SUBPRO-Zero

SUstainable Bridge PROgram towards Zero emissions for the offshore industry

Official opening

27. November 2023

SUBPRO Symposium – Hotel Britannia

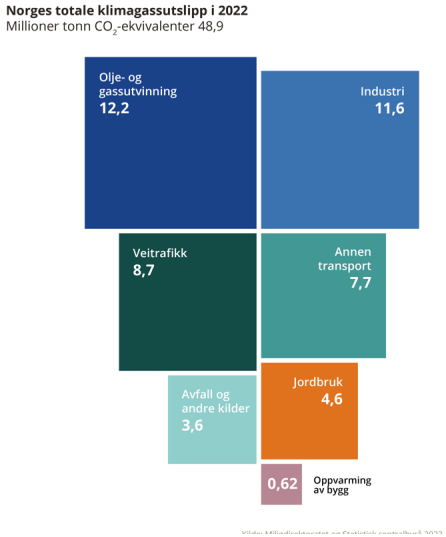
Norwegian University of Science and Technology

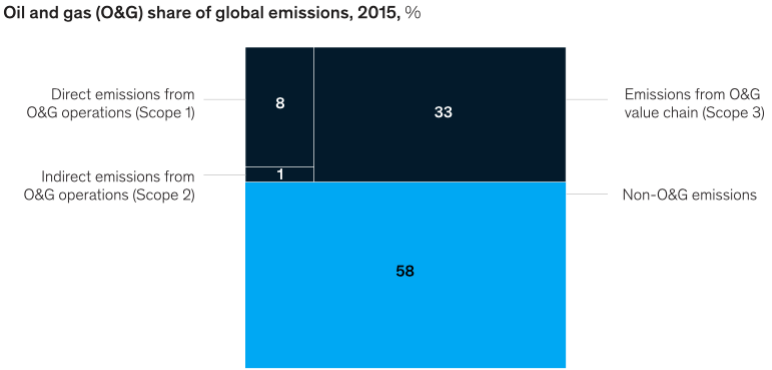
Motivation

- 11 000 tons CO2 equivalents emitted by O&G production in Norway (today during Symposium hours)
  - 11-12 Mton/year
  - Ca ¼ of all emissions in Norway today
  - Tight 2030 and 2050 emission targets

- We have a large potential for impact!
  - Secure energy for growing world population
  - Increase efficiency, Cut emissions,
  - Dispose of CO2

- We are needed to reach national and global climate goals!





https://www.norskpetroleum.no/en/environment-and-technology/emissions-to-air/#:~:text=In%202022%2C%20greenhouse%20gas%20emissions,Norway%27s%20aggregate%20greenhouse%20gas%20emissions.
https://www.mckinsey.com/industries/oil-and-gas/our-insights/the-future-is-now-how-oil-and-gas-companies-can-decarbonize

Starting point

1. SUBPRO team:
   – Successful collaboration between academia and industry
2. Strong academic and industrial network
3. SUBPRO results
4. Interest and need to contribute to low/zero emission offshore industry
5. Continue with the good work and expand to other areas

SUBPRO Zero (2023-2026)

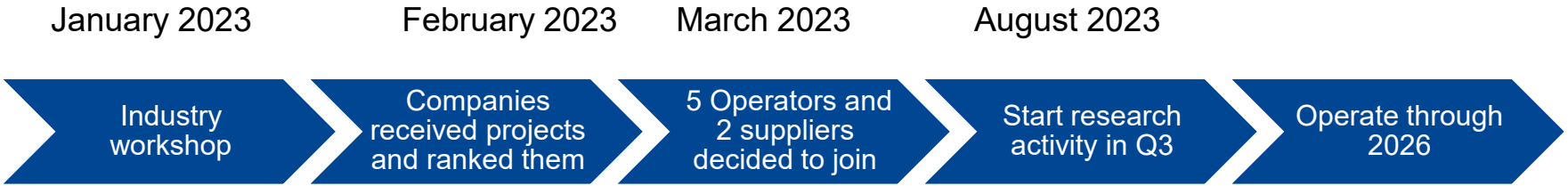
SUstainable Bridge PROgram towards Zero emissions for the offshore industry

- Establish a research center to conduct fundamental and applied research that contributes to net-zero emissions and a competitive offshore oil & gas industry.

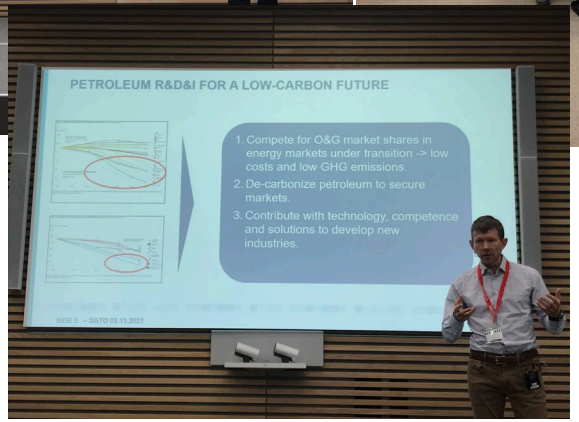
- Build on and extend the expertise built in the center SUBPRO SFI during the last 8 years

- Research is performed mainly in PhD or postdoc projects (tightly connected to industry)

SUBPRO Zero Timeline



Workshop on 2. Nov 2021 in Høvik (DNV)



Founding partners

- Operators
  - Equinor
  - AkerBP
  - Neptune Energy
  - Total Energies
  - Vår Energi
- Suppliers
  - Aker Solutions
  - Kongsberg Digital
- NTNU

Pressemelding

Oljeindustrien gir 47 millioner til NTNU for å forske på overgangen til null-utslipp offshore.

Forskningsrådet og oljeindustrien har i samarbeid finansiert et senter for forskningsdrevet innovasjon (SFI) ved NTNU innen subsea produksjon og prosessering (SUBPRO).

Senteret har operert i 8 år og har hatt et budsjett på 240 millioner kroner. Fire institutt ved NTNU har vært involvert, og 35 phd-kandidater, 11 postdoktorer og mer enn 90 masterstudenter har blitt utdannet fra senteret.

Prosjektet avsluttes i disse dager og resultater presenteres på et symposium i Trondheim den 27. november på Britannia Hotel.

Industripartnerne har vært så fornøyd med samarbeidet og resultatene i SUBPRO at de har bestemt seg for å gå videre med et 3-årig 100% industrifinansiert prosjekt (SUBPRO Zero) der målet er å forske på teknologi som vil bidra til null-utslipp fra olje og gassindustrien. Avslutningssymposiet for SUBPRO markerer også den offisielle oppstarten av SUBPRO Zero *(Sustainable bridge program towards Zero emissions).*

SUBPRO Zero fokuserer på følgende hovedområder: Karbonfangst og blå hydrogen (nullutslipp til luft), vannbehandling og injeksjon (nullutslipp til sjø), digitalisering, optimalisering og energieffektivitet, og feltarkitektur og pålitelighet, tilgjengelighet og sikkerhet. I tillegg til forskningen, skal SUBPRO-Zero-senteret utdanne 9 phd-kandidater, 3 postdoktorer og 20 masterstudenter som vil bidra til det grønne skiftet.

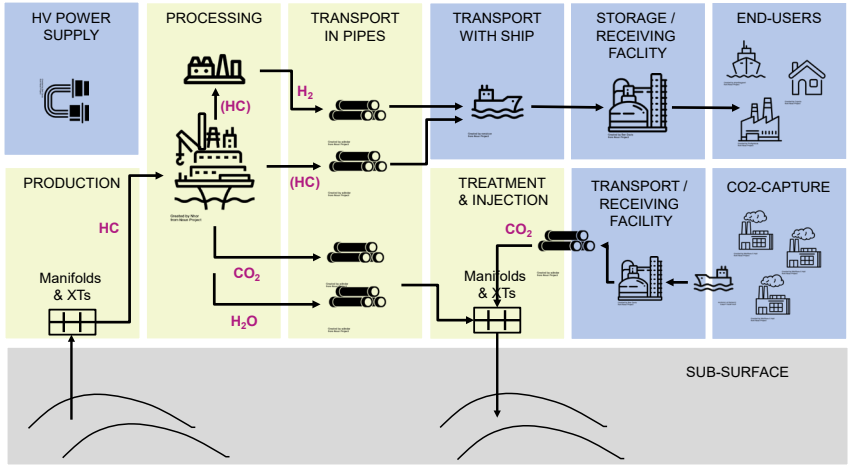
Senteret ledes av professor Johannes Jäschke ved Institutt for kjemisk prosessteknologi ved NTNU og partnere er Equinor, TotalEnergies, AkerBP, Neptune Energy, Vår Energy, Petrobras, Kongsberg Digital, Aker Solutions og Siemens.

SUBPRO-Zero: Research areas

Based on an industry survey and workshop, following research areas have been identified for SUBPRO-Zero:

1. Low Complexity Blue Hydrogen Production (e.g. for offshore applications), Gas Treatment and Carbon Capture (zero emission to air)
2. Water Treatment, including re-injection (zero emission to water)
3. Field Architecture, Optimization, and Energy Efficiency
4. Digitalization, Systems Control and RAMS (Reliability, Availability, Maintenance and Safety)

Value chain approach:
We focus on the activities shaded light:



Process to select projects

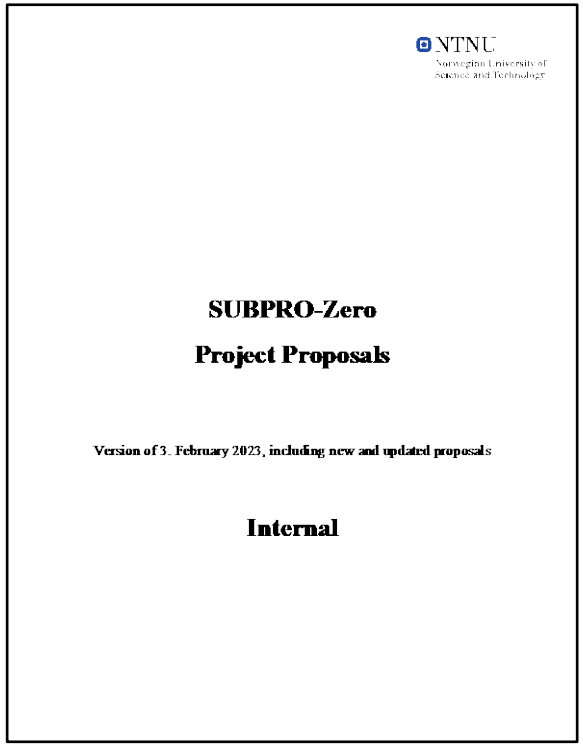
1. Supervisors proposed projects in collaboration with industry

2. Workshop with all partners to refine projects and research problems

3. Updated projects were sent to industry for ranking
   - All partners: high/medium/low priority
   - Operators can select 1 project as high priority (guaranteed)

4. Basis for decision on realized projects

Project selection



NTNU
Norwegian University of Science and Technology

SUBPRO-Zero

Project Proposals

Version of 3. February 2023, including new and updated proposals

Internal

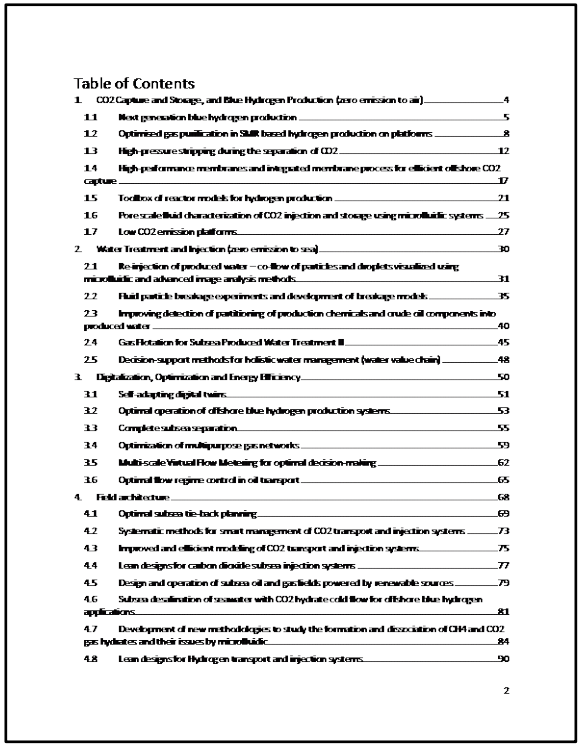


Table of Contents

SUBPRO Zero Projects

Based industry input, currently 10 PhD/postdoc are selected:

Low Complexity Blue Hydrogen Production (e.g. for offshore applications), Gas Treatment and Carbon Capture (zero emission to air)

- Low CO2 emission platforms (Hanna Knuutila)

Water Treatment, including re-injection (zero emission to water)

- Gas Flotation for Subsea Produced Water Treatment (Gisle Øye)
- Decision-support methods for holistic water management - water value chain (Milan Stanko)

SUBPRO Zero Projects

Based industry input, currently 10 PhD/postdoc are selected:

Field Architecture, Optimization, and Energy Efficiency

- Lean designs for carbon dioxide subsea injection systems (Milan Stanko)
- Design and operation of subsea oil and gas fields powered by renewable sources (Milan Stanko)

Digitalization, Systems Control and RAMS

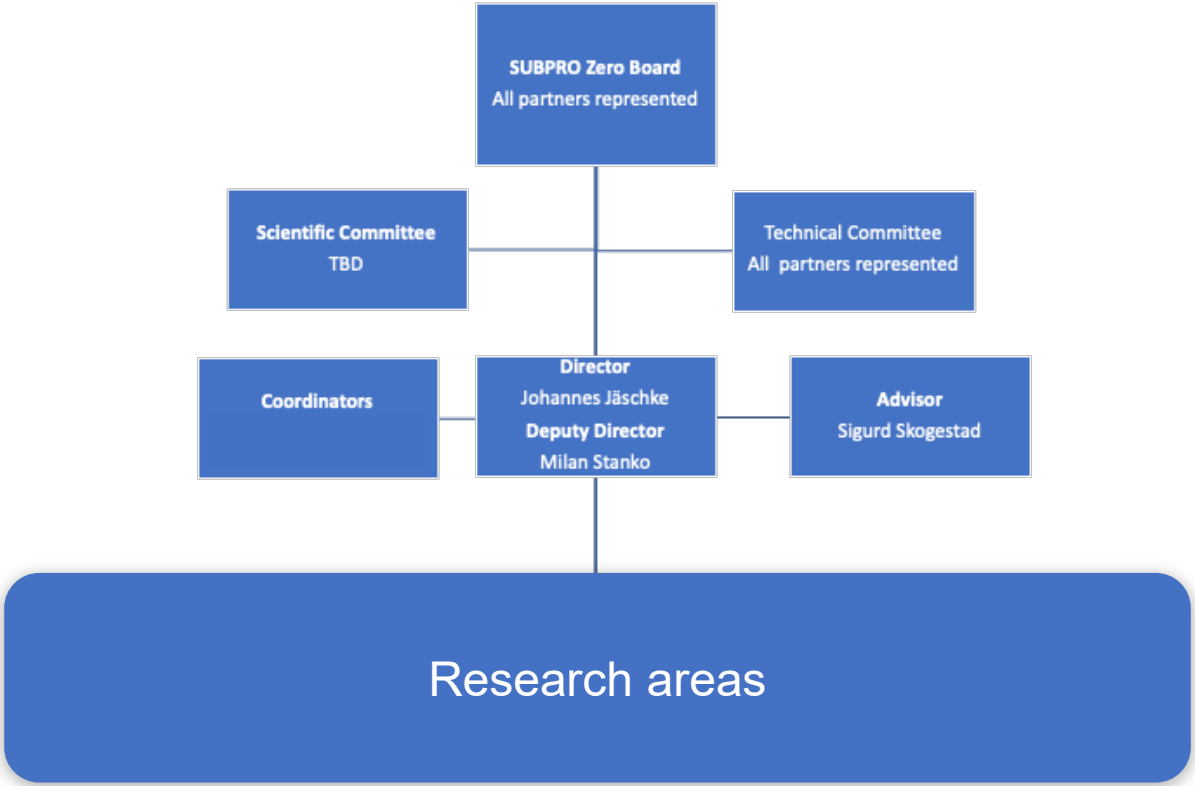
- Complete subsea separation (Christian Holden)
- Multi-scale Virtual Flow Metering for optimal decision-making (Johannes Jäschke)
- Systematic methods for smart management of CO2 transport and injection systems (Johannes Jäschke)
- Optimal flow regime control in oil transport (Idelfonso Nogueira)
- Incorporating artificial intelligence (AI) in Safety-critical systems for CO2 capture, injection, and storage (Shen Yi, Mary Ann Lundteigen)

Status November 2023

- More companies to join!
  - Petrobras
  - Siemens
    - Process to select additional PhD/PD projects

- 3 PhDs and 2 PDs have started
- 4 PhD, 1PD to start in December or Q1 2024
- Second steering committee meeting Nov. 28th

SUBPRO-Zero Organization



Plan forward - 2024

Reference group meetings (feedback from partners)

February

September

NTNU + Industry Workshop

February

Sounds interesting?

Procedure to join SUBPRO Zero

- New participations procedure
  - Center board makes decision of inclusion of new participants
  - New participant signs accession document (Appendix in Contract)

Words from Trine Boyer (Vår Energi), Chair of SUBPRO-Zero board

Words from the Dean of Natural Science faculty at NTNU, Øyvind Gregersen

Words from the the SUBPRO SFI director Sigurd Skogestad

Zoom-out: The big picture

Subsea production and processing

Bridge program towards Zero emissions

Designing and Accelerating the energy transition for the offshore O&G sector

SUBPRO SFI

SUBPRO -Zero

PRO Energy FME

- 2015-2023
- Industry and public funding
- 40+ PhD/PD
- 100+ MSc

- 2023-2026
- Industry funding
- 10 PhD/PD
- 15-20 MSc

- 2025-2033
- Industry and public funding
- 60+ PhD/PD
- 120+ MSc

Research landscape

- Typically, energy research falls into one of 2 categories

Pragmatic today:

Fossil based
+ Energy efficiency +
CCS

PRO Energy
Holistically and proactively designing the energy transition offshore

- Design: What decisions balance the short-term goal of efficiency and emission reduction and long-term energy transition goals
- What role do operation, control and maintenance decisions play in this context?
- Focus on the offshore process industry

The Future:

Fossil free
Renewable energy systems
Solar, Wind, green H2, green ammonia, etc

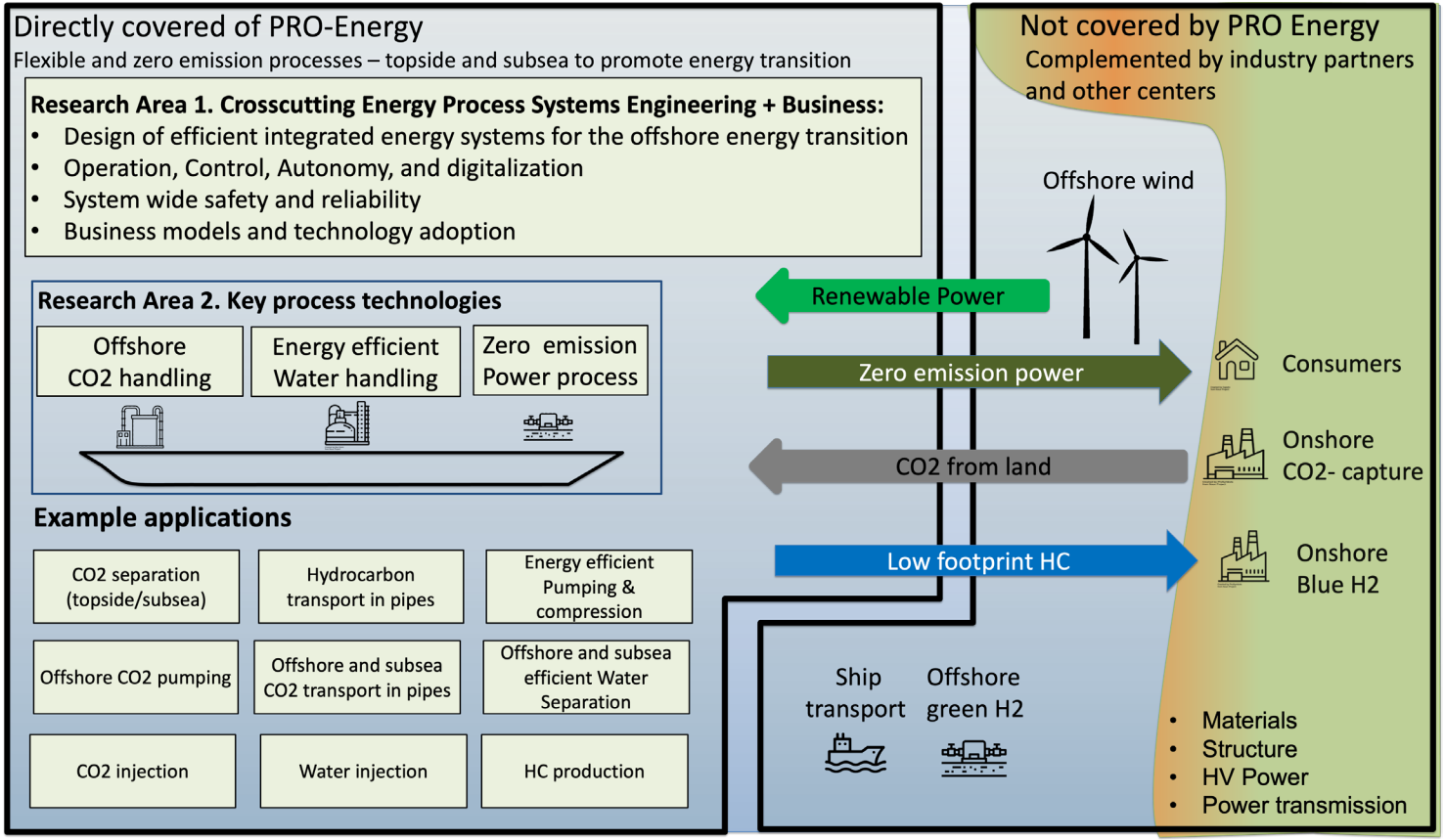
FME PRO Energy

Transform the offshore O&G industry into the solution!

The objective of PRO-Energy FME is to establish a leading international research centre for accelerating the energy transition of the offshore oil and gas sector, such that Norway can reach its climate and energy ambitions for 2030 and 2050 and beyond.



Center concept

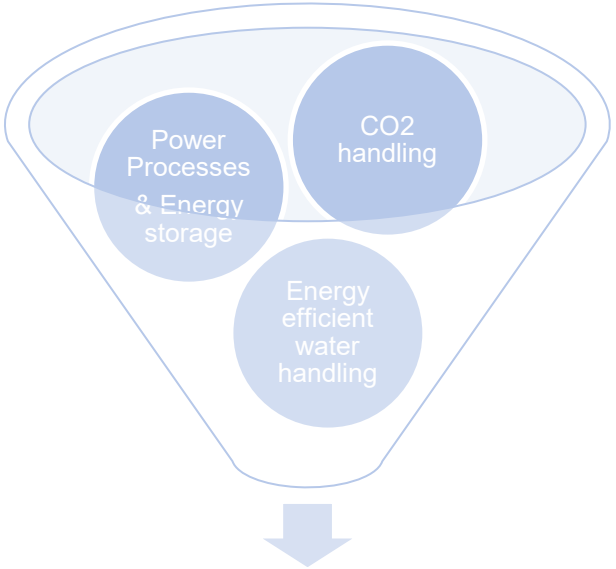


Unique features of PRO Energy FME initiative

- Education for the energy transition, results openly available
  - ca 60 PhD/PD candidates
  - 160 Masters

- Focus on
  - Designing the offshore energy transition
  - The role of processes
    - environment and renewables integration
    - Power (efficiency and no emissions)
    - CO2 handling
    - Water handling

- Focus on research that makes O&G industry part of the solution!



Tailored solutions for designing the energy transition offshore

Application submitted 15.11.2023 → April 2024 Outcome published by RCN → Hopefully: center start January 2025

Back to the present!

SUBPRO SFI	SUBPRO -Zero	PRO Energy FME
Subsea production and processing	Bridge program towards Zero emissions	Designing and Accelerating the energy transition for the offshore O&G sector
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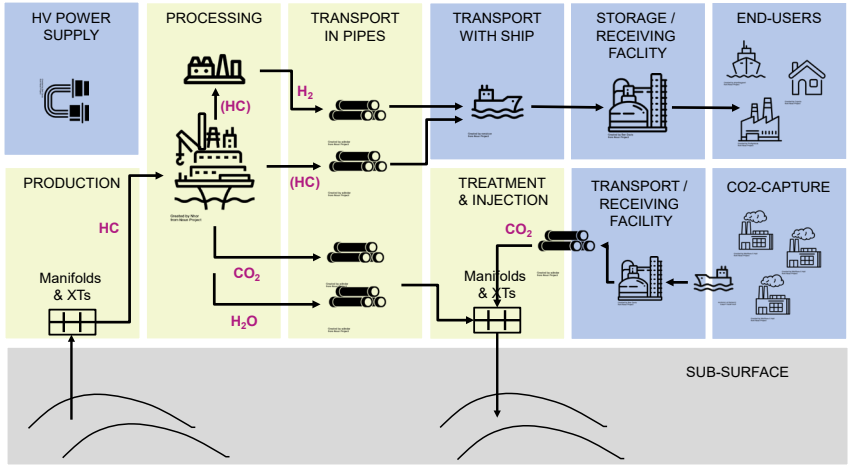

Hello from some of our PhDs/PDs!

Thank you to our SUBPRO Zero partners

We are looking forward to collaboration in this important field!

- Operators
  - Equinor
  - AkerBP
  - Neptune Energy
  - Total Energies
  - Vår Energi
  - Petrobras
- Suppliers
  - Aker Solutions
  - Kongsberg Digital
  - Siemens Digital
- NTNU

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