

Just Catch – Capture Plants

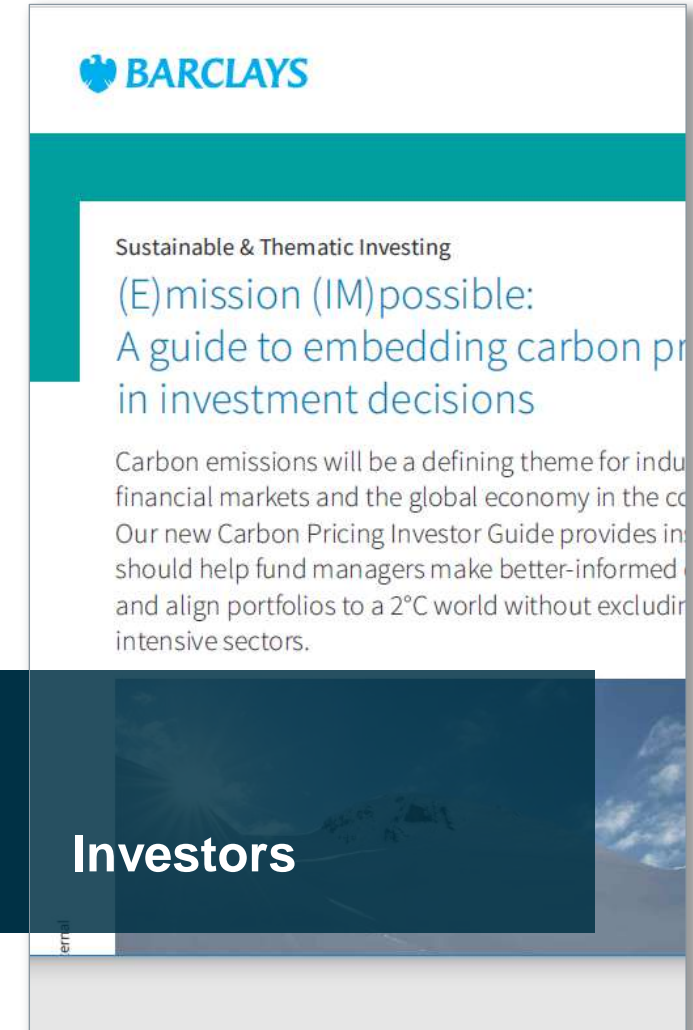
innovative – standardized – modular

Keynote, TCCS-10, Trondheim, 18th June 2019

Oscar Graff, Vice President & Head of CCUS



The World is Changing



Some industries are completely gone
UK had its **first coal-free week** for
a century in May 2019



Meeting the Paris Agreement Targets



Developing Sustainable Energy Solutions



Decarbonization



Floating Wind



CCUS

Germany can only be carbon neutral with CCS – Merkel

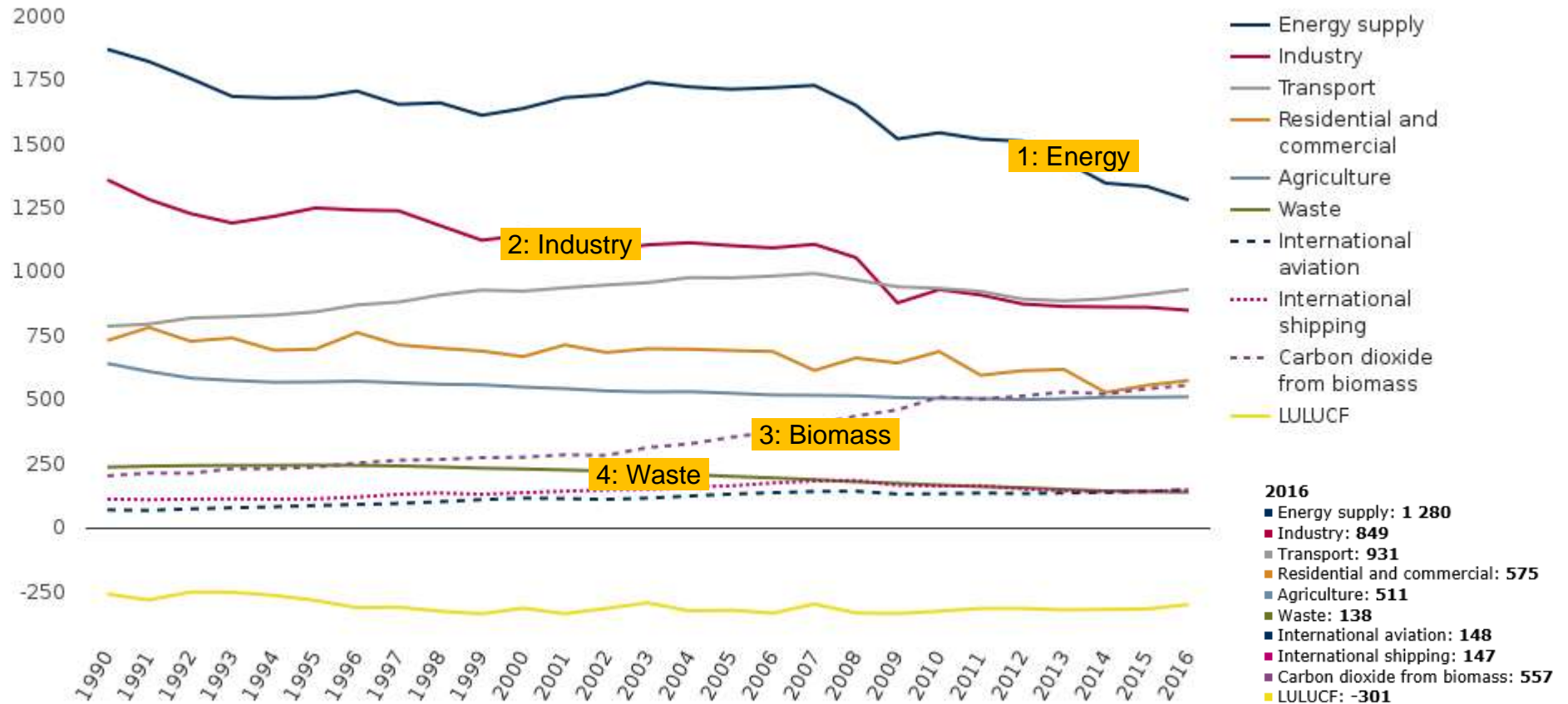
16th May 2019



“Germany will only become carbon neutral by 2050 if it deploys maligned carbon capture and storage (CCS) technology”

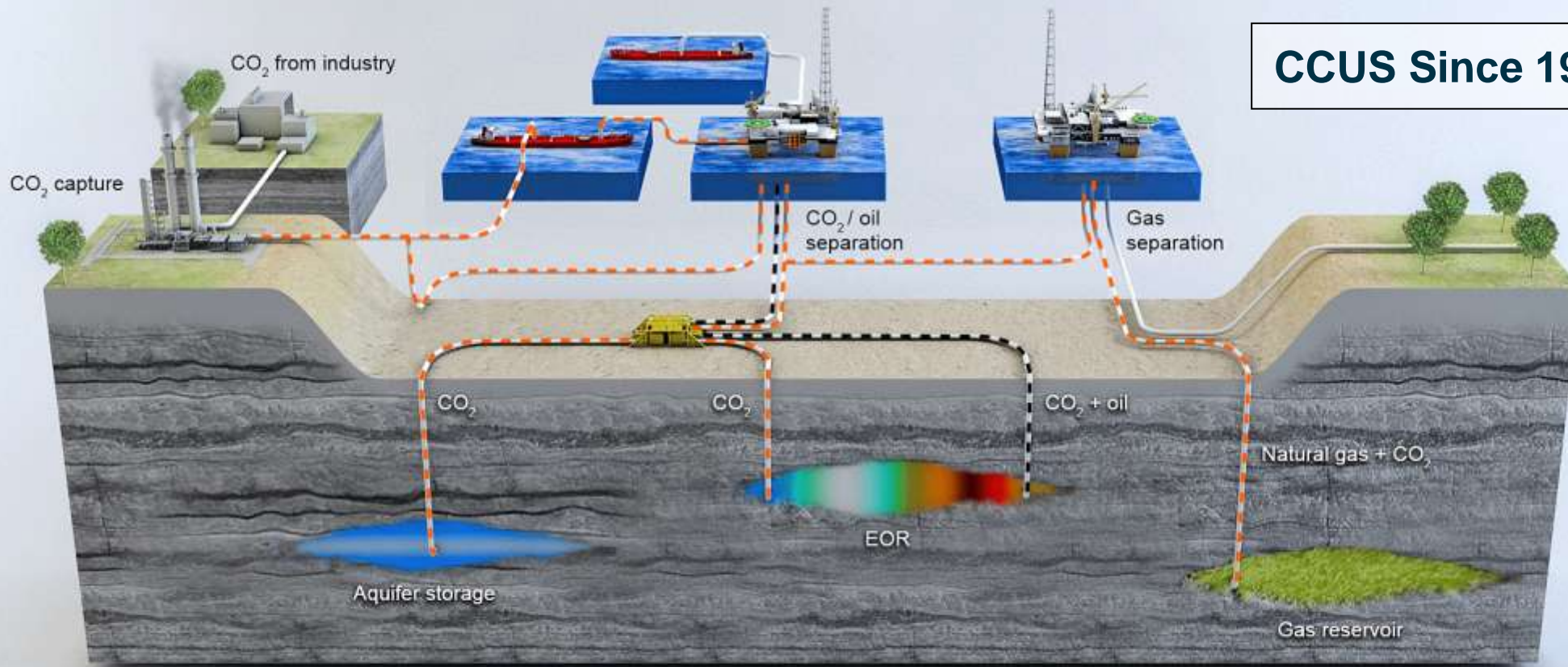
GHG Emission by sector in Europe, 1990 - 2016

Million tonnes of CO₂ eq.



“Important to apply CCUS for large emitters”

Aker Solutions offers Products, Technology and Solutions for the entire Carbon Capture, Utilization and Storage (CCUS) value chain



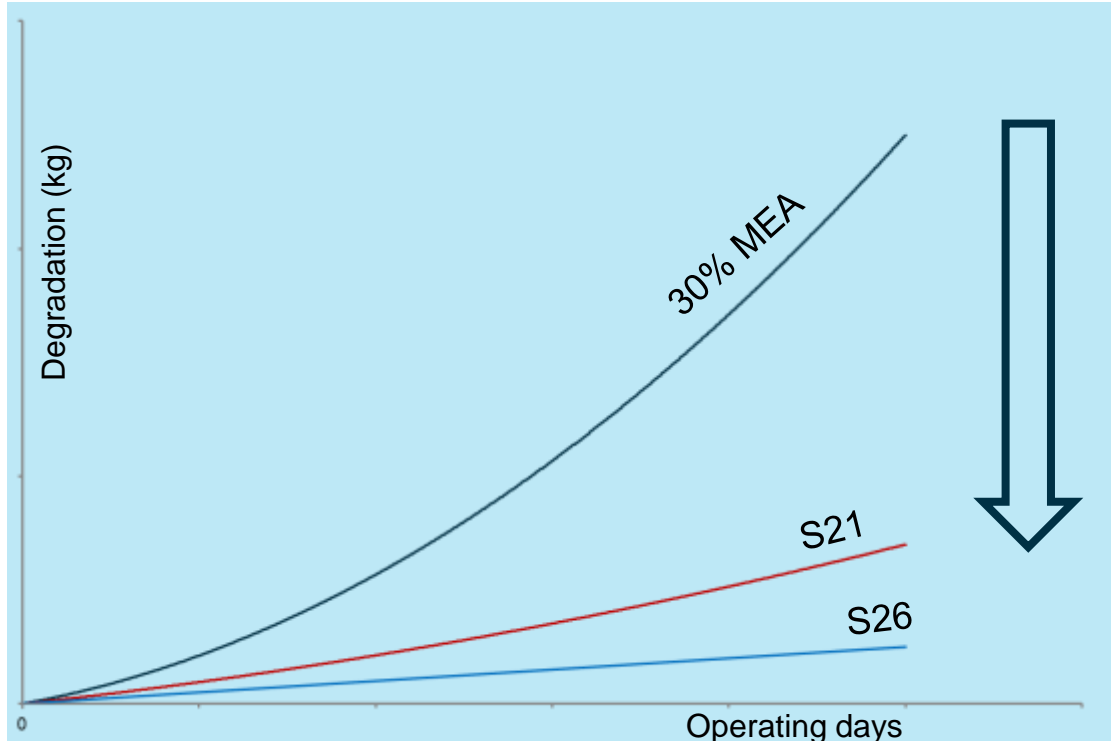
ACC™ Technology Status



Technology and process validated through long-term operation in industrial scale:

- Green solvent with:
 - Improved HSE characteristics (non-toxic, nonhazardous for aquatic organisms, ready biodegradable, etc.)
 - Improved energy consumption
 - Low degradation and waste (very robust)
 - Minimum corrosion (non-corrosive)
 - Efficient reclamation (HSS removal ~90%)
- Improved carbon capture plants with:
 - High CO₂ capture rate (~90%)
 - Minimum emission to air - Anti-Mist (best in class)
 - Minimum liquid waste (robust solvent and efficient reclamation)
 - Less energy requirement (- 35% from reference case)
 - Cheaper materials, lifetime >25 years
 - High plant availability for single train
 - Easy operation and monitoring (minimum manning)
- Plant offerings
 - Big Catch: Integrated capture & liquefaction > 300,000 TPA CO₂
 - Just Catch: Modular capture & liquefaction < 100,000 TPA CO₂
 - Rental of Mobile Carbon Capture Unit (MTU) including operators for clients who wish to test capture at their facility < 2,000 TPA CO₂

Excellent test results at TCM - Solvent degradation



Demonstrating the superior degradation resistance of Aker Solutions' ACC™ advanced solvent: S26

Reduced degradation:

- less make-up
 - less chemical storage
 - less emissions
 - less reclaiming
 - less waste
 - less corrosion
- = **Cost reduction**



30% MEA degradation during 920 operating hours

MTU, Mobile Test Unit | Advanced CO₂ Capture Pilot

- Complete carbon capture plant, owned and operated by Aker Solutions
- Extensive performance data since 2008 on fossil power plants, WtE, cement and refinery
- Next test campaign at Preem Refinery, Lysekil in Sweden

Risavika & TCM
Norway



1st at TCM

Natural Gas: 2008/2012

Longannet Power Plant
Scotland



1st in UK

Coal: 2009

National CCC
Alabama, US



1st at NCCC

Coal: 2011

Heidelberg/Norcem
Brevik, Norway



**1st at
Cement**

Cement: 2014

Klemetsrud WtE
Oslo, Norway



1st at WtE

Waste: 2016



Technology Centre Mongstad

- Capacity: 80,000 TPA CO₂
- World's most advanced amine plant
- Designed and delivered by Aker Solutions/Kvaerner
- Excellent industrial scale test results from two years operations
- Demonstrated scale-up from MTU
- Qualified Advanced Carbon Capture™
- Ready for the market

Two lines of thinking | Small Modularized & Large Custom

Just Catch



Big Catch



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, 12 inches
- One injection well



Øygarden, Hordaland Onshore terminal in



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)

The Norwegian Full-scale CCS Demonstration Project



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



Norcem Heidelberg Cement Plant, Brevik in Norway

- 400,000 TPA CO₂ capture and liquefaction plant
- Equivalent to emissions from 205,000 fossil cars
- CO₂ transport by ship to permanent storage
- Ongoing FEED project, planned operation in 2023

Aker Solutions selected as preferred supplier



Excellent Candidate for CCS

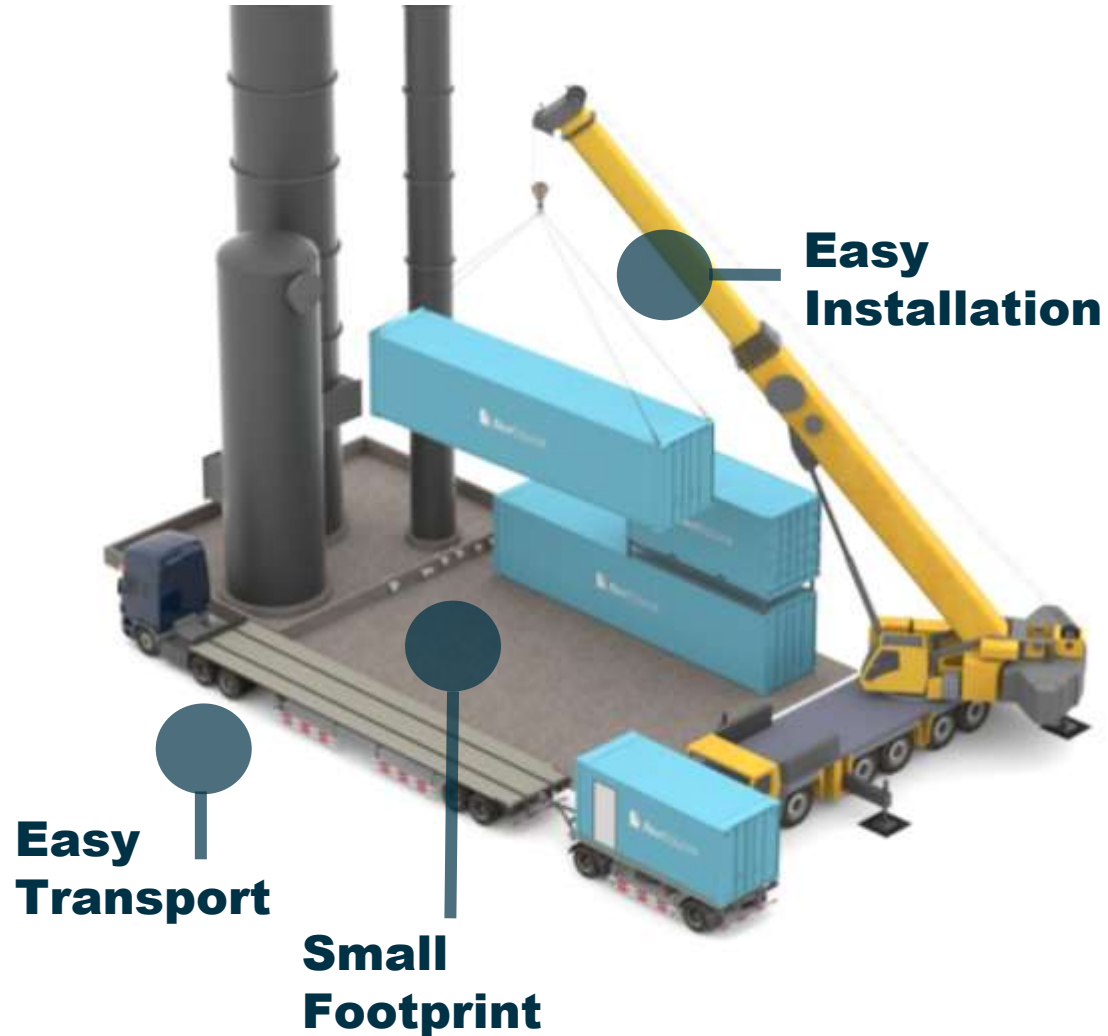
- 18 months test on same solvent (MTU)
- ~20% CO₂ in flue gas – “low hanging fruit”
- All required heat recovered from process: 0 GJ/ton CO₂
- 2/3 of CO₂ emissions from lime stone
- Liquefied CO₂ stored at nearby quay
- Seawater available for process cooling
- ~5% of global man-made emissions from cement
- Cement will be an important future construction material

Aker Solutions is Launching Just Catch – a New Modular Carbon Capture Plant

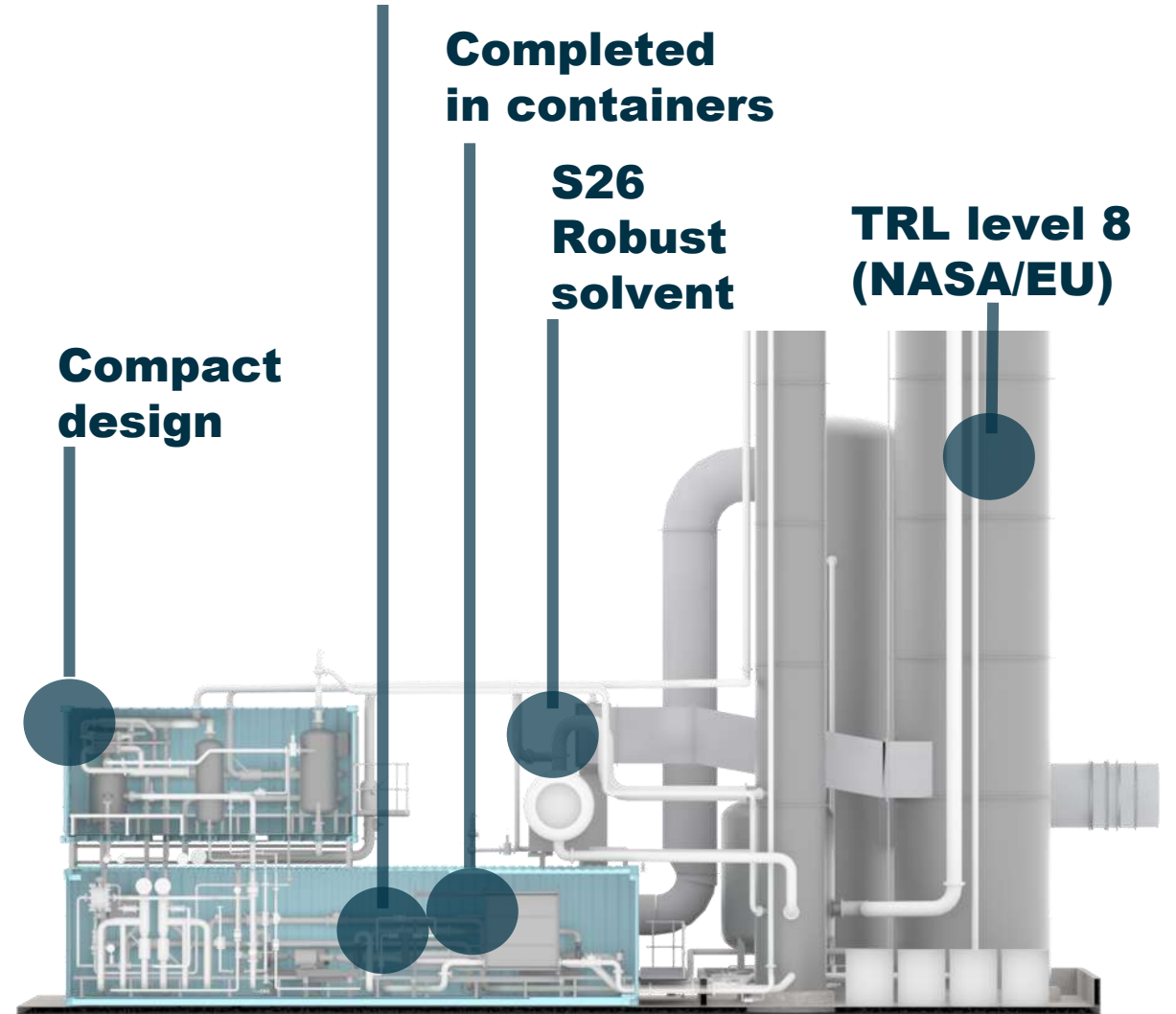
- Capture capacity up to about 100,000 tons CO₂ per year
- Just Catch is delivered as a complete package
- The plant is fully automated (remote control)
- A complete plant normally contains three elements:
 - 4 standard containers (2x20ft & 2x40ft)
 - 3 columns, reboiler and fan
 - “Green” and robust solvent - S26
- Delivery time from order about 15 months
- Basic principles:
 - Standard P&ID’s
 - Standard layout configuration (3D-model)
 - Standard equipped containers
 - Standard concrete foundation



Just Catch Advantages



10 years experience with modular capture plants



Compact Comparison TCM Versus Just Catch Model 100

TCM Plant, Norway (50 x 90m)



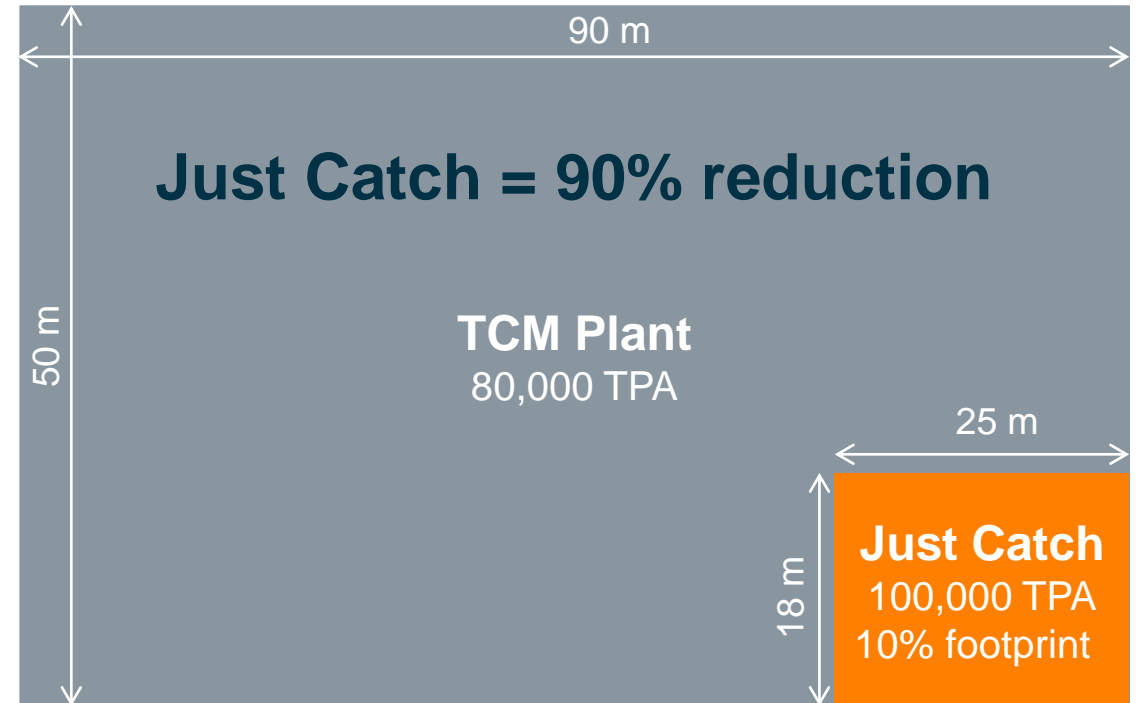
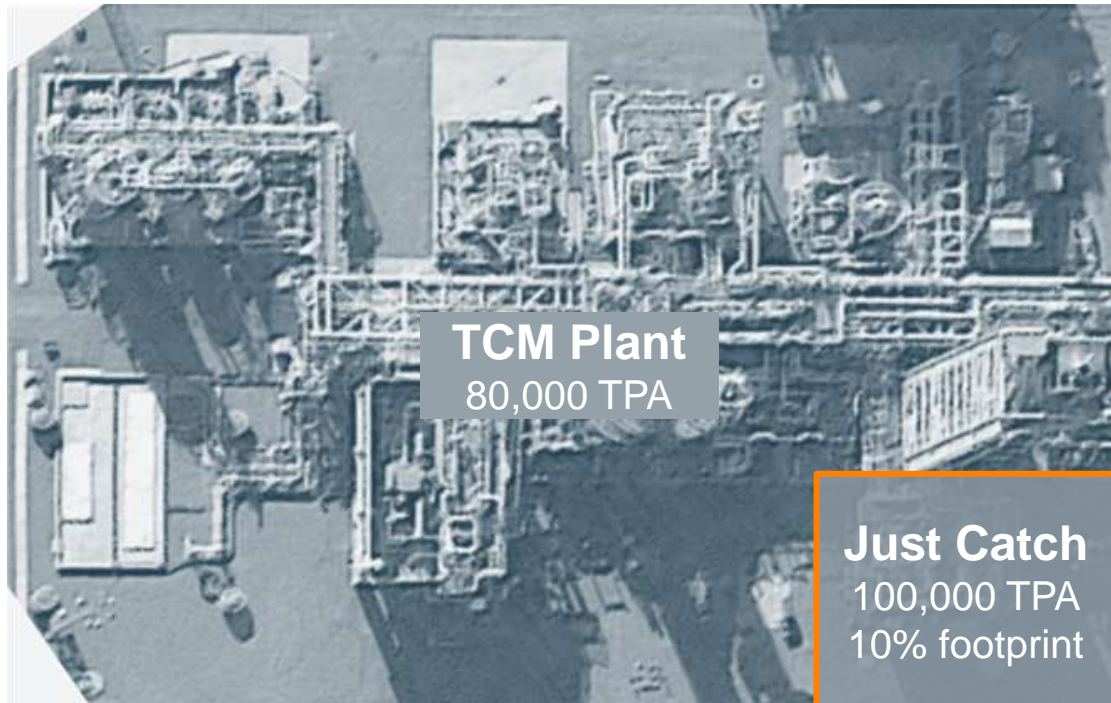
- Large footprint
- Extensive bulk materials
- 32 months delivery

Just Catch (18 x 25m)



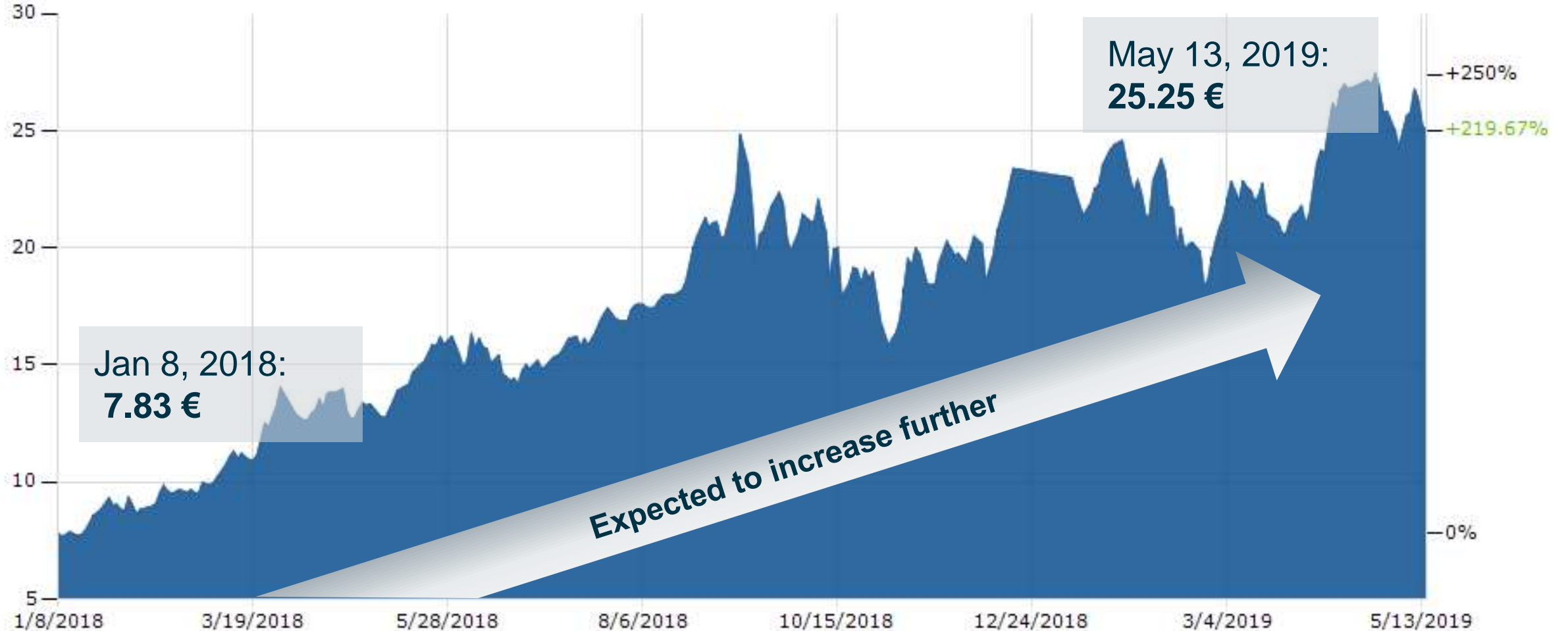
- Compact
- Cost effective
- ~15 months delivery

Compact Comparison TCM Versus Just Catch Model 100

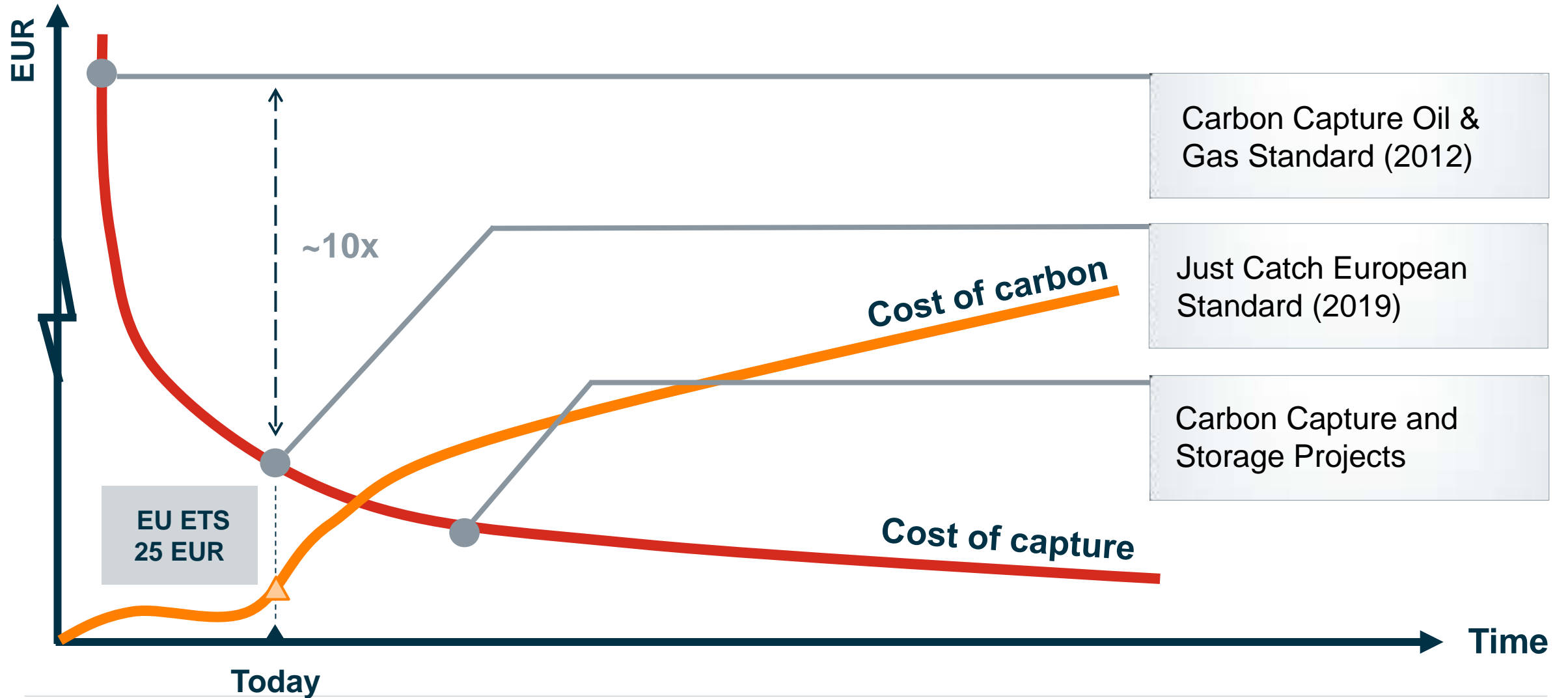


Cost of CO₂ | Expectations of Further Rise

CO₂ European Emission Allowances in EUR - Historical Prices



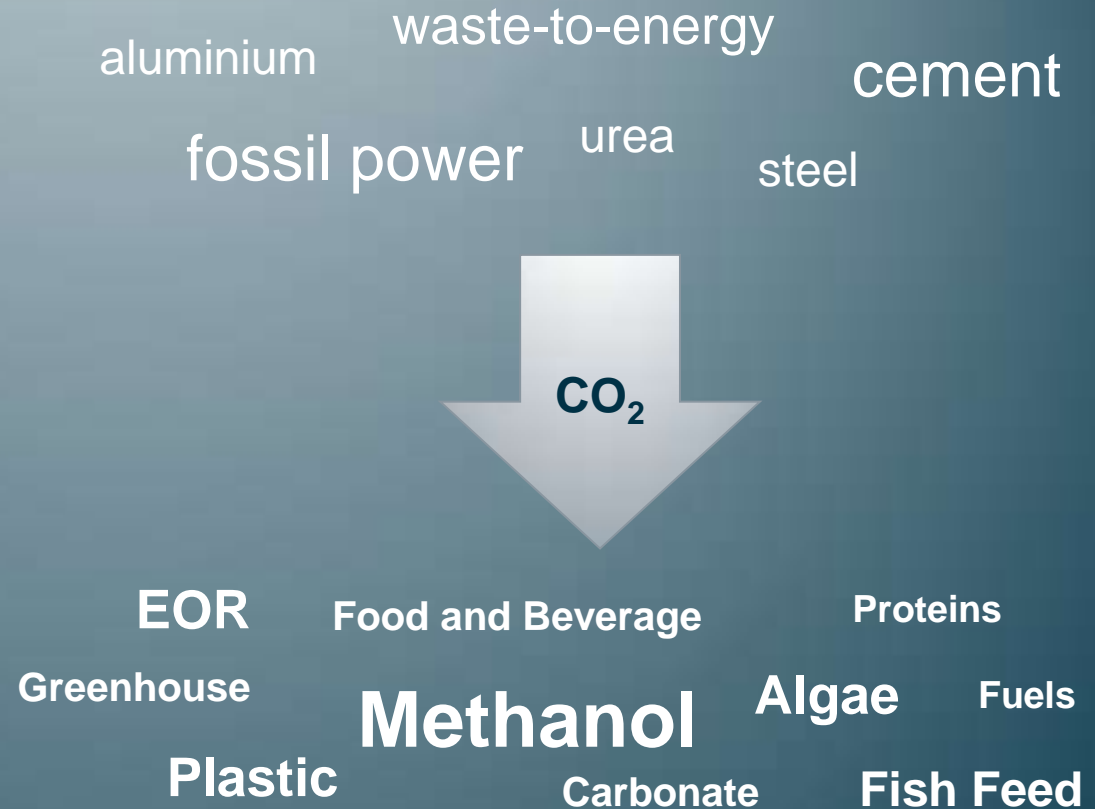
Carbon Capture With Utilization Comes First (Smaller Volumes)



The Initial Key to Carbon Capture is Utilization - CCU

We capture carbon from many sources

That can be used in numerous ways



Twence Waste-to-Energy Plant, Hengelo in the Netherlands



- 100,000 TPA CO₂ capture and liquefaction plant
- Aker Solutions signed delivery contract April 11, 2019
- CO₂ distributed by trucks to local greenhouses
- CO₂ will boost greenhouse production = CCU
- Ongoing project, planned operation in 2021



Twence burning about 600,000 TPA waste

Twence Architect View - 100,000 TPA Just Catch & Liquefaction



Closing remarks

- It's crucial that the national CCS demo project in Norway will be sanctioned by parliament and government within 2020
- It is important that similar projects will be sanctioned by other countries
- Available CO₂ storage sites will open up the CCS market
 - industry is presently on hold
- Authorities should actively support CCU plants
- CCU will be the early movers for carbon capture and bring down cost
- Most CCU plants will have some climate effect and will be part of the growing circular economy
- The deployment of CCS and CCU towards 2050 will be crucial for the emitting industry – a license to operate



**Just Get Going!
Just Catch it!**

Thank you!

 **AkerSolutions**

Thank you!



Vice President, Head of CCUS

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Read more about CCUS at Aker Solutions:

<http://akersolutions.com/what-we-do/products-and-services/carbon-capture-utilization-and-storage/>

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