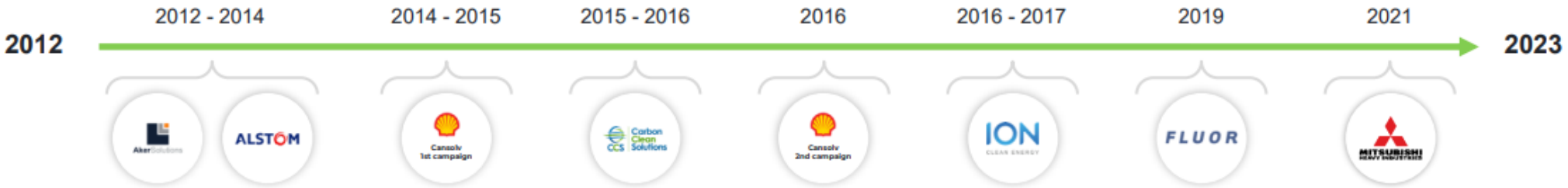



Technology Centre Mongstad
-Operated 10 years by Equinor
-Significant site for CO2 capture technology development and learning
TECHNOLOGY
CENTRE
MONGSTAD

Test campaigns conducted in 9 years of operation

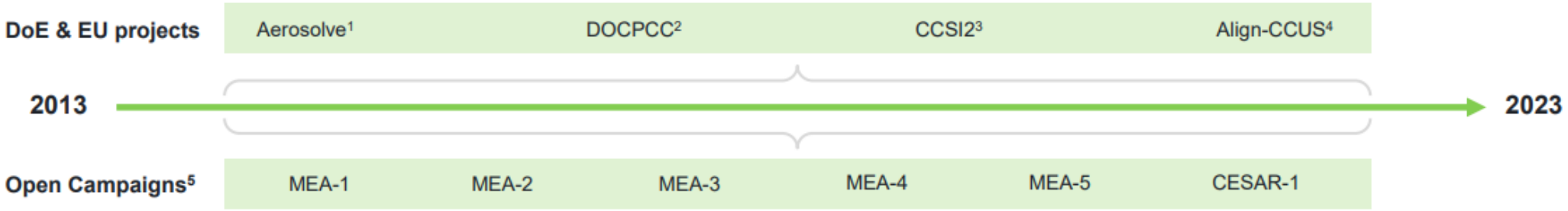
Proprietary test campaigns

Vendors conduct proprietary testing with their own technology.



Non-proprietary test campaigns

Several open scientific campaigns with non-proprietary solvent in collaboration with universities and research organisations, as well as several projects together with the EU.



[1] Project regarding aerosol-related emissions
[2] Demonstration of Optimal Control of Post-Combustion Capture Processes
[3] Carbon Capture Simulation for Industry Impact
[4] Accelerating Low carbon Industrial Growth through CCUS
[5] Long-term testing with monoethanolamine solvents and CESAR-1 (AMP+PZ) solvent

Proprietary testing >20,000 hrs

Non-proprietary testing >20,000 hrs

Elements to consider for industrial CO_2 capture

- What are the flue gas sources
- What flue gas pre-treatment is needed for capture plant
- What is the desired capture rate and CO_2 volume captured
- Utilities available on site
- CO_2 concentrations in flue gas from pulp and paper ~10-30 vol%

- **Amine technology** most mature, fit for small and large sizes
- "Compact technologies" in development
- Membranes, Adsorbents may compete for high CO_2 concentrations
- Cryogenic may compete for high CO_2 concentrations (or hybrid membrane-cryogenic)

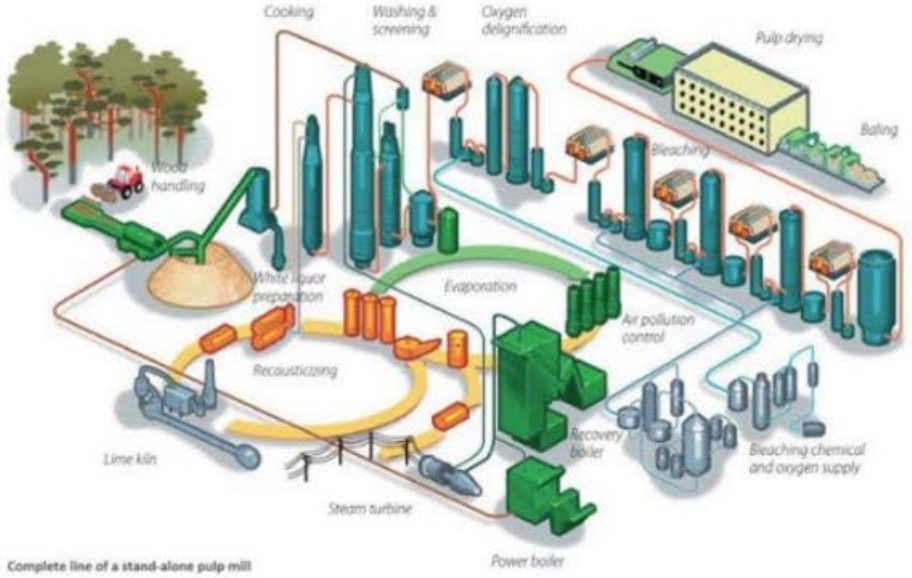
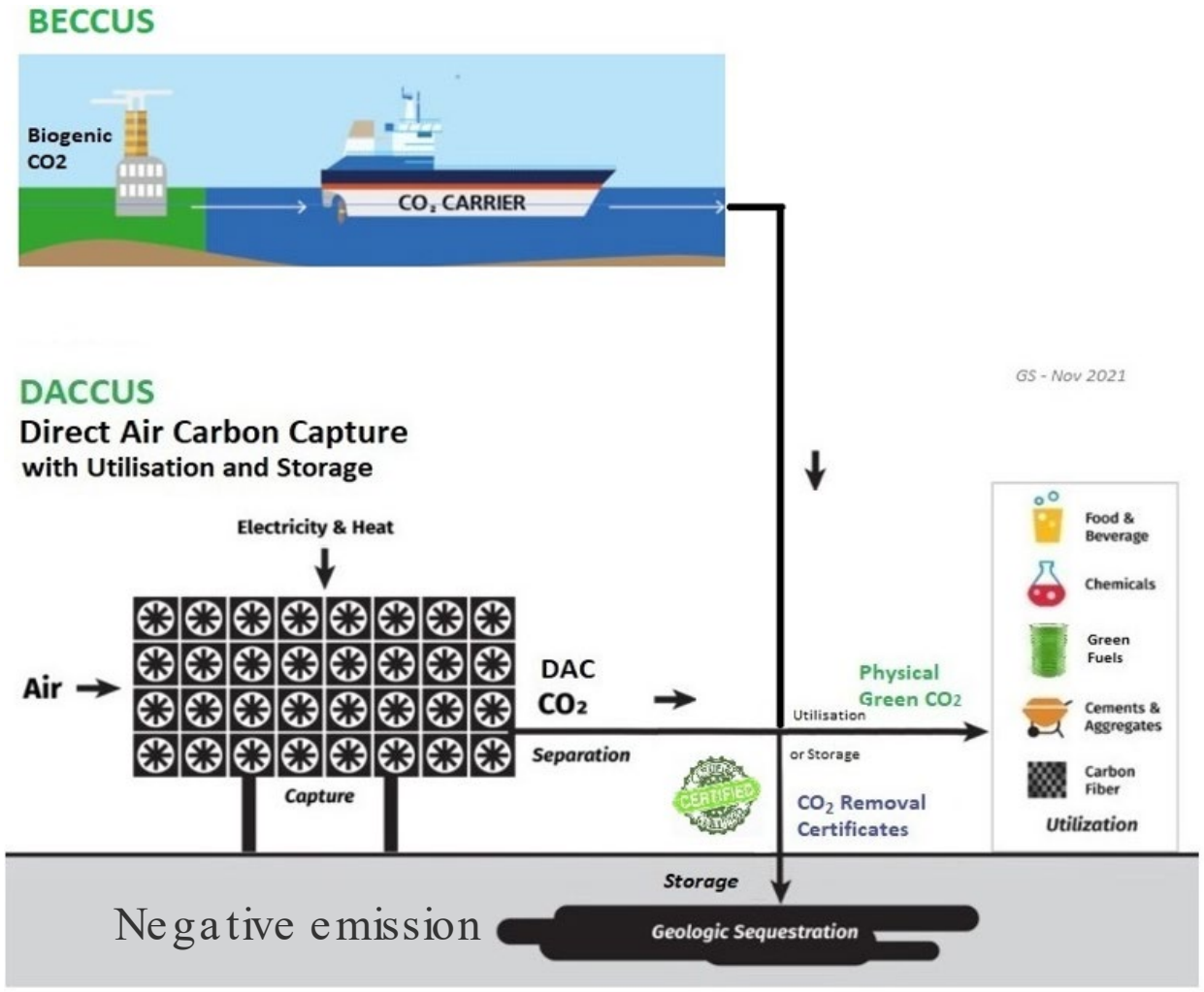


Figure 1 Typical layout of a standalone pulp mill. (Courtesy of Valmet) [25].

2016-10 CCSPnP IEAGHG report
VTT-CR-01051-16/9.1.2017
CCS in P&P Industry – Mills with CCS: Performance, page 133/298

Non fossil carbon value chain



Contact details

- If you are interested in discussing how to collaborate with Equinor in the BECCS value chain, please contact me.

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Thank you for your attention!