

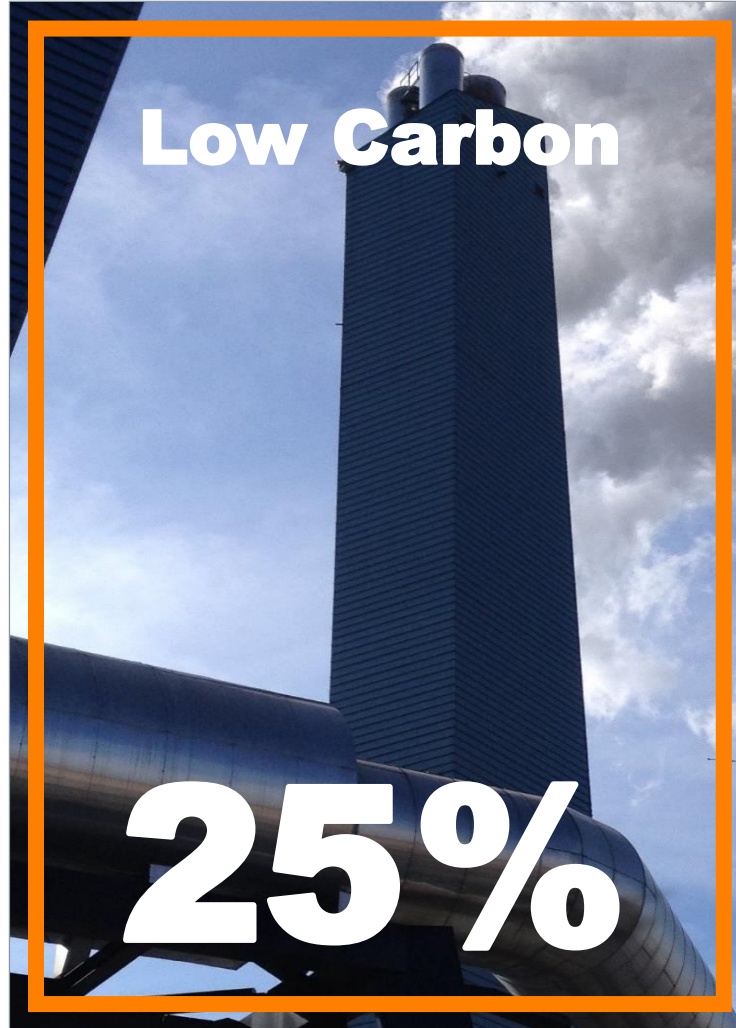
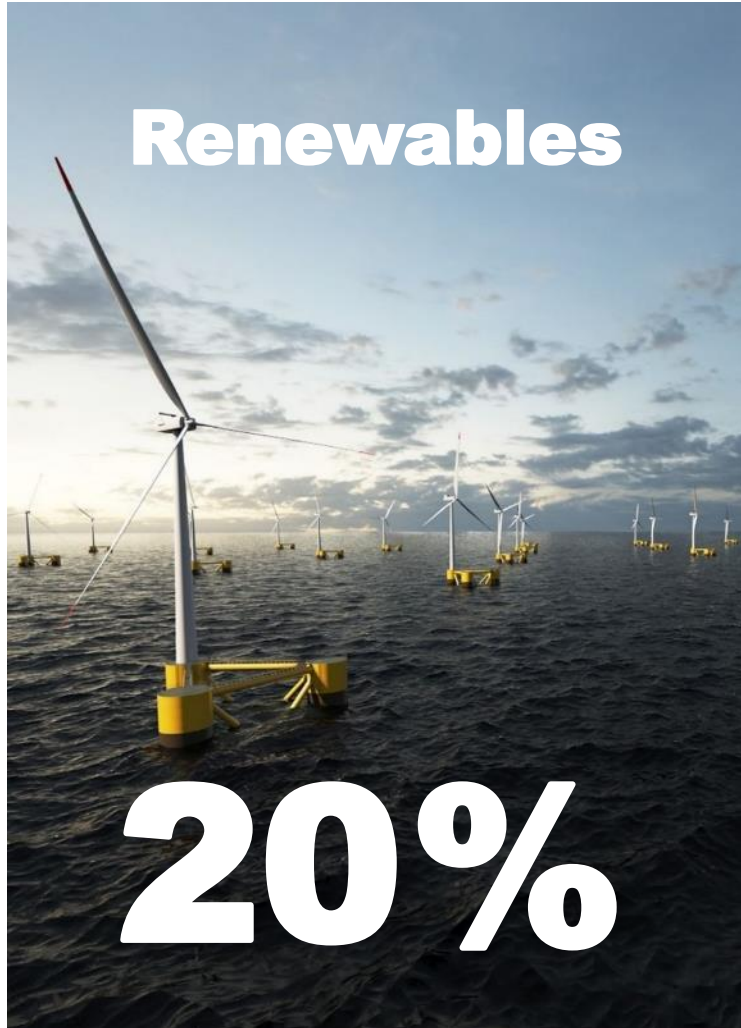
# Carbon Capture, Utilization & Storage Solutions

JP Morgan, Energy Transition Tour, 3 Jun 2020

**Jon C. Knudsen | Vice President, Business  
Development and Carbon Capture  
Aker Solutions**



# Aker Solutions – Leading a Sustainable Energy Future



# Carbon Capture

## Part of the solution

Carbon Capture is required to **meet Paris climate goals**

The technology is **commercially available**

Aker Solutions is playing **a leading role**

**Costs of capture** is decreasing

Enhanced oil recovery – **significant climate effect**

**Projects accelerating** in Europe

North America and Middle East **projects driven by EOR**



# Aker Solutions – Pioneering CCS, at Sleipner since 1996

- **World First** – Sleipner offshore CO<sub>2</sub> injection and permanent storage project, 1996
- **Designed & delivered** by Aker Solutions / Kvaerner
- **~1 million tons of CO<sub>2</sub>** injection per year into aquifer (permanent storage)



# Mobile Test Unit (MTU) – Advanced CO<sub>2</sub> Capture Pilots

- Tested at 7 different flue gases, at 6 different sites since 2008
- Continuously upgraded
- Paramount for technology qualification
- Extensive performance data since 2008

2020 - 2021

Risavika Gas Centre  
**Sola, Norway**



**Natural gas**

Longannet Power  
**Scotland, UK**



**Coal**

National CCC  
**Alabama, USA**



**Coal**

Dong CHP  
Equinor oil refinery  
**TCM, Norway**



**Natural gas (CHP)  
&  
Heavy oil cracker  
(RFCC)**

Heidelberg/Norcem  
**Brevik, Norway**



**Cement**

Klemetsrud WtE  
**Oslo, Norway**



**Waste to  
Energy**

Preem refinery  
**Lysekil, Sweden**



**Hydrogen  
Production  
Unit (SMR)**

Polchar  
**Police, Poland**



**Char  
production**



# Capture technology – Leading Proprietary Solvent

- **8 years** of developing the worlds leading HSE friendly amine
- **-35% less energy** requirement from reference case
- Non-toxic, Non-corrosive, Biodegradable



- **The leading** chemical amine solvent
- **Solvent Degradation** is the key to success

MEA Heilbronn  
Campaign  
**920 h**



SOLVitCampaign  
**1,210 h**



SOLVit Campaign  
**2,090 h**



# Three Versions – Same Proven Technology



## Advanced Carbon Capture (ACC™)

- **Proprietary solvent** and technology
- **Verified** in extensive MTU testing and at Technology Center Mongstad, which was designed and delivered by Aker Solutions
- **Industry leading** HSE characteristics

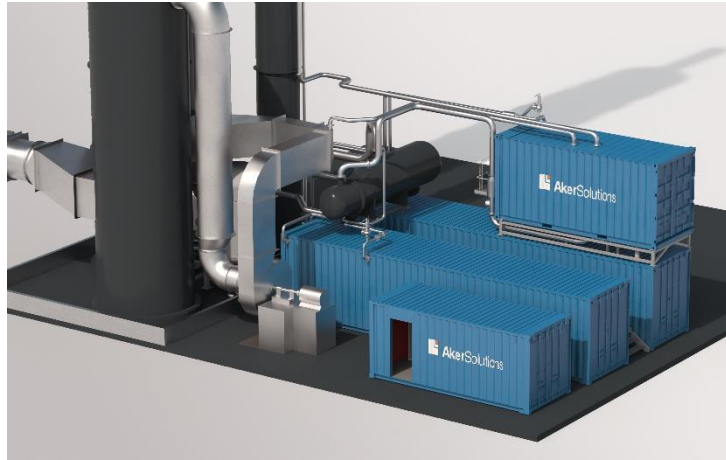
### Industrial CCS

> 400,000 TPA CO<sub>2</sub>



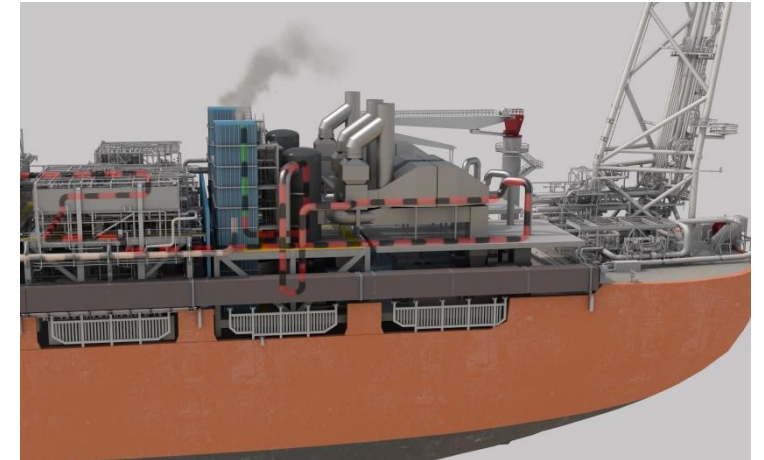
### Modular Just Catch

40,000 - 150,000 TPA CO<sub>2</sub>



### Offshore Just Catch

120,000 TPA CO<sub>2</sub> Per turbine





# Offshore **Just Catch** Carbon Capture for FPSO

**240,000 tonnes**

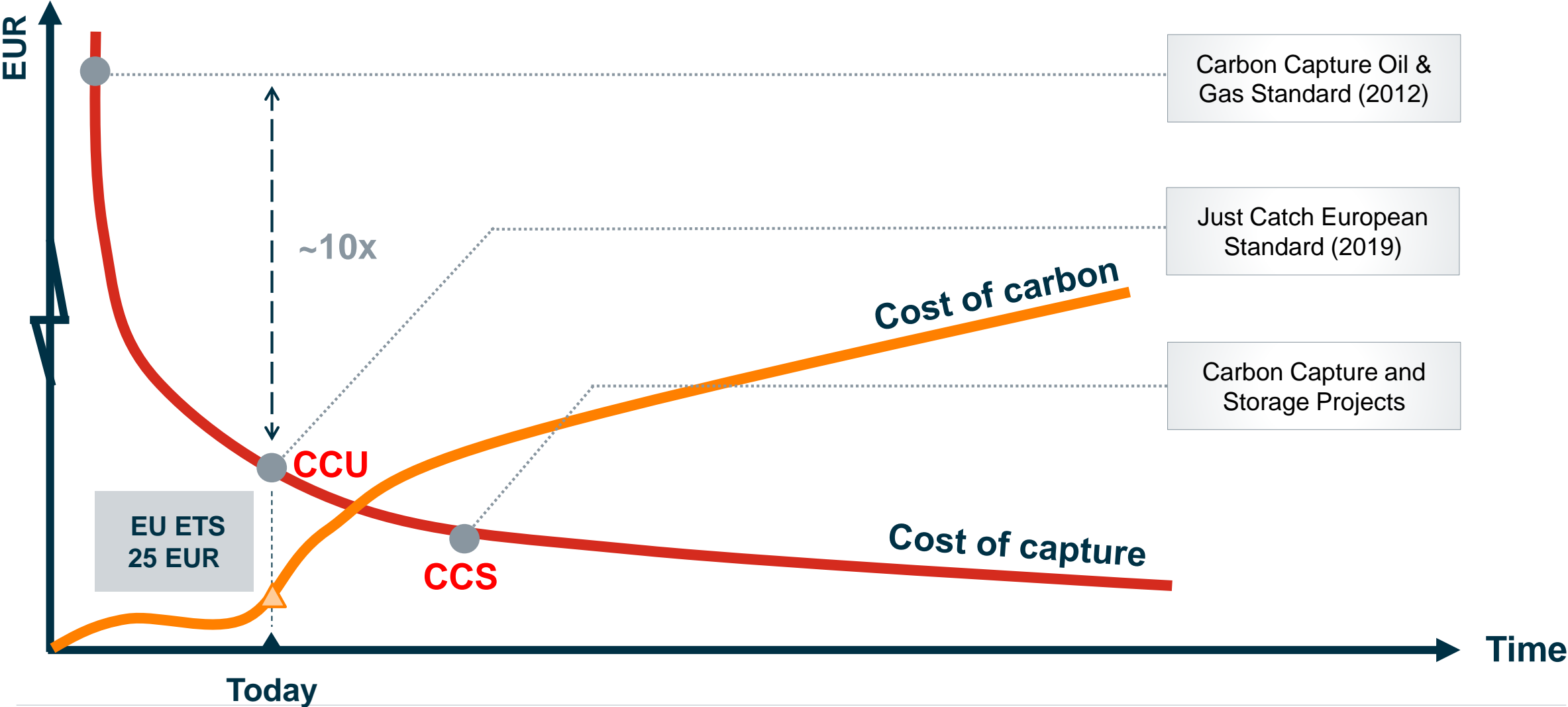
annual CO<sub>2</sub>-capture per FPSO

= 170 MNOK / '120,000 cars'

- Compact, modular and standardized design
- 120,000 tonnes CO<sub>2</sub> capture per year from gas turbines
- CO<sub>2</sub> for water injection (no dedicated CO<sub>2</sub>-well needed)
- Self-powered from the gas turbines, low fuel cost
- Qualified technology, robust solvent
- Automated

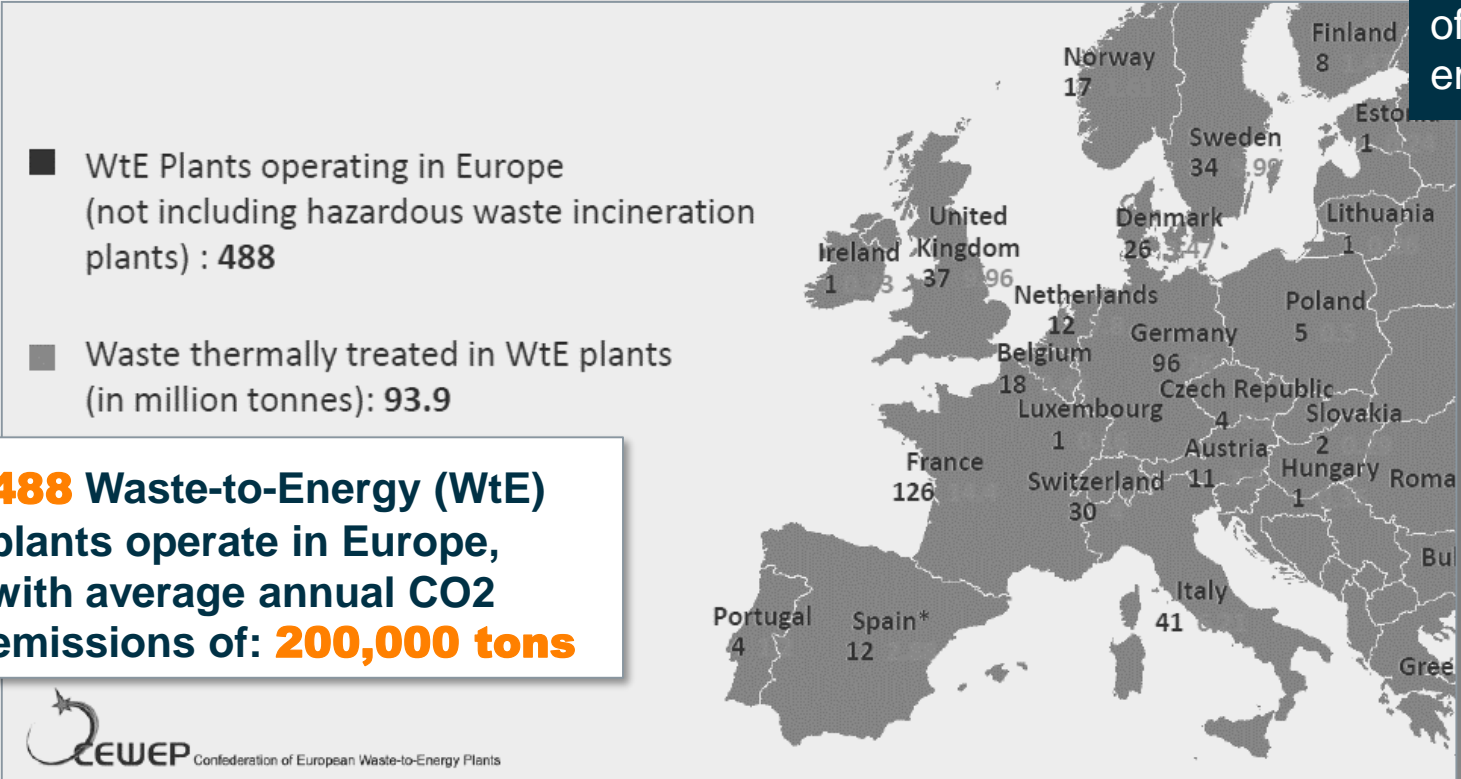


# Cost of Capture and Cost of Carbon



# Waste to energy – Quick route to large reductions

## Waste-to-Energy in Europe



Our **Just Catch™** plants can capture **85%** of Waste-to-Energy emissions

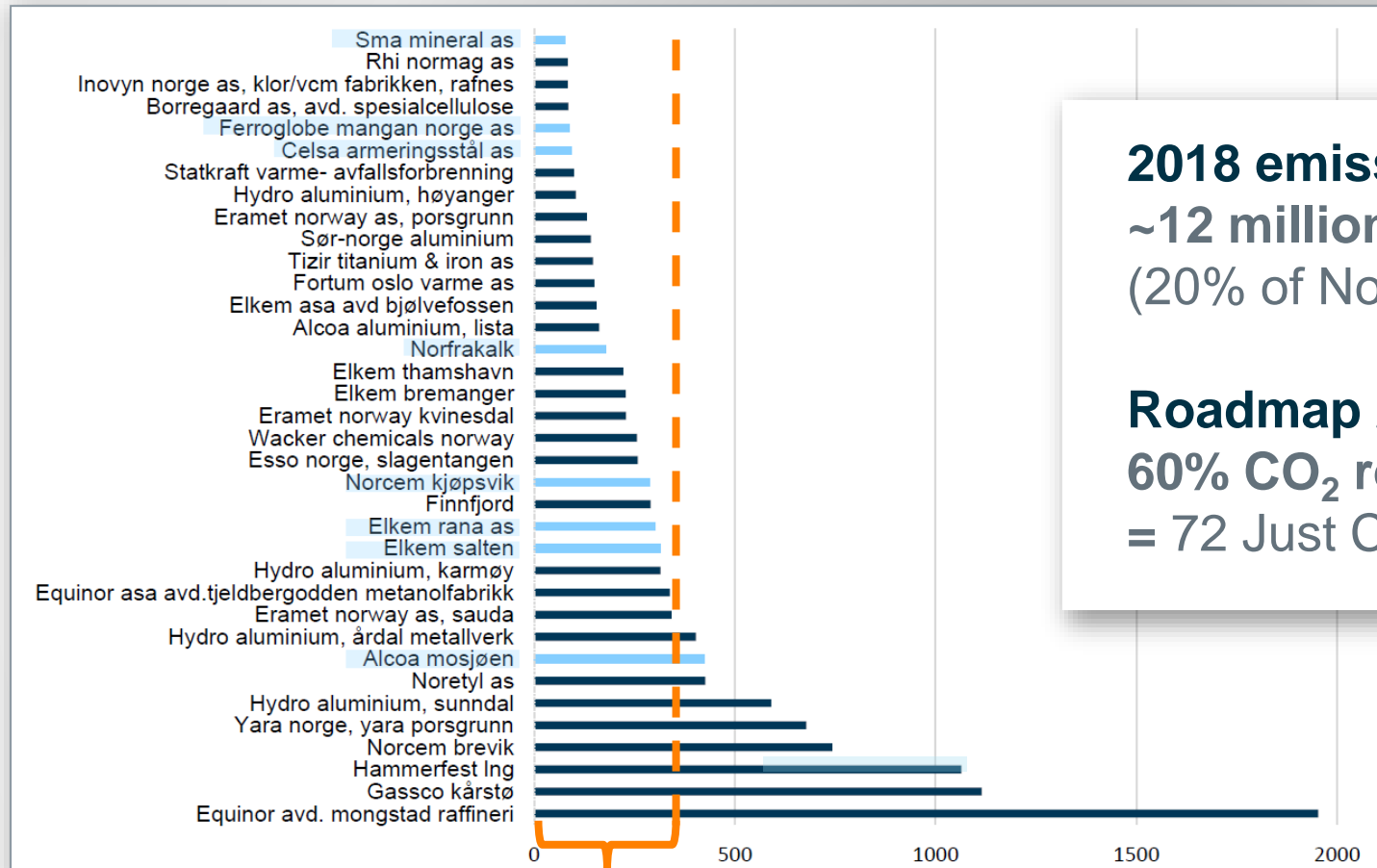


### Average WtE plant, per country:

UK	270,000 tons
Germany	270,000 tons
Finland	183,000 tons
Sweden	176,000 tons
Denmark	133,000 tons
France	114,000 tons
Norway	95,000 tons



# Example – 72 Just Catch units could capture 60% of various industry processes' emissions in Norway



1 to 3 Just Catch units per site

**2018 emissions:**

**~12 million tons CO<sub>2</sub>**

(20% of Norway's total GHG emissions)

**Roadmap 2050:**

**60% CO<sub>2</sub> reductions through CCS**

**= 72 Just Catch units**

Yearly CO<sub>2</sub> emission (ktons)





# Norcem Cement Plant, Norway – **400,000 tons**

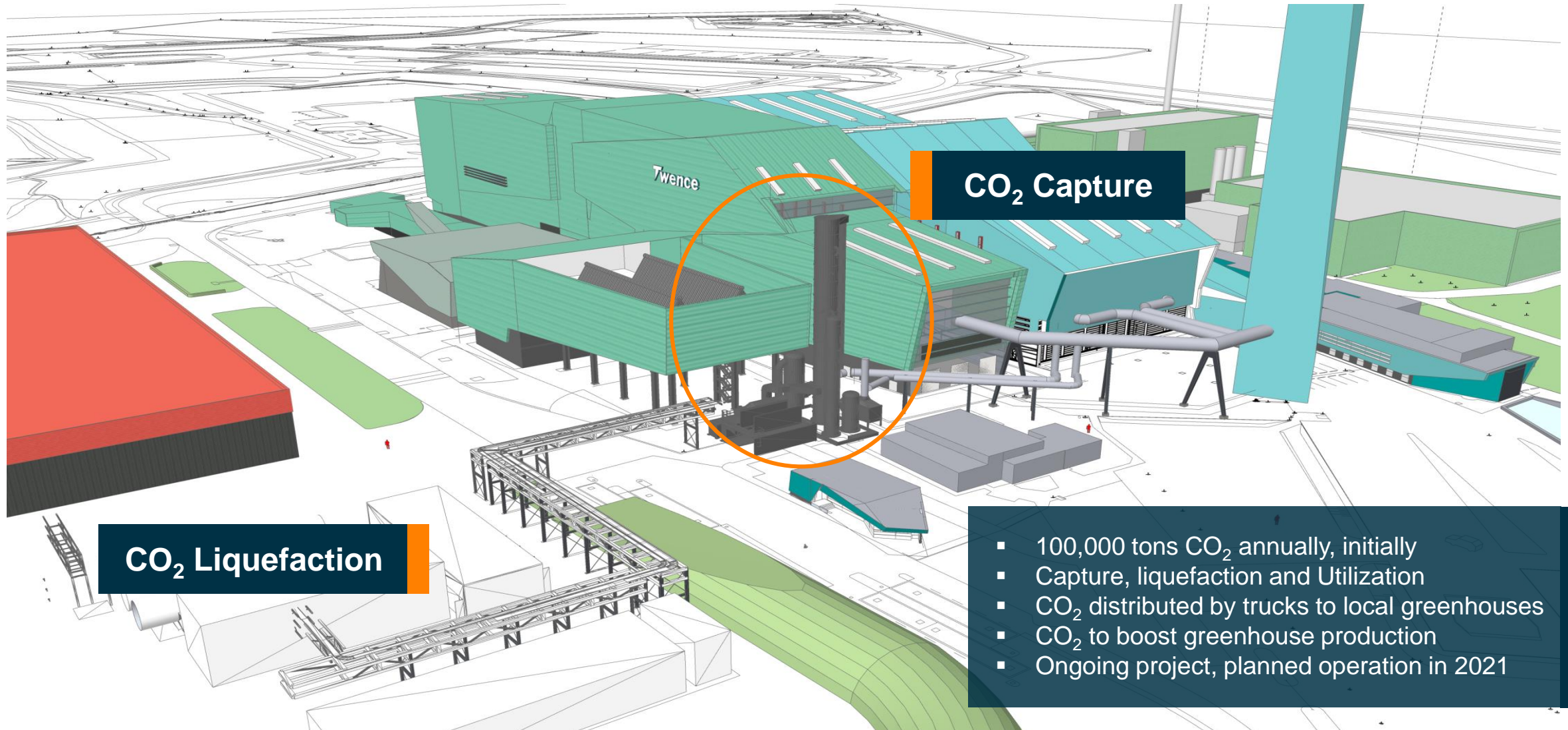
- 400,000 tons CO<sub>2</sub> annually
- Capture and liquefaction plant
- Equivalent to emissions from 205,000 fossil cars
- CO<sub>2</sub> transport by ship to permanent storage
- Ongoing project, planned operation in 2023

## Cement industry

- **5-7%** of global man-made Co<sub>2</sub> emissions



# Twence Waste-to-Energy, Holland – 100,000 tons



- 100,000 tons CO<sub>2</sub> annually, initially
- Capture, liquefaction and Utilization
- CO<sub>2</sub> distributed by trucks to local greenhouses
- CO<sub>2</sub> to boost greenhouse production
- Ongoing project, planned operation in 2021



Very High focus

High focus

Medium focus



**NORCEM**  
project,  
Norway



**TWENCE**  
project,  
Holland

**This is Happening. Now.**

**2.1m tons of capture projects ongoing**



# Northern Lights – full scale storage project

- Equinor, Total and Shell
- CO<sub>2</sub> transport and storage in the North Sea



## Storage

- 110 km pipeline, 12 inches
- One injection well



## Onshore terminal

- Onshore terminal with buffer storage, pump and heater
- 110 km pipeline, 12 inches
- One injection well



## Fortum

Waste-to-energy plant, Oslo, Norway



**Norcem AS, Brevik**  
Cement plant, Norway

- Capture of 400,000 tons annually at Norcem and Fortum Oslo Varme each
- Amine technology
- Includes CO<sub>2</sub> capture, liquefaction and buffer storage (4 days)

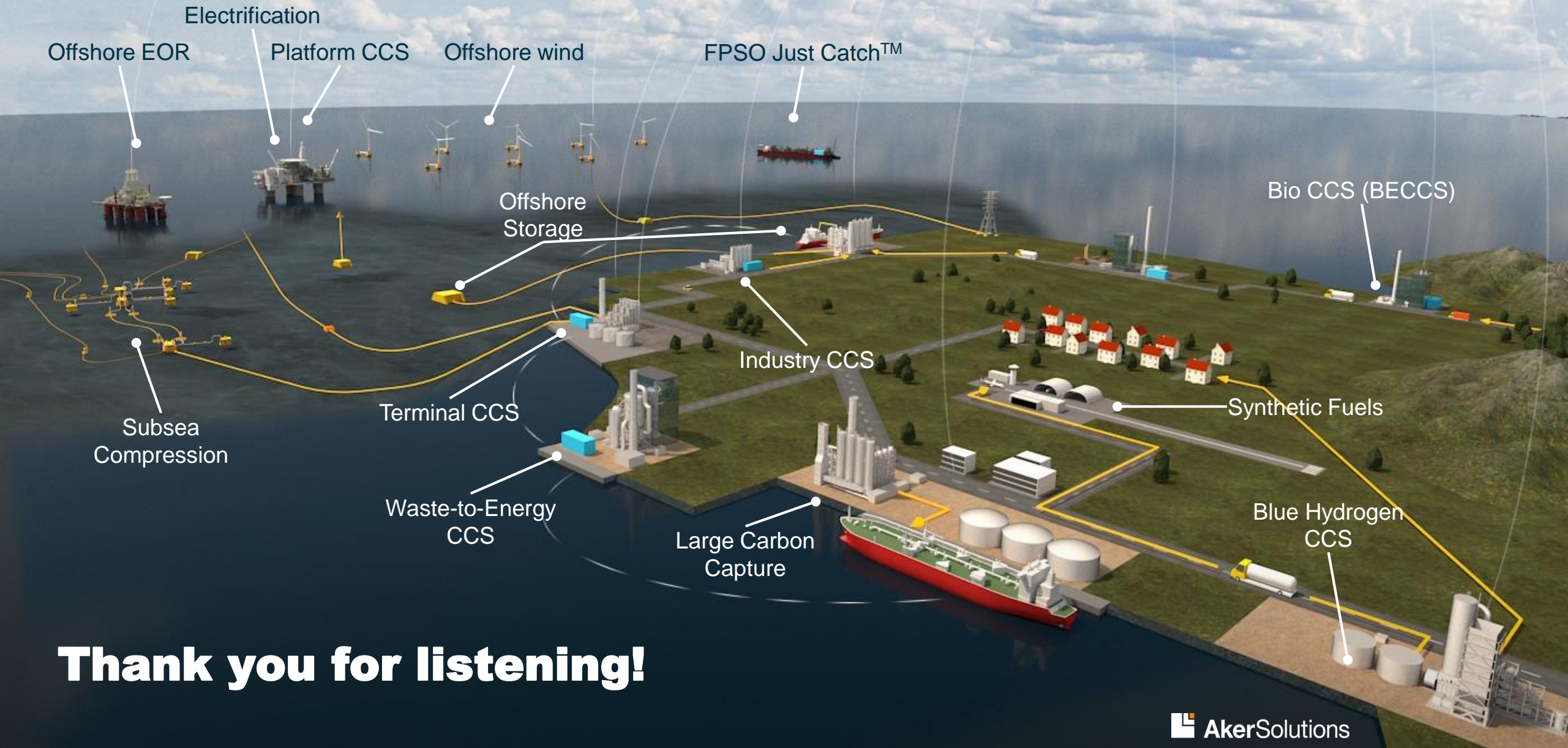


## Transport

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



# Aker Solutions – Leading a Sustainable Energy Future



**Thank you for listening!**



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