

# Havbunnsmineraler – Integrert Verdikjede

- Hva vi vet / ikke vet – Hva skal til for å lykkes?

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Jon Oddvar Hellevang . . . . . R&D MANAGER

# GCE Ocean Technology

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### R&D



### Development Contributors



### Higher Education Institutions



## MEMBERS



## Supported by



## Cluster Relations



## National Relations



## International Relations



Marine Minerals



© The metals company

Offshore Renewable Energy



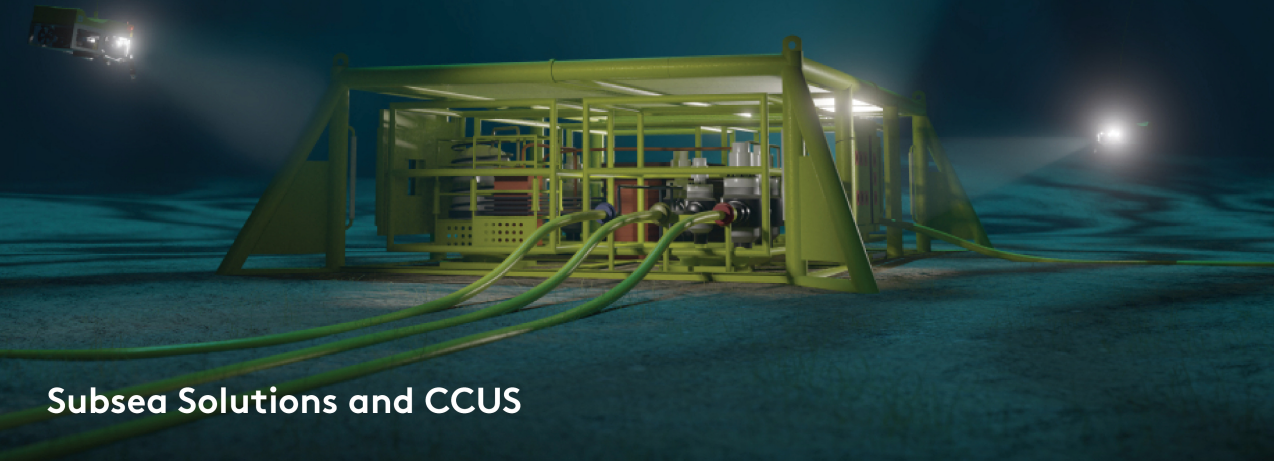
Sharing and Circular Economy

© CCB Subsea



Autonomy

© Eelume



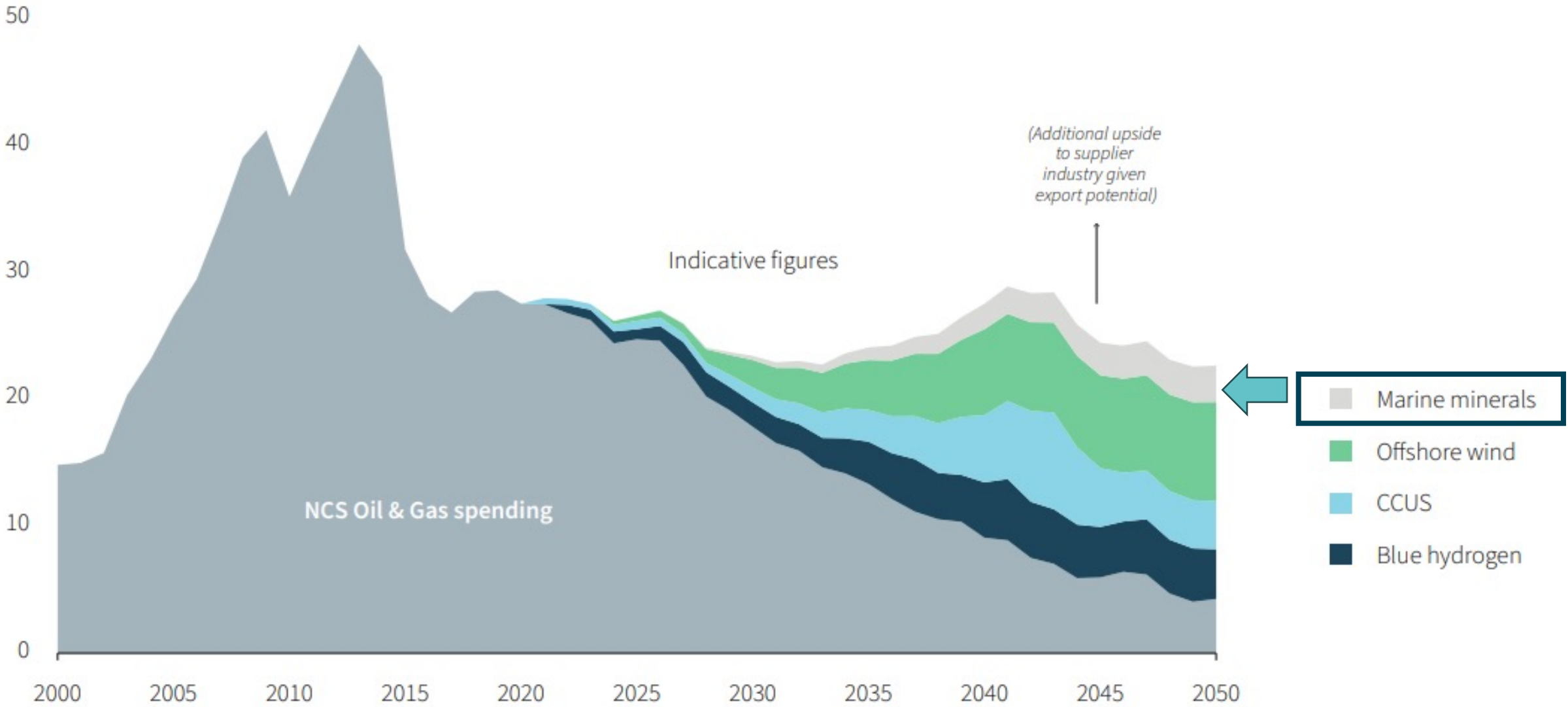
Subsea Solutions and CCUS



Hydrogen

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**Figure 60. Estimates on potential investments (billion USD) in new industries as compared to the expected investment level\* on the NCS (Rystad Energy, 2021)**



\*Includes both capital and operational expenditures, in addition to historical exploration costs and assumed future exploration costs  
 Source: Rystad Energy research and analysis; Rystad Energy UCube



*«Nest etter Fiji, er Norge det landet i verden med flest mineralrike områder innenfor egen økonomisk sone»*

*«Elbilen som tar oss fra A til B vil ha seks ganger det mineralbehovet som en tradisjonell bensinbil har»*

*«Behovet for syv av de mest kritiske mineralene kan reduseres med hele 58 prosent frem til 2050»*

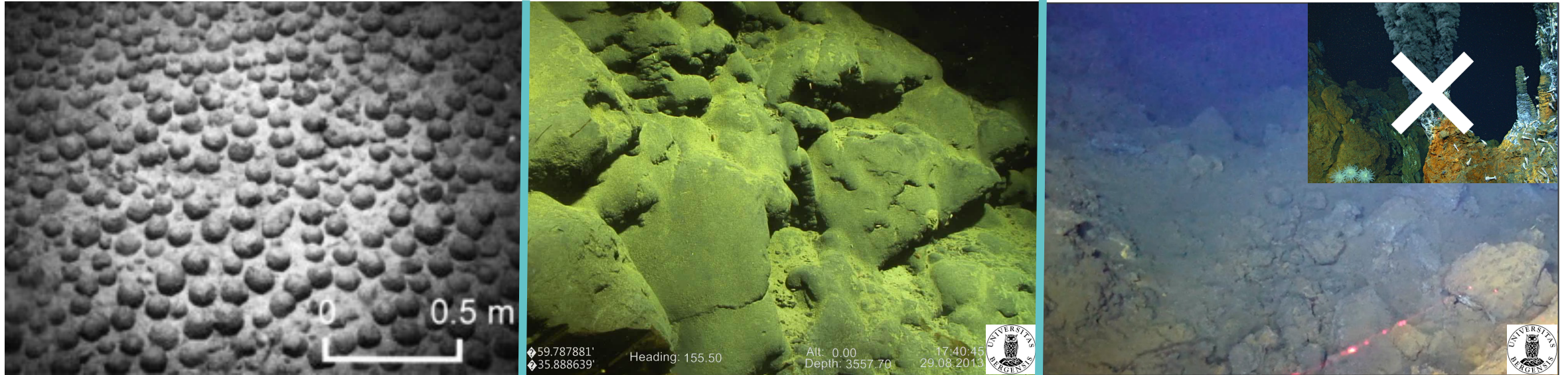
*«Åpner for ødeleggende gruvedrift på et område med størrelse med Tyskland»*

*«90% av artene i havet er ukjente»*

*«Umoden teknologi»*

*«Ulønnsomt»*

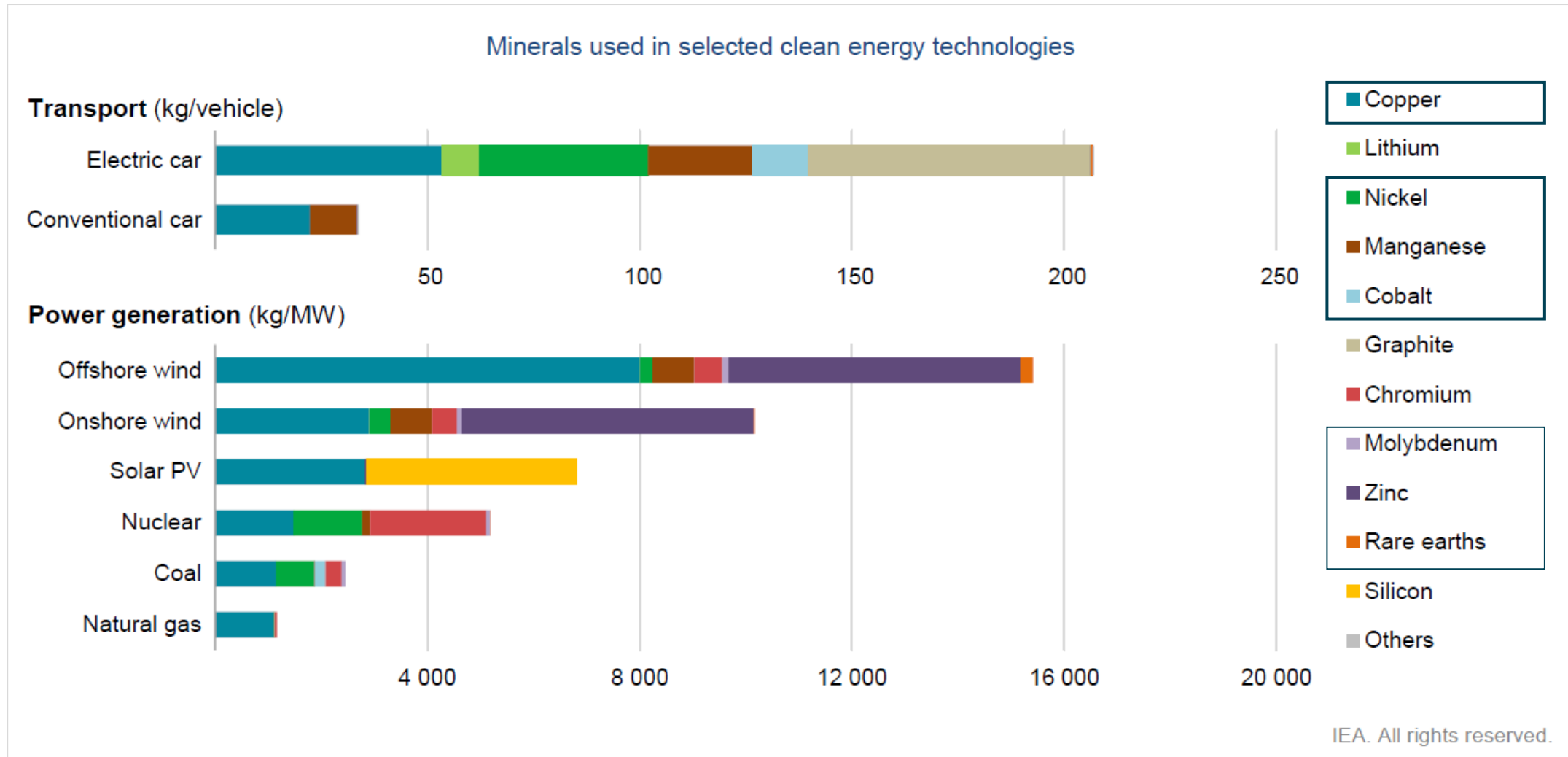
# Norge – Nest mest havbunnsmineraler i verden?



Polymetallic Nodules	Cobalt-rich Crust	Seabed Massive Sulfide (SMS)
2D deposit ~5-25 kg/m <sup>2</sup>	2D deposit ~5-30cm thick	3D deposit < 1km <sup>2</sup>
Ni, Co, Cu, Mn, Mo, Fe +	Co, Ni, Cu, Mo, Mn, REE +	Cu, Zn, Co, Au, Ag +
Not found on NCS	<b>Found on the Norwegian Continental Shelf (NCS)</b>	
<ul style="list-style-type: none"> <li>Similar, yet different environmental challenges and impact</li> <li>Similar, yet different technology and methodology for exploration, production and processing</li> </ul>		

(X) Norge vil ikke tillate utvinning av aktive hydrotermale strukturer (Stortingsmeldingen)

# Elbilen – 6 ganger så mye mineralbehov som bensinbil?

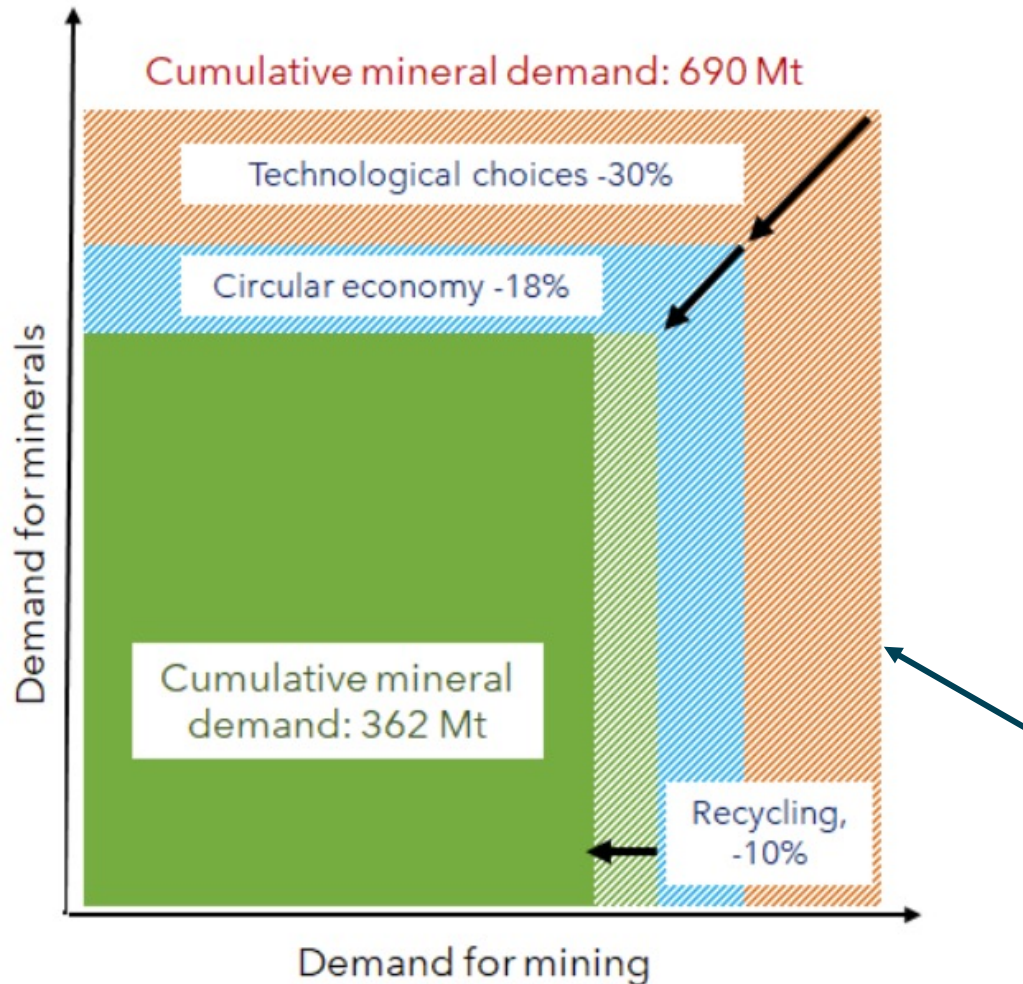


Note: Steel and aluminium not included

IEA 2021

Seabed metals of highest economical interest

# Behov for gruvedrift kan reduseres med 58% til 2050?



*“The coming decades will rely on the primary extraction of minerals for the transition to a net-zero energy system”*

Note: The outer box is IEA Net Zero scenario, forecasting 6X higher minerals demand in 2050 vs. 2020.

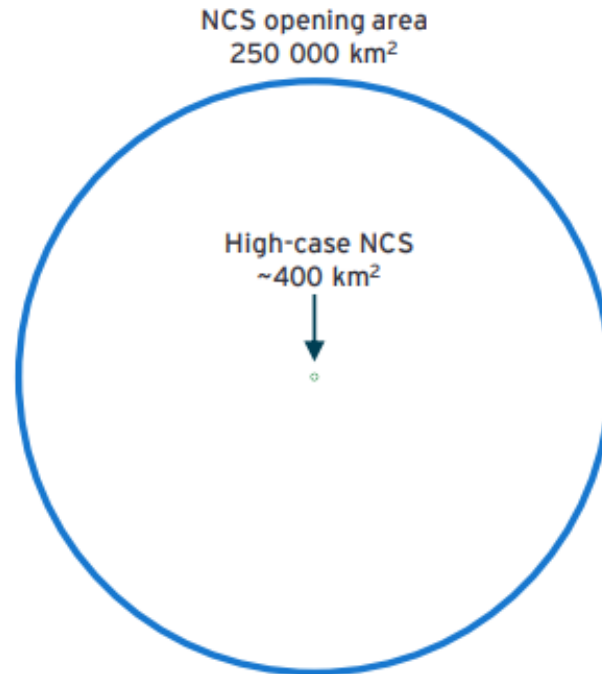




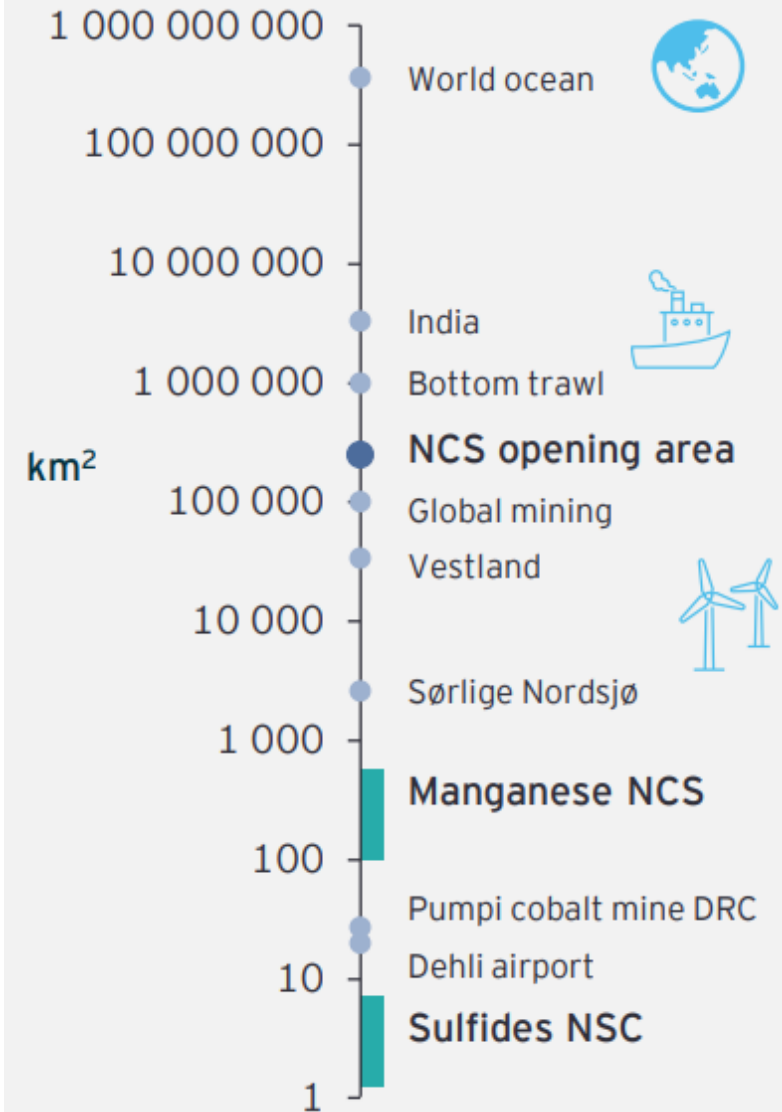
# Areal = Tyskland?

Exploration area >> possible mining area

*“The area that will potentially be mined on the NCS is a fraction of the exploration area”*



The amount of ocean floor that will be affected by the mining will be much smaller than the opening area



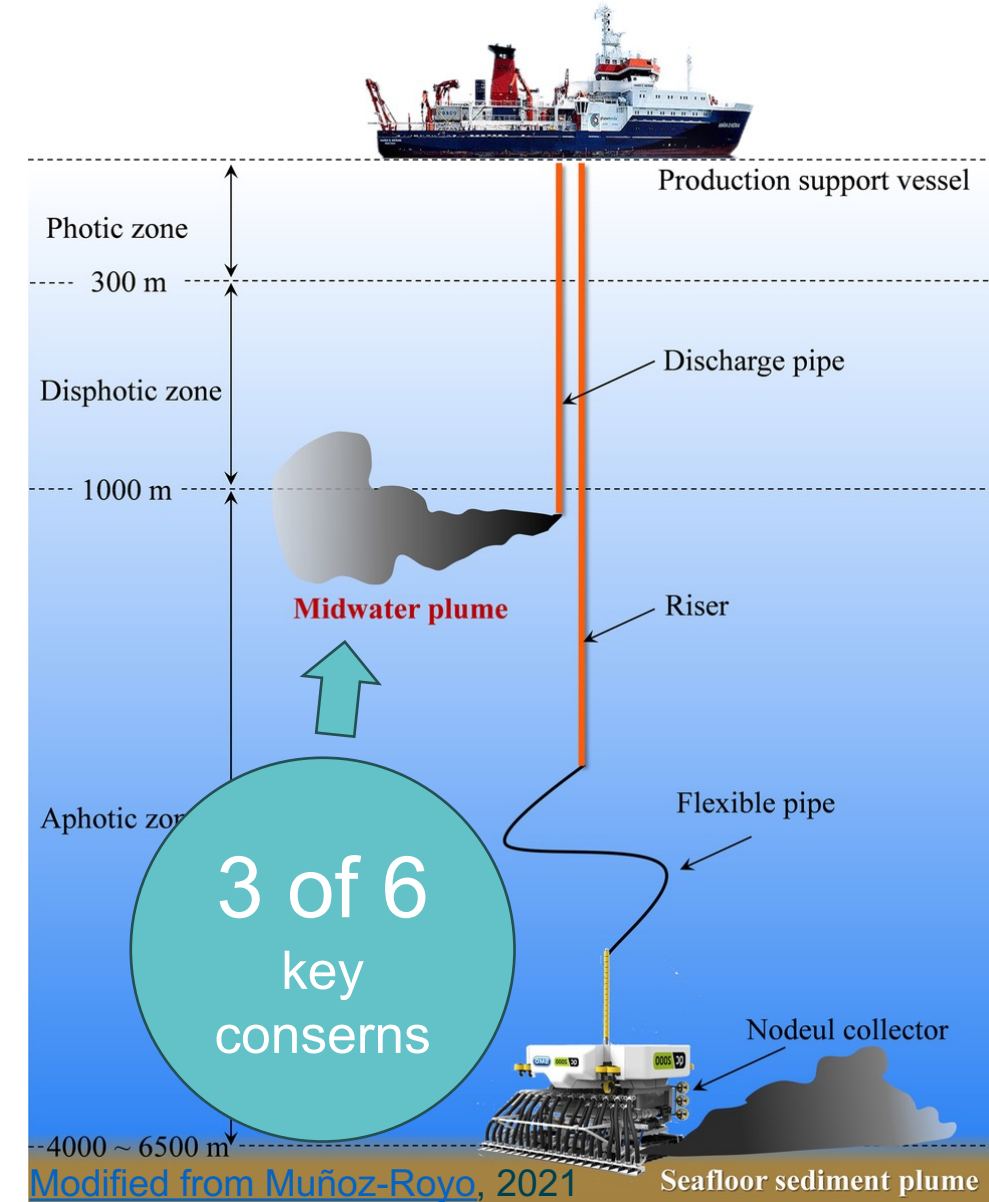
# Ny teknologi → redusere miljøpåvirkning



Example: Closed-loop production system will eliminate 3 of 6 of the main concerns

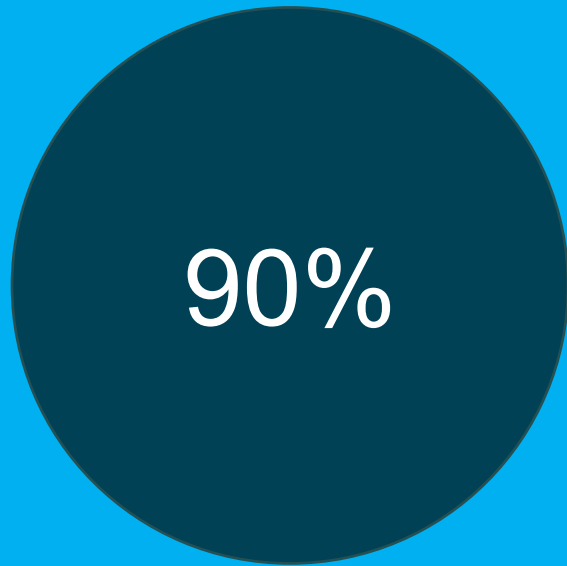
## Key concern - Deep-Sea Mining Science Statement (\*)

- the direct loss of unique and ecologically important species and populations as a result of the degradation, destruction or elimination of seafloor habitat, many before they have been discovered and understood;
- the production of large, **persistent sediment plumes** that would **affect seafloor and midwater species and ecosystems well beyond the actual mining sites**;
- the interruption of important ecological processes **connecting midwater and benthic ecosystems**;
- the **resuspension and release of sediment**, metals and toxins **into the water column**, both from mining the seafloor and **the discharge of mining wastewater from ships**, detrimental to marine life including the potential for contamination of commercially important species of food fish such as tunas;
- noise pollution arising from industrial machine activity on the ocean floor and the transport of ore slurries in pipes to the sea surface, that could cause physiological and behavioral stress to marine mammals and other marine species;
- uncertain impacts on carbon sequestration dynamics and deep-ocean carbon storage.



(\*) <https://seabedminingsciencstatement.org/>

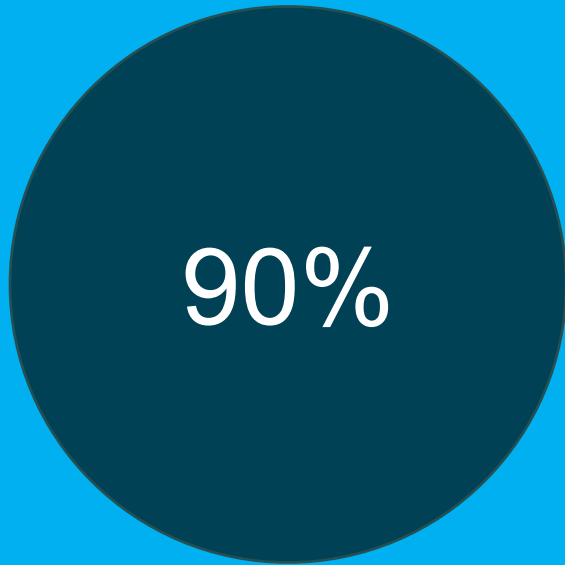
**90% av artene i havet er ukjente?**



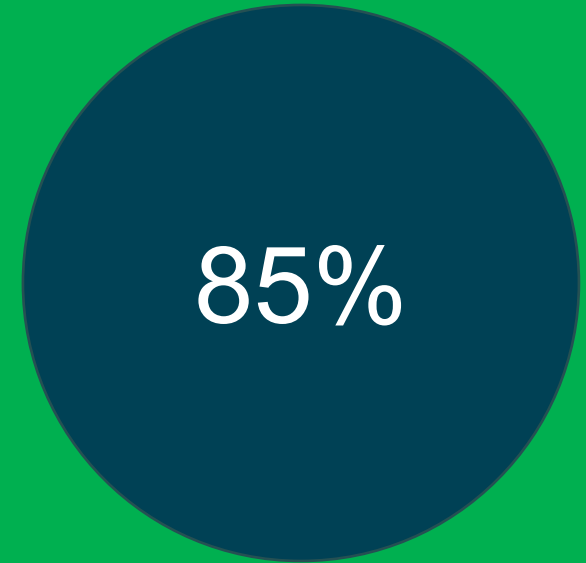
*Sources: National Geographics, NCBI, Eurekalert*

# Ukjente arter

Havet



Land



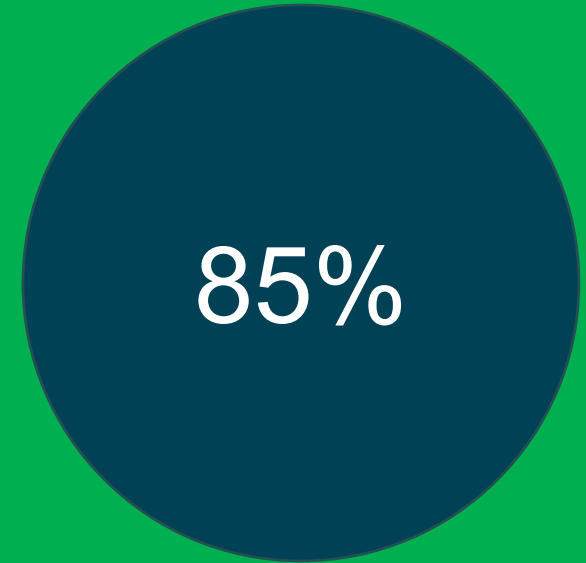
## Ukjente arter

Havet



~2 million

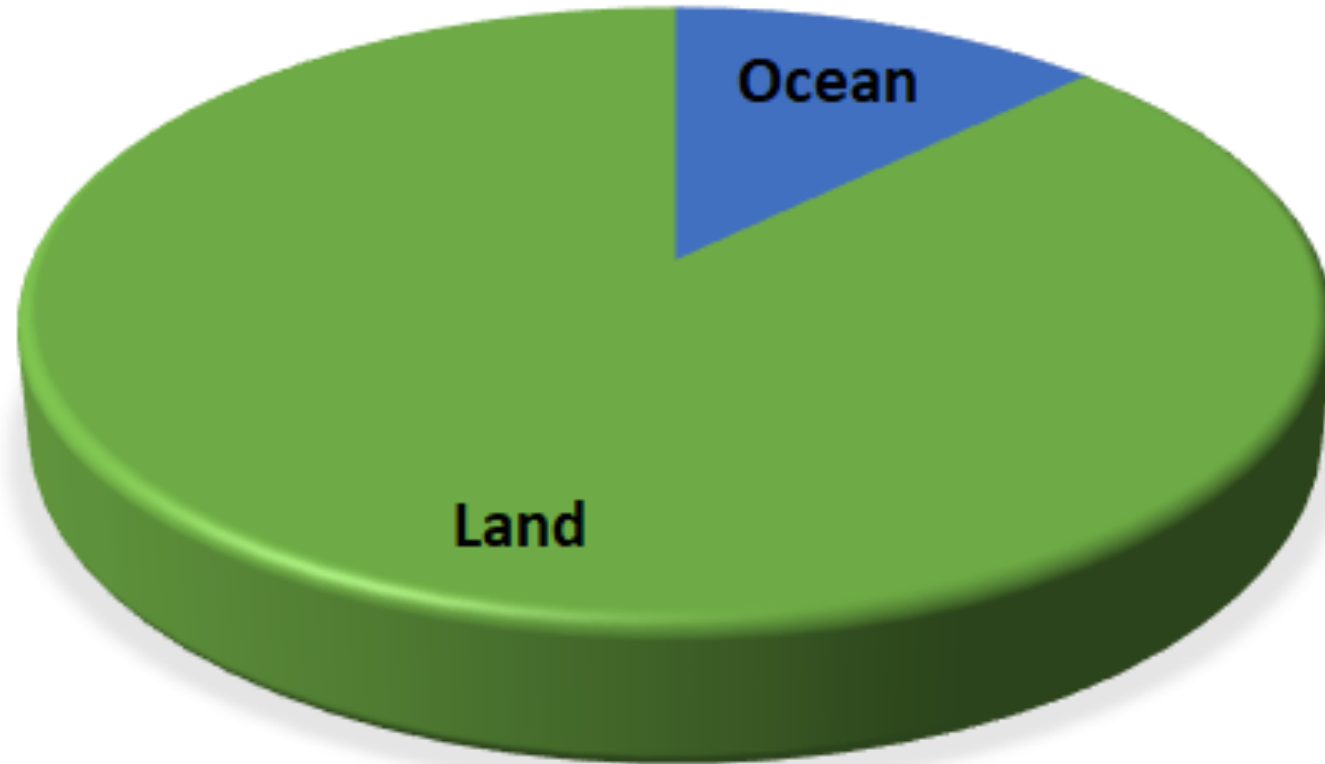
Land



~5.5 million



## Ukjente arter per areal



**~7X så sannsynlig å finne en ukjent art på et gitt areal på land som i havet**

# Umoden teknologi ?

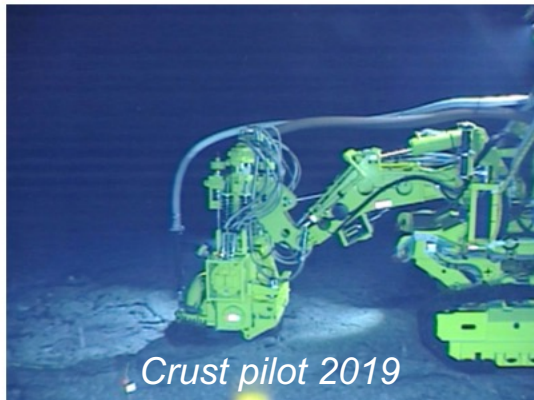


*SMS pilot 2017*

*D/V Chikyu, a Japanese scientific drilling ship used in deep-sea exploration for minerals, departing Shimizu port in August, 2022. Image courtesy of JAMSTEC.*

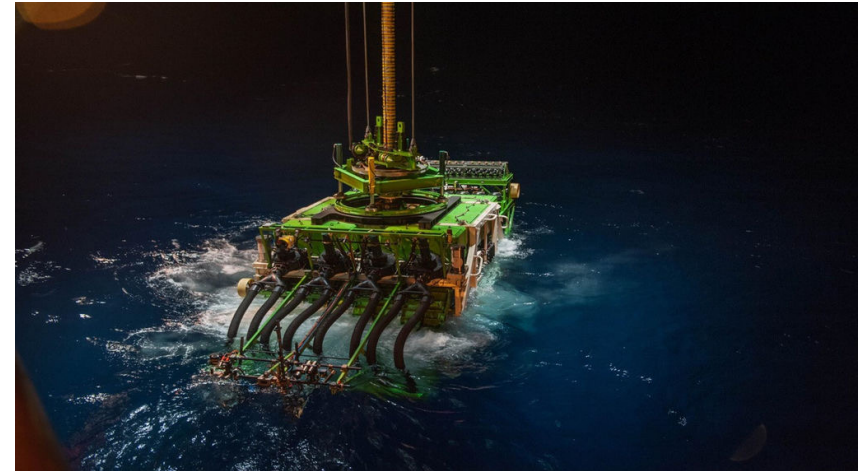
## Polymetallic sulfides at hydrothermal vents

In January and late summer 2017, JOGMEC performed the world's first test excavations of polymetallic sulfides containing zinc, lead, copper, gold and silver from an inactive hydrothermal vent roughly 1,600 meters (5,249 feet) deep in the Okinawa Trough, southwest of Japan's main islands.



*Crust pilot 2019*

**JOGMEC Conducts World's First Successful Excavation of Cobalt-Rich Seabed in the Deep Ocean; Excavation Test Seeks to Identify Best Practices to Access Essential Green Technology Ingredients While Minimizing Environmental Impact**



*GSR, part of DEME group Patania II trial in the Pacific, 2021*



**The Metals Company and Allseas pilot Q4-2022 3000 tonn of nodules collected from NORI-licence in the Pacific**



Kan havbunnsmineraler være et bedre  
alternativ enn dagens gruvedrift?

Og kan det bli lønnsomt?



# Konsentrasjon (gehalt) er sentralt for lønnsomhet



Publicaiton	Cu/1000 km <sup>2</sup> [Mt]	Cu grade [%]	#SMS/1000 km <sup>2</sup>
Hannington et al. 2010/2011	0.21	3	10.1
Juliani & Ellefmo 2018b	0.11	2	8
Ellefmo & Søreide 2019	0.41	5.78	11.1
<b>NOD 2023</b>	<b>0.36</b>	<b>2.27</b>	<b>9.5</b>
NGU 2023	0.18	1.47	9.2

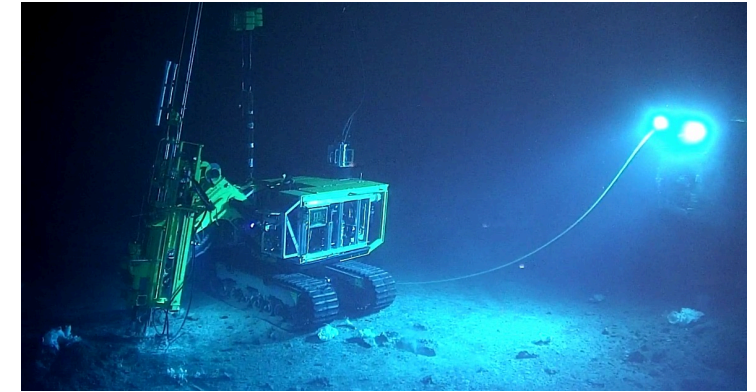


Photo: EMINENT

Seabed minerals: Substantial resources on the Norwegian shelf

– Derfor er det viktig å få samlet mer data, hovedsakelig gjennom flere boringer under havbunnen. Det er det som i bunn og grunn vil fortelle noe om faktiske tonnasje og gehalter. Sannheten ligger i bunnen av borekrona.  
Terje Bjerkgård, NGU (fra Geo 365)



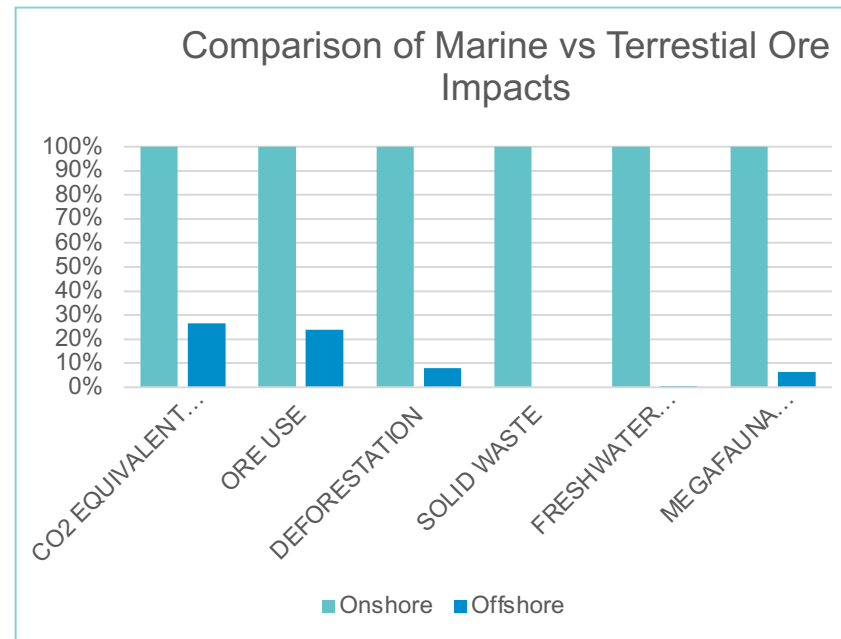
# Havbunnsmineraler – Et bedre alternativ?

Høyere metall konsentrasjon og mindre næring / biomasse i dyphavet

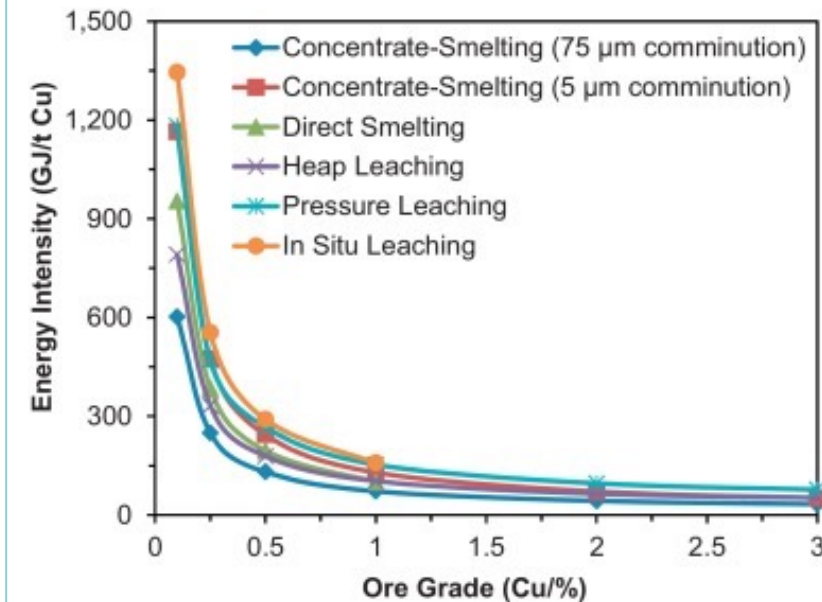
→ Potensiale for mindre miljøpåvirkning, energibruk og restmasse



Dillon Marsh artwork from Palabora mine



Paulikas et al, 2020 (for nodules)

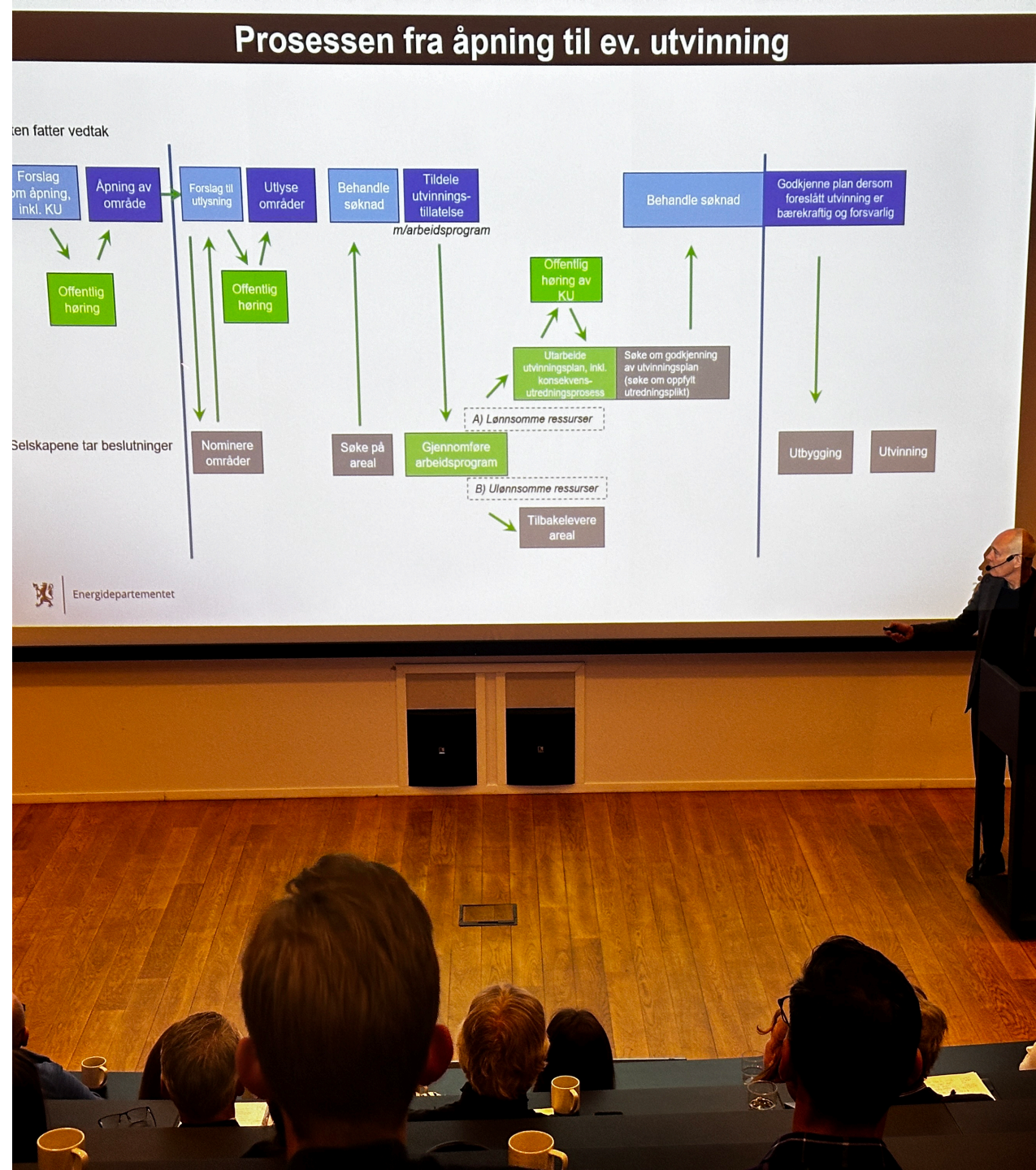


S. Northey et.al. (2014)

# Hva er det åpnet for?

– Før en eventuell utvinning kan tillates trengs det mer kunnskap. Eventuelle planer om utvinning skal både godkjennes av departementet og av Stortinget, og vil kun bli godkjent dersom utvinning kan skje på en bærekraftig og forsvarlig måte.

Regjeringen





# Prosjekt eksempler

# EcoSafe Ridge Mining



- Address knowledge gaps regarding benthic ecosystems associated with mineral deposits
- Investigate potential environmental risk and impacts from deep-sea mining
- Assess the possibility of environmentally responsible deep-sea mining in Norway
- <https://ecosafe.w.uib.no/>



Picture: Courtesy of UiB



OFFSHORE NORGE



# ESG Handbook

- Disclosure guidance for the marine minerals industry
- Developers, contractors, financial institutions, science institutions, NGOs, and regulators – including IMMS

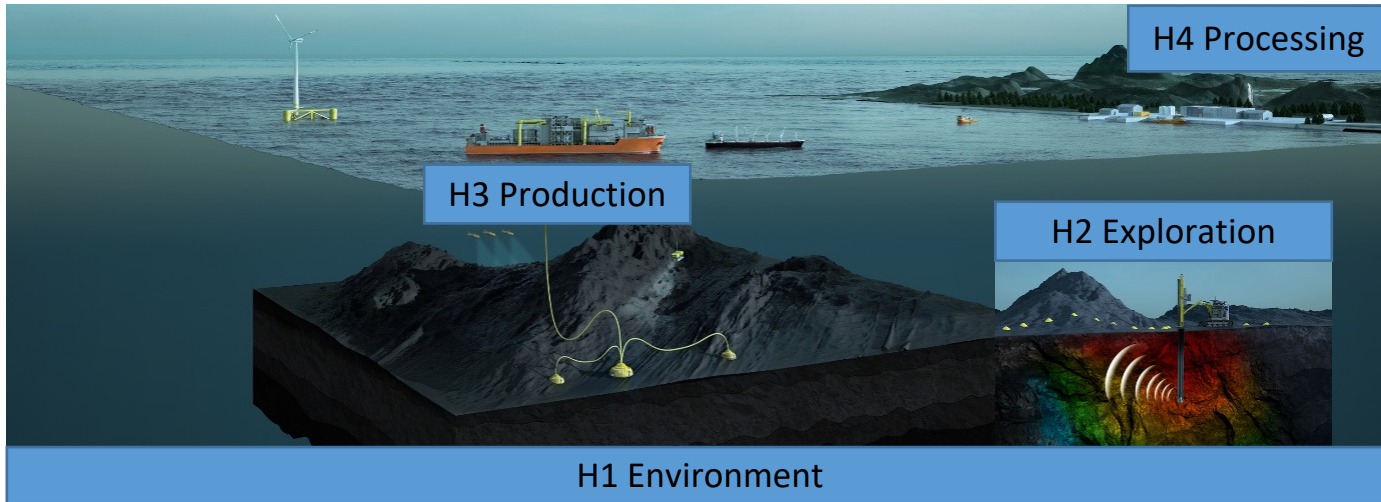
Kicked-off in October 2022  
Planned finalize Q2 2024

<https://www.gceocean.no/projects/gce/esg-handbook-for-marine-minerals/>

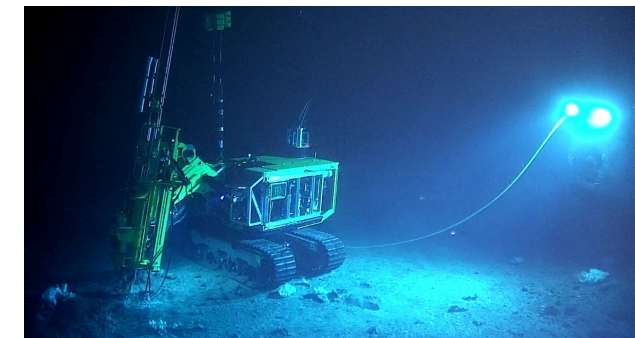
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# EMINENT – Green Plattform



Establish the basis for an integrated value chain for deep sea minerals with far smaller environmental footprint than current mining operations.



Granted: 70,8 MNOK  
 Total budget: 139 MNOK  
[www.eminent-project.com](http://www.eminent-project.com)

# Norge er i en unik posisjon



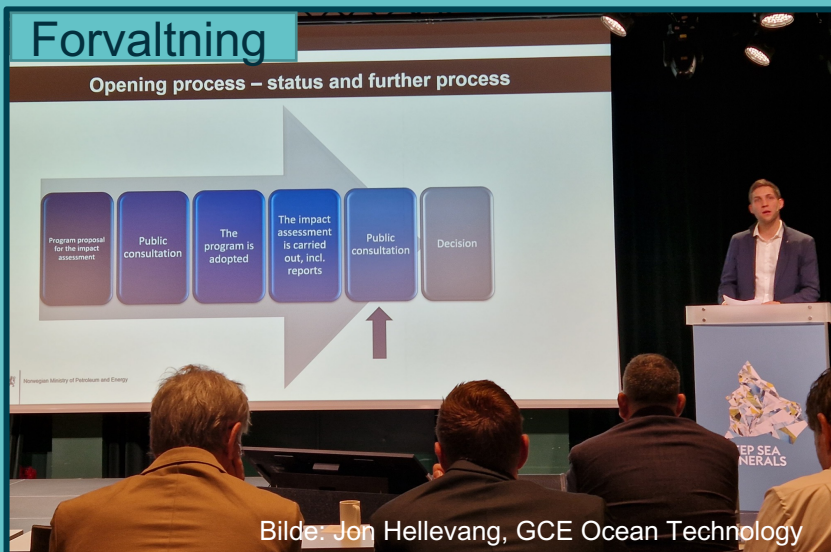
## Ressurser

Påviste mineralressurser på egen kontinentalsokkel. Store havområder hvor mineraler avsettes.



## Teknologi og kompetanse

Verdensledende offshore kompetanse. Store teknologi-overførings-muligheter.



## Forvaltning

Lang og god erfaring med forvaltning av havressurser. Etablert lovverk. Høy ESG-standard. God HMS erfaring fra petroleum.

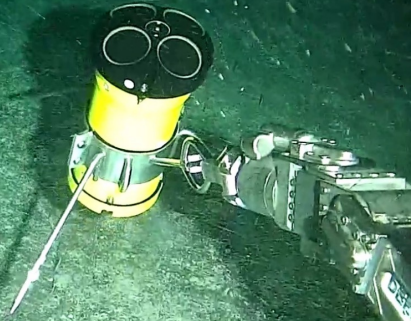


## Verdikjede

Verdensledende prosessindustri. → Mulighet for å etablere en helhetlig og komplett verdikjede.

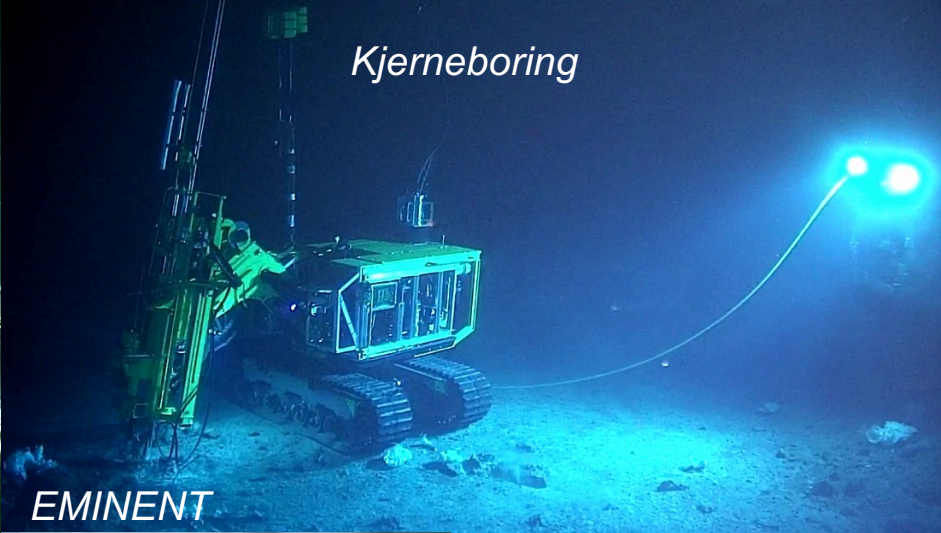


Miljømåling



EMINENT

Kjerneboring



EMINENT

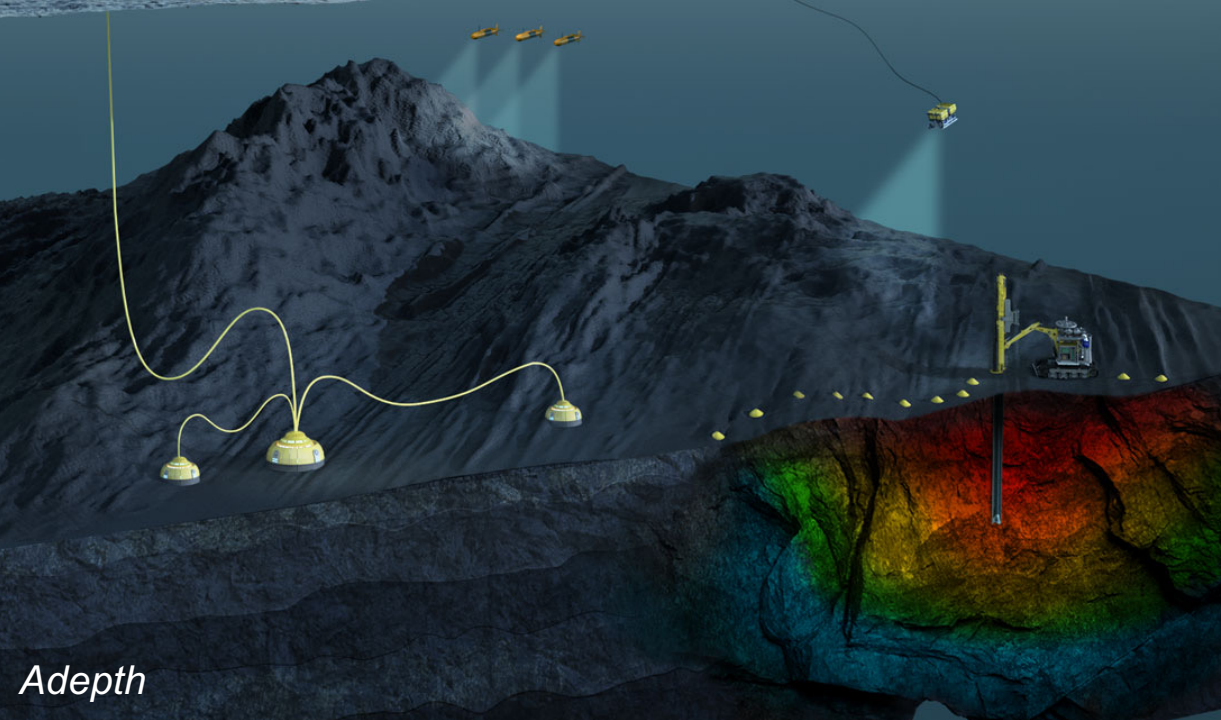
AUV, Seismikk, EM



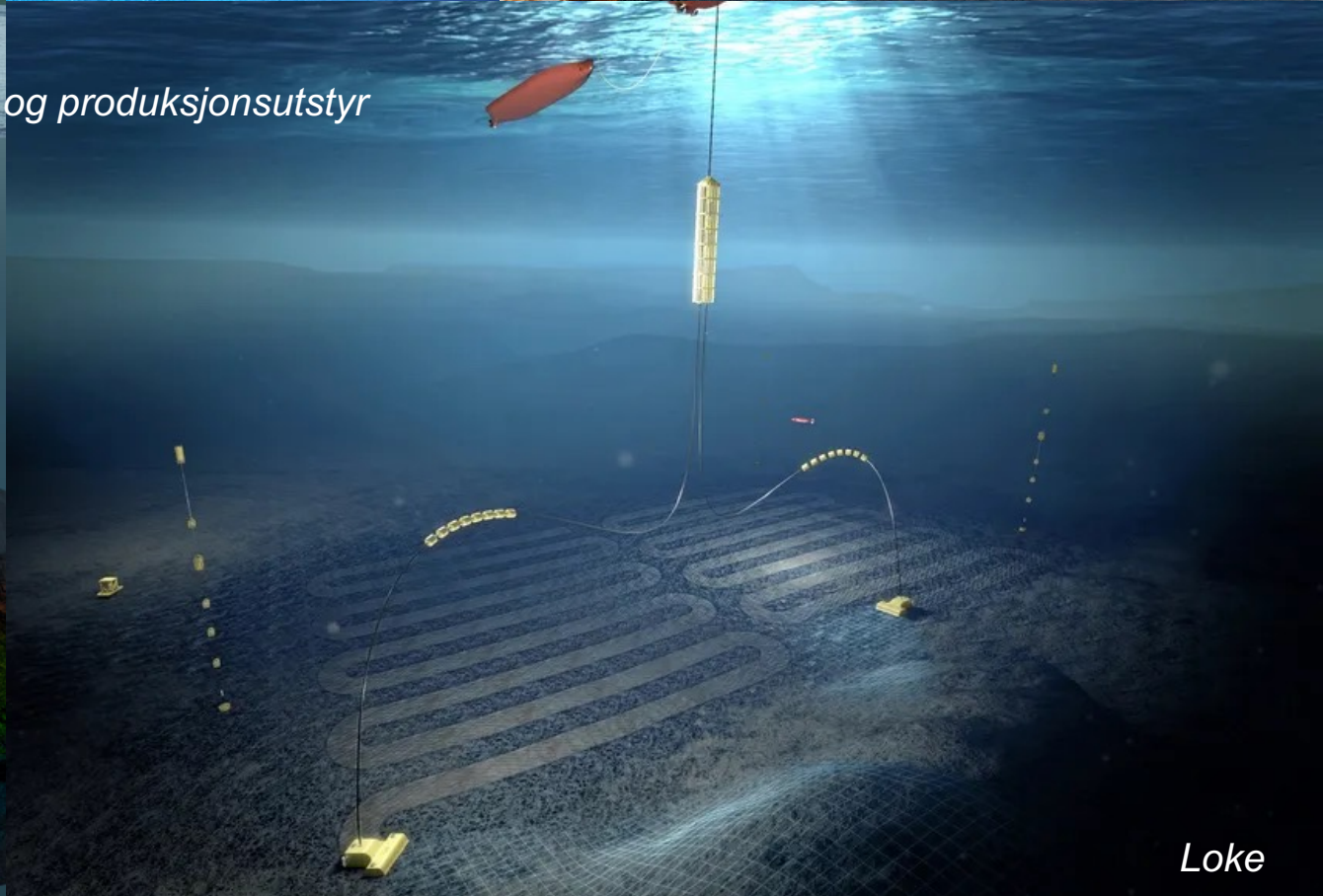
UiB



Et bredt spekter av lete og produksjonsutstyr



Adepth



Loke

# Overordnede anbefalinger: Målrettet og helhetlig satsing



Rammevilkår som gjør det forutsigbart og attraktivt å satse.



Etablere en nasjonal FoUI-strategi med dedikert finansiering (\*)



Gjennomgående fokus på bærekraft og ESG.



Bilde: Hydro

Etablere helhetlige og integrerte verdikjeder. Unngå «siloer» mellom nasjonale strategier og departementer.



Bilde: PLOCAN

Etablere verdensledende FoUI-infrastruktur og testfasiliteter.

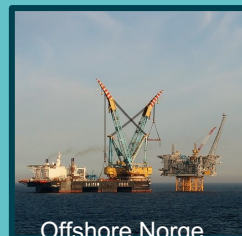


Bilde: UiB

Styrke samarbeidet mellom miljø- og ressurskartlegging.



Styrke internasjonalt samarbeid. Bli ISA sponsor stat.



Offshore Norge

Etabler teknologi- og kompetanseoverføringsprogram langs verdikjeden. Støtte større pilotprosjekt.



Styrke tverrfaglig samarbeid mellom industri, forskning og det offentlige.

(\*) Etter modell fra [OG21](#), DEMO2000 & Petromaks. [Frankrike satser 3.5 milliarder til 2030](#) - Norge bør ha minst like store ambisjoner.

# World Class Ocean Technology from Norway



Jon O. Hellevang

**R&D MANAGER**

jon.hellevang@gceocean.no

+47 988 488 28



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