

Carbon Capture Utilization and Storage (CCUS)

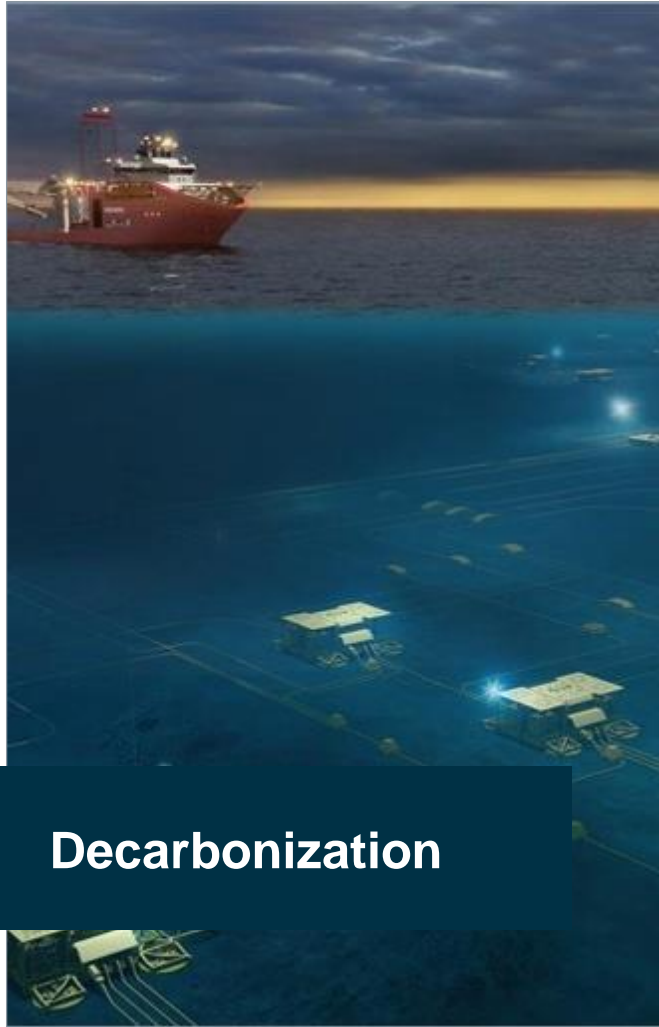
Carnegie ESG Seminar

Oslo, November 21, 2019

Jon C Knudsen, Vice President, Global BD



Aker Solutions – Leading a Sustainable Energy Future



Decarbonization

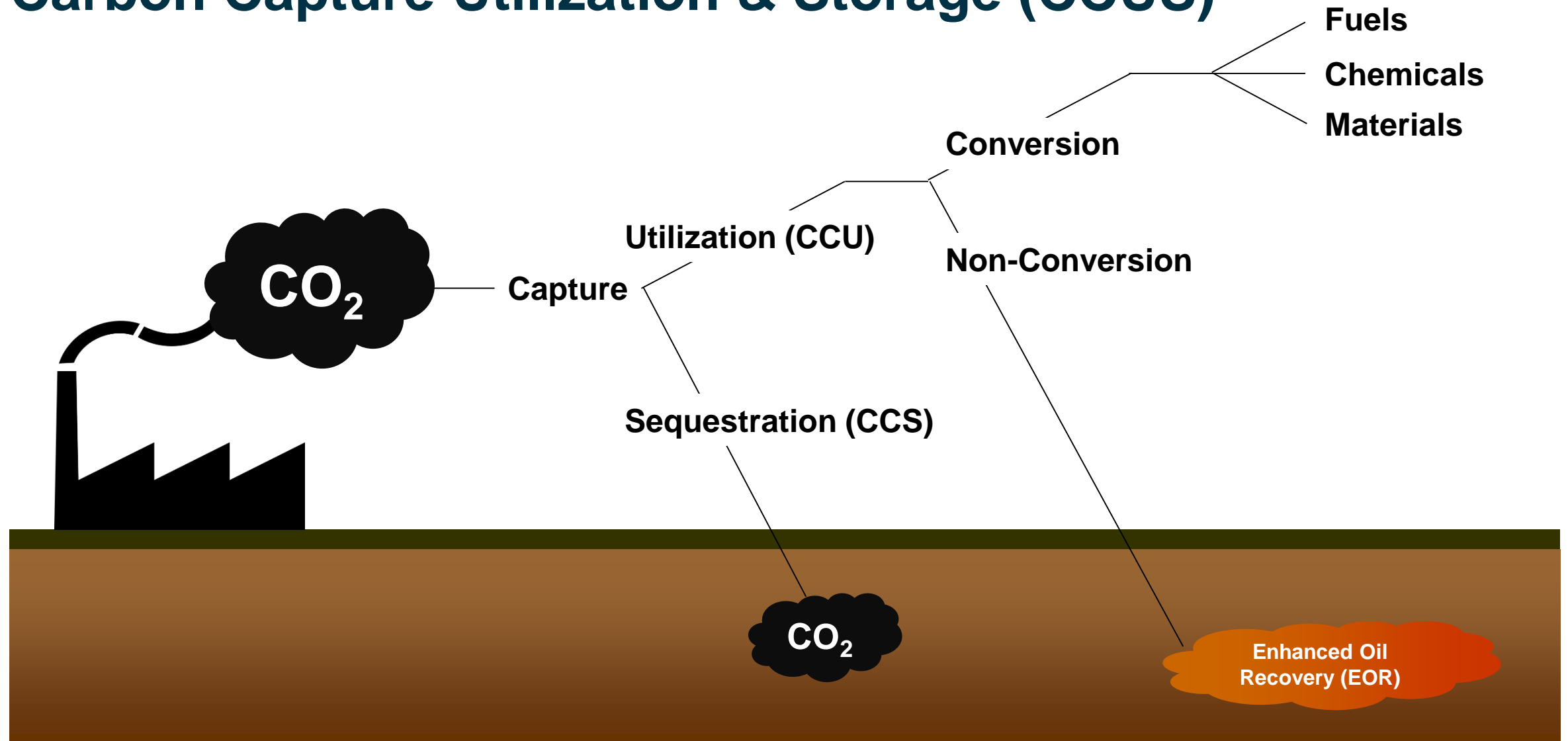


Floating Wind

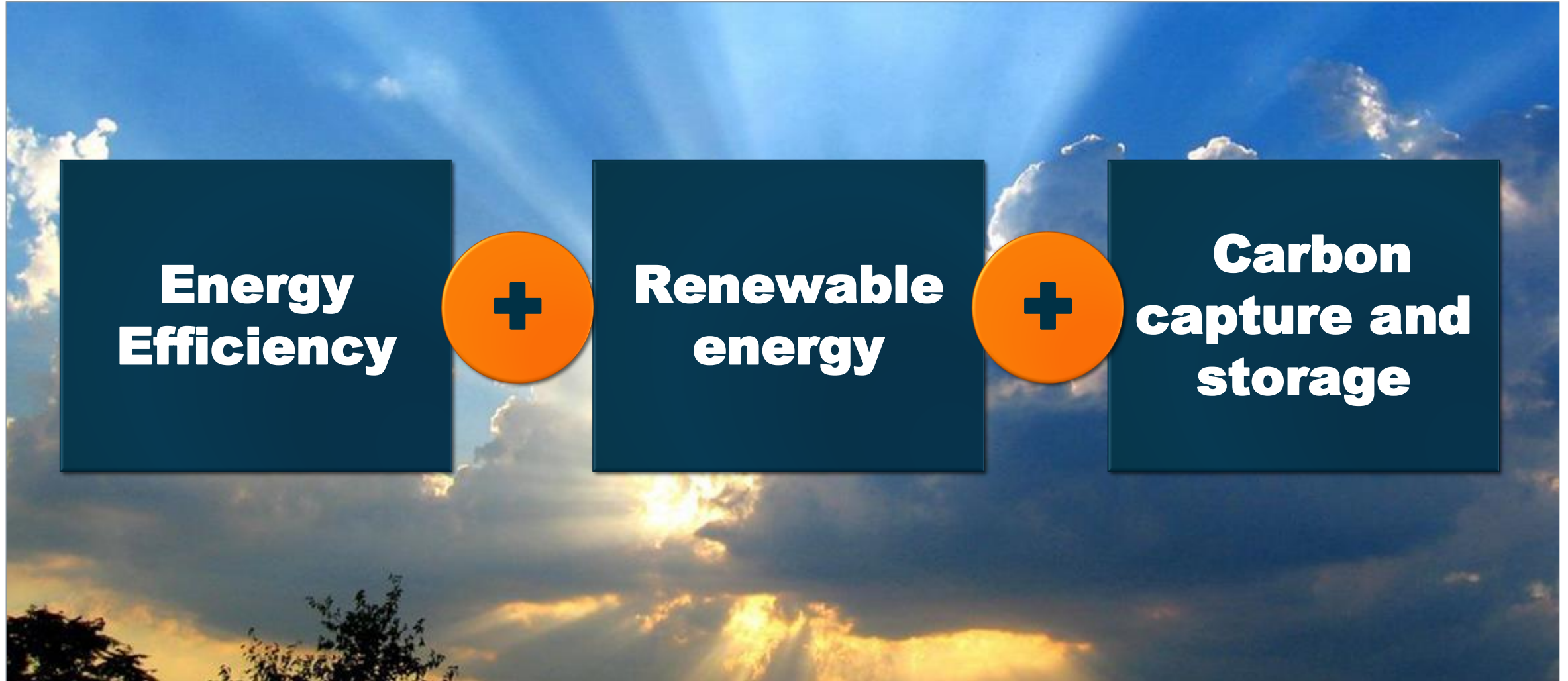


CCUS

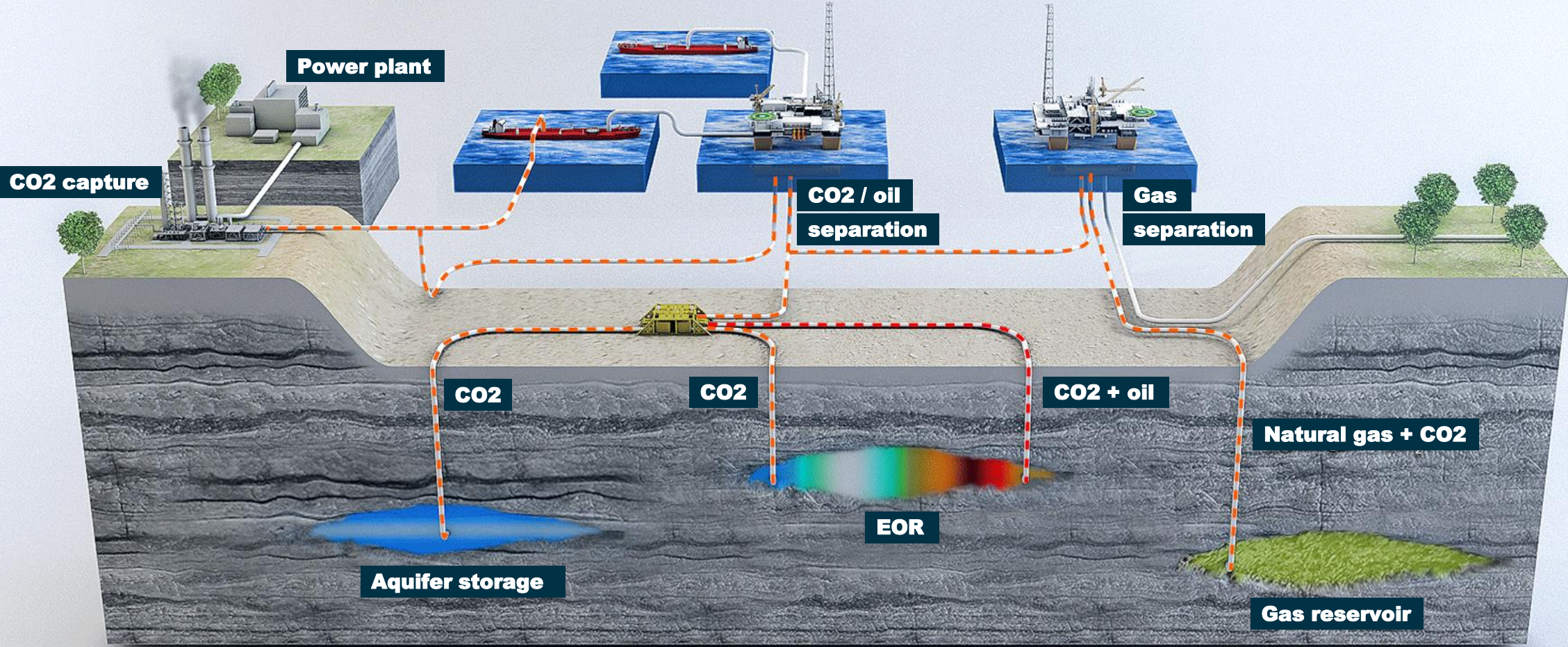
Carbon Capture Utilization & Storage (CCUS)



Meeting the Paris Agreement Targets



Enabling Sustainability: Capturing the Carbon Market



Europe is feeling the impact

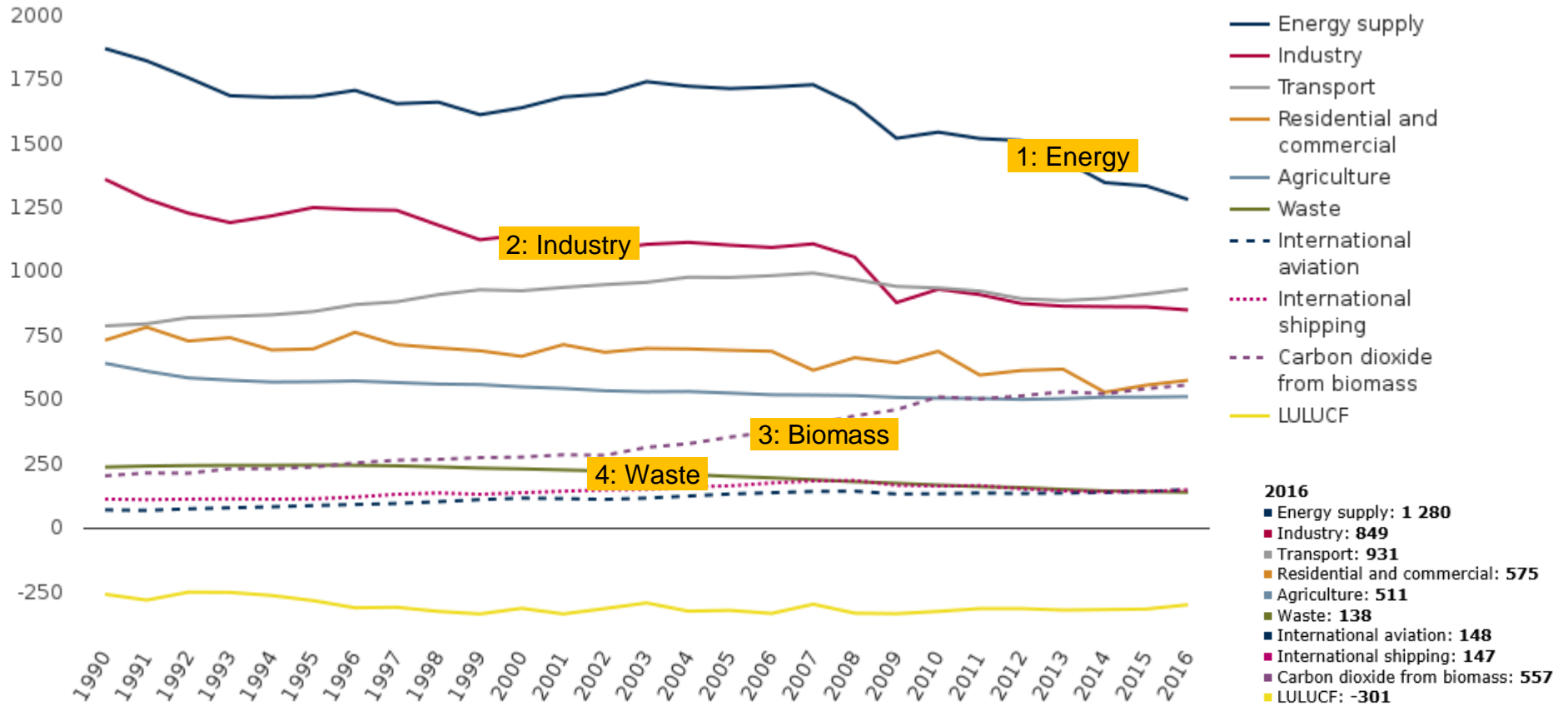
Very high

High

Medium

GHG Emission by sector in Europe, 1990 - 2016

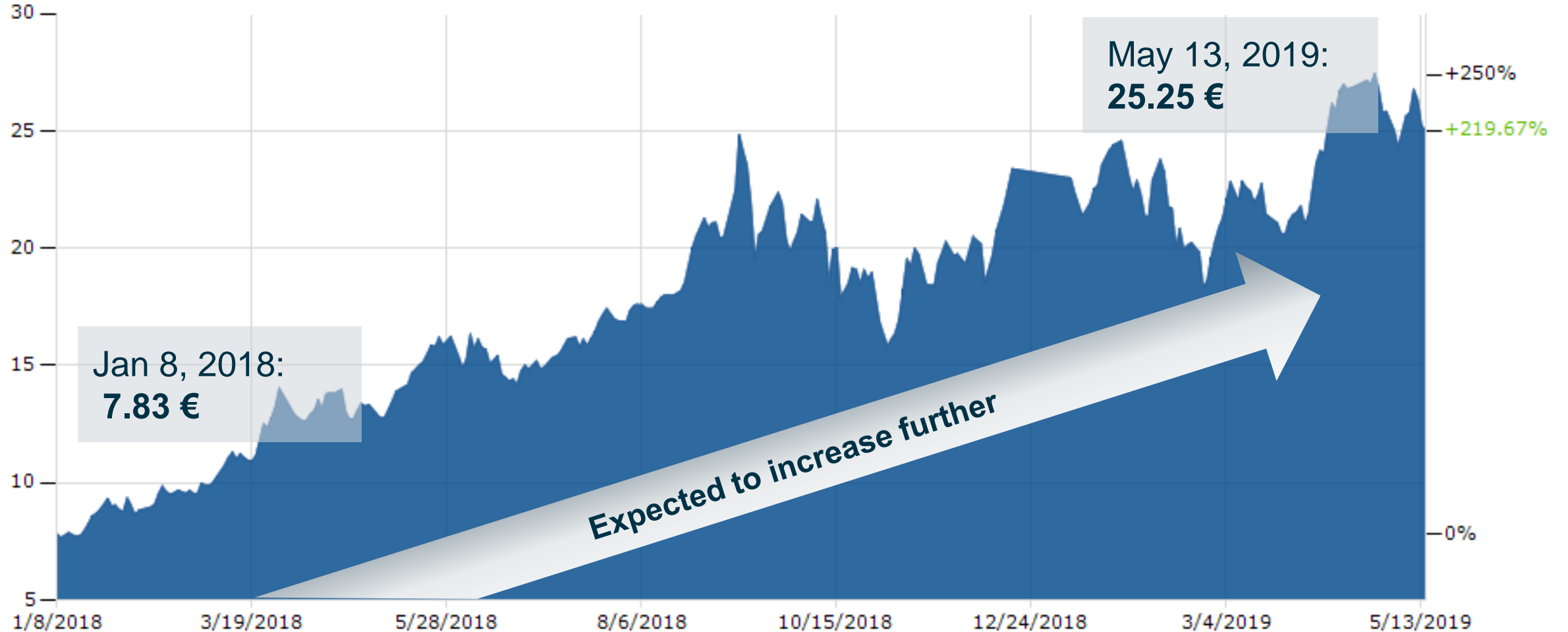
Million tonnes of CO₂ eq.



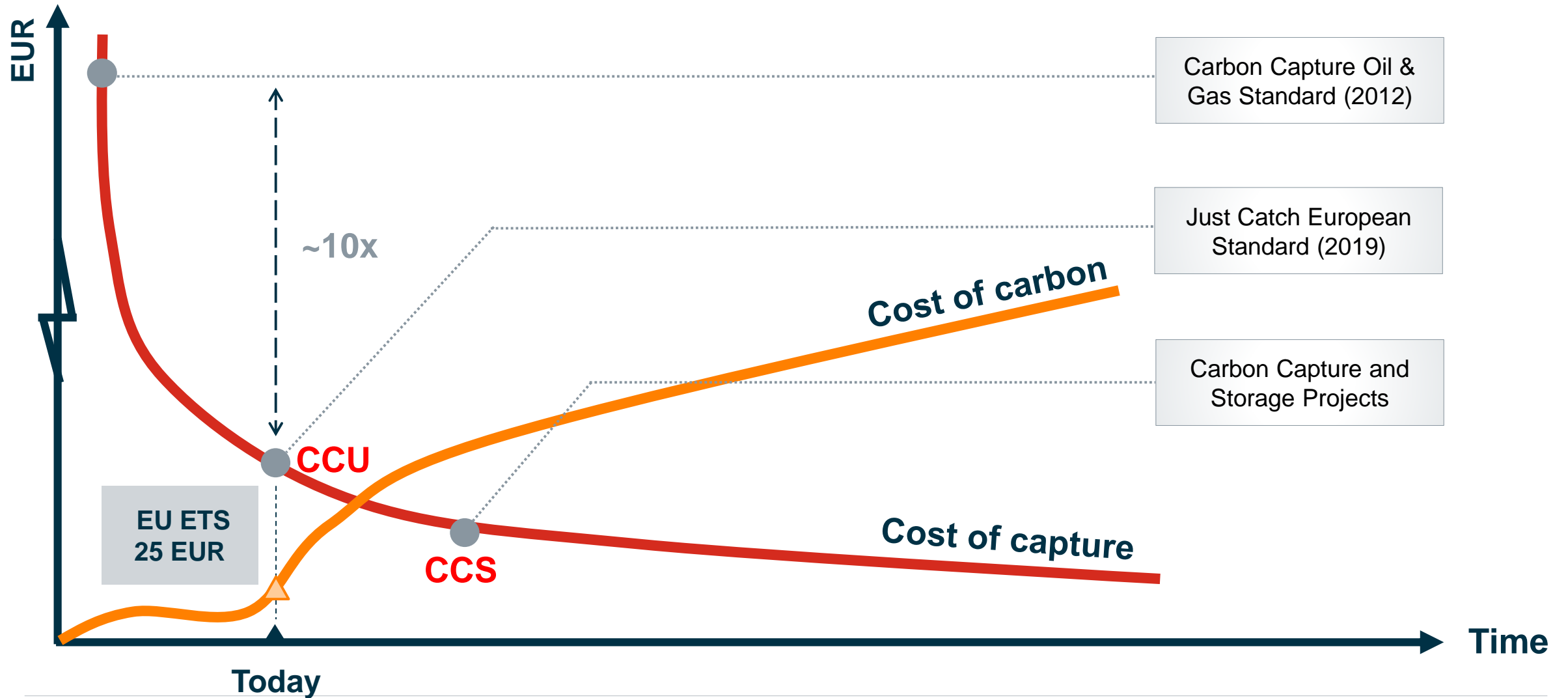
“Important to apply CCUS for large emitters”

Cost of CO₂ – Expectations of Further Rise

CO₂ European Emission Allowances in EUR - Historical Prices



Carbon Capture With Utilization Comes First (Smaller Volumes)



From Ambitious Targets to Action

Our **Just Catch** plants can capture **85%** of these emissions



Location	Plant (waste management)	CO ₂ emissions
Rådal	BIR Avfallsenergi AS	220,000
Trondheim	Heimdal Varmesentral	220,000
Kristiansand	Returkraft Langemyr	120,000
Oslo	Haraldrud	100,000
Fredrikstad	FREVAR forbrenning	92,000
Fredrikstad	Bio-EI Fredrikstad	66,000
Total emissions		818,000

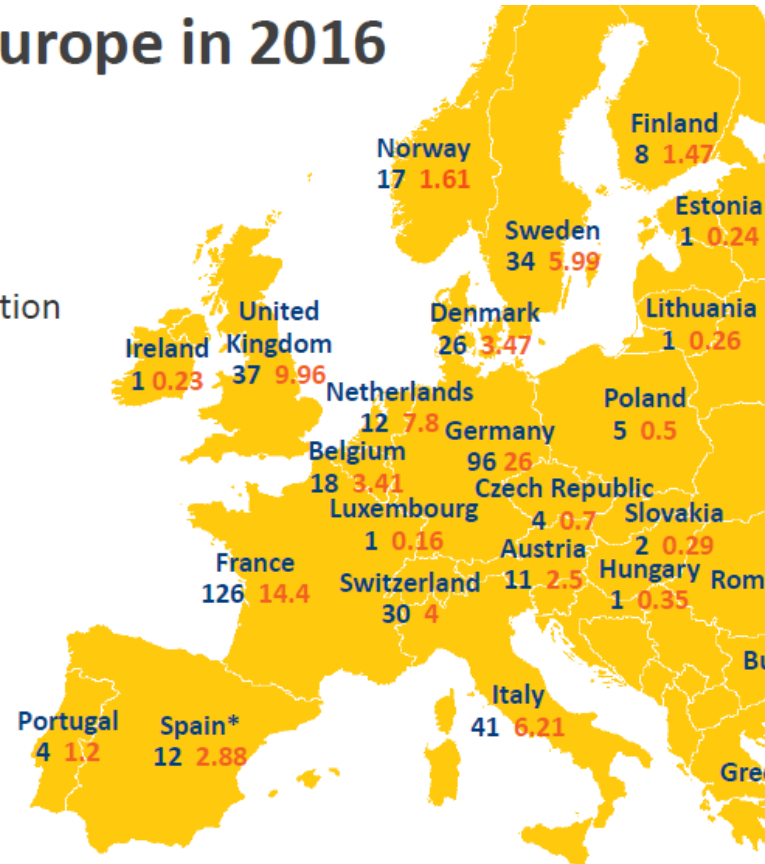
Waste plants – significant opportunities for AKSO

Waste-to-Energy in Europe in 2016

- WtE Plants operating in Europe (not including hazardous waste incineration plants) : 488
- Waste thermally treated in WtE plants (in million tonnes): 93.9

Data supplied by CEWEP members and national sources

* Includes plant in Andorra



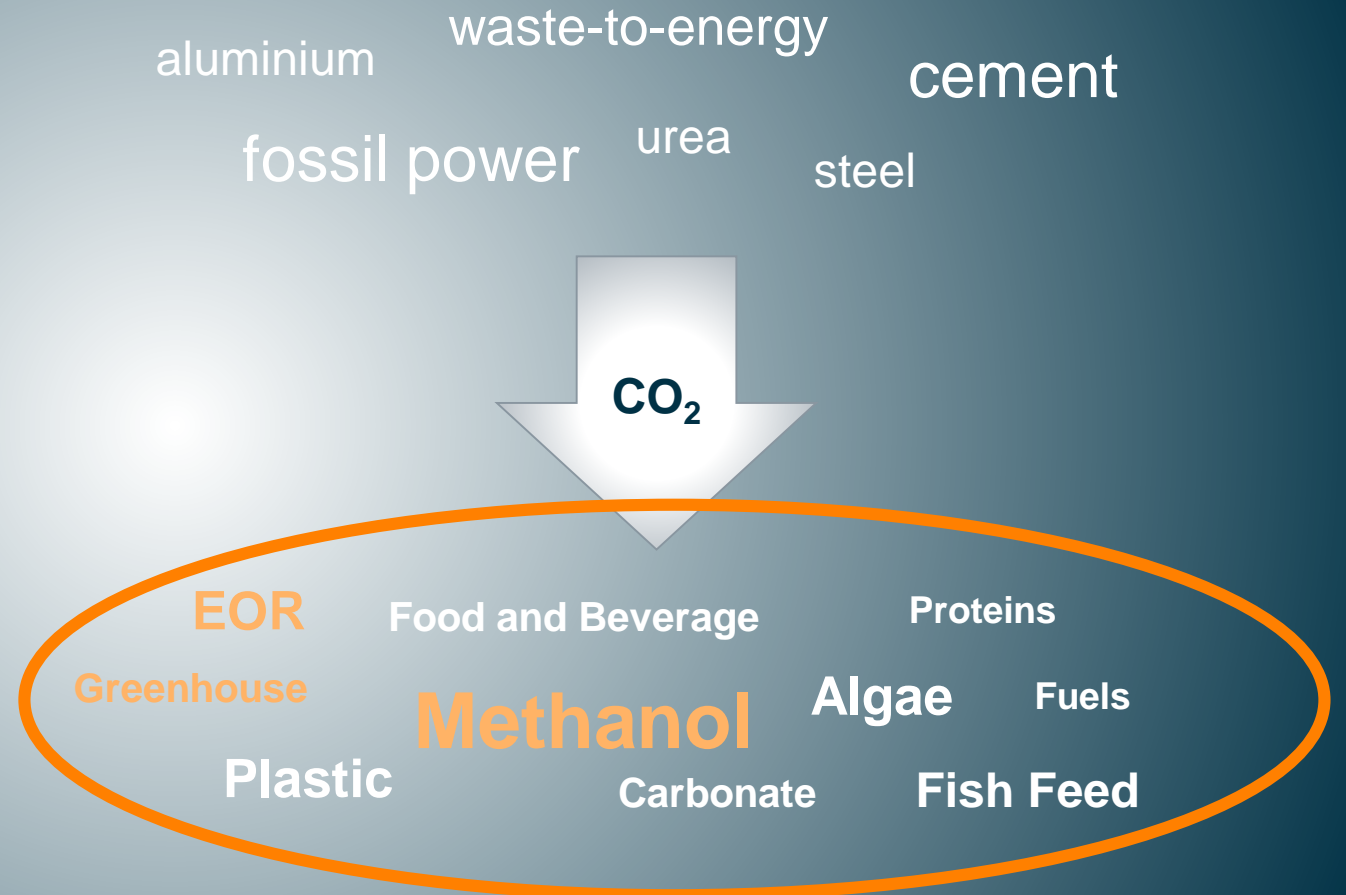
Country	Emissions per plant (average tonnes of CO2 emitted per year)
UK	270 000
Germany	270 000
Finland	183 000
Sweden	176 000
Denmark	133 000
France	114 000
Norway	95 000

Just Catch – an ideal solution for waste plants, in Norway and abroad

Carbon Capture and Utilization – CCU

We capture carbon from many sources

That can be used in numerous ways



Two lines of thinking – Small Modularized & Large Custom

Just Catch



Big Catch



Just Catch Advantages

- 100,000 tons CO₂ per year capacity
- 100% automated (remotely controlled)
- 100% standardized
- 15 months delivery time from order
- Cost effective

Easy Installation

Compact design

10 years experience with modular capture plants

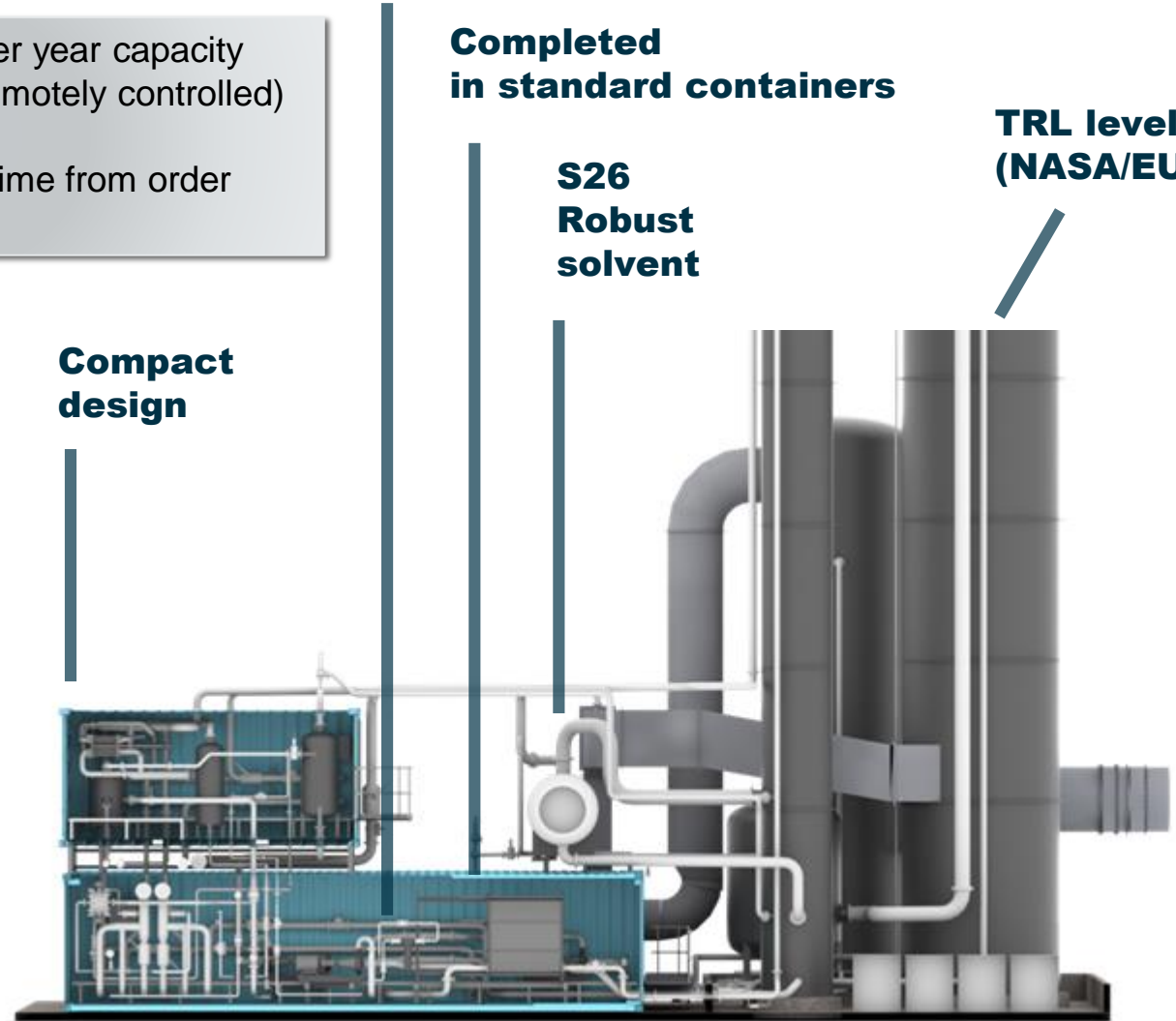
Completed in standard containers

S26 Robust solvent

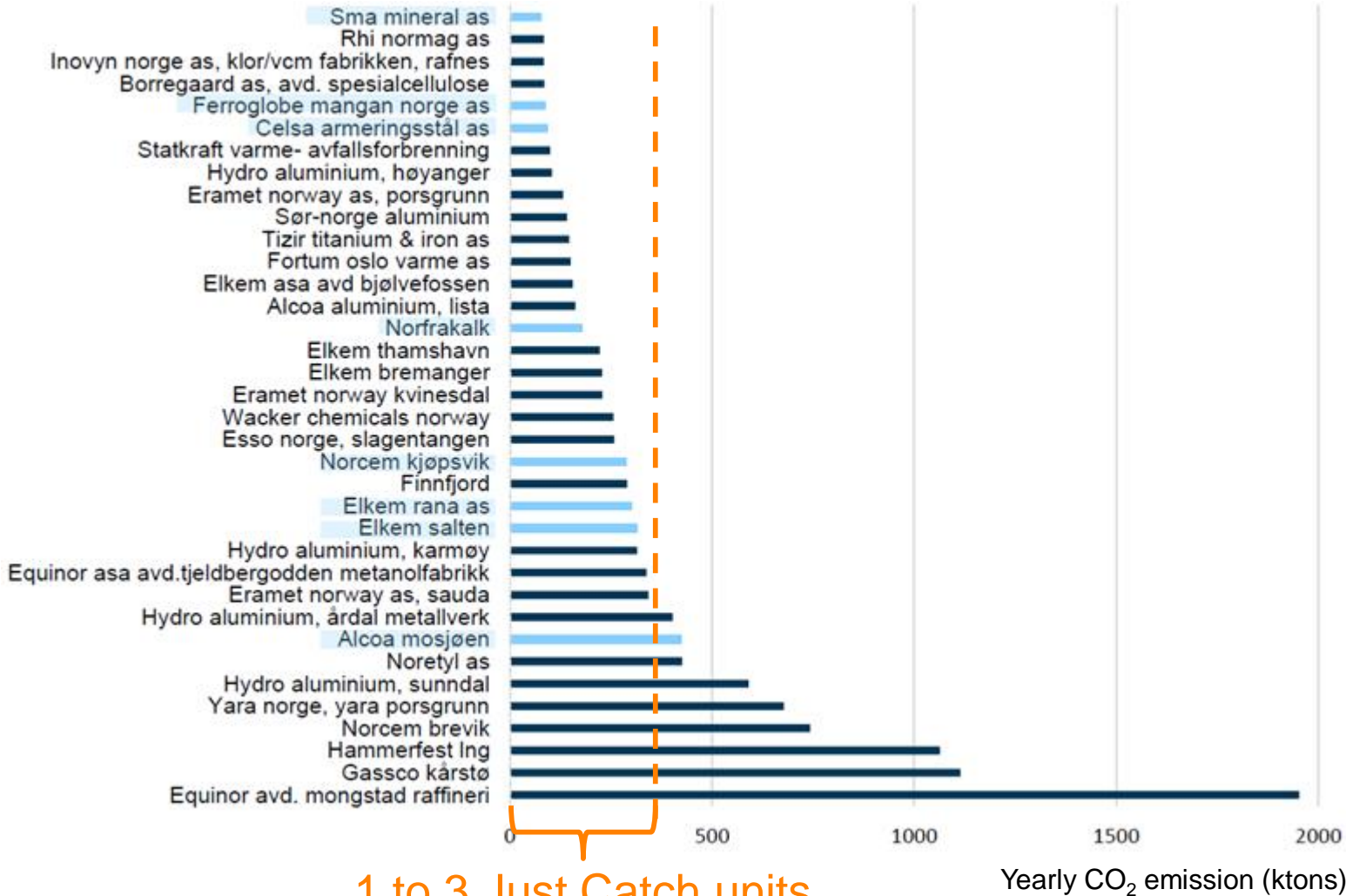
TRL level 8 (NASA/EU)

Easy Transport

Small Footprint



Present CO₂ emissions from Norwegian Process Industry

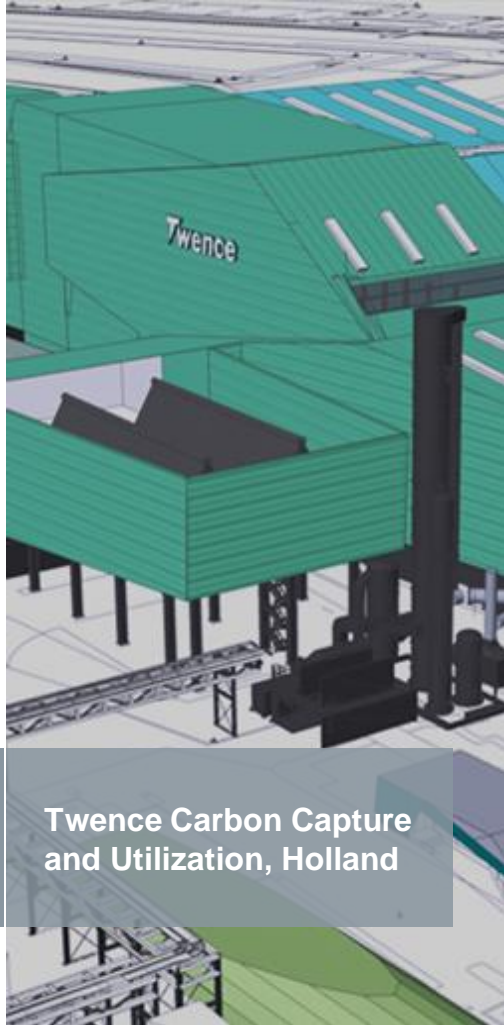


1 to 3 Just Catch units cover most industries

Just Catch is an ideal solution for the processing industry

- Emissions 2018: ~12 million tons CO₂
- (20% of total Norwegian GHG emissions)
- Road Map 2050, cut in CO₂ emission:
- 9.2 million tonnes = **92 Just Catch units**

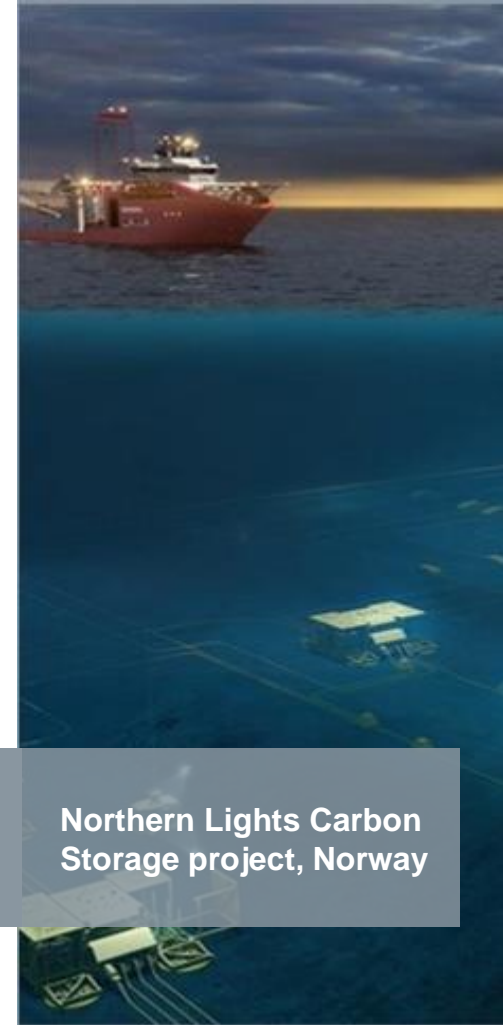
This is Happening Now



Twence Carbon Capture and Utilization, Holland



Heidelberg / Norcem, cement factory Carbon Capture FEED, Norway

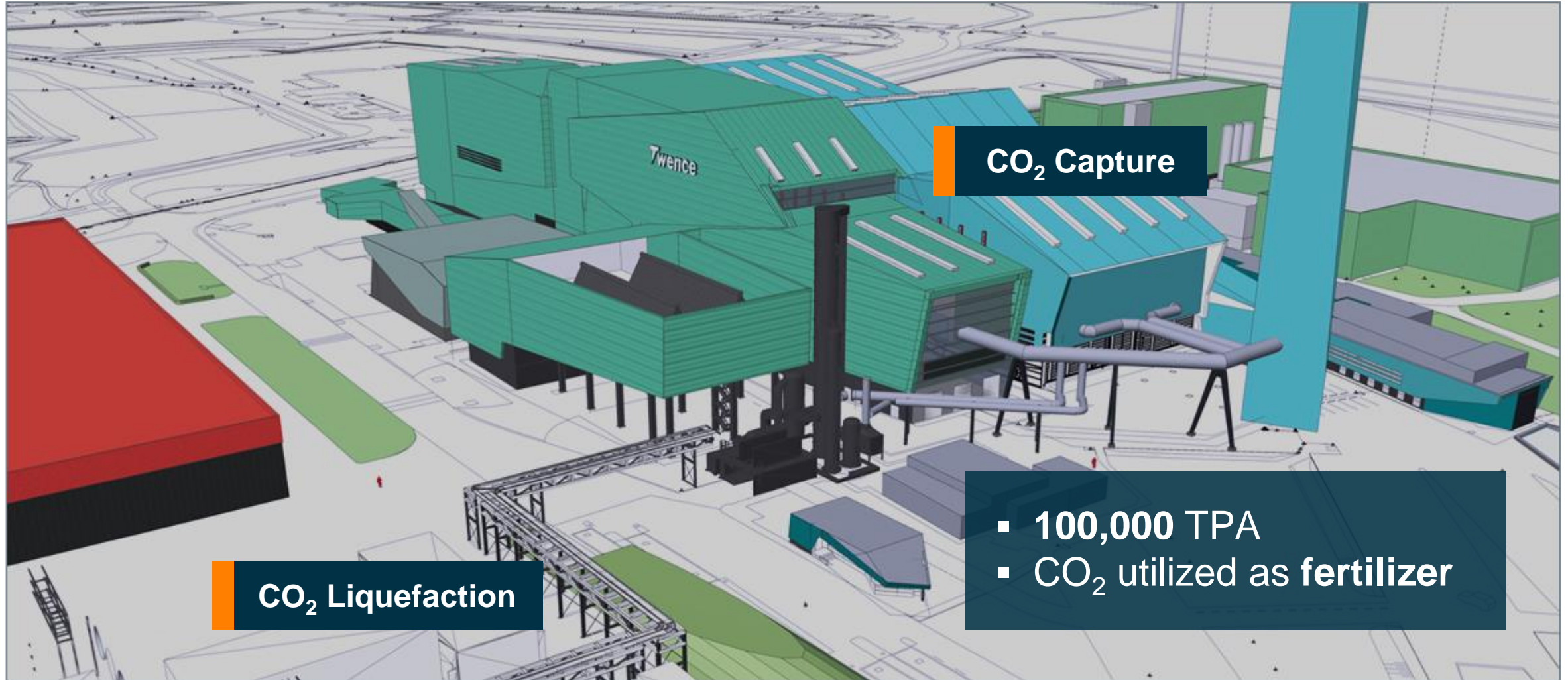


Northern Lights Carbon Storage project, Norway



Preem, Scandinavia's largest oil refinery, pre-FEED, Sweden

Carbon Capture Contract With Twence in the Netherlands





Norcem Cement Plant, Brevik in Norway

- 400,000 TPA CO₂ capture and liquefaction plant
- Equivalent to emissions from 200,000+ fossil cars
- CO₂ transport by ship to permanent storage
- Ongoing FEED project, planned operation in 2023

Northern Lights – carbon capture and storage project

Equinor, Total and Shell are planning the CO2 transport and storage in the North Sea



- Onshore terminal with buffer storage, pump and heater
- 110 km pipeline
- One injection well

The Norwegian Full-scale CCS Demonstration Project



- Transport by 1 or 2 ships
- 700 km distance
- Liquefied state (15 barg, -26°C)



Øygarden, Hordaland
Onshore terminal



Fortum Oslo Varme AS
Waste-to-energy plant



Norcem AS, Brevik
Cement plant

- Norcem and Fortum Oslo Varme capture 400 kt/y each
- Amine technology
- Includes CO2 capture, liquefaction and buffer storage (4 days)

Thank you!

Just Get Going! Just Catch it!

Jon Christopher Knudsen

Vice President | Global Business Development

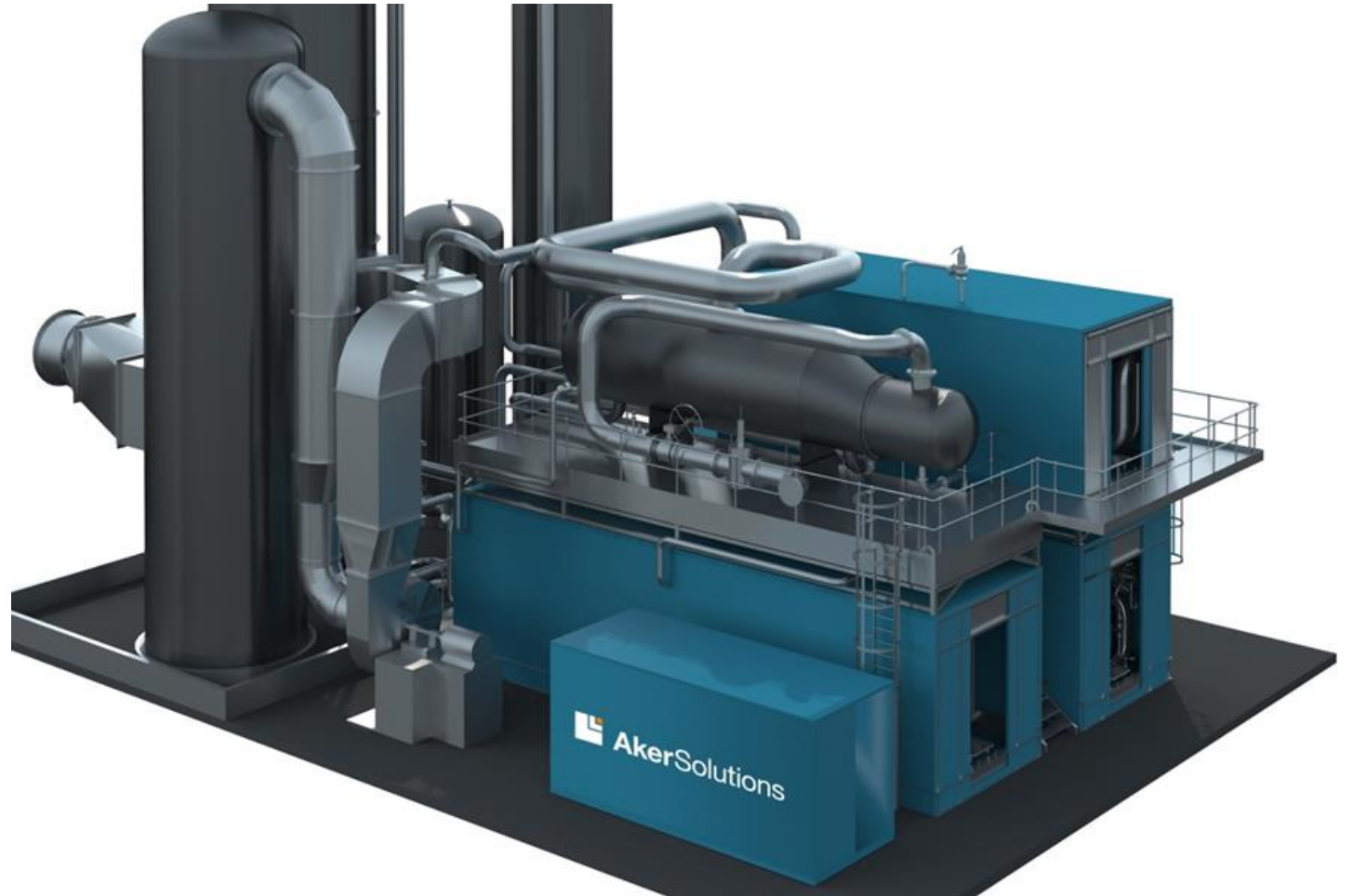
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