Northern Lights

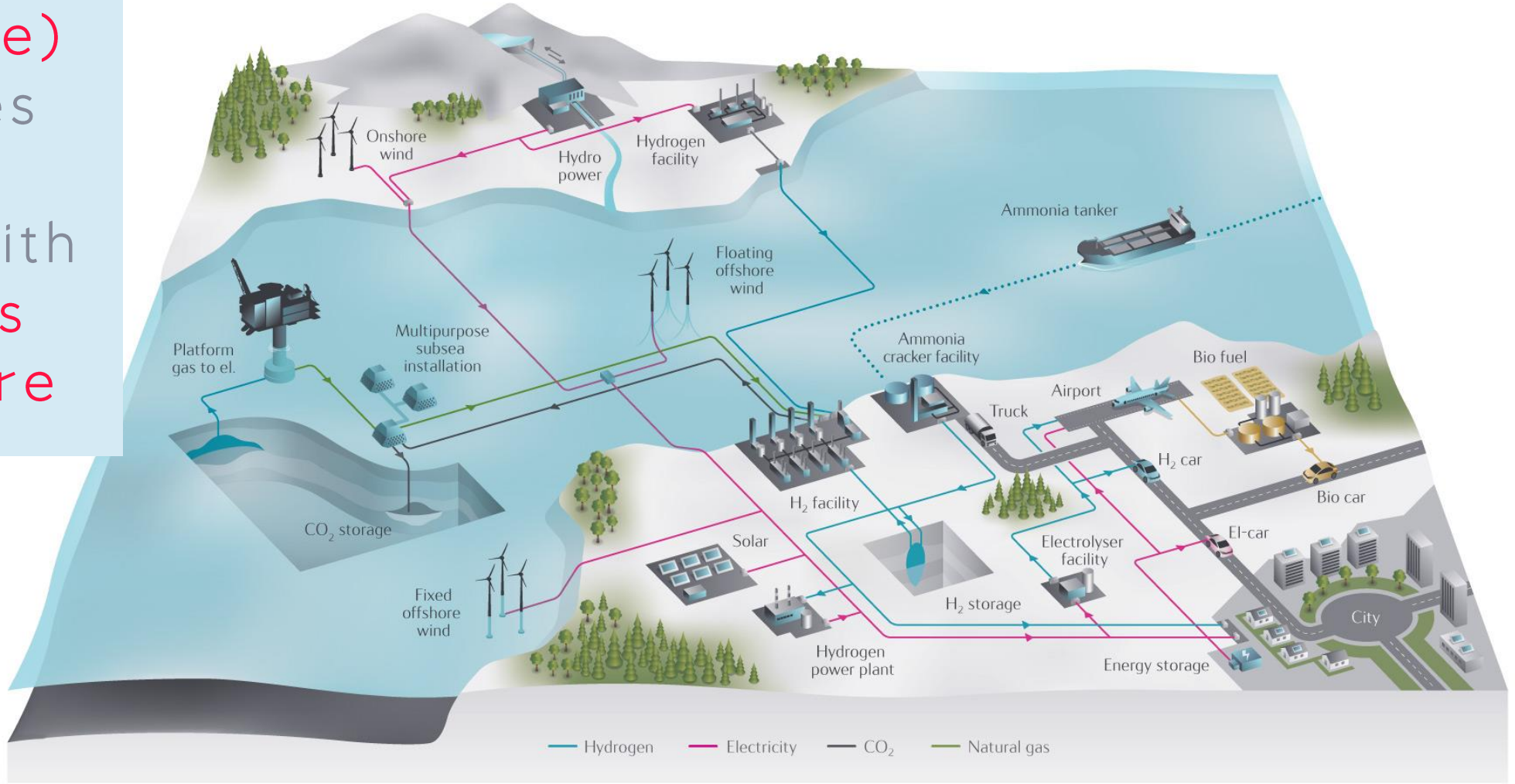
A European CO_2 transport and storage network

FEBEG Knowledge Sharing Lunch – 19 February 2020

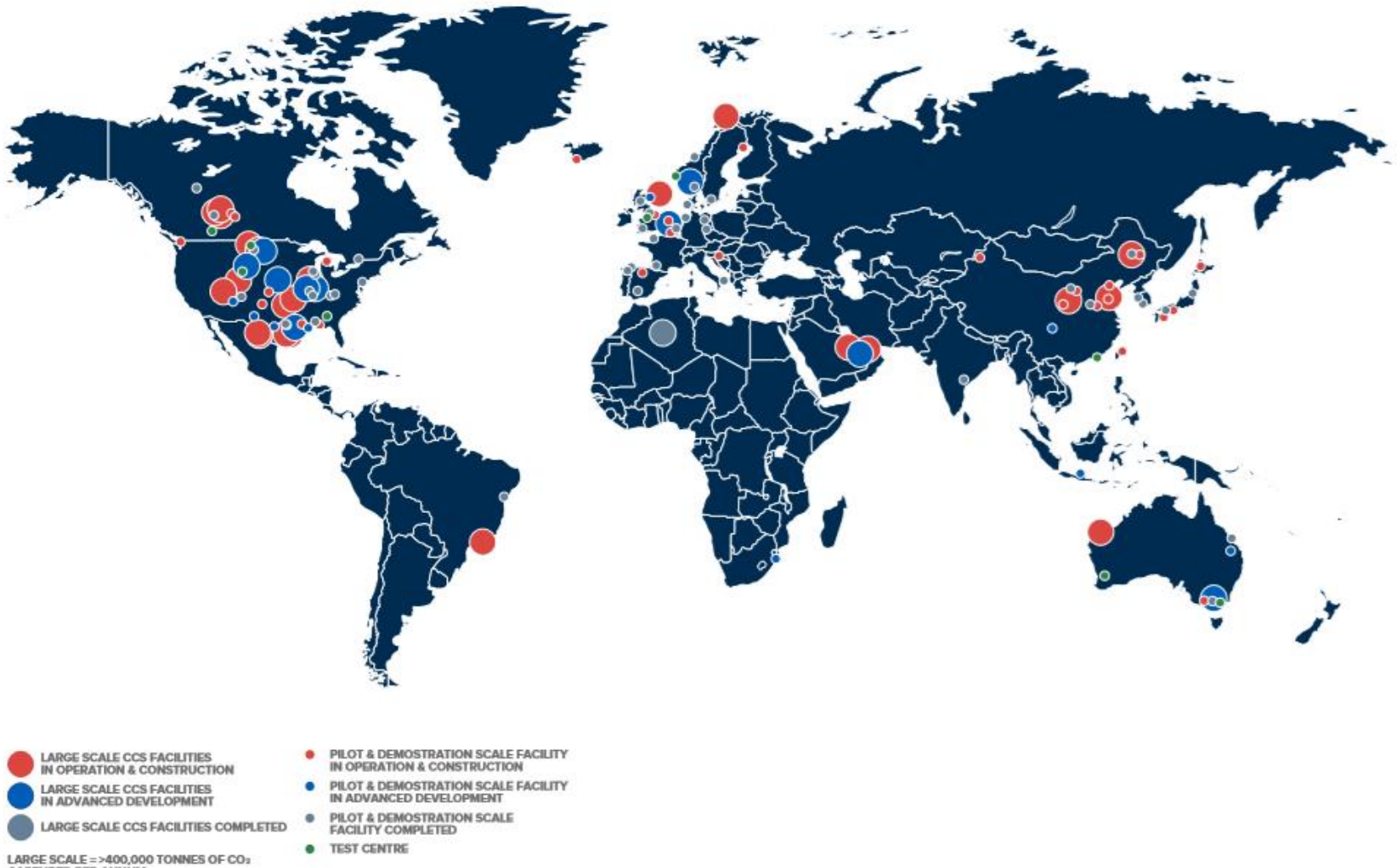
Lucie Boost, Equinor

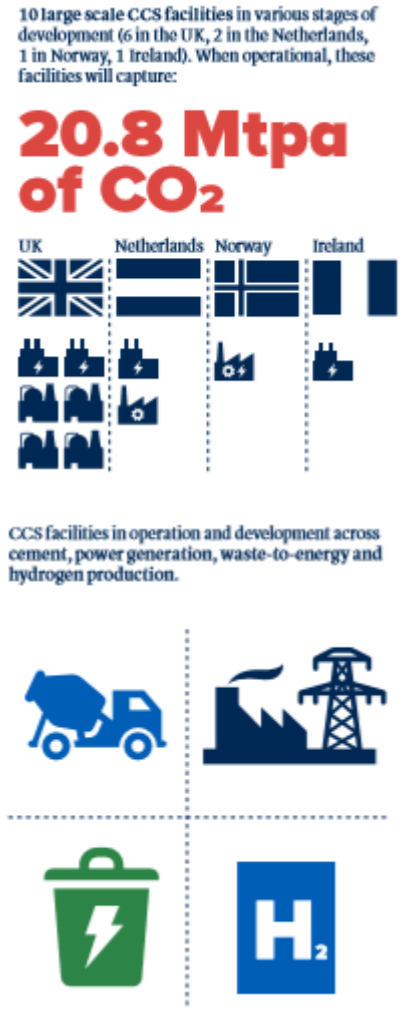
CCS is an integral part of a low carbon energy system

(Re)new(able) technologies smartly integrated with Existing gas infrastructure



Large scale facilities in operation or under construction





Reprinted from: Global CCS Institute (2019). *Global Status of CCS 2019*

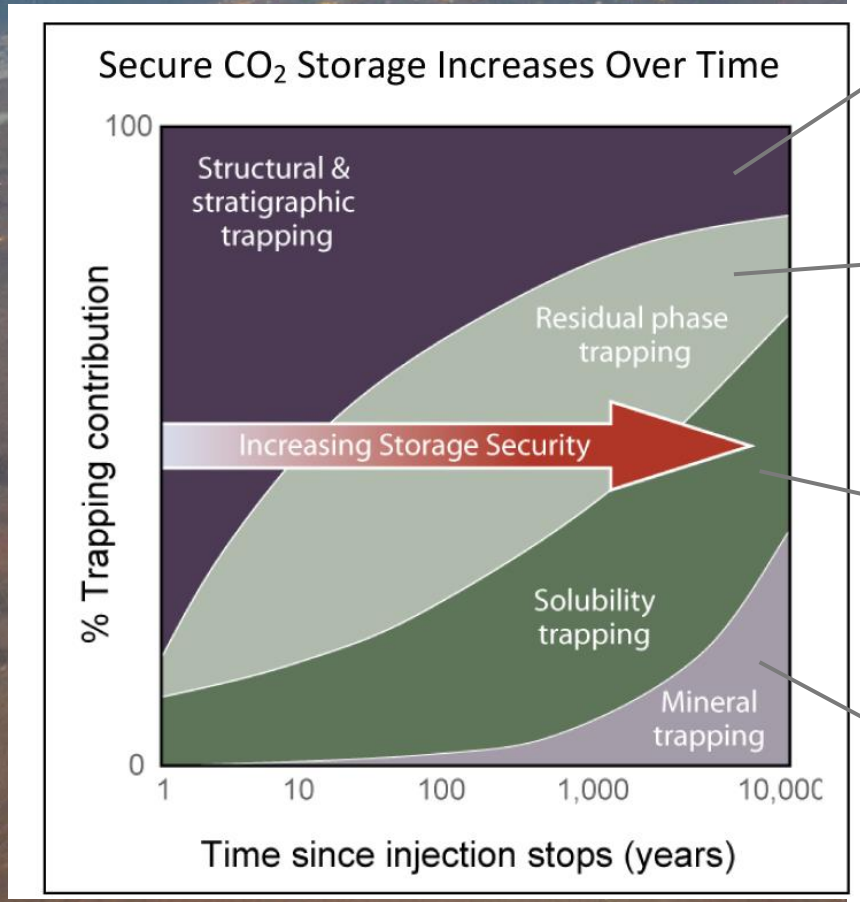
Building confidence in CCOS and CO_2 storage

"CO_2 is trapped in microscopic rock pores by the same process that has trapped natural gas for millions of years"

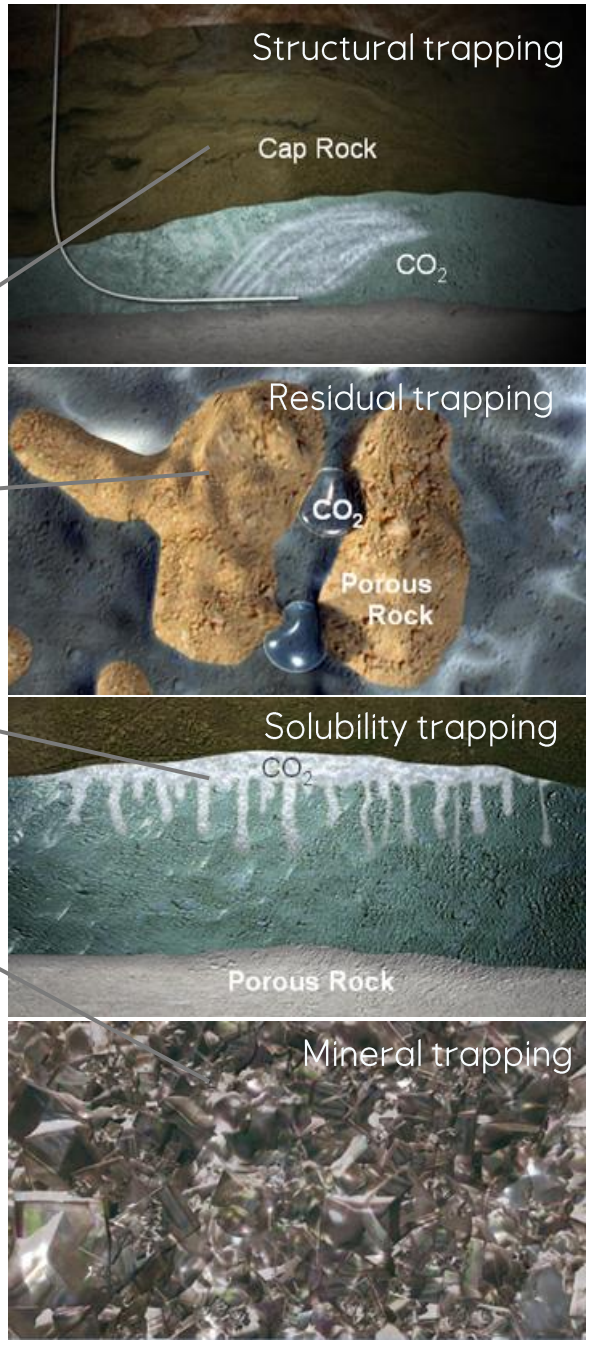
"We know from 23 years of operations that CCOS works"

"We can see where the CO_2 is and show it is safely stored"

"We can demonstrate regulatory conformance"

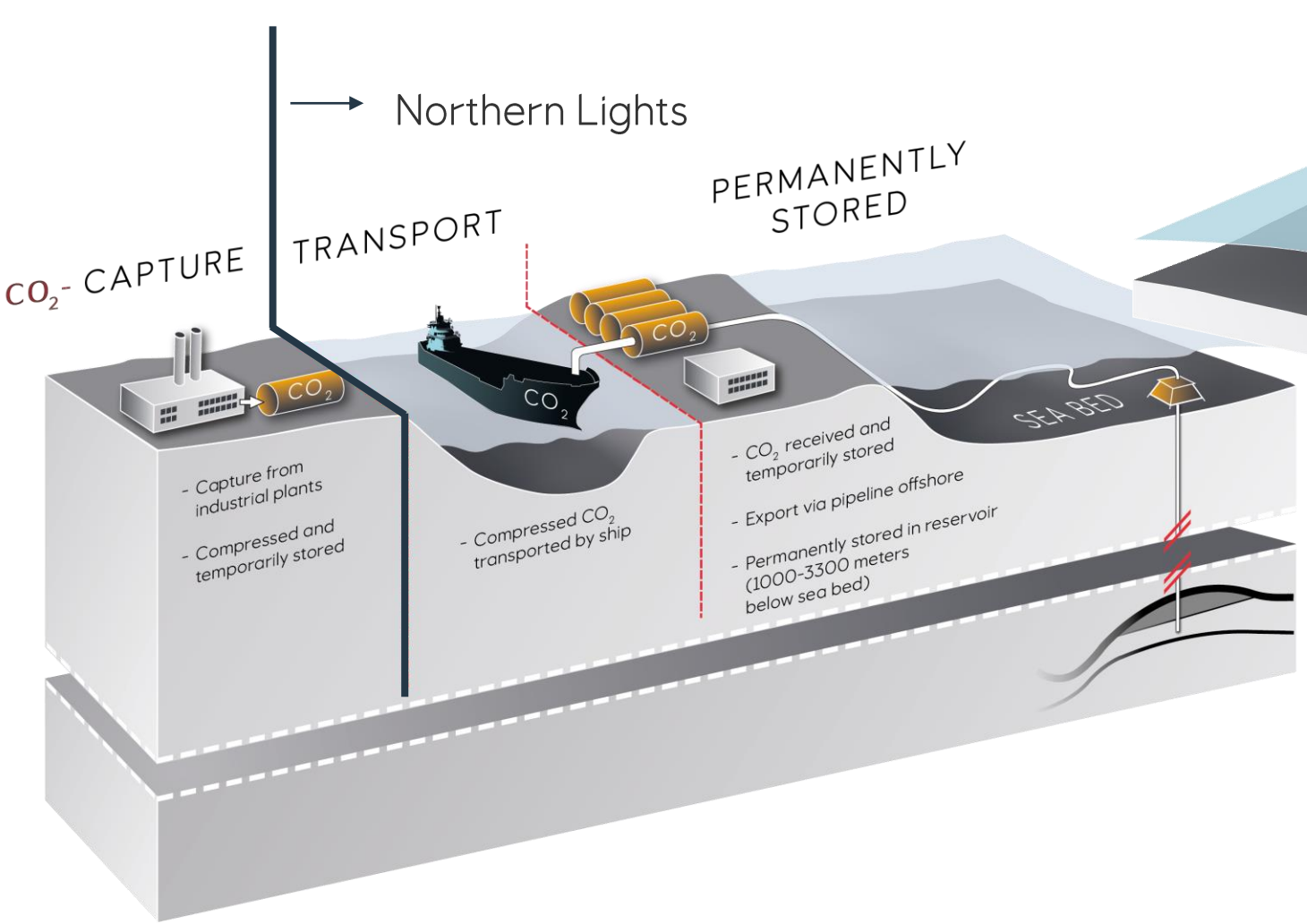


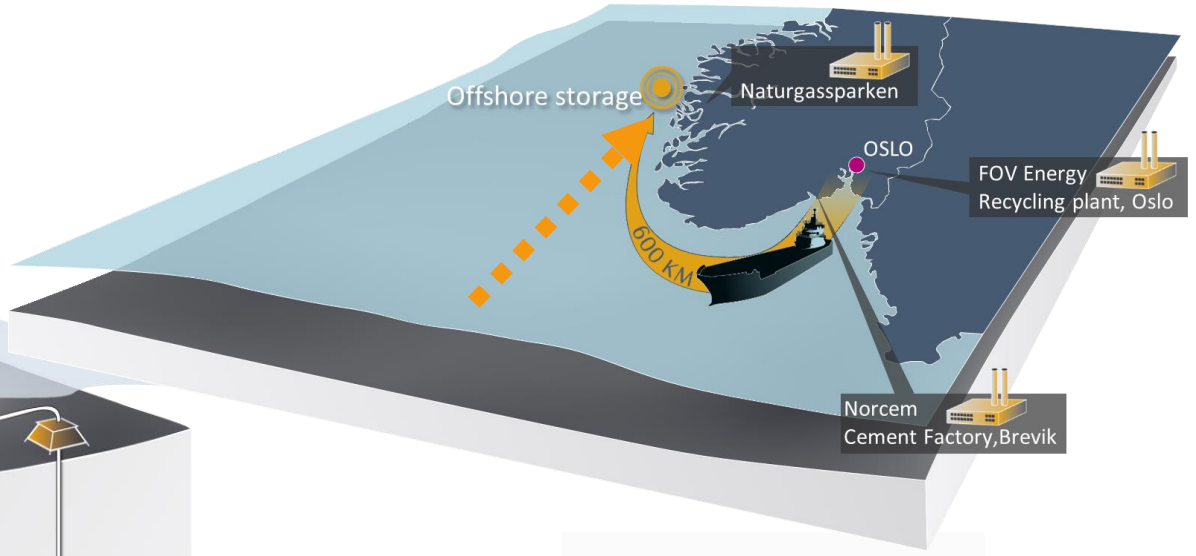
After IPCC (2005): Carbon Dioxide Capture and Storage



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

Northern Lights – transport, injection and permanent storage of CO_2



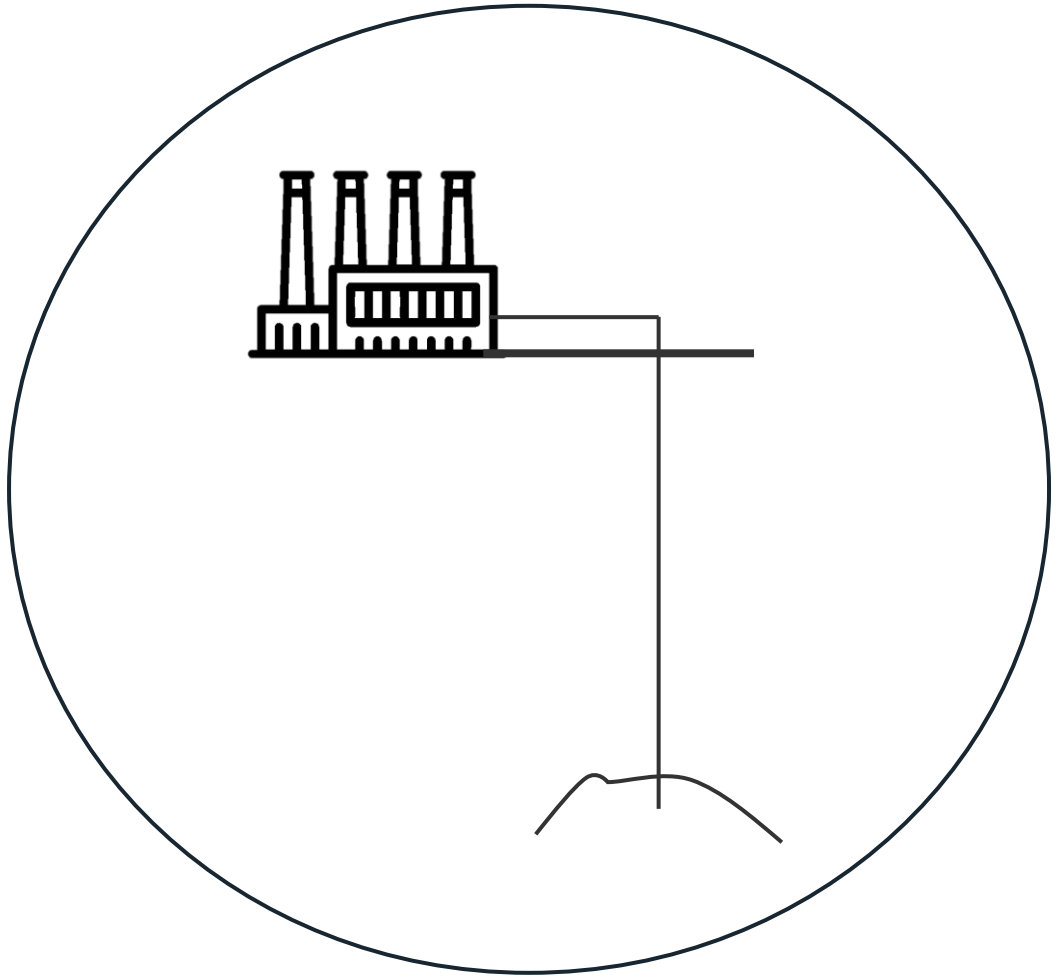


GASSNOVA

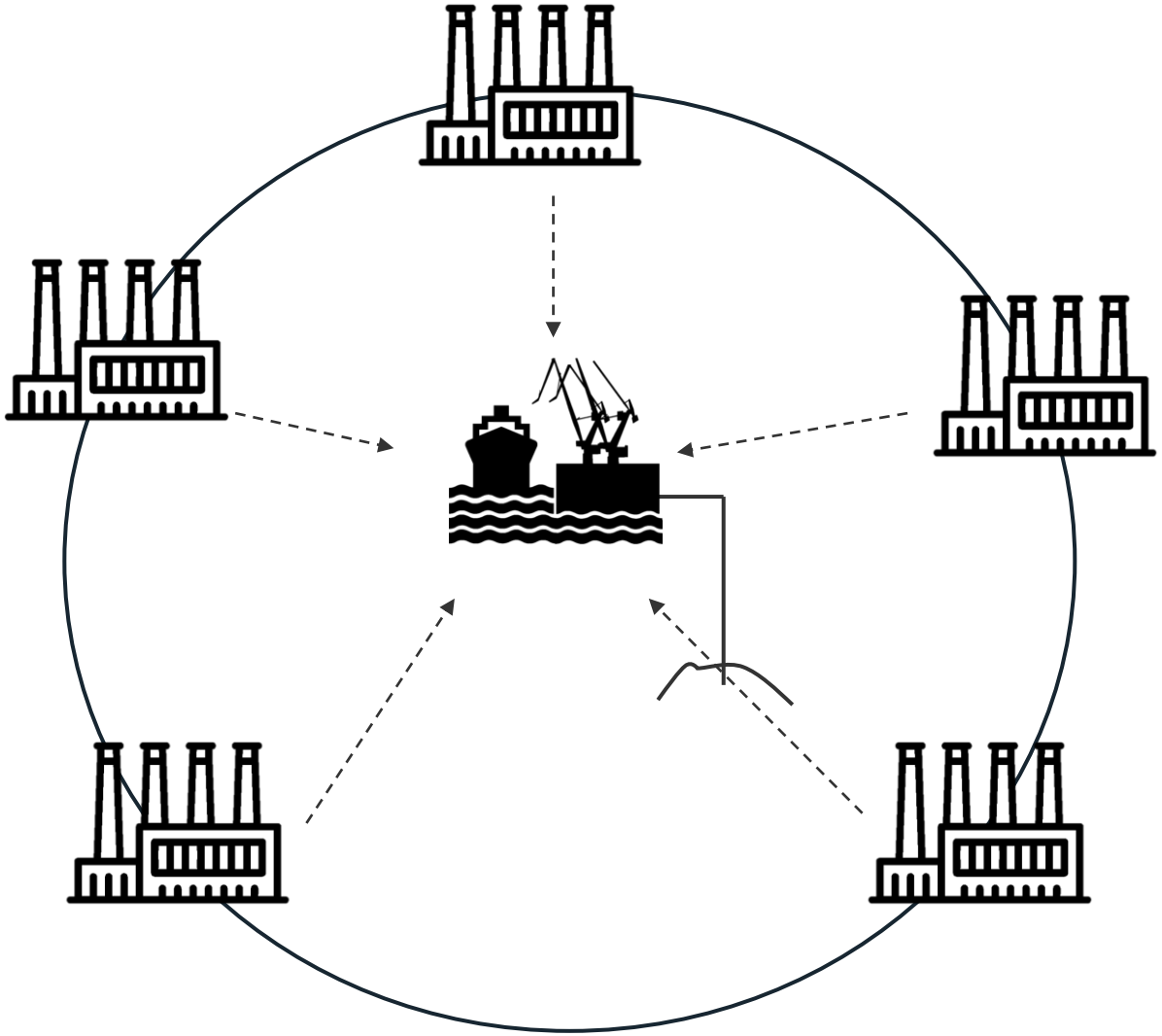
equinor

TOTAL

Innovating the value chain: Separating source and sink - open source business model - open innovation

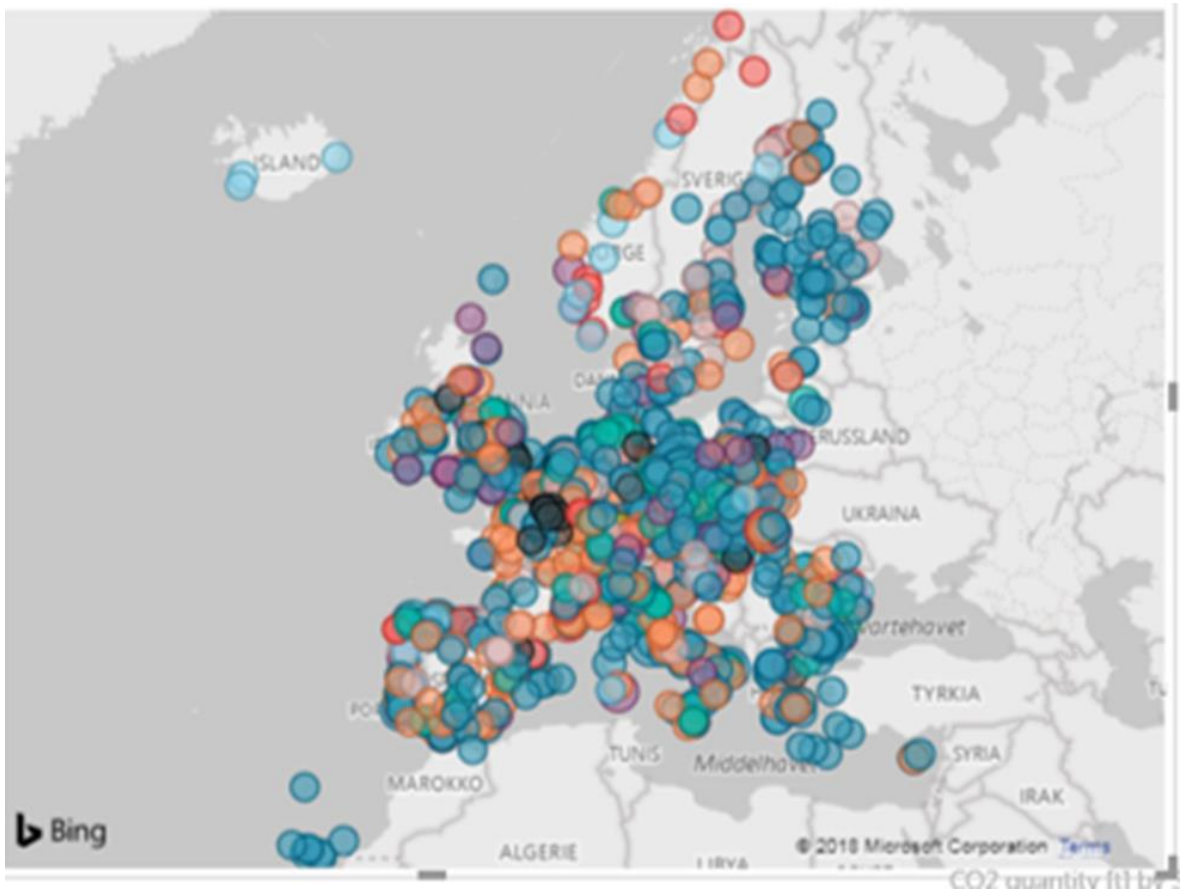


Traditional



Northern Lights

Enables "open source" offer for CO_2 emitters to establish capture



Source Endrava & Carbon Limits

Large potential with long-life sectors:

- Waste incineration
- Cement
- Steel
- Chemicals & Petrochemicals
- Hydrogen and power from natural gas
- Biomass and biofuel

=> We will need these sectors beyond the energy transition

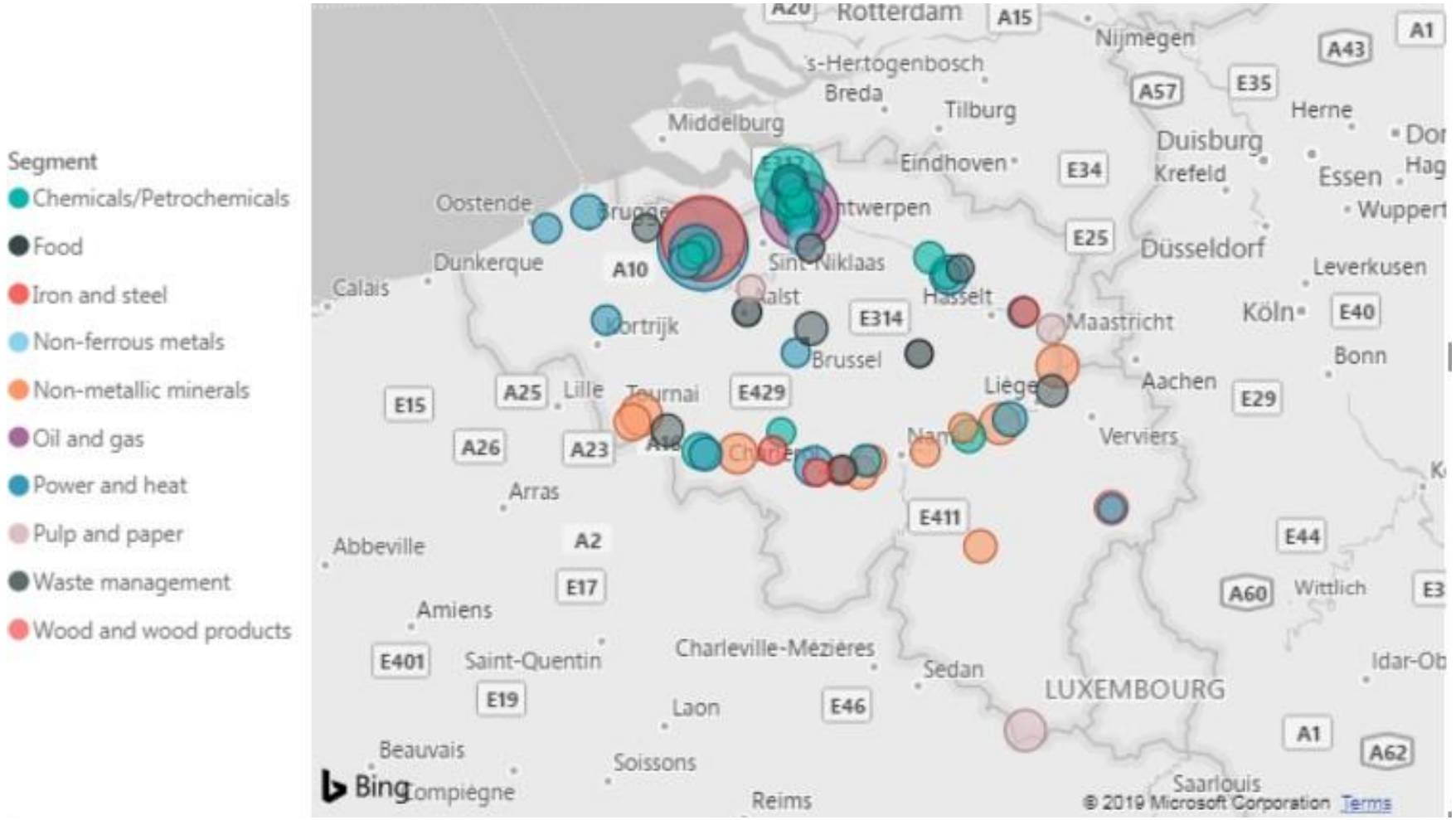
Northern Lights is relevant and within reach for about 350 facilities and 300 MTPA of these "most attractive candidates"

What are the emitters in Belgium?

67 facilities

eq.

45 MTPA of CO2



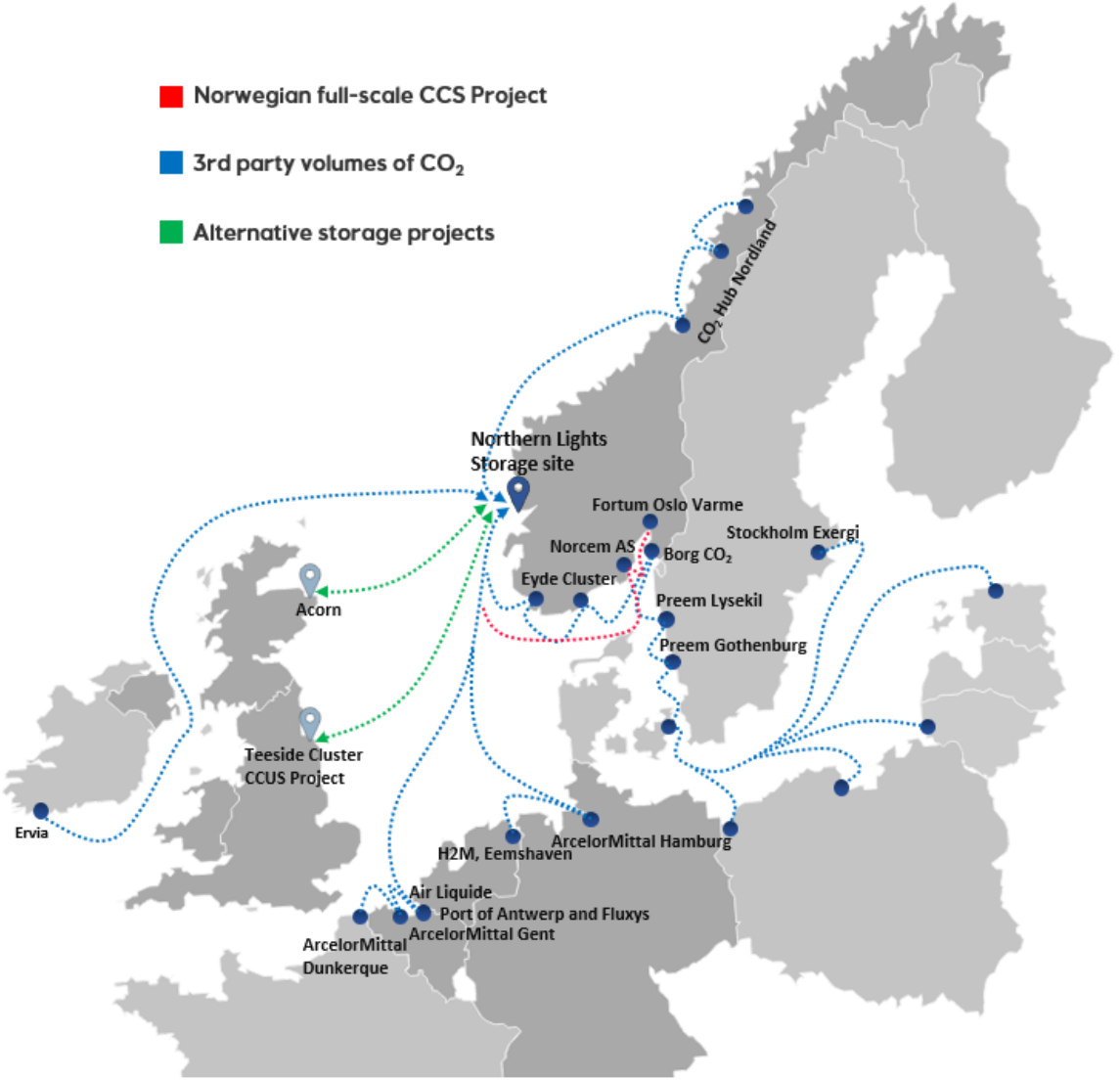
Seven MoUs signed in Oslo on September 5. 2019 – with more pending

COMPANIES

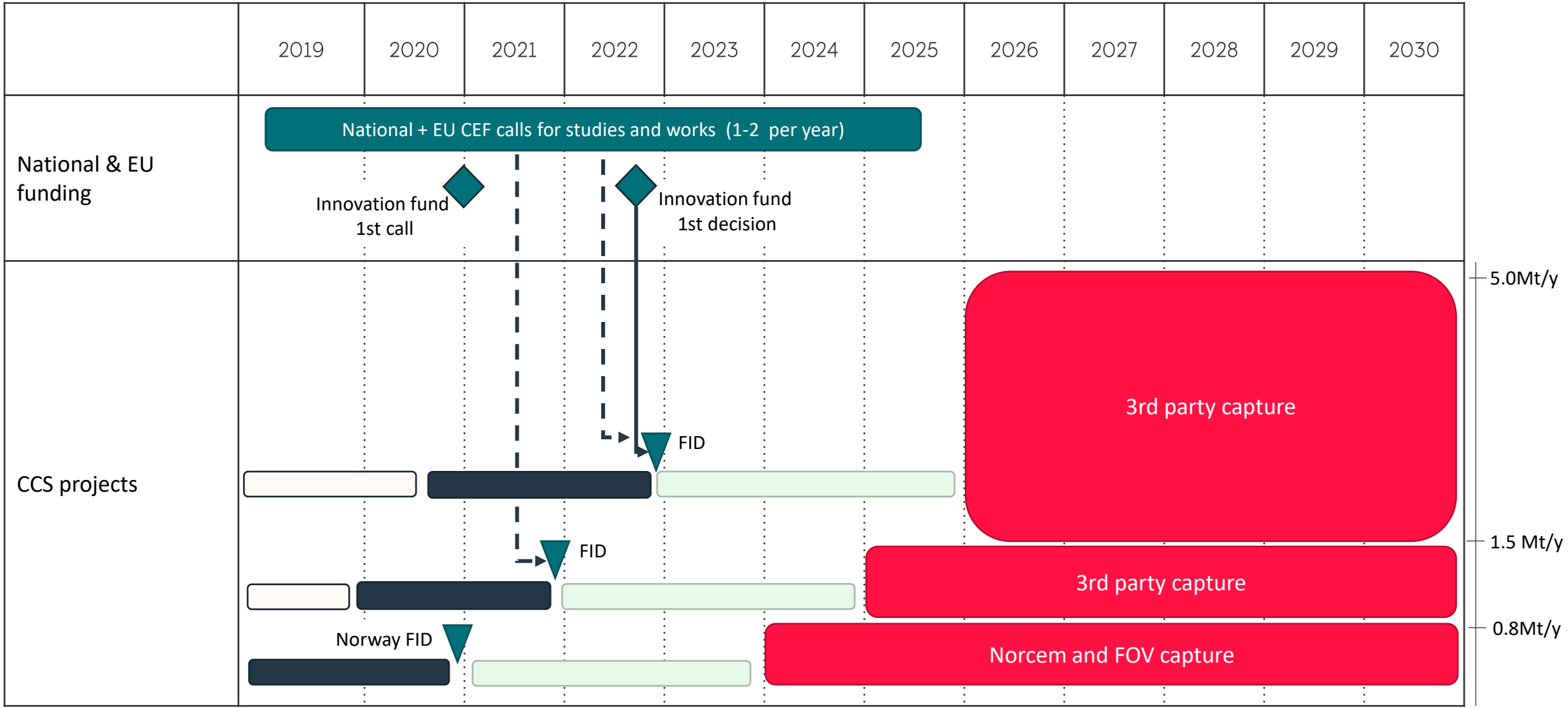
- Fortum Group,
- Ervia,
- Air Liquide,
- Stockholm Exergi,
- ArcelorMittal,
- Preem,
- Heidelberg Group

TYPICAL CONTENT

- Logistics studies
- CO_2 specifications optimized across value chain
- Roadmap towards potential start of operations, including key activities
- Joint advocacy for CCS and its importance for the successful decarbonization of European industry
- Initiate dialogue with National Government and dialogue with Norwegian government



Early Norwegian investment decisions can enable rapid European capture



Key actions to realise full industrial potential of CCS and Northern Lights

Northern Lights

- Sanctioning of storage site(s)
- Mature 3rd party customers
- Develop business models for CCS with relevant industries
- Agree commercial terms
- Reduce cost of CCS technology through projects and R&D
- Enable industrial development
- Mature European CCS ecosystem with other clusters
- Advocate with stakeholders, EU and nation states
- Secure support for capacity expansions of Northern Lights
- Mature future storage sites

3rd Party Companies

- Establish carbon reduction strategies with rapid scaling
- Finance and execute projects by pragmatic use of EU and other support mechanisms
- Build trust with partners in technical solutions and commercial models
- Use and enhance European CCS ecosystem
- Support development of policy and funding frameworks

Norwegian State

- Realize Norwegian full-scale value chain project
- Agree bilateral treaties with relevant states
- Enable CO2 capture project in in Baltics/Poland (incl. door opening and EEA/ Norway Grants to 3rd parties)
- Make CCS a cornerstone in Nordic ambition to be world's most sustainable region
- Enable further 3rd party CO2 capture projects in Norway
- Incentivize low carbon products and production by procurement and legislation in Norway
- Mature storage sites

EU & Nation States

- Support CCS whole-heartedly
- Make IF, CEF and other relevant funds effective tools for 3rd parties and storage expansion
- Resolve CEF and ETS shipping issues
- Give financial guarantees to 3rd parties via EIB and NIB
- Increase cost of carbon
- Incentivize low carbon products and production by procurement and legislation
- Include CCS in national plans (NDCs)
- Remove national barriers
- Develop national funding
- Mature storage sites

DEVELOP PROJECTS, BUSINESS and MARKETS

ENABLE by SUPPORT, POLICY and FUNDING

Roadmap towards a commercial large scale hydrogen value chain

From Market Build Demonstrators to Large Scale Implementation

2023

Northern Lights

CO_2 storage infrastructure

- Liquid CO_2 carriers
- Storage capacity, integrity & monitoring

2025/26

Hydrogen Demonstrator

Clean hydrogen CCUS demonstrators

- Medium scale H_2 production with CCS
- H_2 to regional markets in UK, Germany and Norway
- H_2 for power, industry and other sectors

2025/26

Magnum

Hydrogen for power generation with CCS

- Large scale onshore H_2 gas turbines
- Cavern H_2 storage
- High efficiency H_2 production

Market build

2027

Maritime Fuel

Hydrogen for marine propulsion

- Liquid H_2
- LOHC and ammonia
- Fuel cells and gas engines

2028

Hydrogen to Offshore

Full hydrogen value chain with CCS

- Offshore H_2 gas turbines
- Pipelines and risers
- Safety in design

2028/29

Mission 2050

Hydrogen for Energy

- Large scale onshore H_2 gas turbines
- Cavern H_2 storage
- Hydrogen for industry
- Hydrogen as feedstock
- Low carbon footprint

2030

H21

Hydrogen to heat

- Safe utilization of existing gas infrastructure
- Very large scale H_2 production
- Integration with industry and power generation

2030+

Steel

Hydrogen for heavy industry

- Hydrogen direct reduction
- CO2 transport from in-land sites
- Large scale single consumer
- Public acceptance

Large Scale Implementation

Northern Lights, an open source solution

Lucie Boost