Strategic Research Area 2014–2023

NTNU ENERGY

Kampen mot karbonet

NTVA-seminar Oslo 24.October 2018

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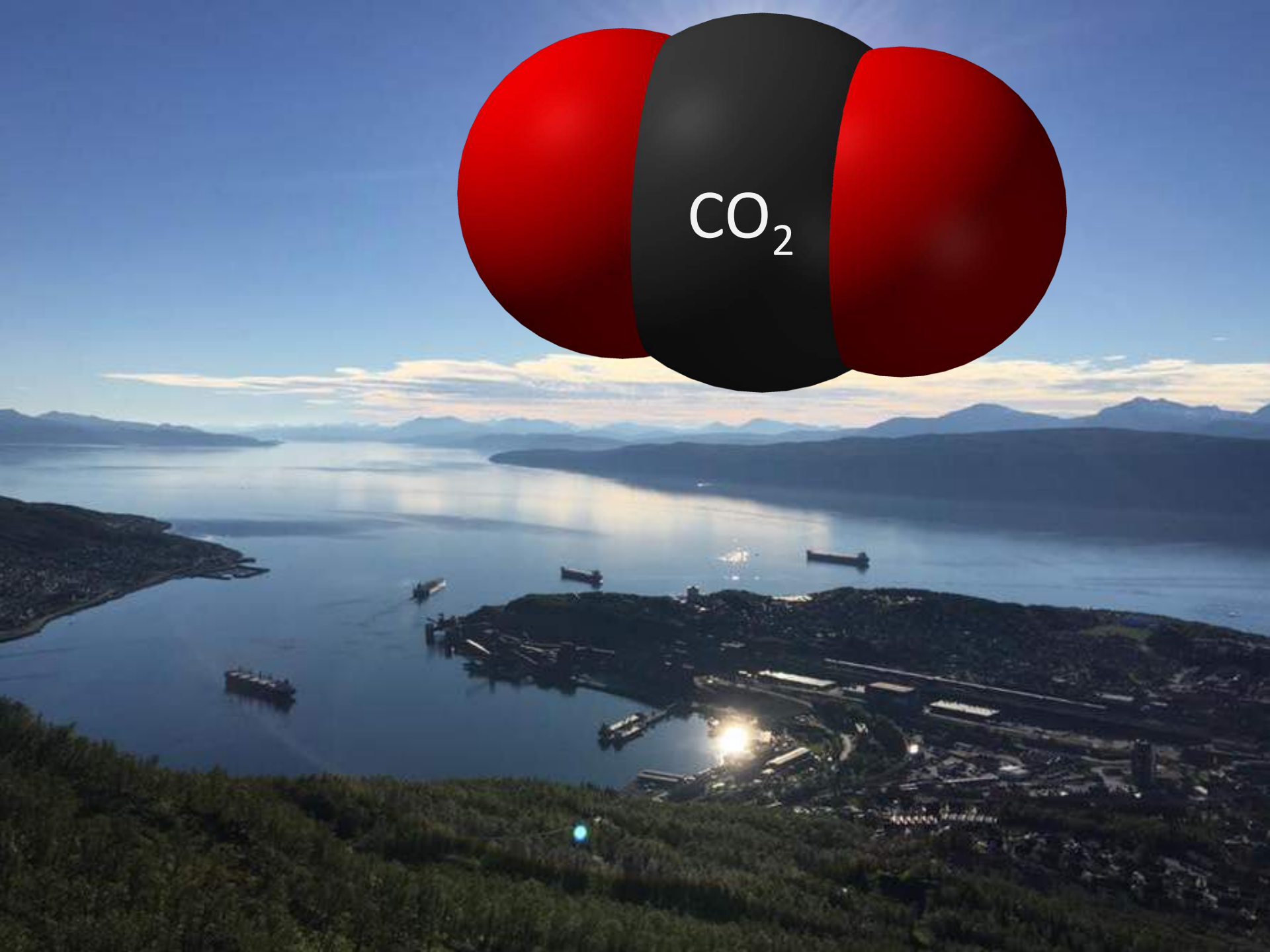
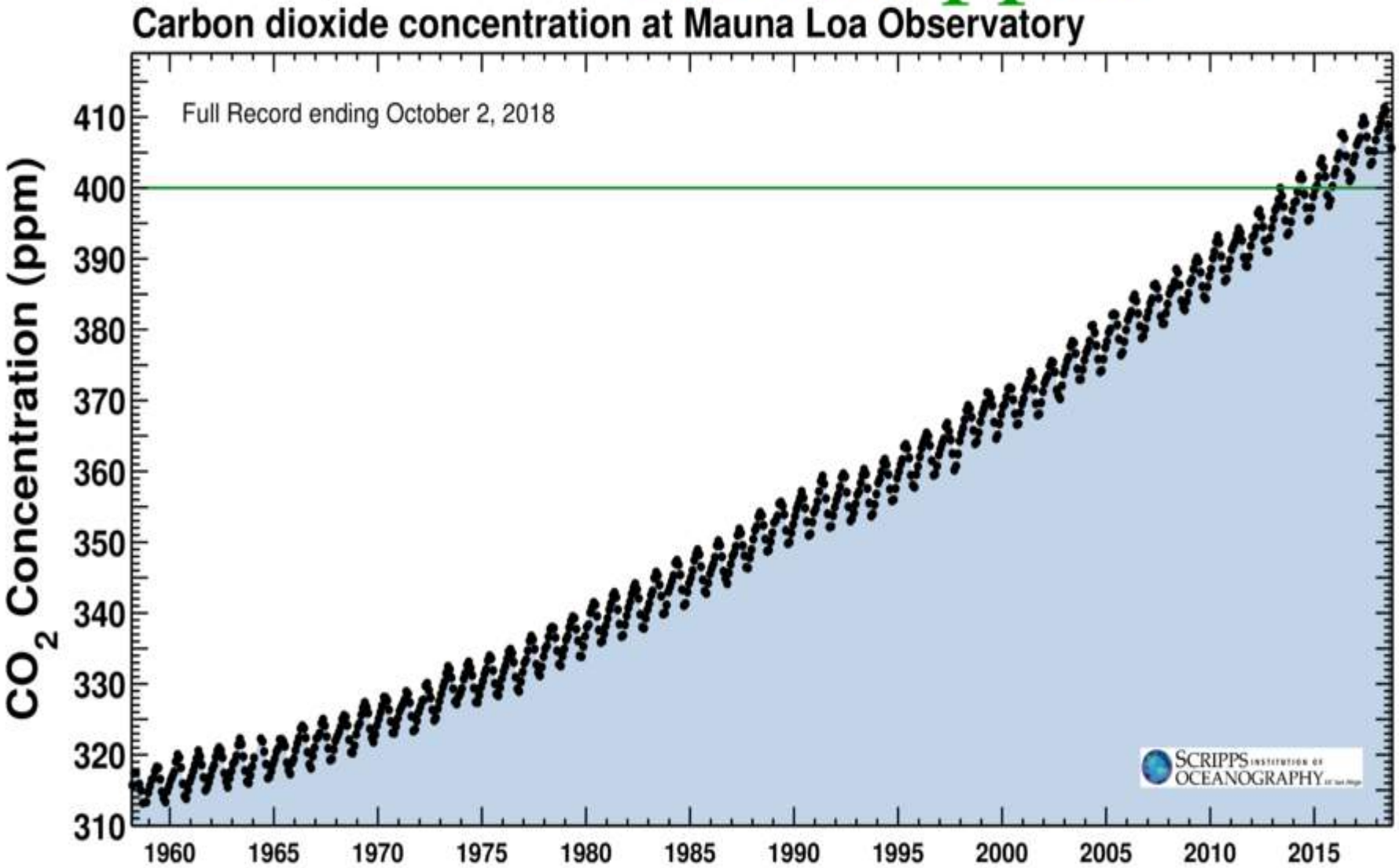
NTNU – Trondheim
Norwegian University of
Science and Technology

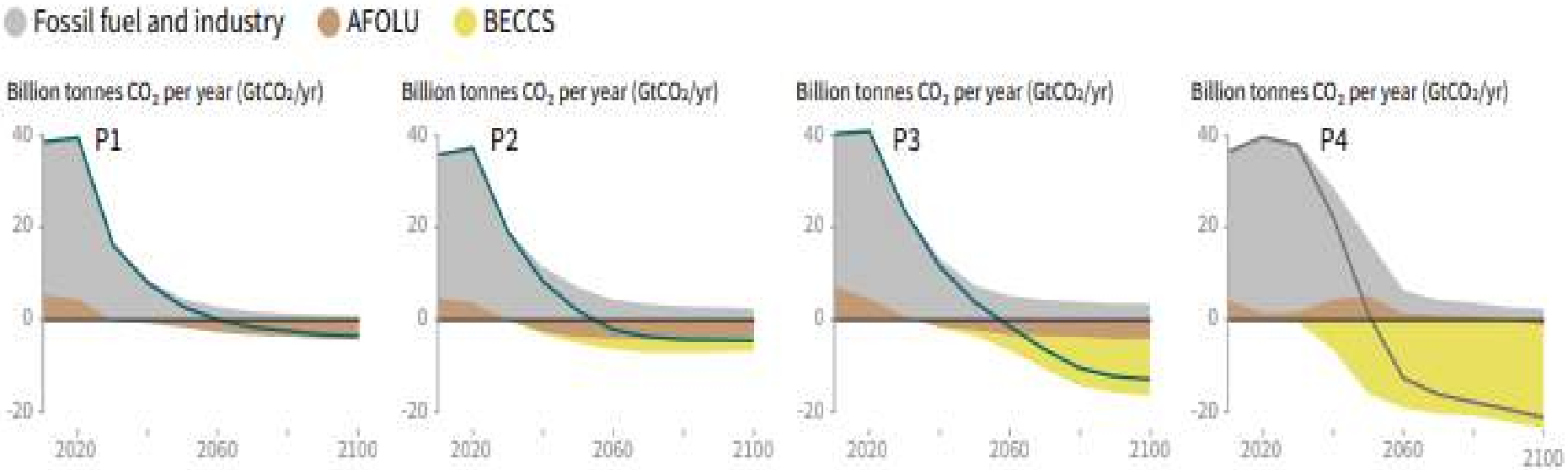

CO_2

Latest CO_2 reading
October 02, 2018

405.46 ppm



Hvor mye mindre CO2 kan vi slippe ut?



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.

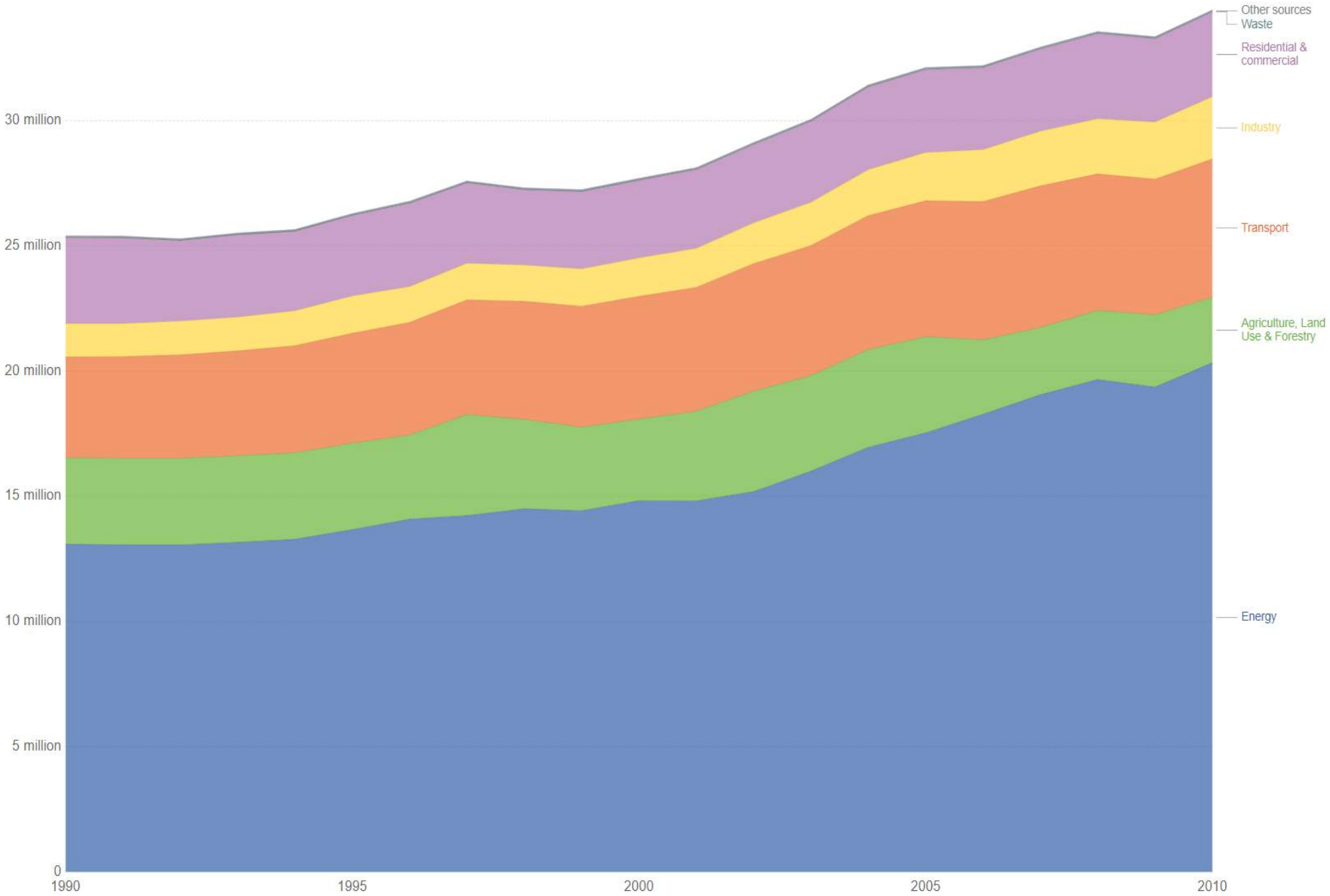
P2: A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal 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 carbon dioxide emissions by sector (Gg CO_2)

Global carbon dioxide (CO_2) emissions, measured in gigagrams of CO_2 per year.

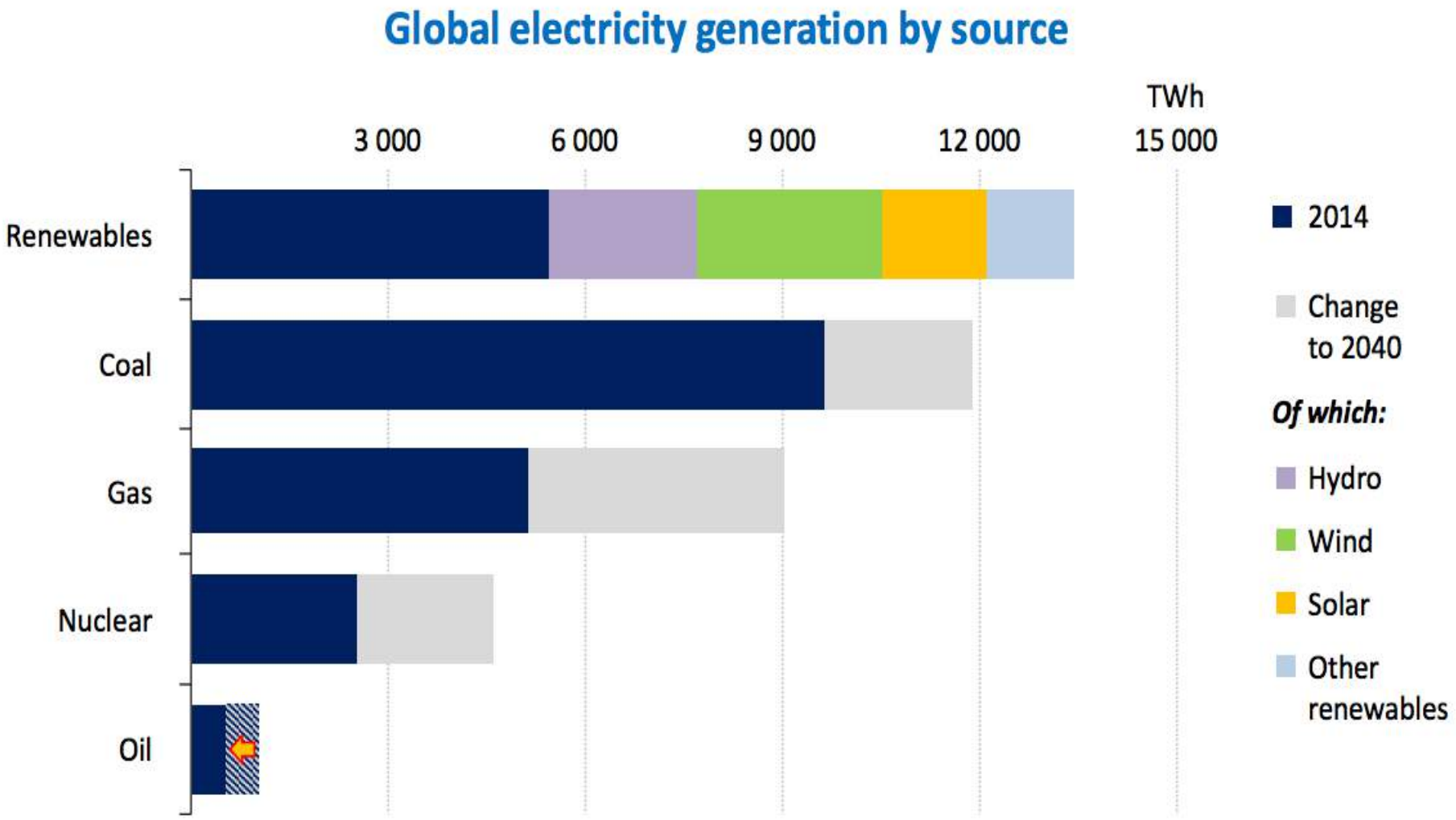


Source: UN Food and Agricultural Organization (FAO)

OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY-SA

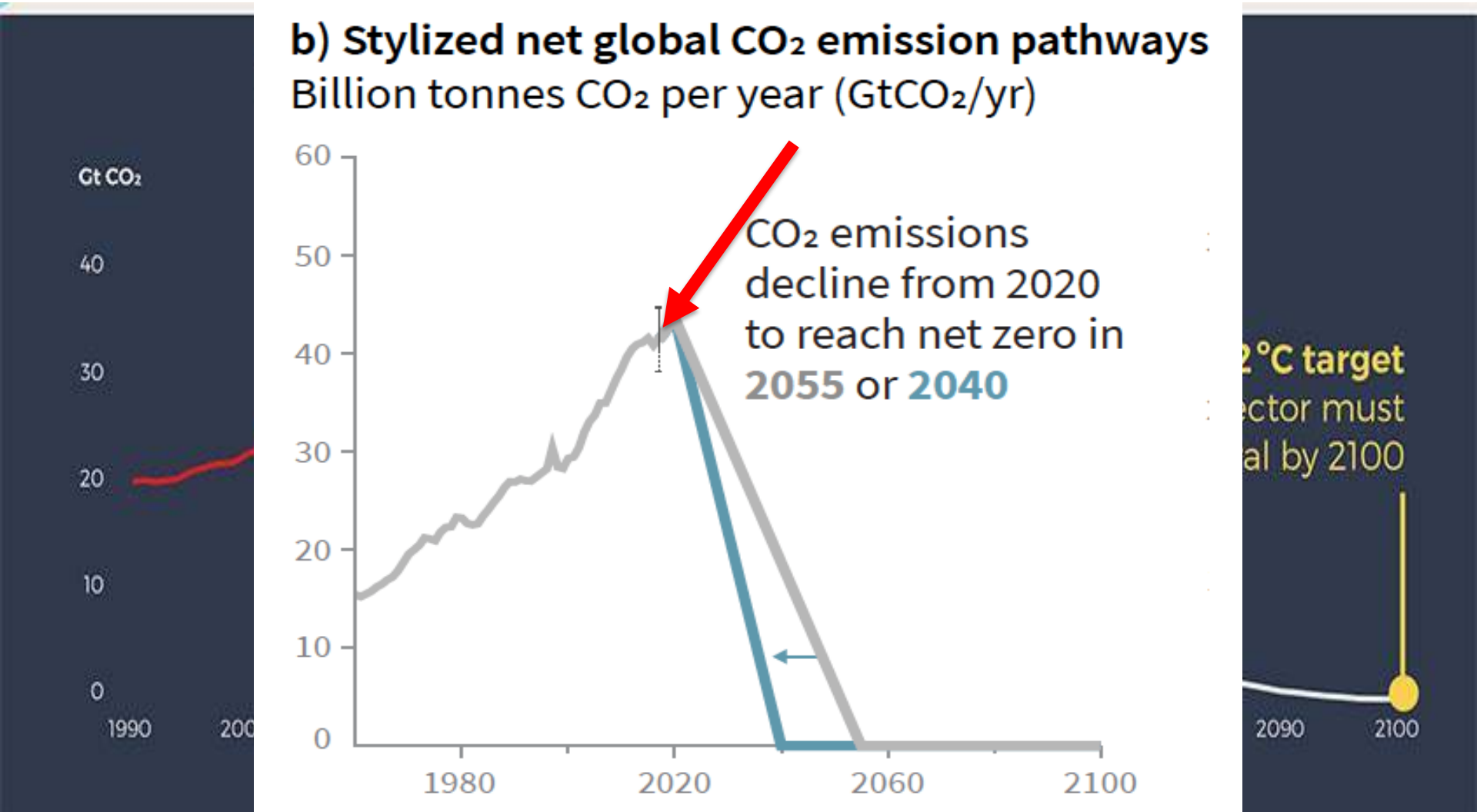
Change country | Relative | CHART | DATA | SOURCES

Energibehov VIL øke



Paris agreement

Paris er ikke nok.



9,4

MRD. TONN CO_2 I 1960

9,4

MRD. TONN CO_2 I **1960**

36,2

MRD. TONN CO_2 I **2016**

CO2-håndtering status

- mer enn 220 millioner tonn CO2 er allerede lagret under bakken

- Ingen enkel historie i Norge

Læring eller Kræsjlanding?

«Veien frem til utvikling av lagringsteknologi har vært lengre og tyngre og mer kostbar enn det vi forutså. Jeg er redd for at Mongstad ikke vil være et prosjekt som vil være et eksempel til etterfølgelse.»

Ola Borten Moe, 2014

Europa

- Norge, England og Nederland eneste med CCS prosjekter i Europa nå.
- Ikke populært i EU

Implementation

ECCSEL preparatory phase

- Legal & governance
- Financing strategy
- Infrastructure development plan
- Access Policy & IPR
- Communication
- Outreach strategy
- Business Plan

H2020 Infradev3 Consortium (2015 - 2017) with 42 research facilities/installations

NCCS

NORWEGIAN CCS RESEARCH CENTRE

Industry-driven innovation for fast-track CCS deployment

Vision

NCCS will enable fast-track CCS deployment through industry-driven science-based innovation, addressing the major barriers identified within demonstration and industry projects, aiming at becoming a world-leading CCS centre

A world-leading partnership

users

GASSCO, Shell, equinor, TOTAL

vendor, in-kind

CoorsTek, AkerSolutions, emgs, ANSALDO ENERGIA, QUAD GEOMETRICS, KROHNE, NORCEM HEIDELBERGCEMENT Group, LarvikShipping, OSLO KOMMUNE

university

NTNU, RUHR UNIVERSITÄT BOCHUM, RUB, UNIS, MIT, UiO University of Oslo, University of Zurich, TUM

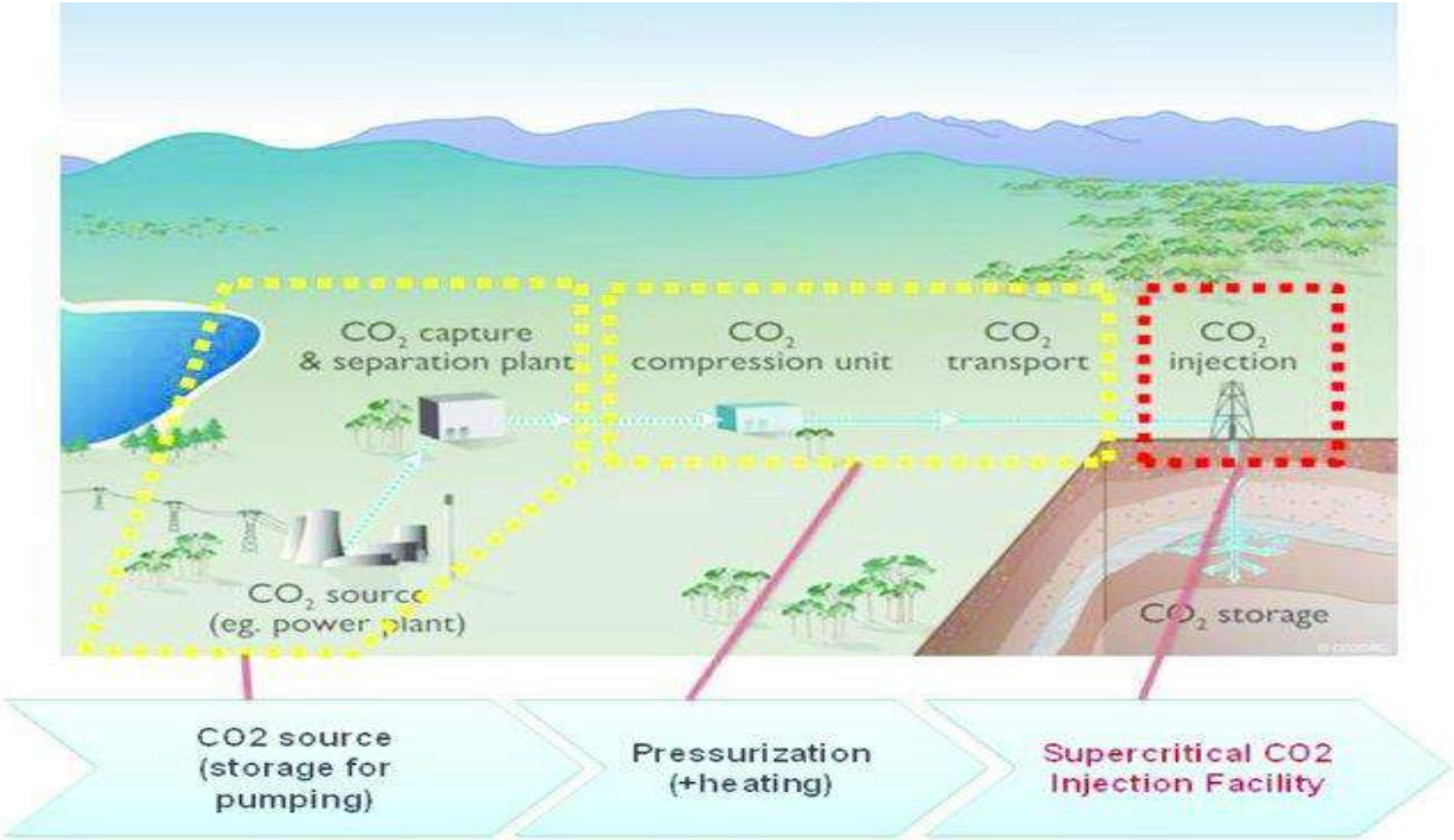
research inst.

TNO innovation for life, BGS British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL, NIST National Institute of Standards and Technology, NGI, SINTEF, Lawrence Livermore National Laboratory

associated

ECCSEL, Norges Rederiforbund Norwegian Shipowners' Association, Norsk olje&gass, U.S. DEPARTMENT OF ENERGY, UKCCS RESEARCH CENTRE, GASSNOVA, SCCS

CO_2 verdikjede

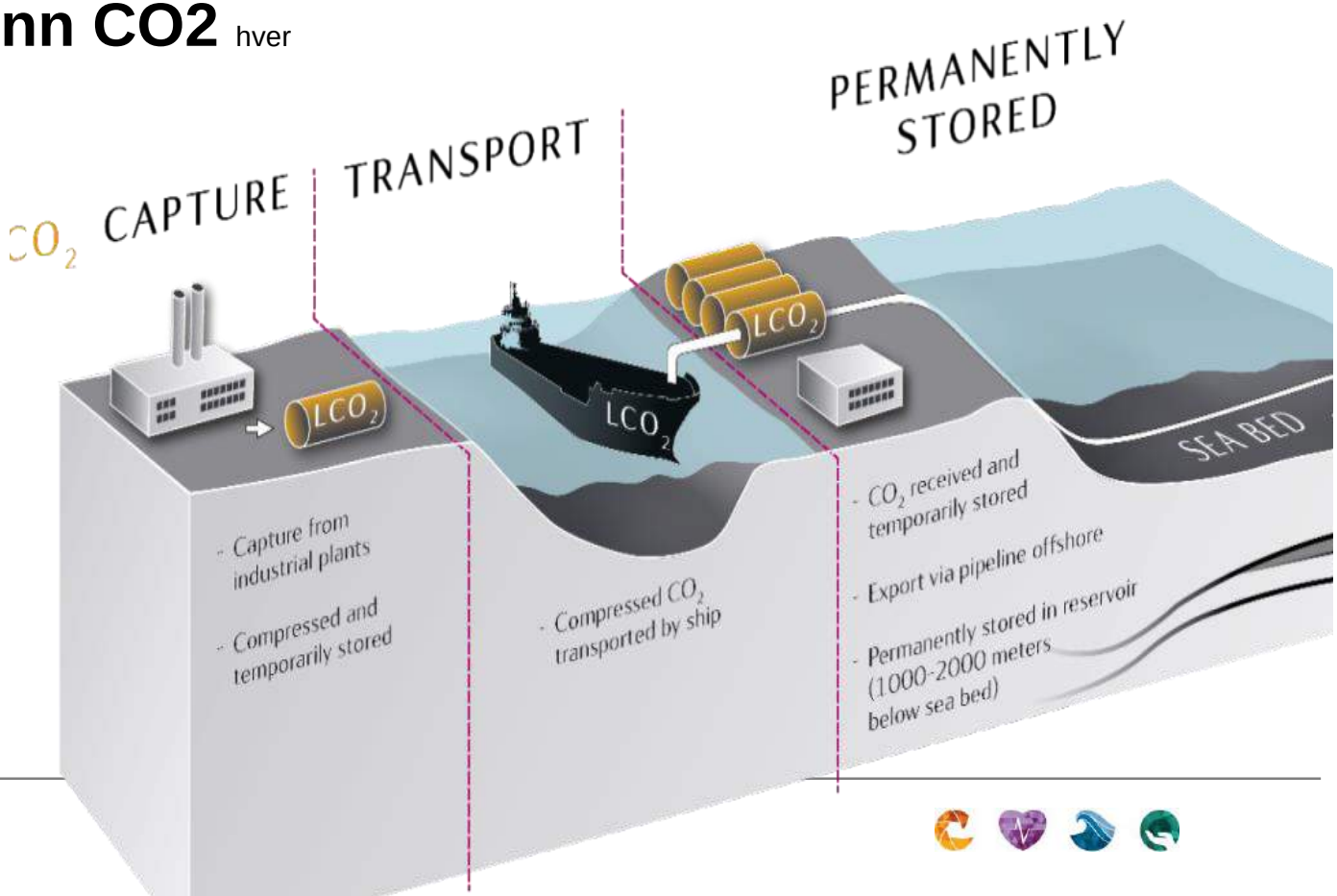


Fullskala: Karbon fangst og lagring

Det norske fullskalaprosjektet:

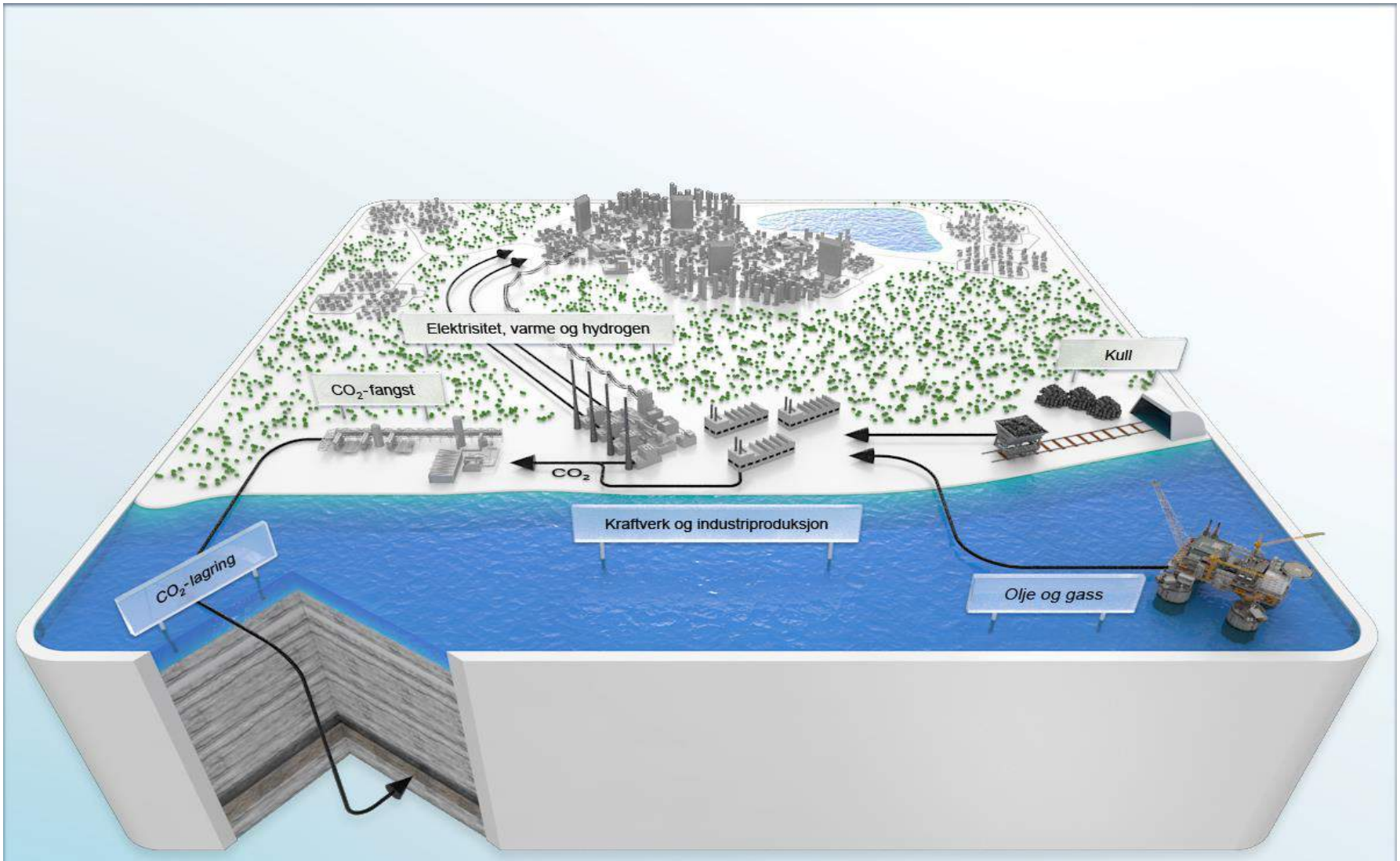
Norcem og Fortum Oslo Varme
planlegger å fange
ca.

400.000 tonn CO2 hver

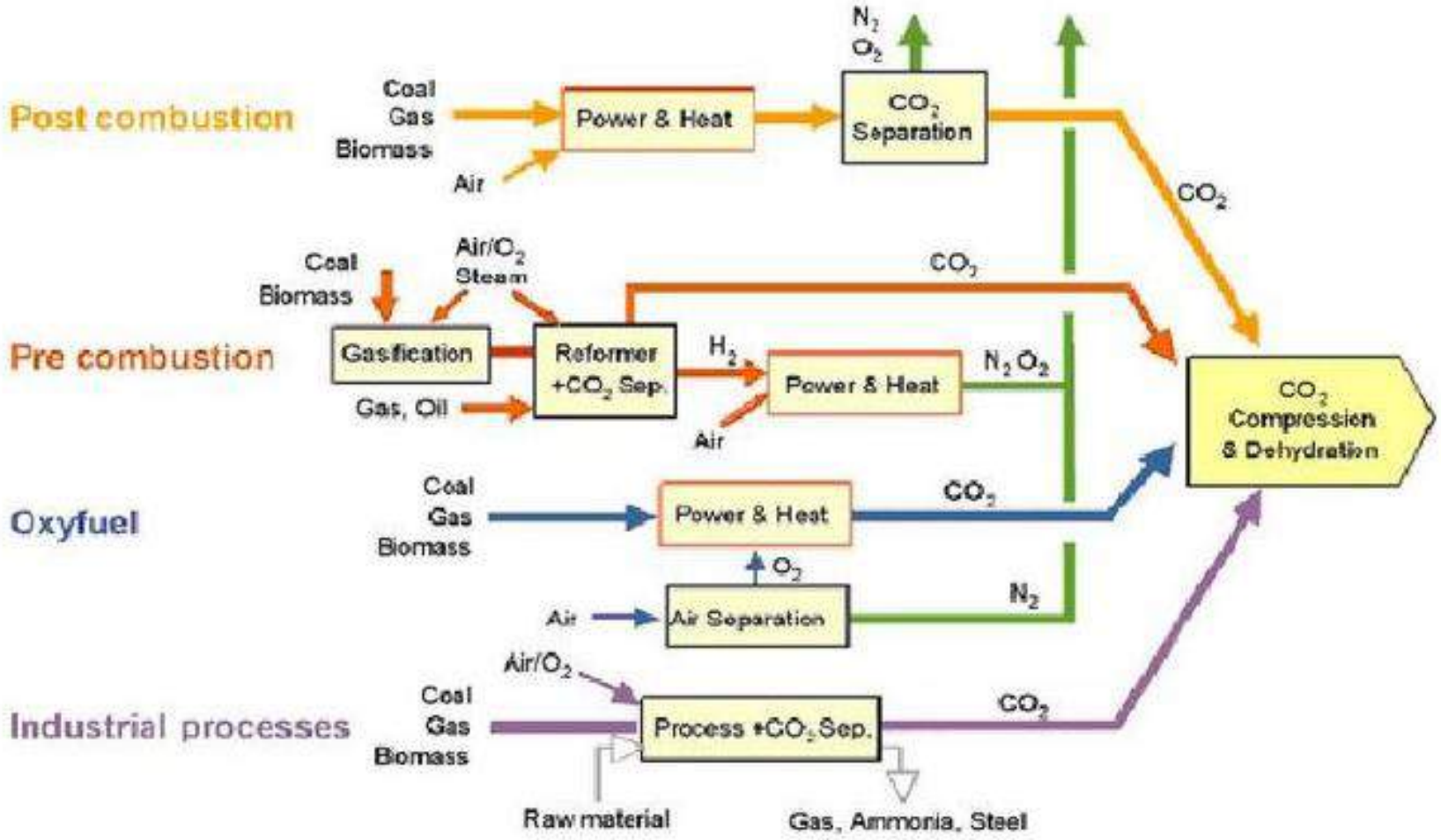


Muligheter: Karbon fangst og lagring

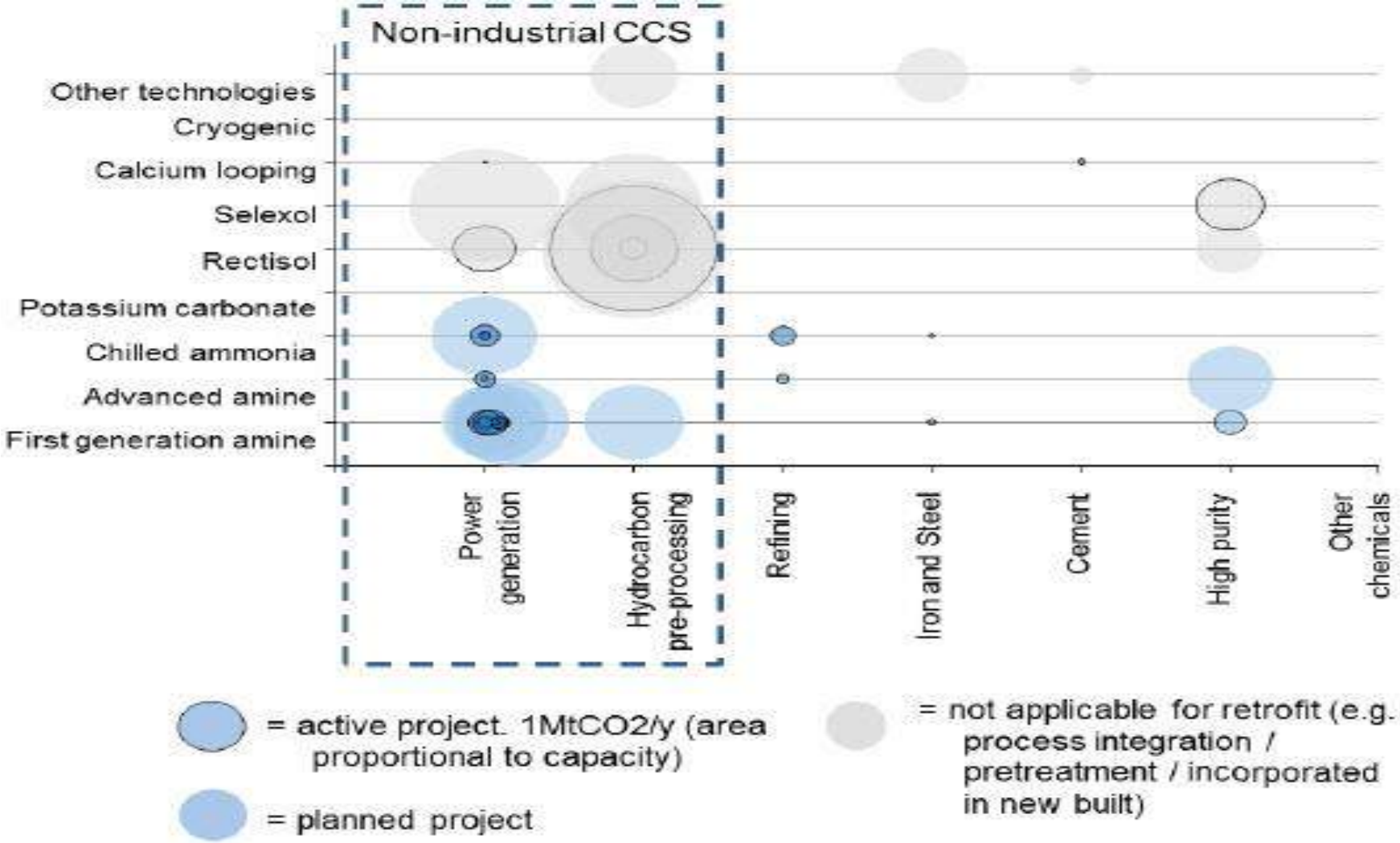
CCS er muliggjørende for fremtidig norsk utnyttelse av naturgass via hydrogen.



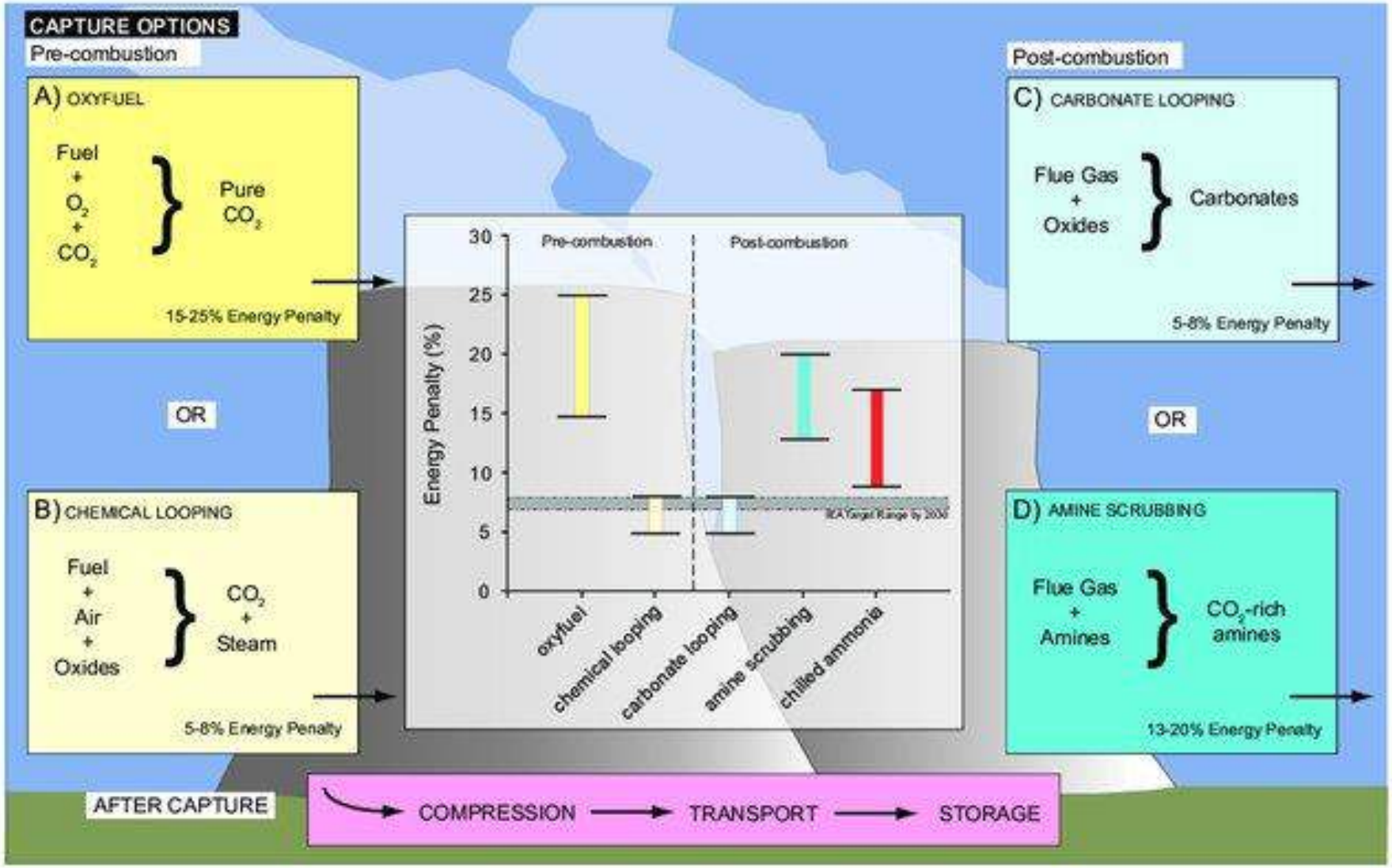
CO_2 fangst systemer

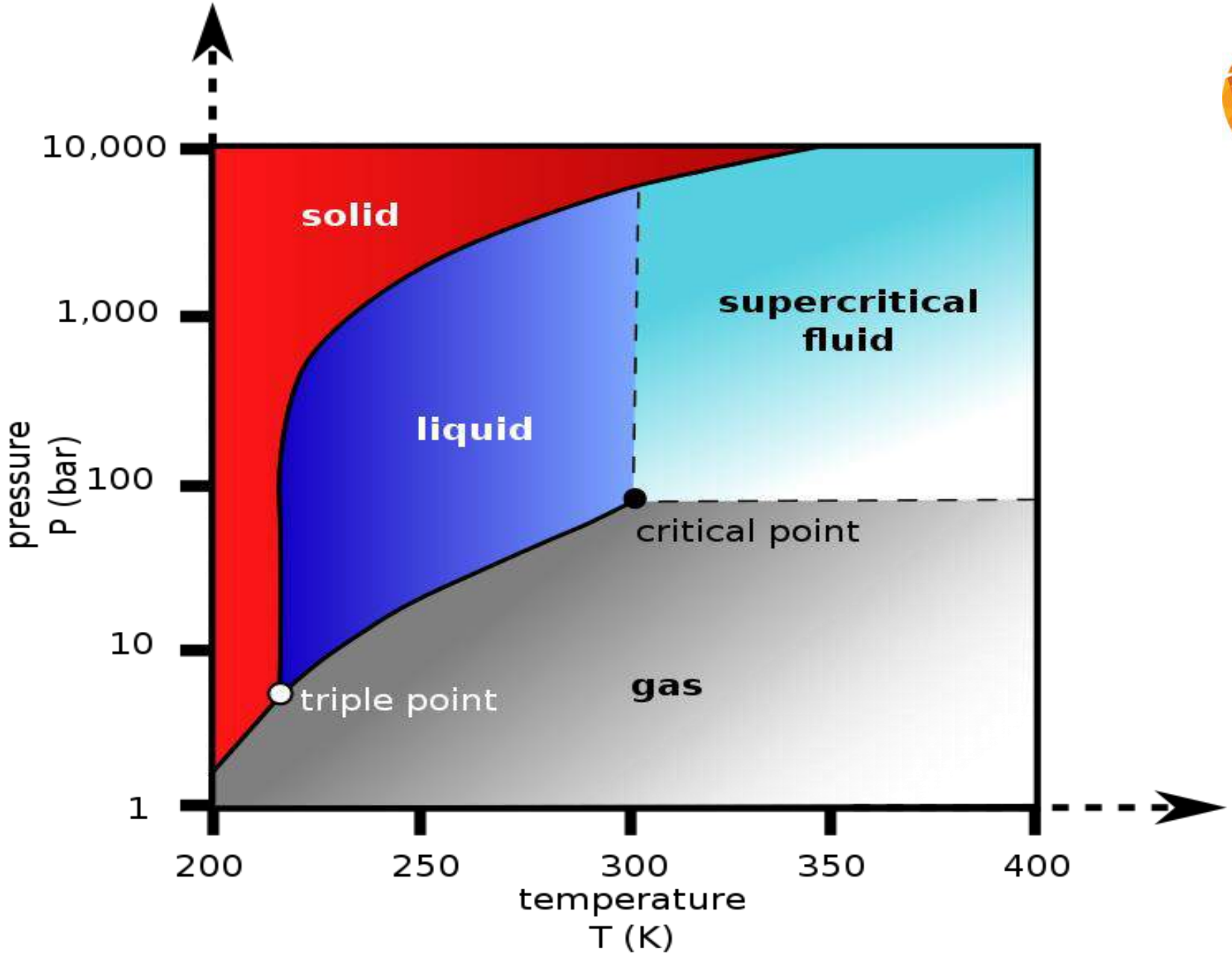


Fangstteknologier/prosesser



Energy penalty – Capture options



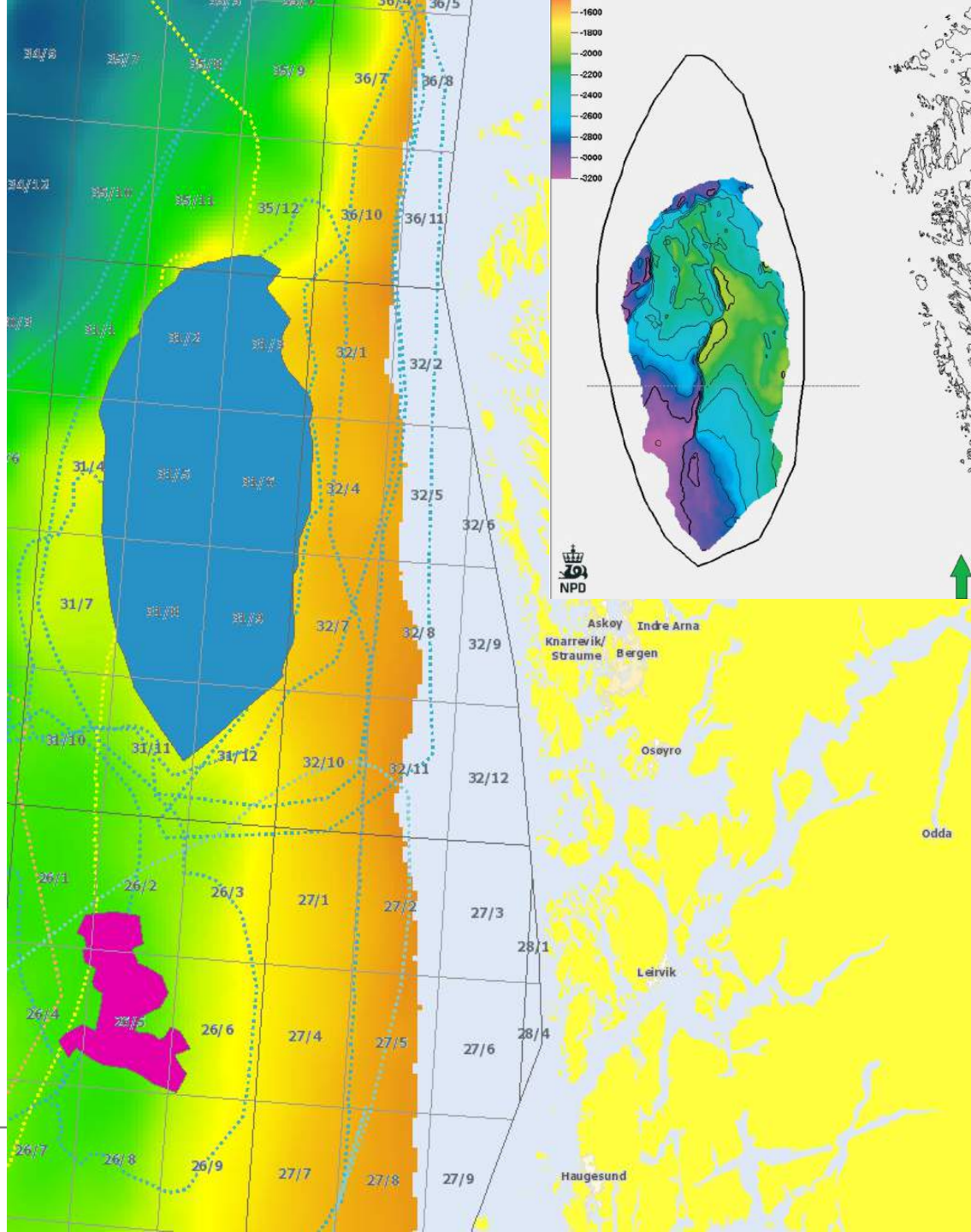

10,000
1,000
100
10
1
pressure
P (bar)
solid
liquid
supercritical
fluid
critical point
triple point
gas
200
250
300
350
400
temperature
T (K)

Transport

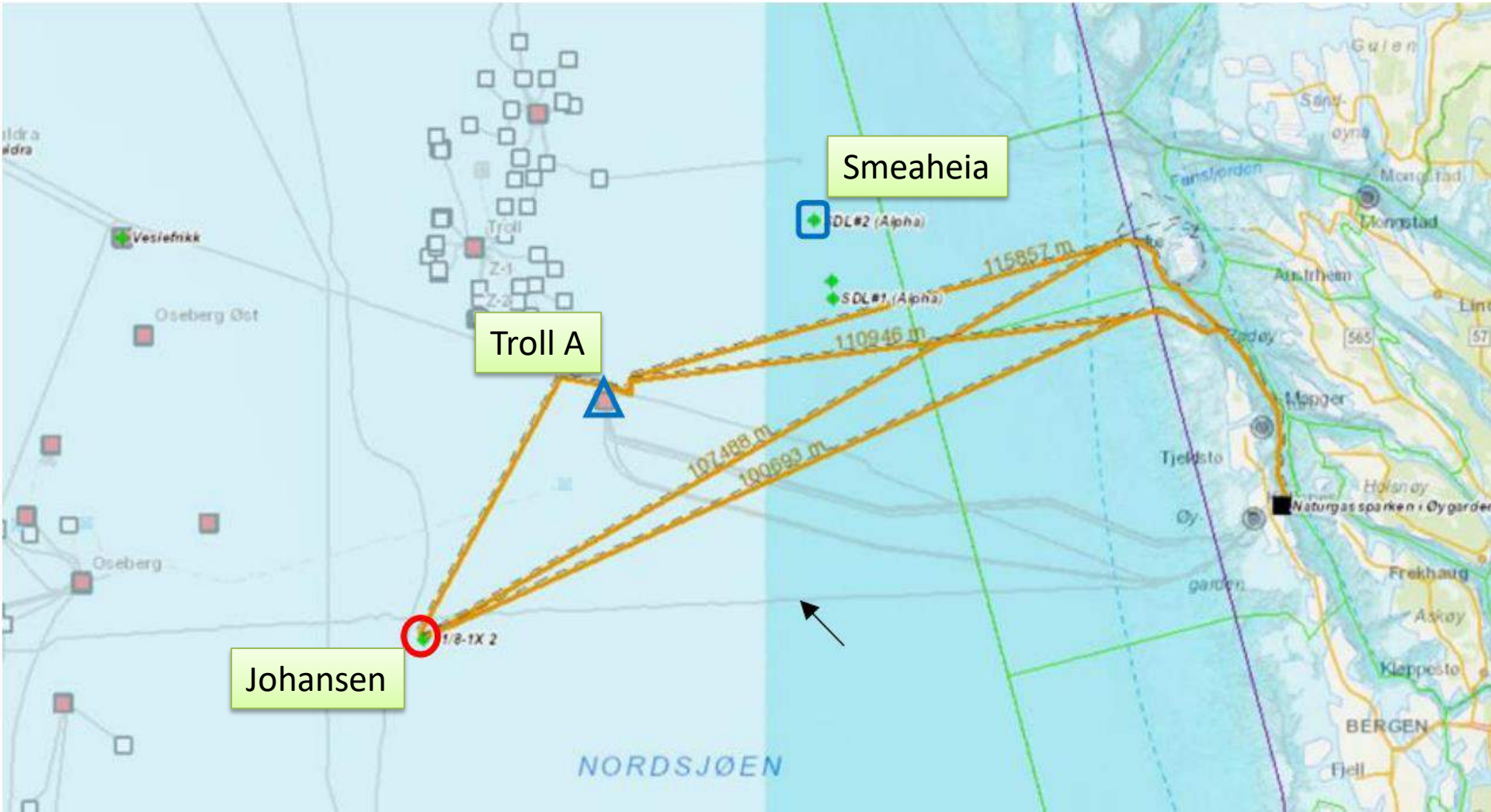
Lagring

Equinors Northern Lights prosjekt

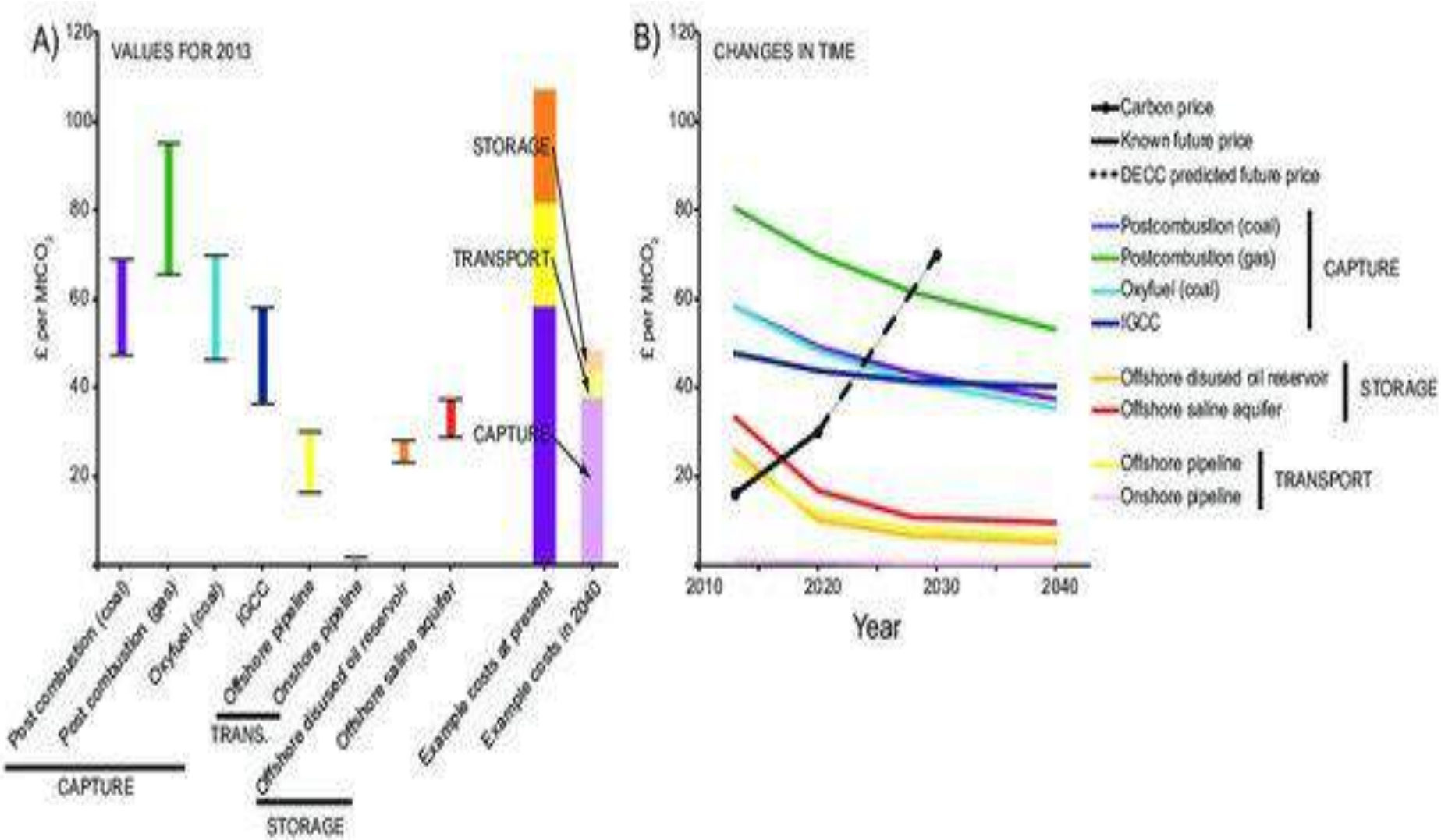
- Smeaheia utgår. Johansen er det nye stedet.
- Kan lagre 150 millioner tonn CO2
- Johansen-formasjonen er vist i blått, som omfatter Trollfeltet
- Utsnitt i lite bilde viser dybde
- Lys fiolett farge viser et dyp på 3.200 meter



Lagring – nytt forslag



Kostnader


A)
VALUES FOR 2013
£ per MtCO2
120
100
80
60
40
20
STORAGE
TRANSPORT
CAPTURE
Post combustion (coal)
Post combustion (gas)
Oxyfuel (coal)
IGCC
Offshore pipeline
Onshore pipeline
Offshore disused oil reservoir
Offshore saline aquifer
Example costs at present
Example costs in 2040
TRANS.
CAPTURE
STORAGE
B)
CHANGES IN TIME
£ per MtCO2
120
100
80
60
40
20
2010
2020
2030
2040
Year
Carbon price
Known future price
DECC predicted future price
Postcombustion (coal)
Postcombustion (gas)
Oxyfuel (coal)
IGCC
CAPTURE
Offshore disused oil reservoir
Offshore saline aquifer
STORAGE
Offshore pipeline
Onshore pipeline
TRANSPORT

Norske aktører

- Gassnova SF (2007-)
  - Climit er et program for forskning, utvikling og demonstrasjon av teknologi for CO2-håndtering i samarbeid med NFR.
  - Technology Center Mongstad (TCM DA) er verdens største testsenter for testing og forbedring av CO2-fangstteknologier
- NTNU, UiO ++
- SINTEF, IFE +
  - > NCCS
- Equinor, Total, Shell, Aker Solutions
- Gassco
- Norcem
- Fortum Varme
- (Yara)
- Forskningsrådet
- OED
- ++

……Myteknusing….?

- MYTH #1 - Europe has tried CCS, it failed. It will fail again.
- MYTH #2 - CCS is about saving the fossil fuels industry.
- MYTH #3 - CCS is not a climate mitigation technology.
- MYTH #4 - CCS is expensive and uncommercial.
- MYTH #5- CCS is unsafe and untested.
- MYTH #6 - There is not enough underground storage capacity.
- https://www.linkedin.com/pulse/demystifying-carbon-capture-storage-olav-aamlid-syversen/?published=t

Finansiering (til diskusjon under middagen?)

- CCS-avgift? (på toppen av CO_2-avgift)?
- Forretningsmodell forutsetter verdikjede
- Hvem skal betale investering?
- Hvordan tjene penger på fangst, transport og lagring av CO_2?