# Northern Lights

A European $CO_2$ transport and storage network

*Baltic Carbon Forum 2019*

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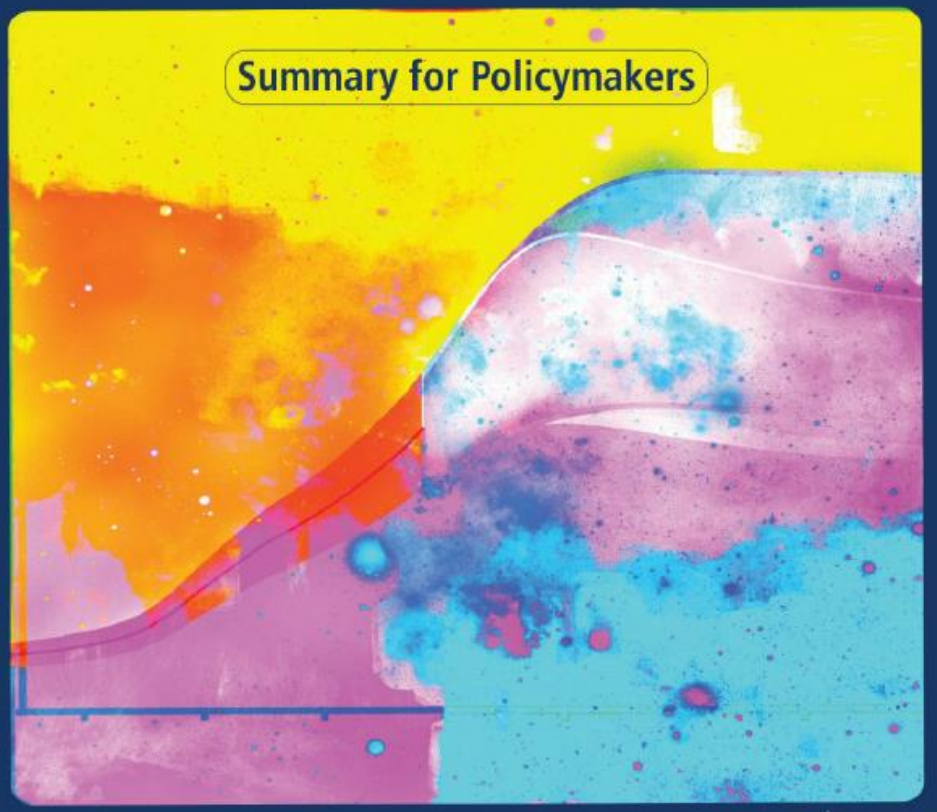
ipcc

INTERGOVERNMENTAL PANEL ON climate change

# Global Warming of 1.5°C

An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty

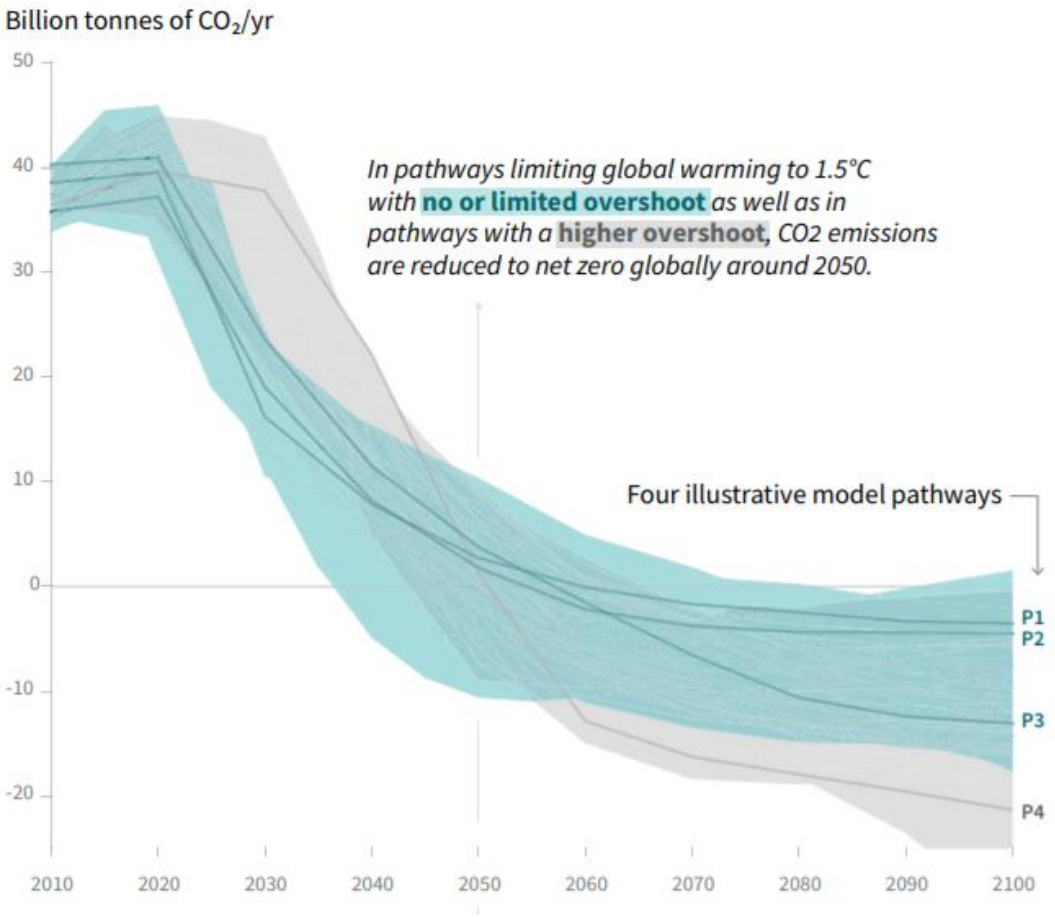



WG I WG II WG III

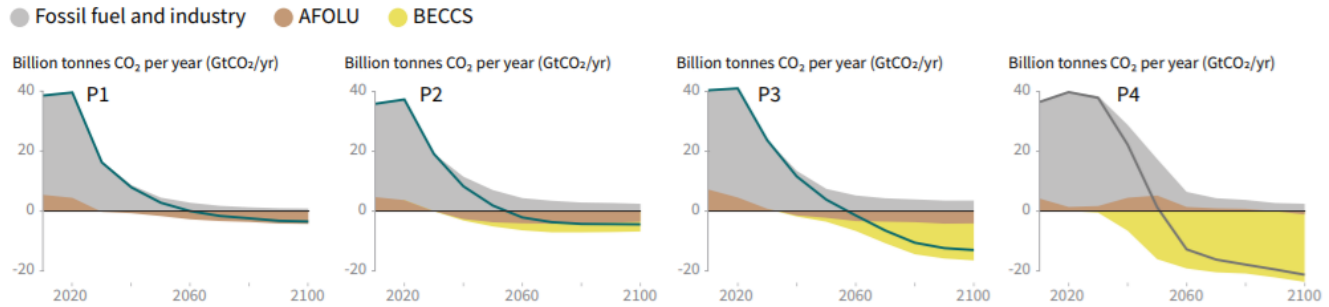
WMO UNEP

# Why do we need CCS?

## Global total net $CO_2$ emissions




## Breakdown of contributions to global net $CO_2$ emissions in four illustrative model pathways




**P1:** A scenario in which social, business and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A downsized energy system enables rapid decarbonization of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

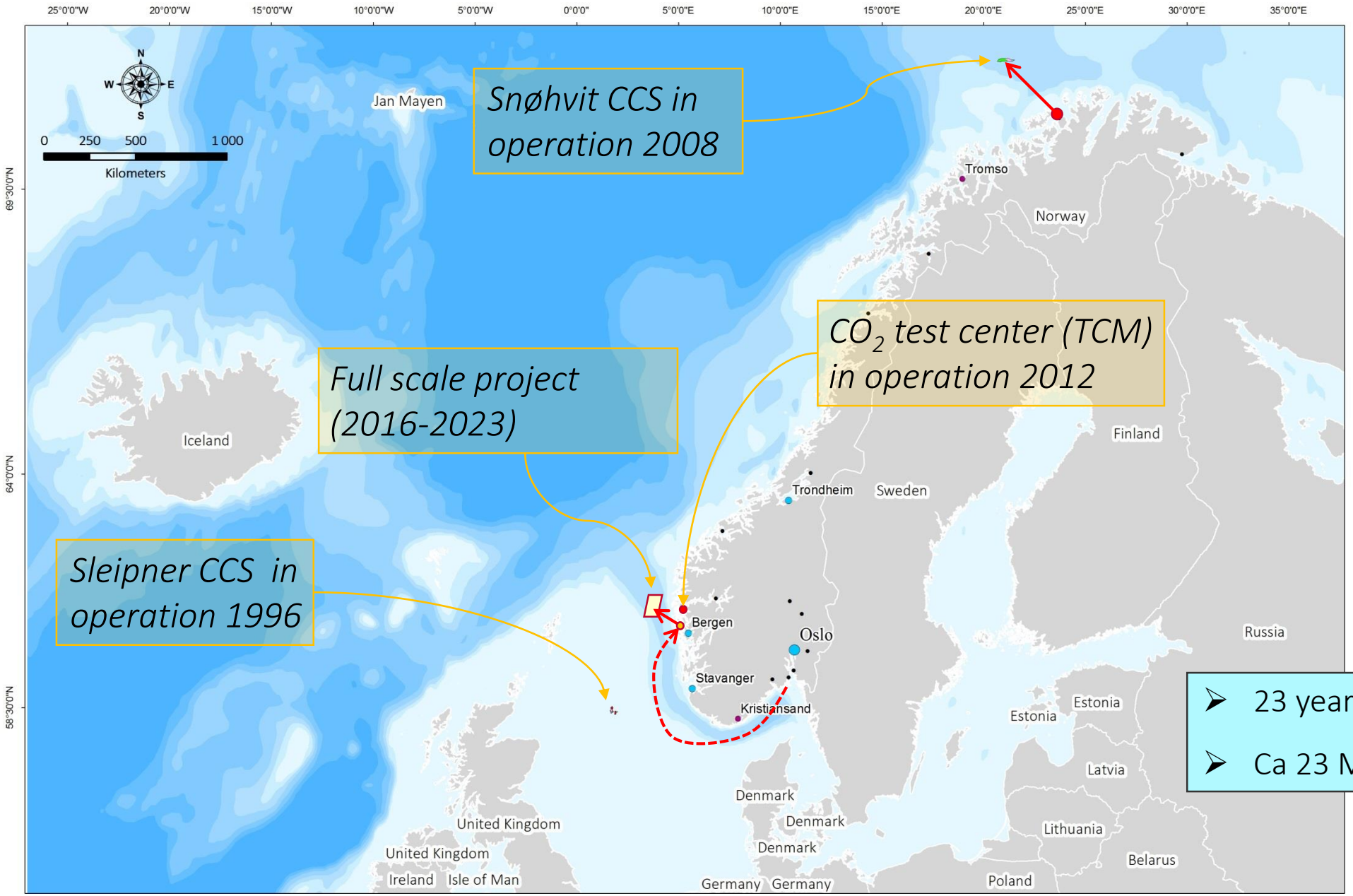
**P2:** A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

**P3:** A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

**P4:** A resource- and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas-intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

| **Global indicators** | P1 | P2 | P3 | P4 | **Interquartile range** |
|---|---|---|---|---|---|
| *Pathway classification* | No or limited overshoot | No or limited overshoot | No or limited overshoot | Higher overshoot | No or limited overshoot |

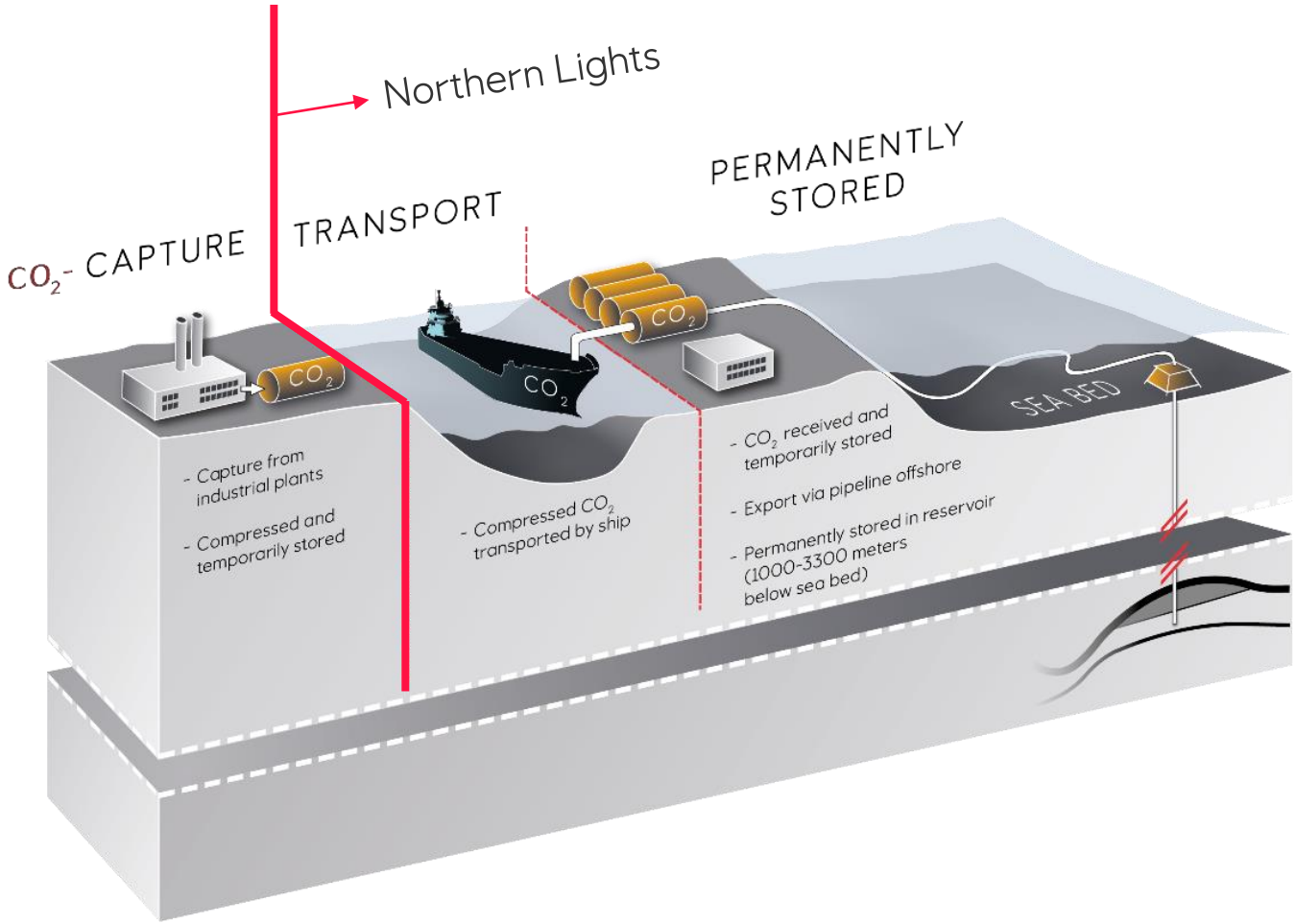
# CCS in Norway – 23 years of succesful industrial experience

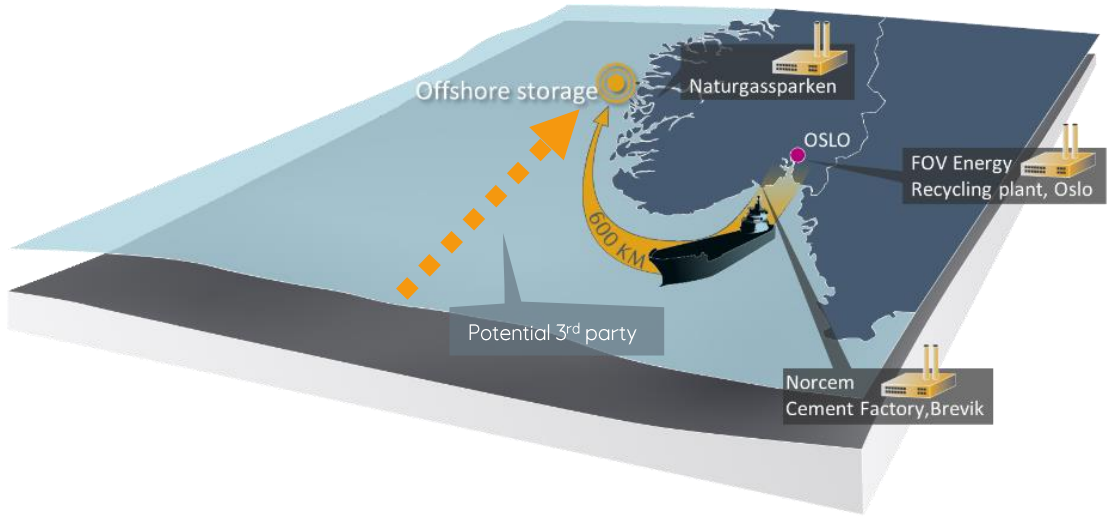



- 23 years of experience
- Ca 23 Mill tonnes of $CO_2$ stored

# Norwegian full scale CCS demonstration project

- Enabling industrial decarbonisation -



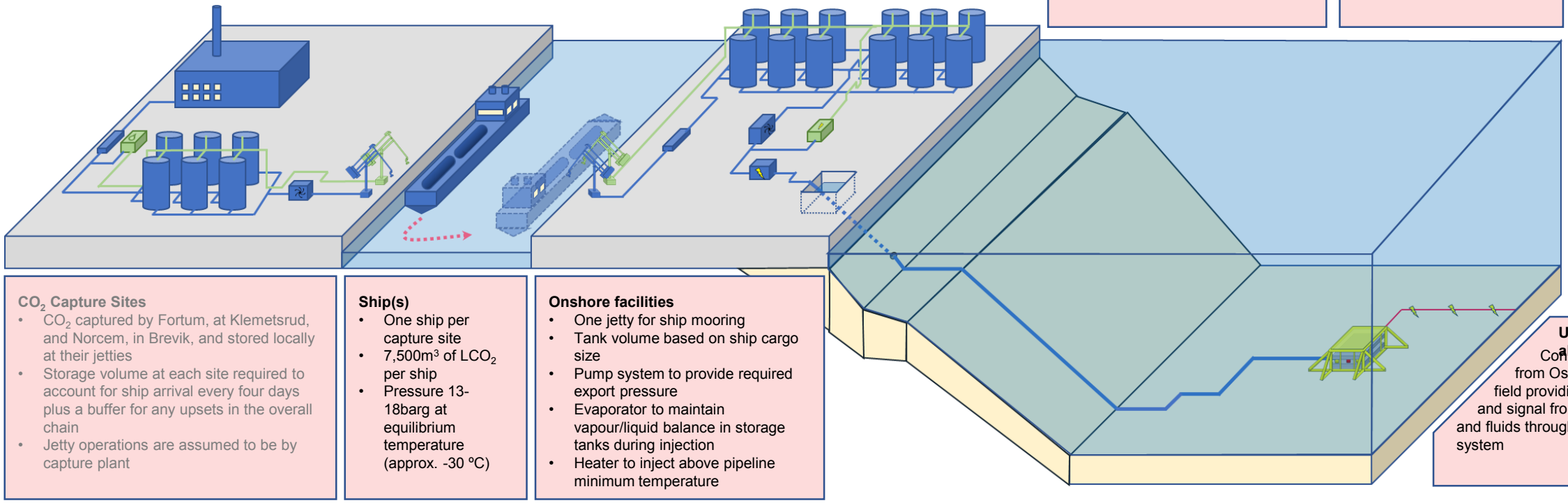




GASSNOVA

# Northern Lights – concept overview

**Pipeline**
- 110km un-insulated pipeline
- 12 ¼ inch
- Single phase (liquid) $CO_2$

**Subsea facilities**
- Connecting pipeline, umbilical and well(s)
- Water depth ~300m
- Connection for future step-out



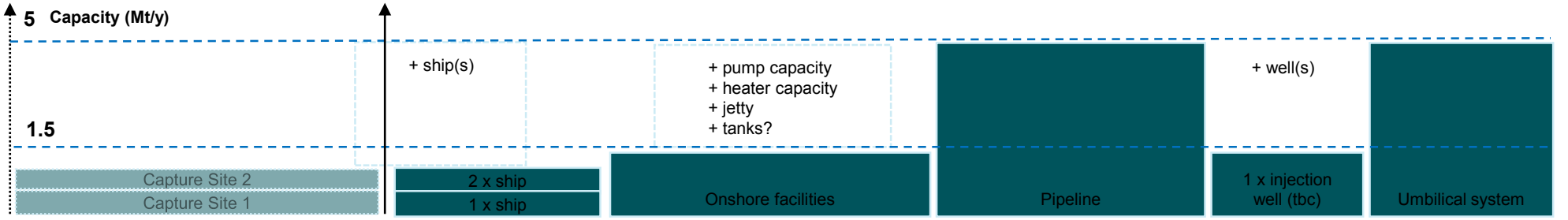
**Subsea injection well**
- Injection of $CO_2$ into reservoir at ~2-3000m depth
- Pressure in reservoir ~2-300bar
- Temperature in reservoir ~100 ºC

**$CO_2$ Capture Sites**
- $CO_2$ captured by Fortum, at Klemetsrud, and Norcem, in Brevik, and stored locally at their jetties
- Storage volume at each site required to account for ship arrival every four days plus a buffer for any upsets in the overall chain
- Jetty operations are assumed to be by capture plant

**Ship(s)**
- One ship per capture site
- 7,500m³ of $LCO_2$ per ship
- Pressure 13-18barg at equilibrium temperature (approx. -30 ºC)

**Onshore facilities**
- One jetty for ship mooring
- Tank volume based on ship cargo size
- Pump system to provide required export pressure
- Evaporator to maintain vapour/liquid balance in storage tanks during injection
- Heater to inject above pipeline minimum temperature

**Umbilical**
Connection from Oseberg-field providing power and signal from DC/FO and fluids through umbilical system




**Storage complex**
- Planned in the Johansen formation south of Troll ("Aurora") with an expected capacity of at least 100 Mt of $CO_2$

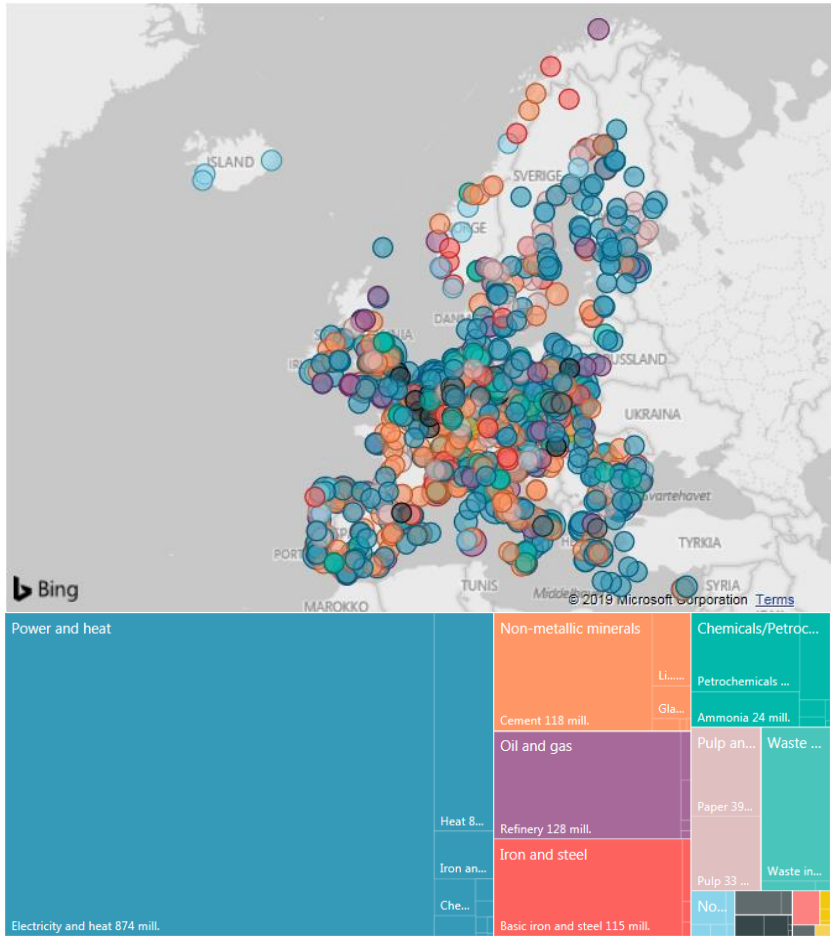
# Visualisation of land facilities (Naturgassparken in Øygarden)

# The European potential – understanding the scale

## Europe

1994 facilities

1680 million tons of $CO_2$



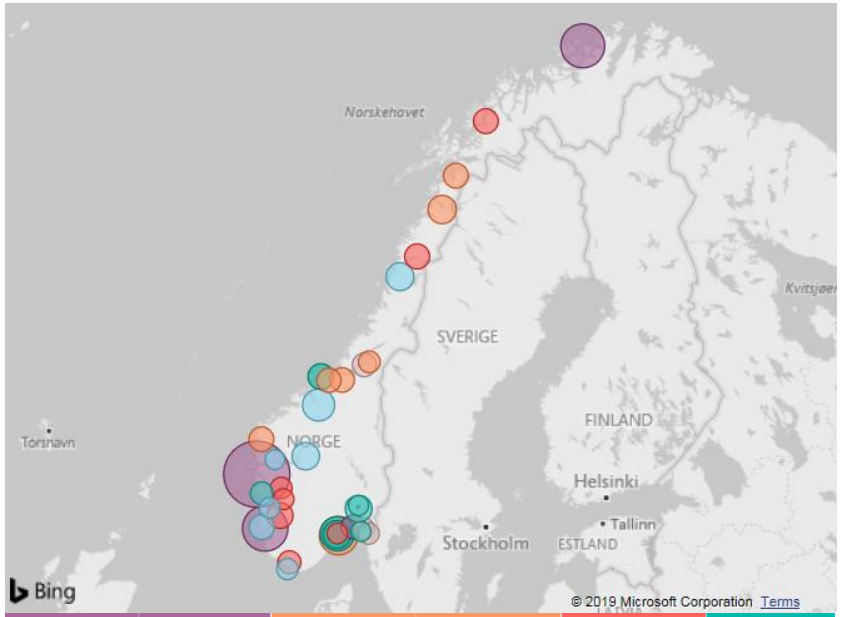


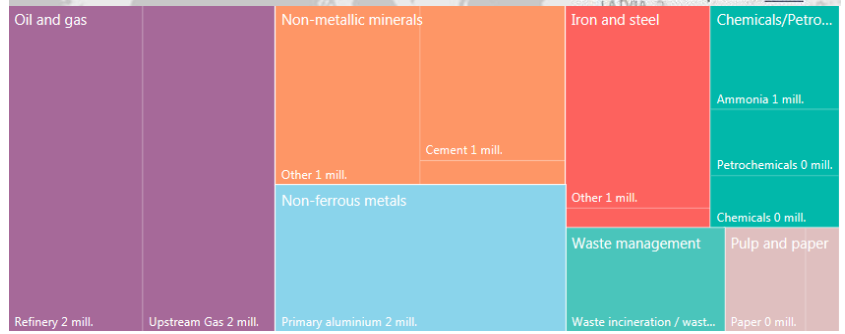


## Norway

35 facilities

13.6 million tons of $CO_2$

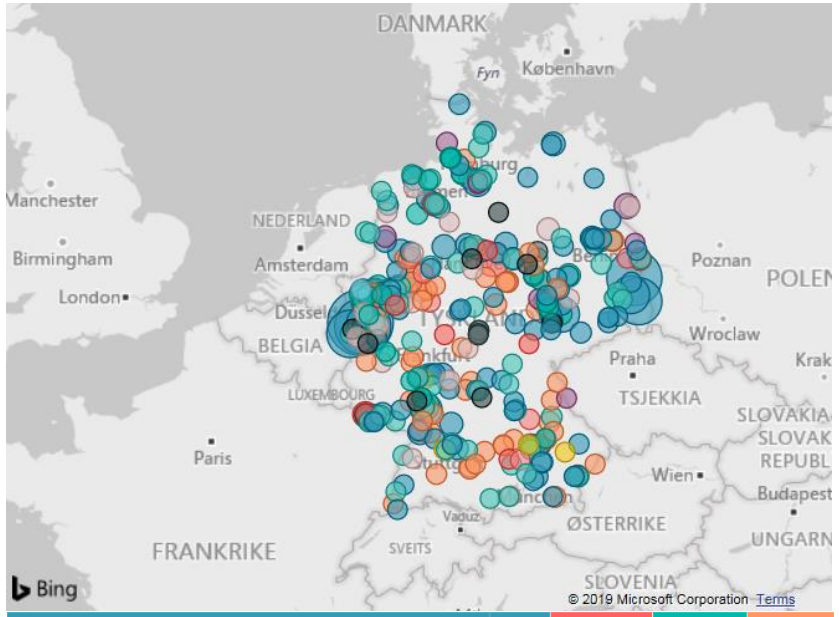


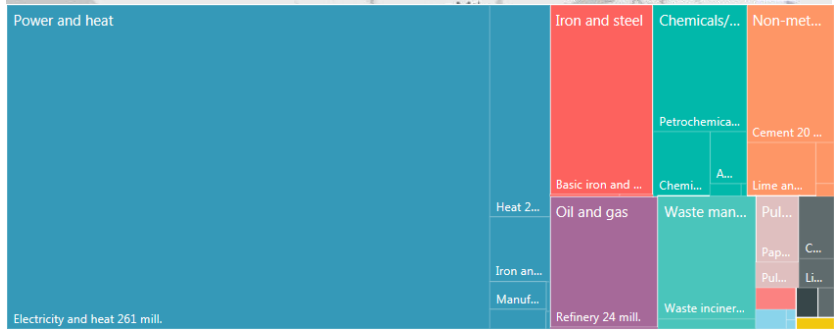




## Germany

397 facilities

358 million tons of $CO_2$

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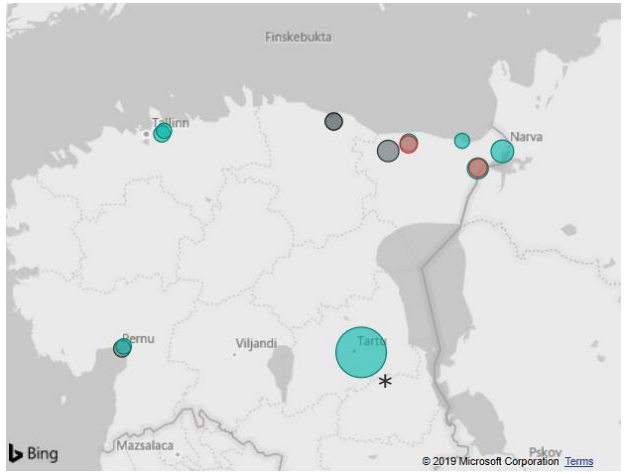
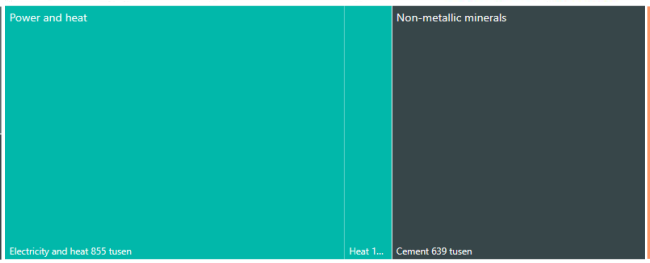
# The Baltic potential – understanding the scale

## Estonia
14 facilities
16 million tons of $CO_2$

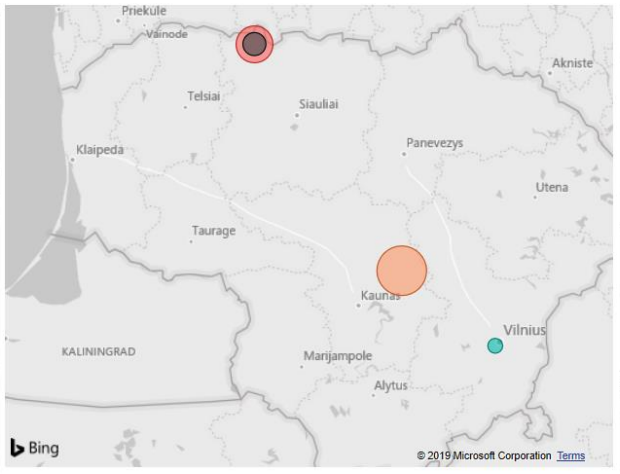


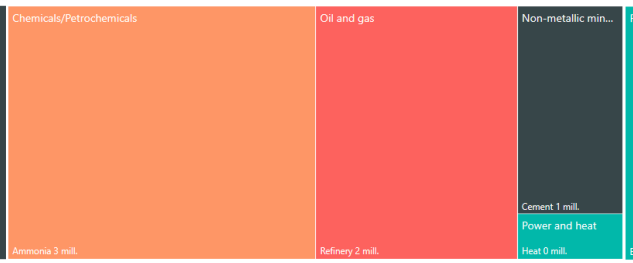


## Latvia
4 facilities
2 million tons of $CO_2$

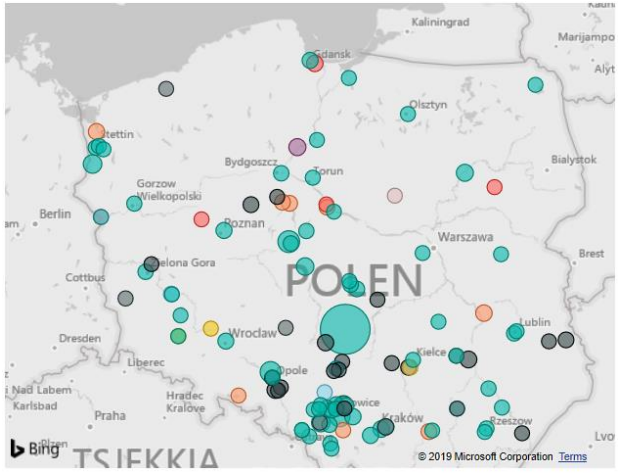




## Lithuania
5 facilities
5 million tons of $CO_2$




## Poland
125 facilities
137 million tons of $CO_2$





* Datapoint is out of scale. Responsible for E-PRTR database has been notified.

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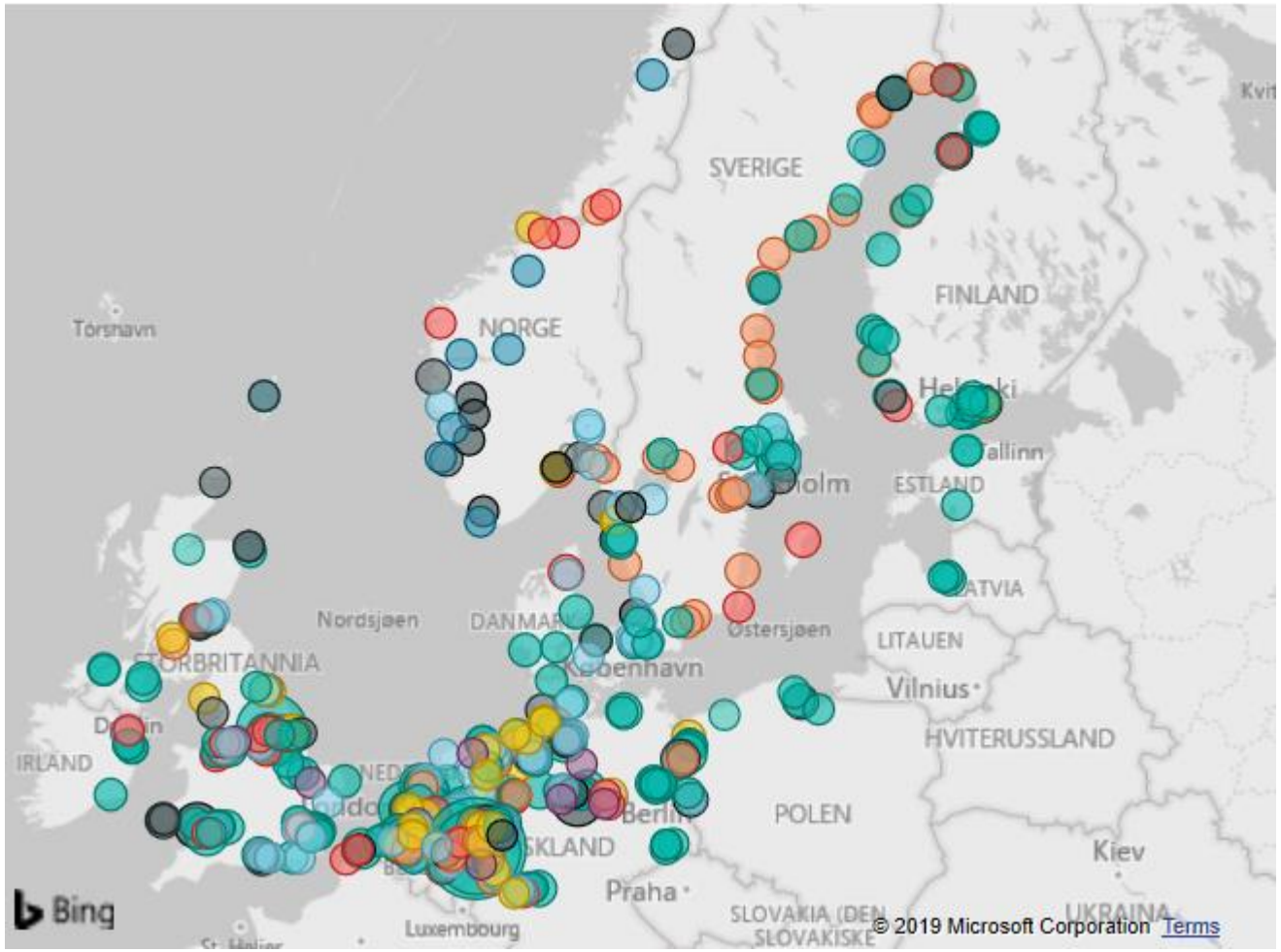
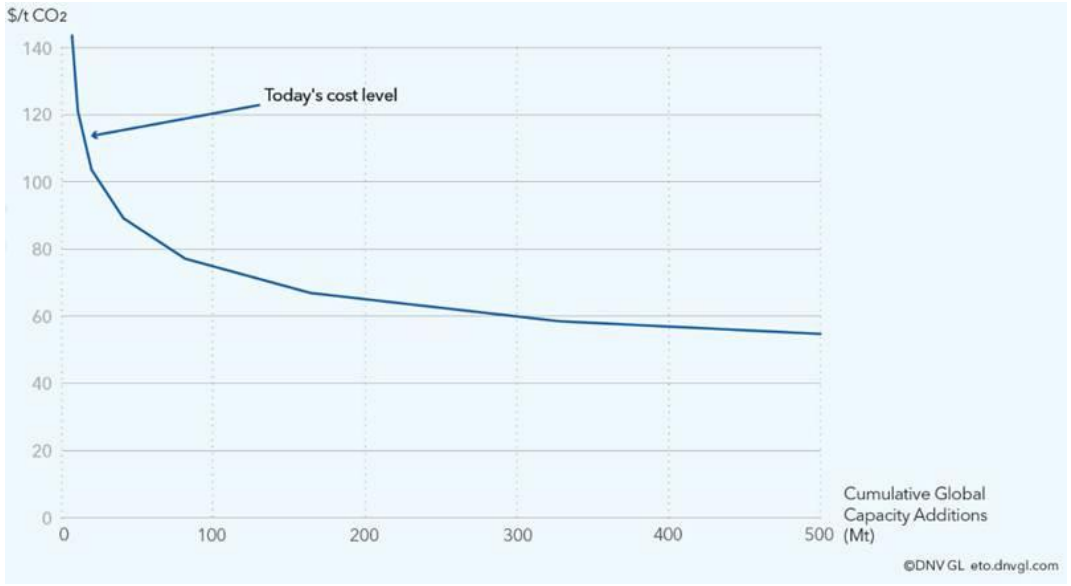
# "Open access" offer for $CO_2$ sources to establish capture



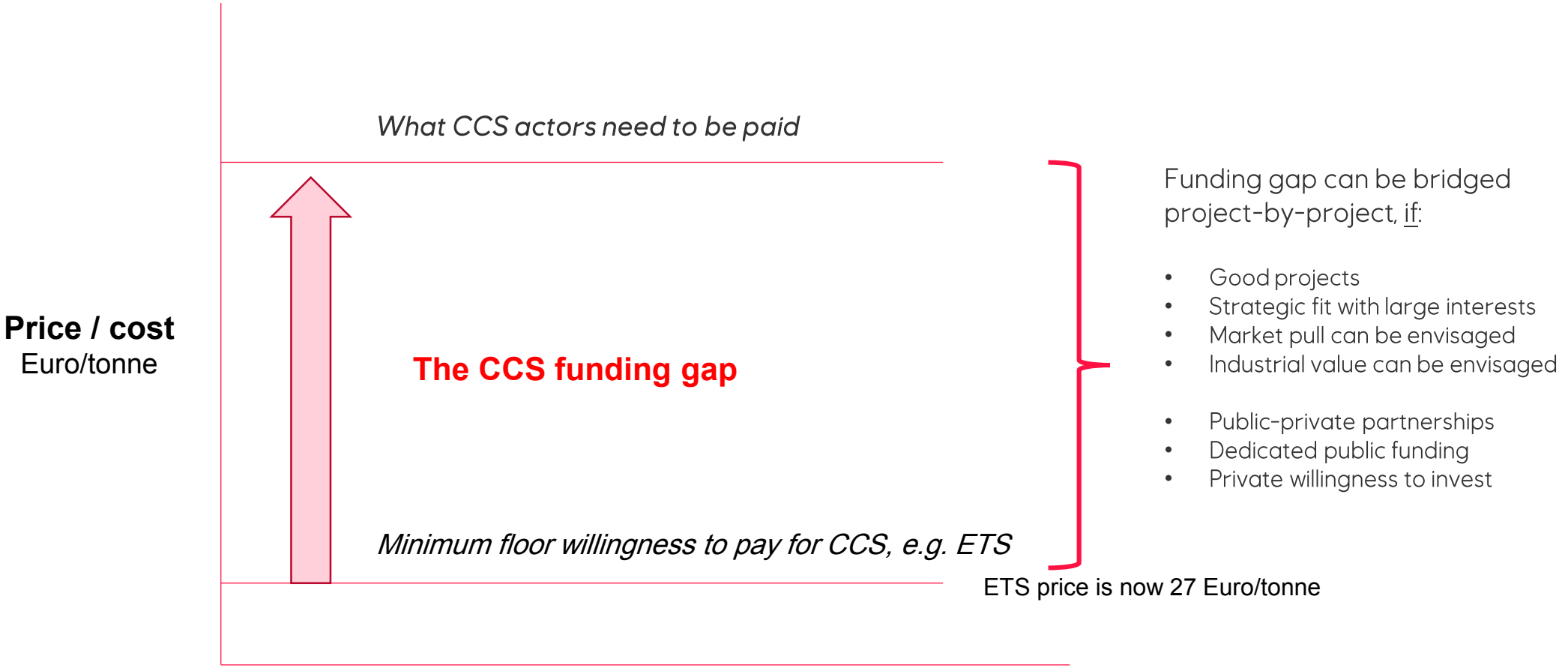

Sectors with largest potential

- Hydrogen and electricity production from natural gas
- Waste incineration
- Cement
- Biomass and biofuel
- Steel production
- Refineries
- Aluminium

# Relevant cost trends for CCS

# The CCS funding gap




Funding gap can be bridged project-by-project, if:

- Good projects
- Strategic fit with large interests
- Market pull can be envisaged
- Industrial value can be envisaged

- Public-private partnerships
- Dedicated public funding
- Private willingness to invest

## CCS funding gap can be bridged – by «handcrafted» funding packages

# The CCS funding gap – POLNOR CCS 2019 Call


Expected result for CCS Call:

1. Enhanced cooperation between the Polish and Norwegian partners involved in projects with the aim for building cooperation for future activities.
2. Support to technology transfer, sharing experiences and best practices between science and enterprises.
3. Development of new products and technologies.
4. Internationally refereed joint publications in the best journals.

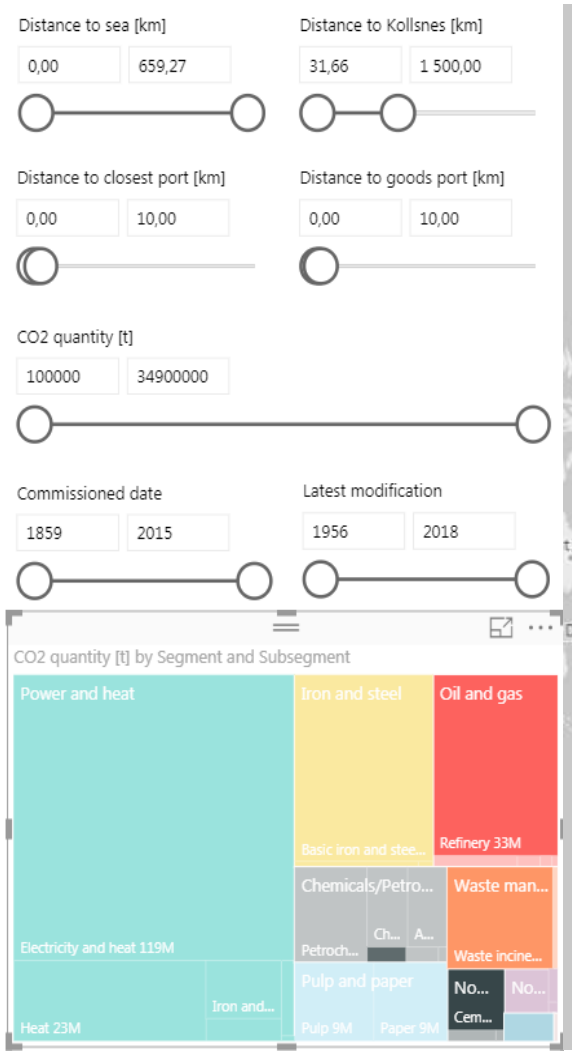
Total allocation in call: EUR 11.764.706
Financing range: EUR 500.000 – 5.000.000

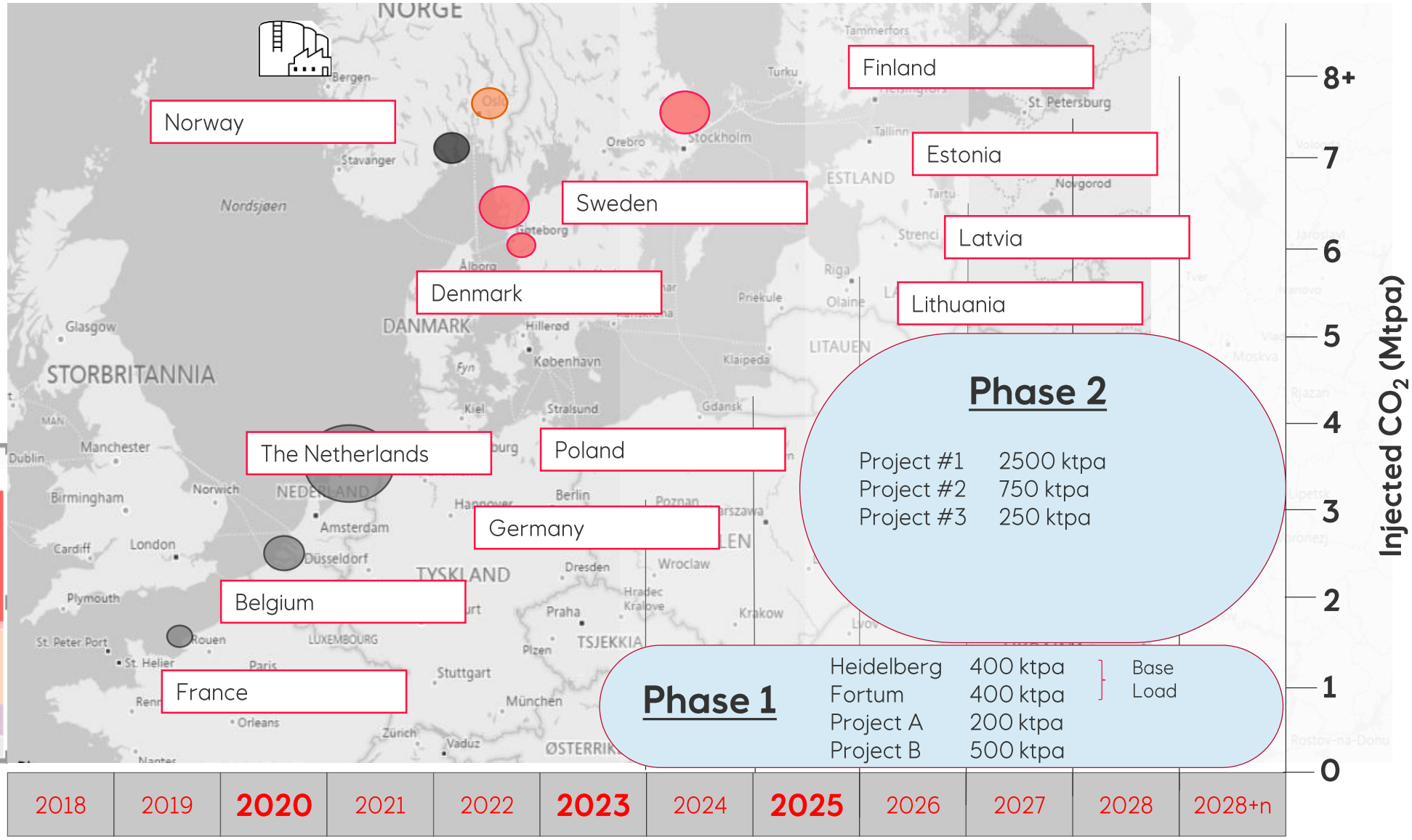
Deadline for submission of proposals: 12 December 2019

Projects have to be submitted by consortia comprising at least of one Polish and one Norwegian entity.

https://www.ncbr.gov.pl/en/programmes/international-programmes/iii-edition-of-eea-and-norway-grants/polnor-ccs-2019-call/

# Phase 1 and Phase 2 CO2 Volumes *Rates and timelines for illustration purposes only



# Beginning of a European network for CO2 removal

## EU PCI application with 15 partners submitted 1.3.19

***What are Projects of Common Interest (PCIs)?***

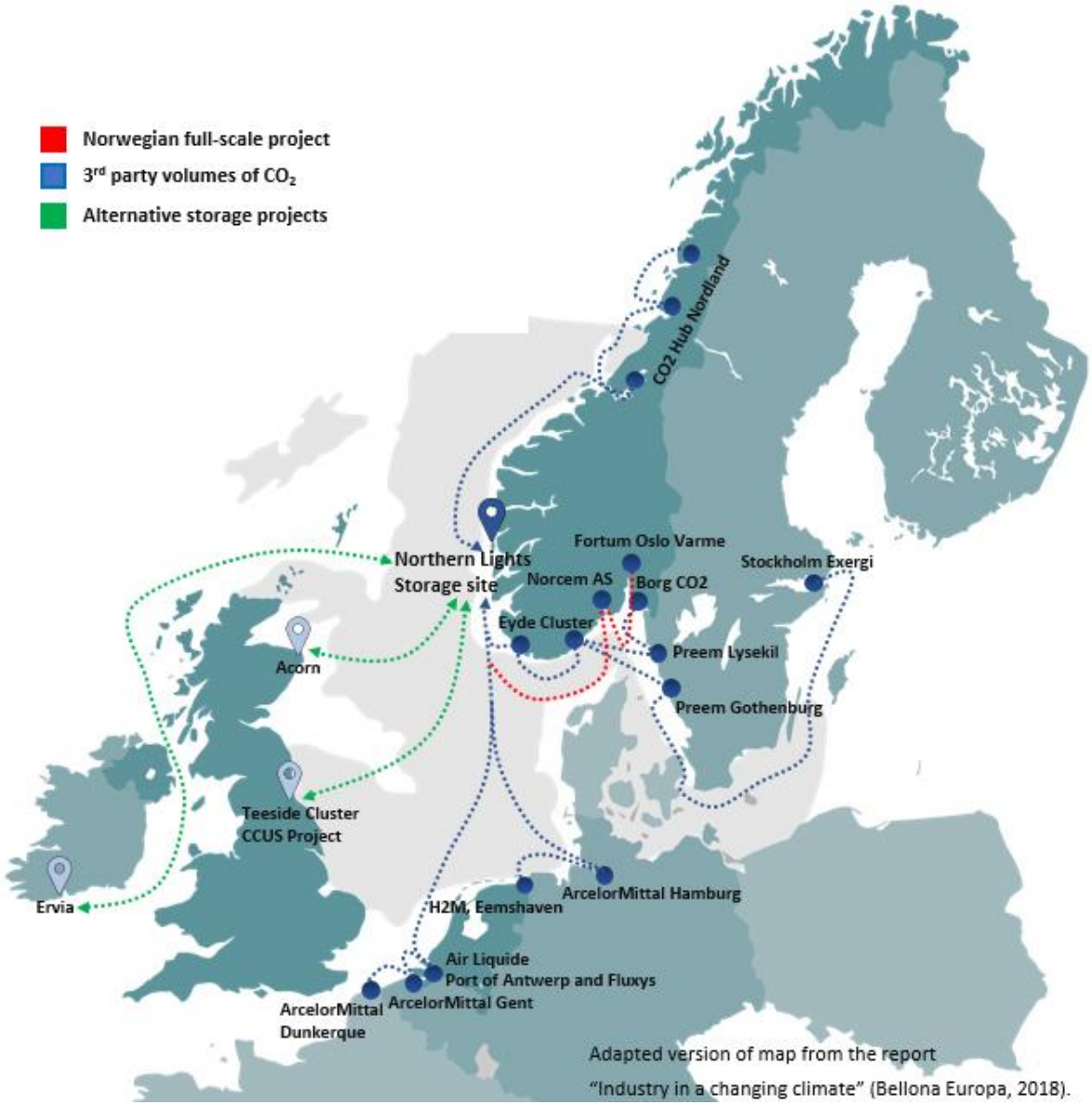
PCIs are infrastructure project that link the energy systems of EU countries.

***Why are they important?***

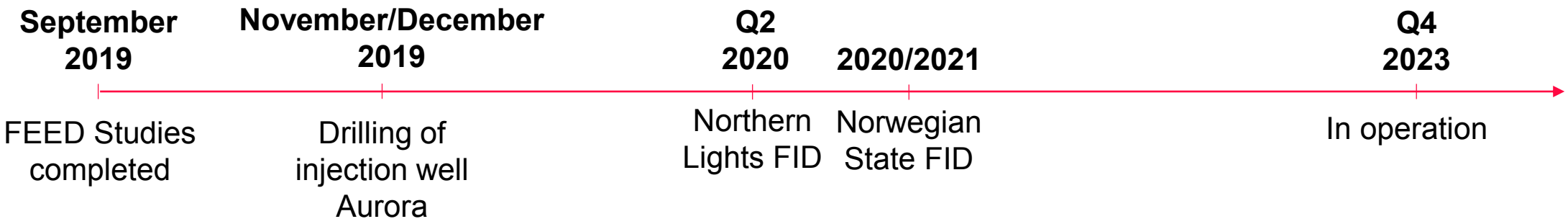
To have PCI status is the first important milestone for a Project to be eligible for funding from the EU.

**The Northern Lights PCI**

- 15 partners
- 7 countries
- 3 reciprocal alternative storage sites

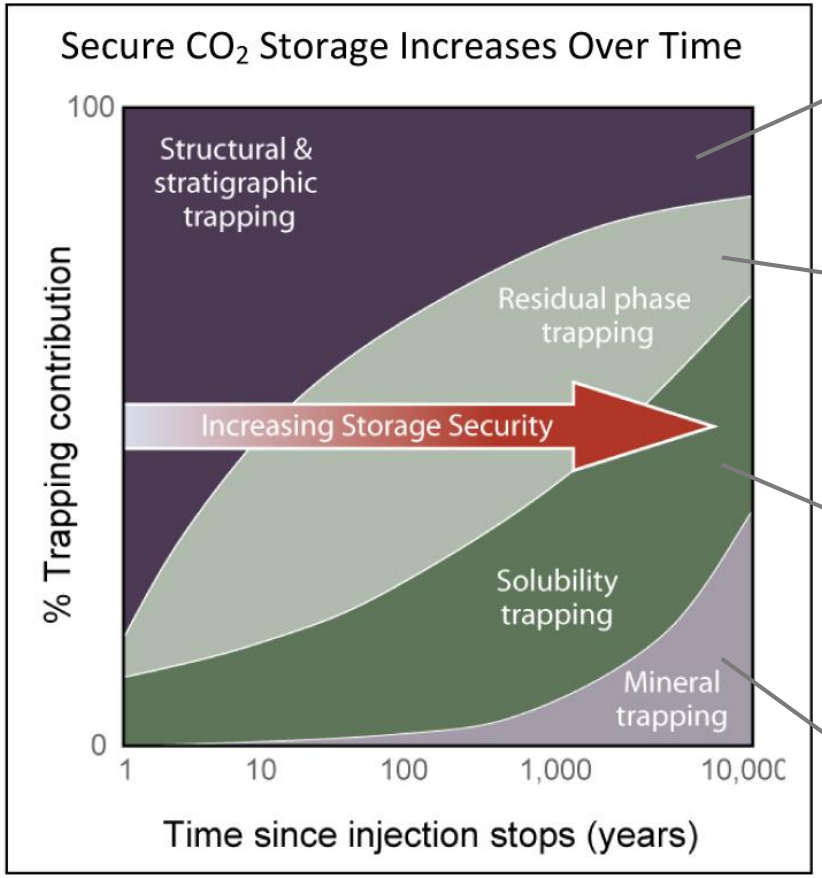


# The road ahead

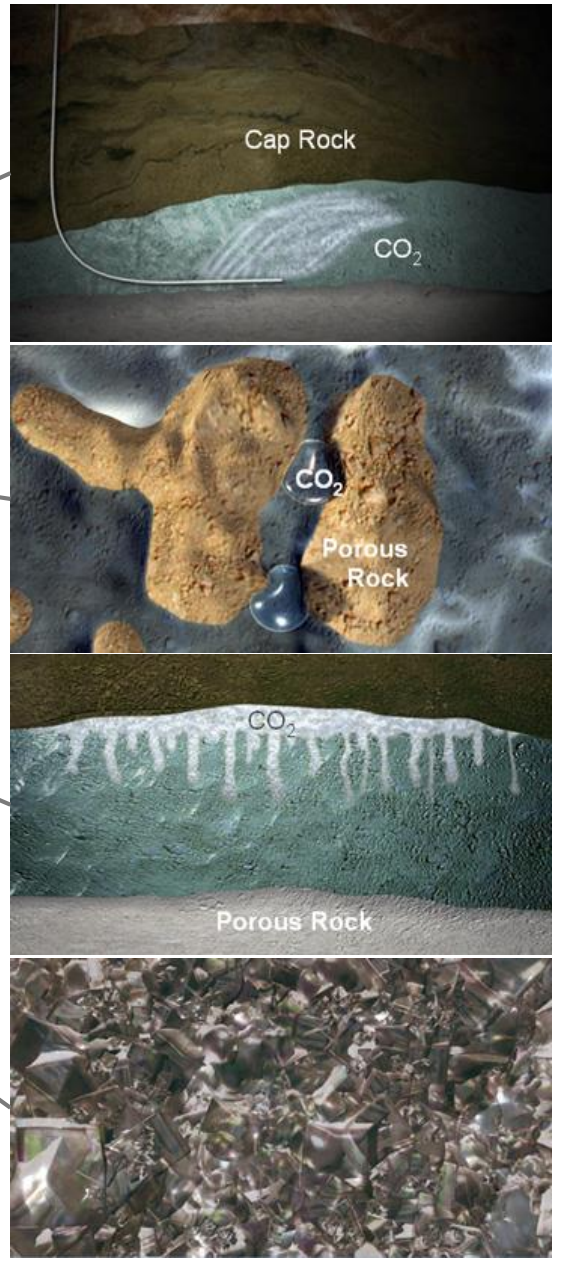


# Questions?

# Storage mechanisms – increasing safety over time

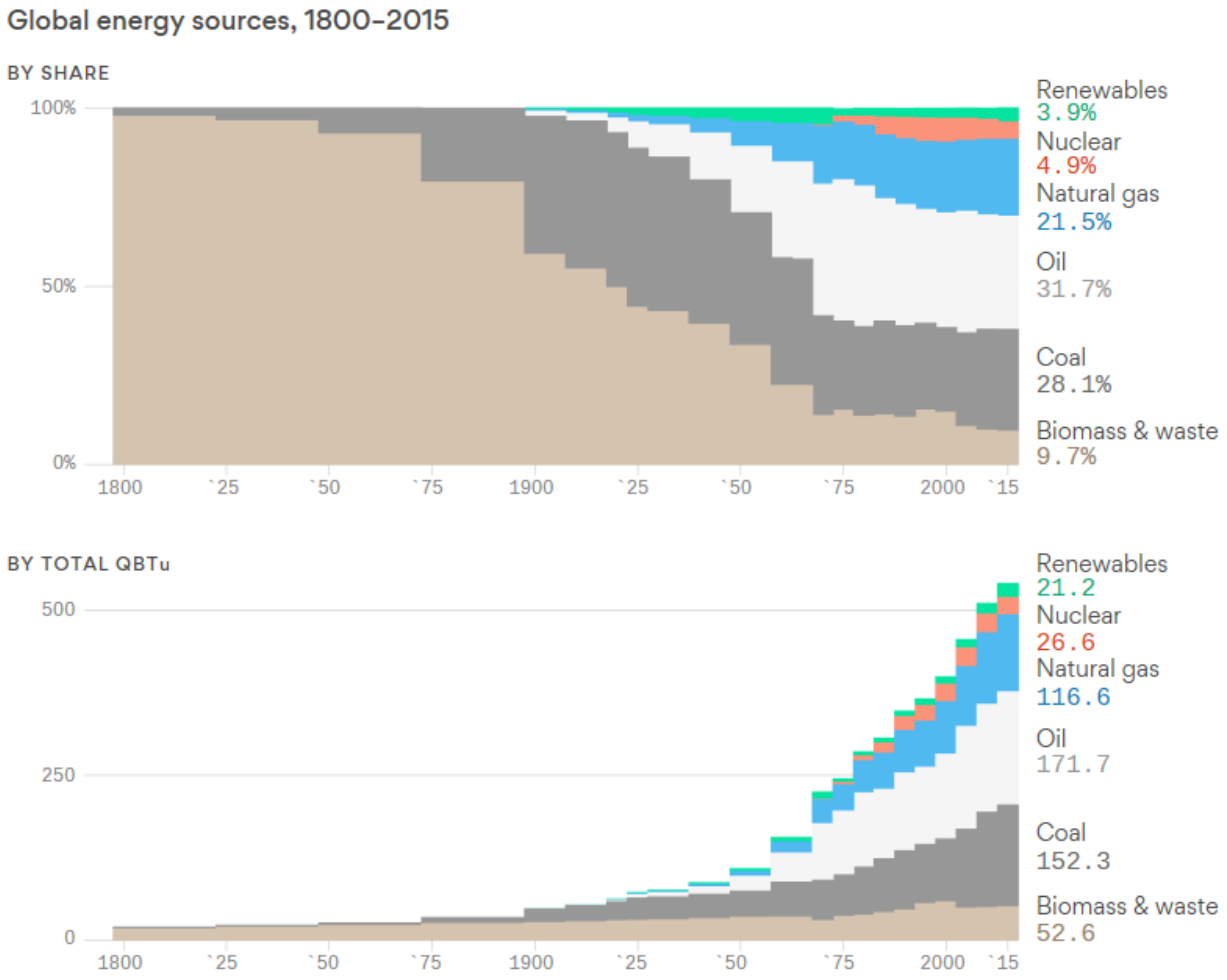



After IPCC (2005): Carbon Dioxide Capture and Storage




http://www.co2captureproject.org/co2_trapping.html

# Despite new technology, there has never been any energy transition




Note: 1800–1900 data shown at 25-year intervals, 1900–1920 & 1930–1970 data shown at 10-year intervals, and 1920–1930 & 1970–2015 data shown at 5-year intervals. Data: Arnulf Grubler (2008), International Energy Agency (2017). Reproduced from charts by Richard Newell and Daniel Raimi. Chart: Axios Visuals

- Shifts in primary energy supply has taken decades in the past
- …but GROWTH in energy demand more than outweigh shift between supply sources
- To meet the 1.5 degree target, <u>all energy use has to be carbon neutral by 2050!</u>
- This cannot be solved by phasing in renewables only - it is currently a small fraction
- We need to use the entire toolbox to have the slightest chance of succeeding

# «Market pull» for low carbon products and services can be created, and will provide viable revenue stream – but takes time

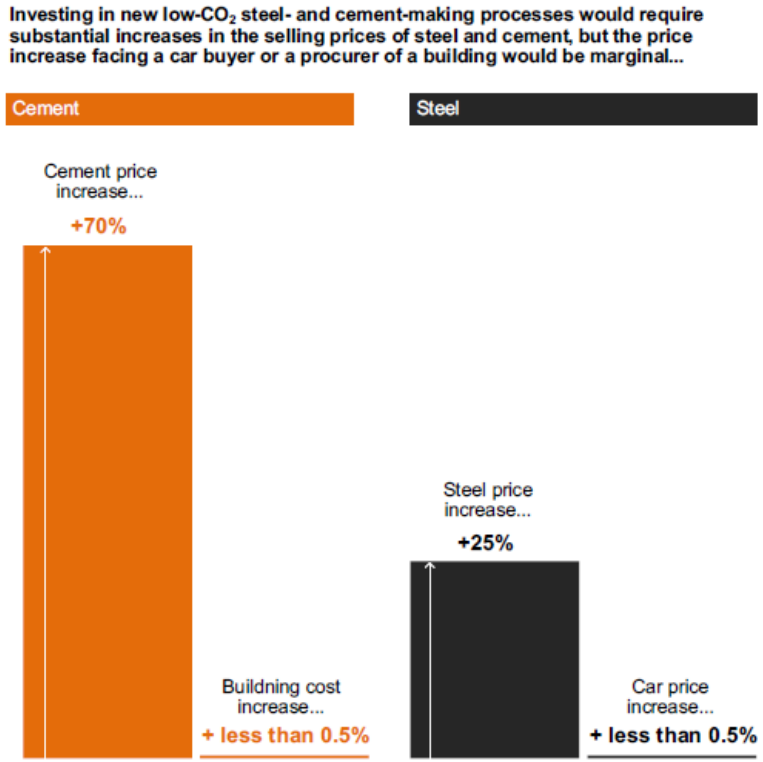
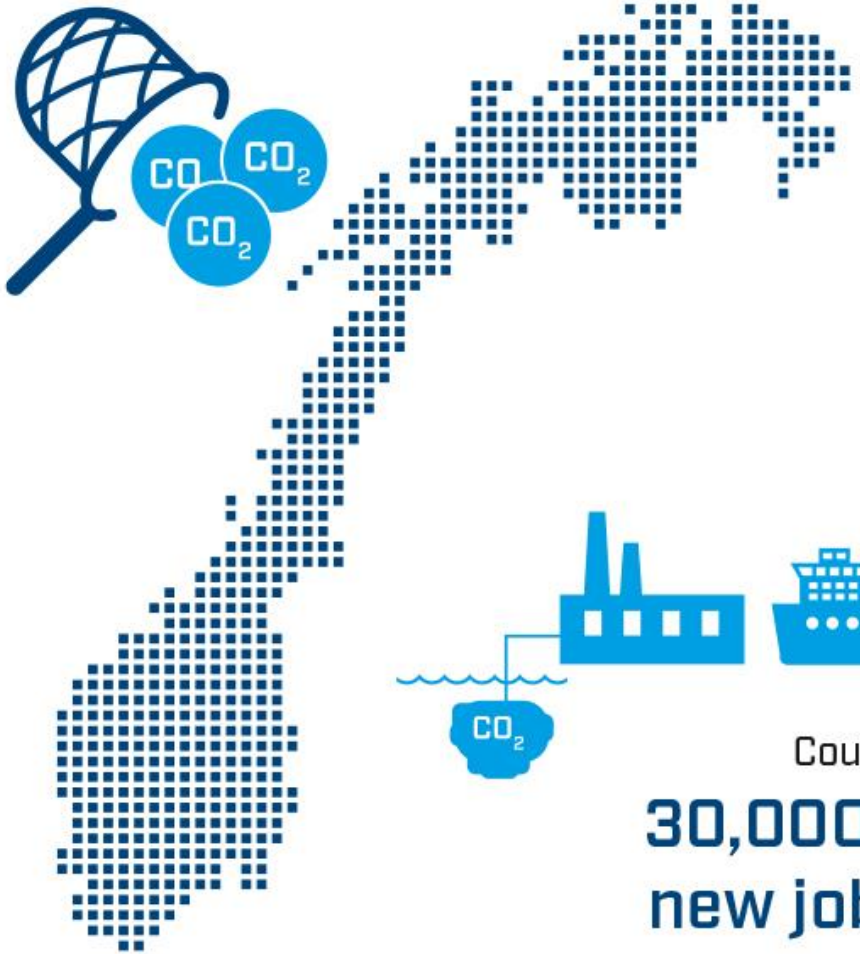



*Figure 2. Cost impacts along the supply chains of steel and cement of investing in new low-$CO_2$ steel- and cement-making processes in primary production. Adapted from Rootzén and Johnsson (2015; 2016a; 2016b).*

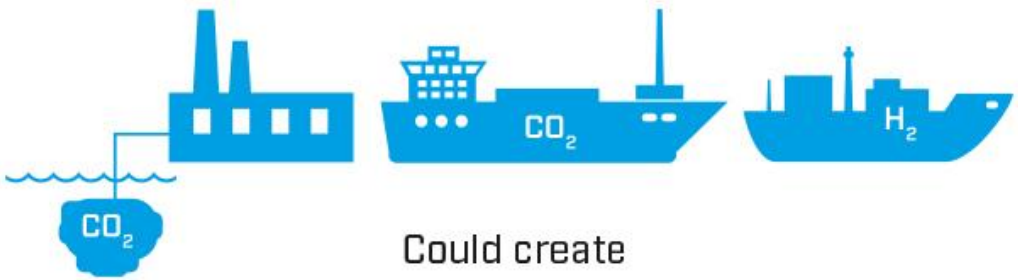
- Norwegian government and parliament ask for viable commercial models that can live beyond initial state investments.
- NHO has taken initiative to study how one best can build markets for low carbon products and services, with Norog, Norsk Industri, LO, Fellesforbundet, Energi Industri
- ZERO is running  project and workshops on financing models
- Timing, strength and reliability of  market pull mechanisms will determine the need for other (financial) public support.
- But these models will not have effect quickly enough for FIDs in Norwegian CCS value chain project




# Carbon capture and storage investment in Norway

could strengthen the competitiveness of

**80,000 – 90,000 jobs**




Could create

**30,000 – 40,000 new jobs in 2050**

- 6,000 – 20,000 CCS-related jobs
- 25,000 – 35,000 jobs in natural gas hydrogen production, half of which would be new jobs

With **ripple effects**, could strengthen

**160,000 – 200,000 jobs**

and contribute to creating up to

**70,000 new jobs**

in 2050

SINTEF

From the SINTEF report:
Industrielle muligheter og arbeidsplasser ved $CO_2$-håndtering i Norge