CO_2 HUB NORD
– CO_2 fangst, skipstransport og logistikk

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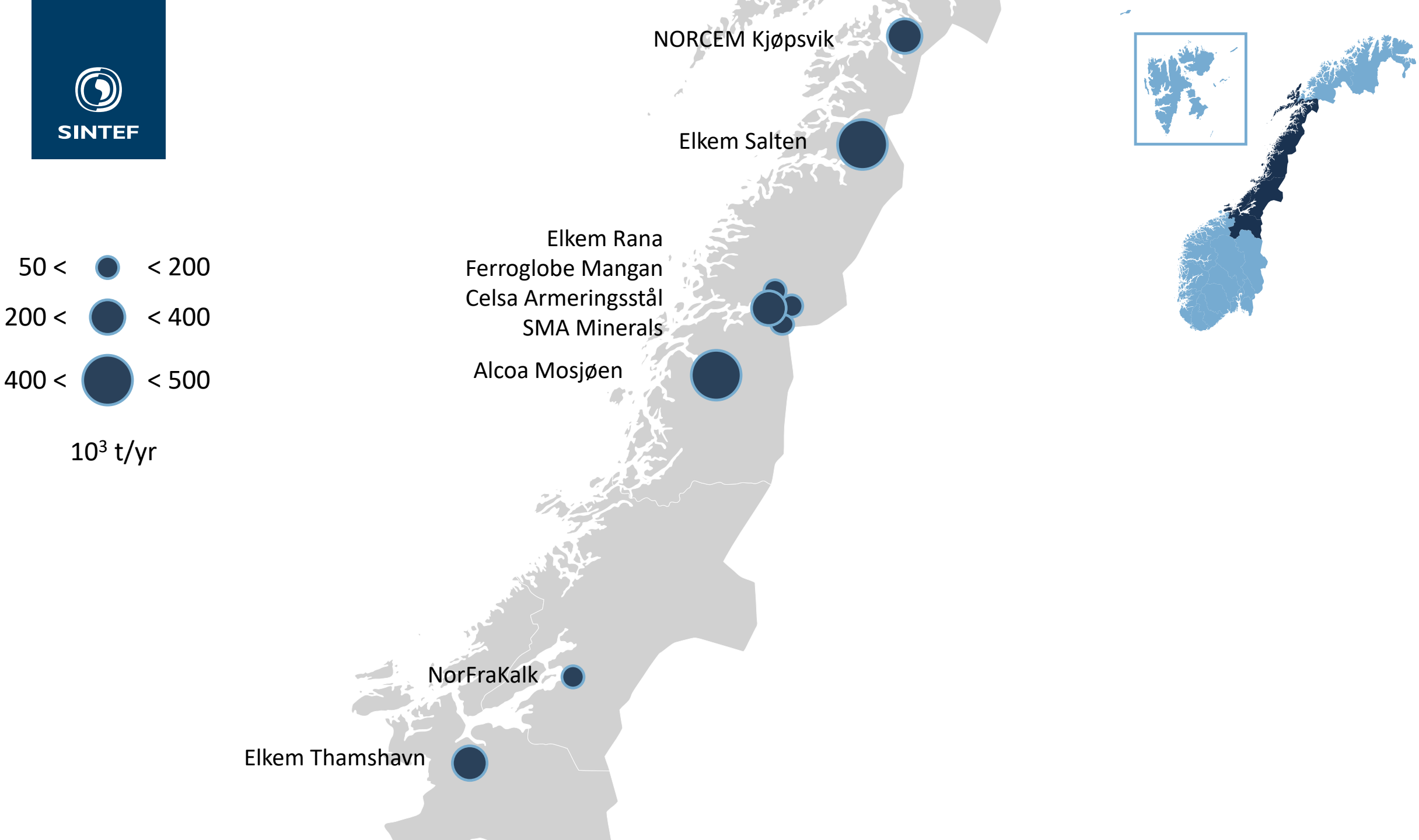
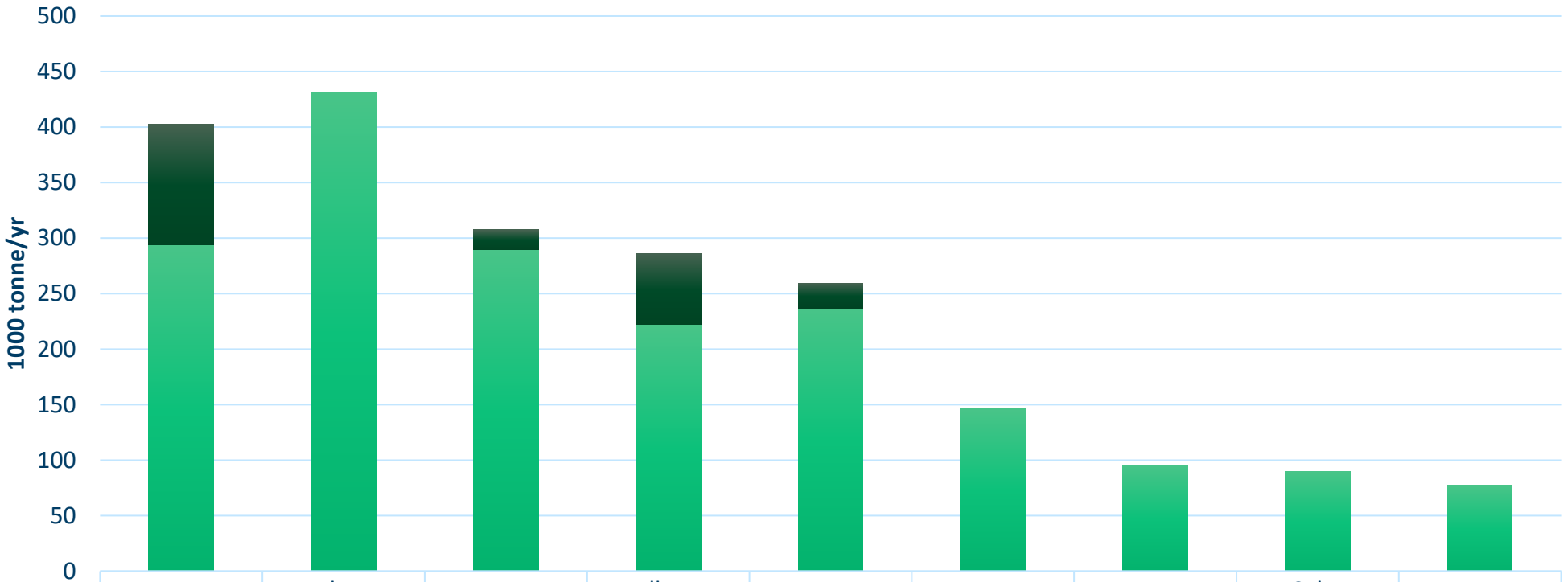
Teknologi for et bedre samfunn


SINTEF
NORCEM Kjøpsvik
Elkem Salten
Elkem Rana
Ferroglobe Mangan
Celsa Armeringsstål
SMA Minerals
Alcoa Mosjøen
NorFraKalk
Elkem Thamshavn
50 < < 200
200 < < 400
400 < < 500
10³ t/yr

CO_2-utslipp (2019)

Sum: 2,1 millioner tonn



	Elkem Salten	Alcoa Mosjøen	Norcem Kjøpsvik	Elkem Thamshavn	Elkem Rana	NorFraKalk	Ferroglobe	Celsa Armeringsstål	SMA Minerals
Bio	108	0	18	64	23	0	0	0	0
Fossil	294	431	290	222	237	146	96	90	77

CO_2-HUB NORDLAND 2018 - 2021

MAPPING OF ALL EMISSION POINTS

MAPPING AND EVALUATION OF CAPTURE TECHNOLOGIES

(maturity, potential, opportunities of integration, overall optimal operation and energy utilization for industrial and CO_2-capture facilities)

DESIGNED CO_2-CAPTURE AND LIQUIDIFICTION FACILITIES ON ALL SITES

ESTIMATING NEEDS OF ENERGY AND COOLING WATER

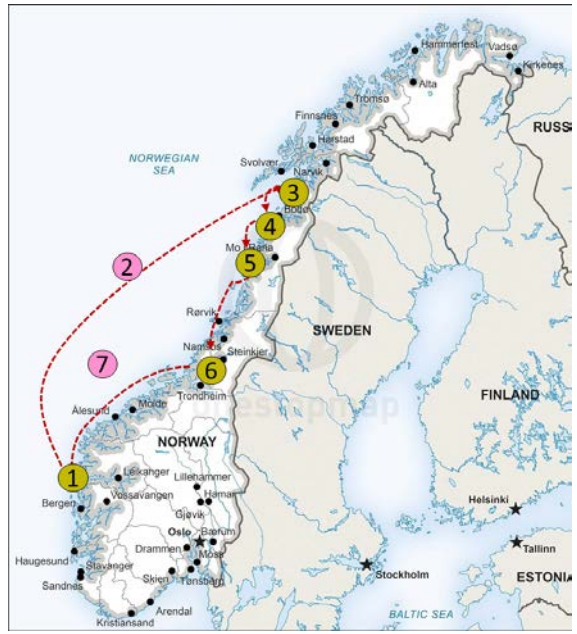
EVALUATED AVAILABLE AREA FOR CO2 CAPTURE FACILITIES

COST ESTIMATION STUDY FOR ALL CAPTURE AND LIQUIDIFICTION PLANTS (CAPEX and OPEX)

ASSESSMENTS MADE FOR EACH FACILITY :

- Off-gas treatment for impurities
- Available surplus heat
- Optimization of CO_2-concentration

MORE THAN 1.5 MILL. TONNES CO_2 MAY BE CAPTURED



CO_2 Hub Nord – tidslinje mot fullskala CO_2 fangst.

2018-2021:
CO2 Hub Norland fase 1.
Innledende kartlegging og vurdering av ulike teknologier.
Kompetansebygging.
Konkrete spin-offs.

2022-2023:
Industrikonsortium totalt 9 industribedrifter.
Pilot-testing med Aker Carbon Capture fangst-teknologi

2024 -
Utvikling av industriell CCUS.
Norsk prosessindustri ledende på energi-effektivitet og produkter med lavt CO_2-avtrykk.

- **Verdens første test av CO_2 fangst fra metallurgisk industri** skal gjøres i regi av CO_2 Hub Nord

Status CO_2 Hub Nord

- Aker Mobile Test Unit (MTU) ferdig installert på site i Mo i Rana
- Klar for testing med røykgass fra to kilder (Elkem Rana og SMA Mineral)
- Første test av CO_2-fangst fra metallurgisk industri
- Verdens første med samtidig testing av to røykgasskilder
- Pilotkampanje: 6 mnd fra November 2022

CO_2 transport and logistics study, CO_2 Hub North

- The five locations in the CO_2 Hub North project

Paper at GHGT-15 – Eldrup et al.

15th International Conference on Greenhouse Gas Control Technologies, GHGT-15

15th 18th March 2021 Abu Dhabi, UAE

Cost estimation of low-pressure CO_2 shipping

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Abstract

In Norway, the full-scale project Longship will capture CO_2 from one or two sources, transport the CO_2 by ship to a hub at Kollsnes, where the CO_2 is heated and pumped before transported by a pipeline to an offshore storage site. It is likely that other CO_2 sources in Norway will adopt the same transport strategy, i.e., transport of captured CO_2 from the capture site to the hub at Kollsnes before being transported in a common pipeline to permanent storage.
In this paper, the results of an investigation into CO_2 ship transport configurations for CO_2 sources located in the Nordland County in Norway is presented. Five regional hub locations have been identified, each serving one or more emission sources. These regional hubs are then connected to the Kollsnes hub via ship transport. Each regional hub will be different and are sized according to the CO_2 volumes to be transported. There could be many suitable shipping configurations based on the ship size and number of ships used for the operations. Six shipping configurations have been described and cost estimated. The configuration where each regional hubs is served by a dedicated ship, is according to the results the most cost effective alternative. It has the lowest CAPEX and an OPEX in line with the other configurations. The ships are specifically sized according to the CO_2 volume at each regional hub. This configuration is also attractive as it does not depend on the readiness of the other hubs as they are operated independently of each other.

Keywords: CO_2 transportation, CO_2 shipping, Cost estimation

1. Introduction

There is much focus on research, development, and implementation of carbon capture and storage (CCS) in Norway. North Sea contains the largest storage capacity for CO_2 in North-western Europe (1). It is a challenge to transport captured CO_2 from onshore to offshore storage locations, especially during the early phases of the development of large-scale CCS (1). Ship transportation of CO_2 is identified as an attractive solution due to its inherent flexibility and low initial cost compared to pipelines (1-3). Because of this, the plan of the ongoing Norwegian Longship project is shipping of CO_2 from one or two emission sites to a hub located at Kollsnes. From here, the CO_2 is to be transported to an offshore aquifer through a common pipeline.

The process industry in Nordland county in Norway is collaborating in the CO_2-hub Nordland project with partial funding from Gassnova's CLIMIT-Demo program. A part of the project involves an investigation into CO_2 transport of captured CO_2 from the industrial sites to permanent storage. Five regional hub locations have been identified, each serving one or more emission sources. These regional hubs are then connected to the Kollsnes hub via ship transport. In Fig. 1 the location of the regional hubs and the hub at Kollsnes is shown. The CO_2 supply to these five local hubs

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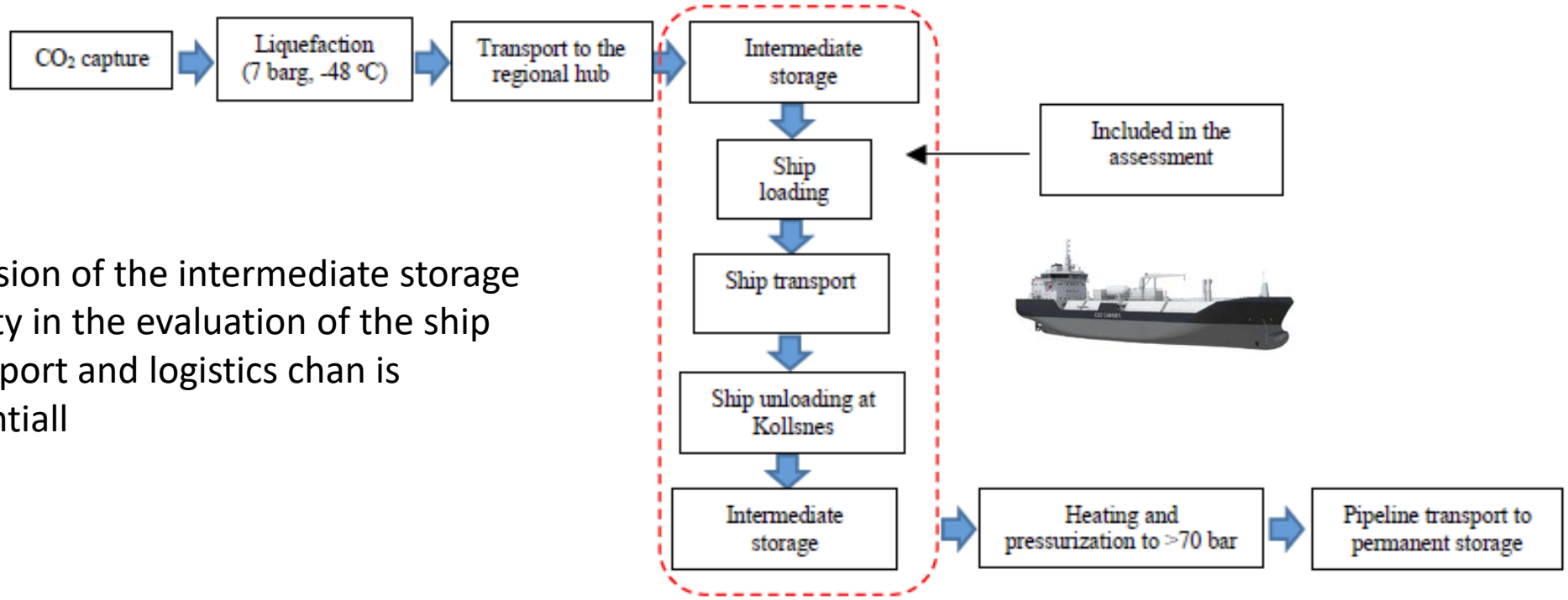
Ship-based CCS chain



Inclusion of the intermediate storage facility in the evaluation of the ship transport and logistics chan is essentiall

Configurations evaluated in CO_2 Hub North

1. One large ship to serve all location – one week roundtrip
2. Seven ships with standard size (7500 m3) – each site visited once per day
3. Five dedicated ships
4. Multiple ships with standard size
5. Two ships
6. Multiple ships with standard size serving four of the locations

- Each of the configurations presented are assessed and cost estimated to identify the most promising alternative.
- The calculation includes the cost of the investment cost of the ship and intermediate storage tanks, and the associated operational cost.

Configuration 1 – dedicated ships

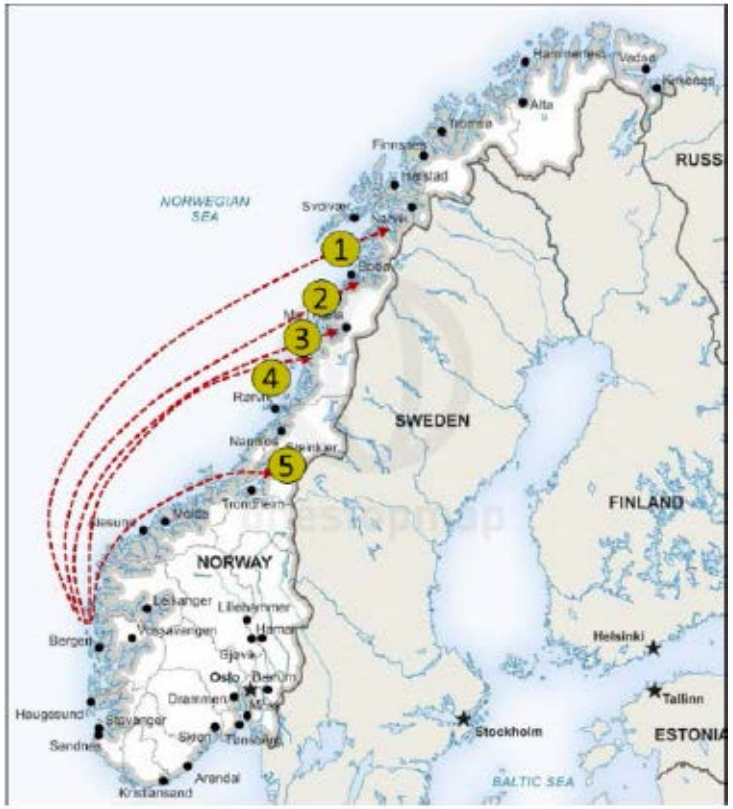
Specific shipping cost for each configuration

Shipping solution	CO_2 shipping cost (NOK/tonne$_{CO2}$)					
	Kjøpsvik	Straumen	Mo i Rana	Mosjøen	Verdal	**Total**
Configuration I	351.6	351.6	351.6	351.6	351.6	**1758**
Configuration II	304.3	304.3	304.3	304.3	304.3	**1521.5**
Configuration III	208.3	189.3	196.8	338.1	219.2	**1151.7**
Configuration IV	253.0	219.1	235.5	777.5	401.6	**1886.7**
Configuration V	308.6	308.6	308.6	308.2	219.2	**1453.2**
Configuration VI	266.0	266.0	266.0	266.0	219.2	**1283.2**

Conclusions

- Six shipping configurations have been described and cost estimated.
- The configuration where each regional hubs is served by a dedicated ship, is according to the results the most cost-effective alternative.
- It has the lowest CAPEX and an OPEX in line with the other configurations.
- The ships are specifically sized according to the CO_2 volume at each regional hub.
- This configuration is also attractive as it does not depend on the readiness of the other locations as they are operated independently of each other.

Configuration 3 – dedicated ships



Partnere i CO_2 Hub Nord

Mo Industripark as

AKER CARBON CAPTURE

Elkem

sma mineral

NORCEM HEIDELBERGCEMENT Group

Ferroglobe

celsa nordic

NorFraKalk

ALCOA

ACT ARCTIC CLUSTER TEAM
Sammen om nye bærekraftige løsninger for Nord-Norge, Paris og hele verden.

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