Western Norway University of Applied Sciences

Hydrogen in maritime sector, and related activities at HVL

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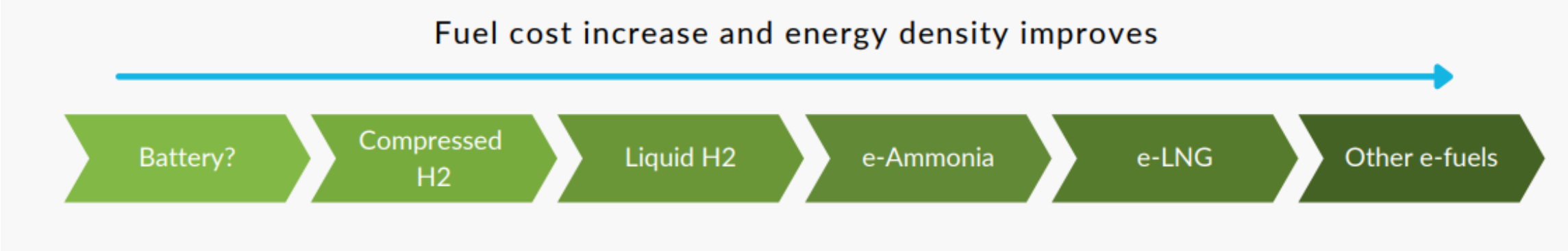
INTERACTION
SUSTAINABILITY
INNOVATION

THE SHIPPING CONFERENCE - LEADERSHIP 2023

IMO 2030 reduction target:

Improve the carbon intensity of international shipping by at least 40 % by 2030 compared to 2008

- how do we achieve this?



LOHC

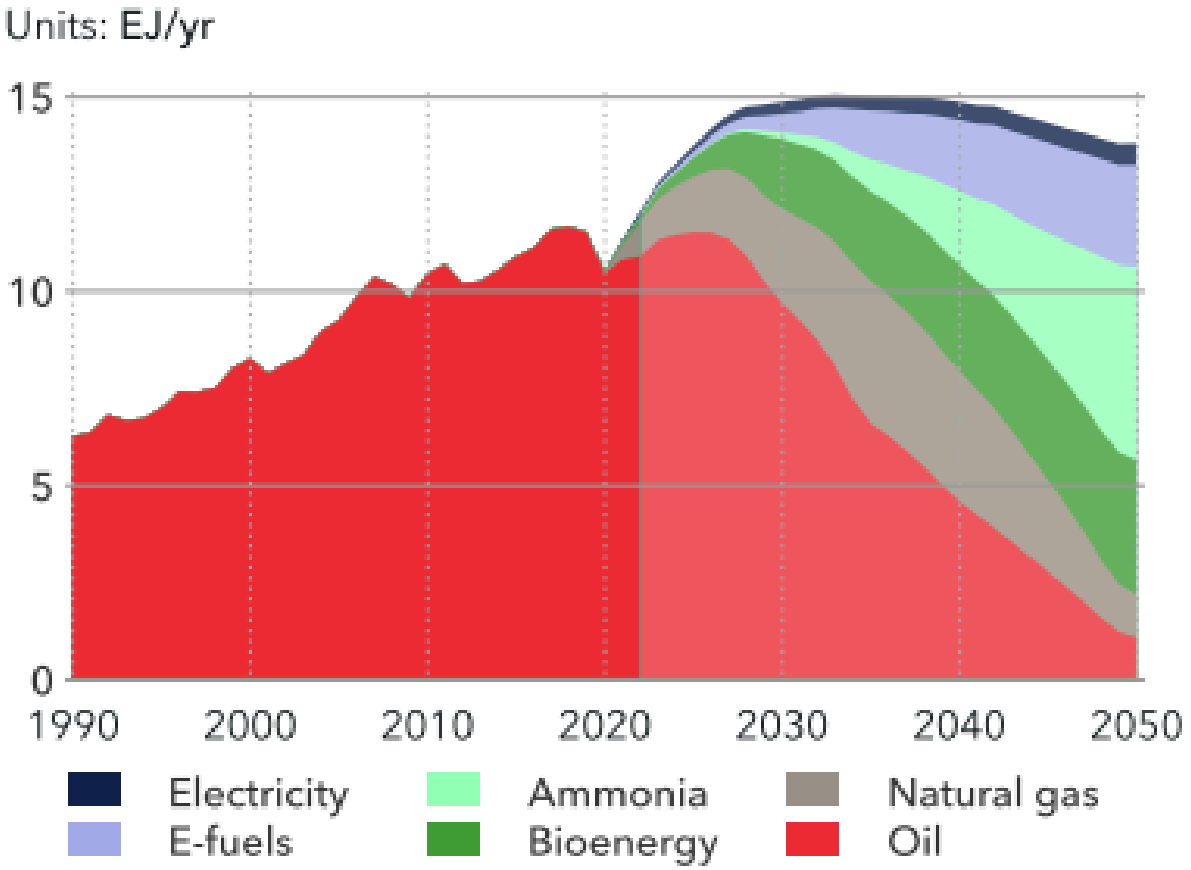
Metal hydrides

Nuclear energy

How hydrogen can help decarbonise the maritime sector. Hydrogen Europe, policy paper 2021

FIGURE 1.11

World maritime subsector energy demand by carrier



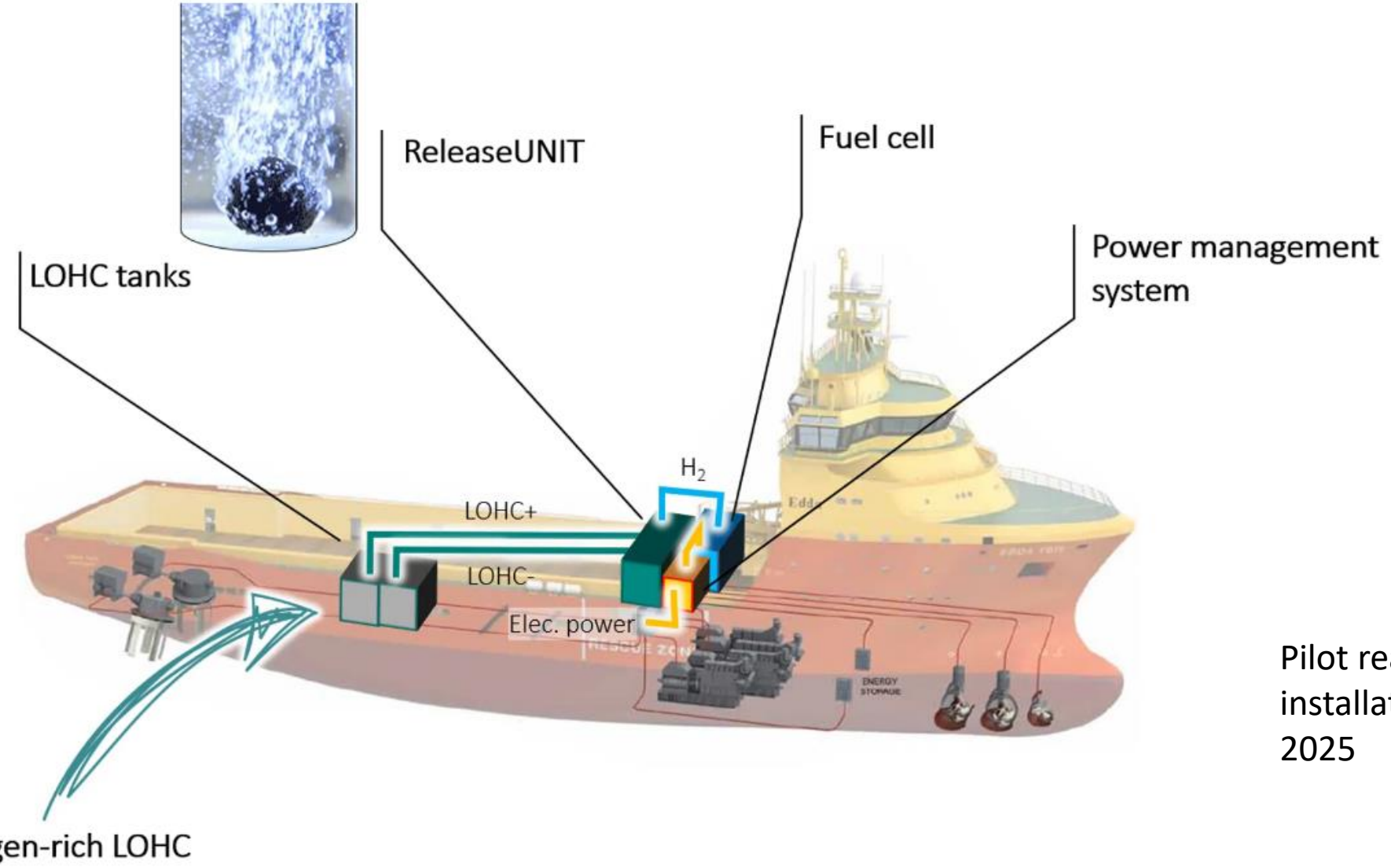
Natural gas includes LNG and LPG. Historical data source: IEA WEB (2023)

Energy transition outlook. DNV, 2023.

Viking energy:

- Eidesvik
- Runs on LNG today
- By 2024: ammonia on SOFC tested on the ship
- Clara Venture Labs shall deliver 2 MW fuel cells

Tu.no 23.01.2020



Prinsippskissse i forbindelse med HyNjord-prosjektet. *Illustrasjon: Østensjø/Hydrogenious*

Pilot ready for installation by 2025

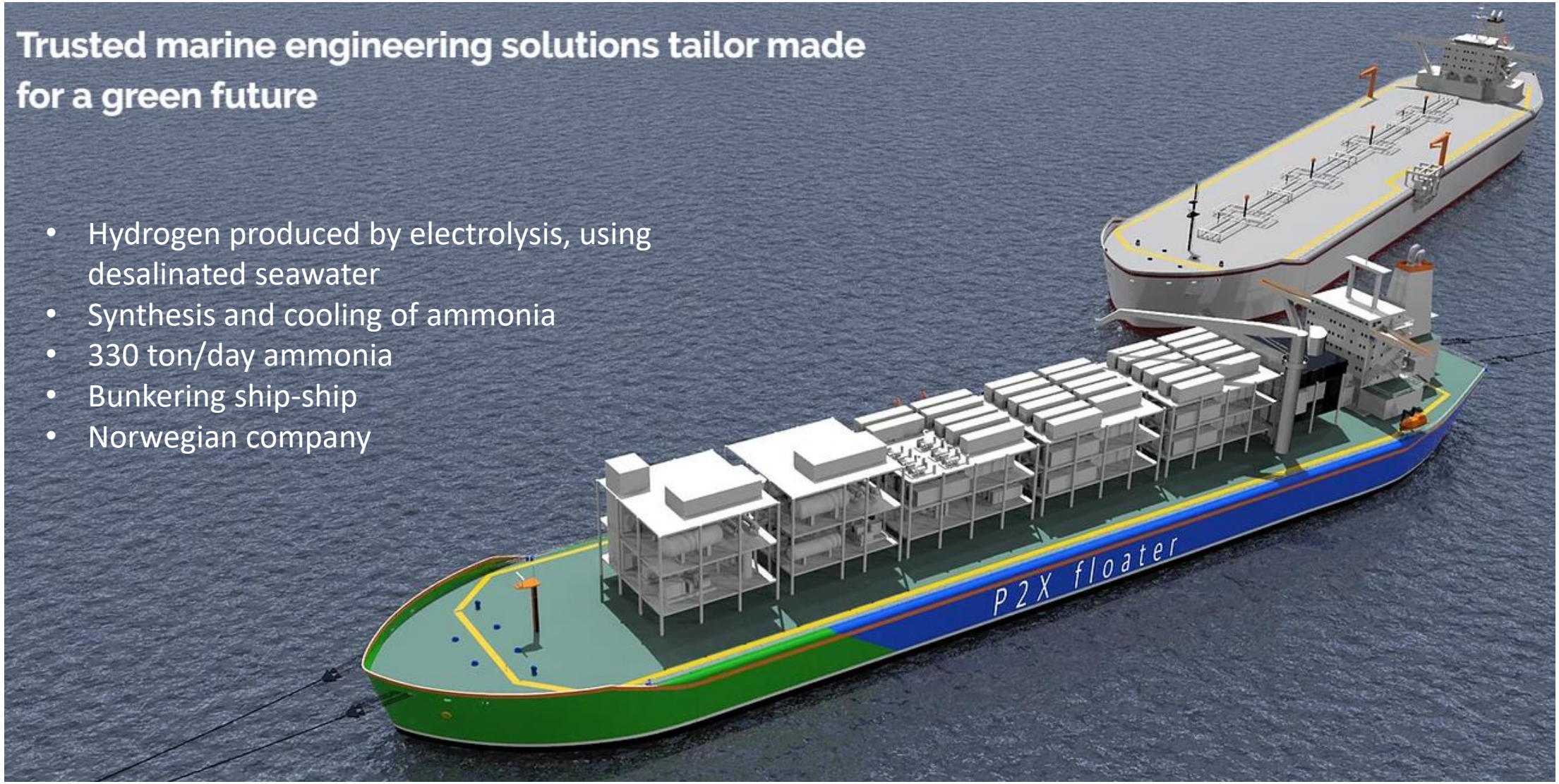
TU 9. mars 2023

Norled have built the world's first hydrogen ferry

- Liquid hydrogen
- 50/50 hydrogen / battery
- Liquid hydrogen from Germany
- Operational on hydrogen from 2023

www.tu.no 28.02.2019.

NORLED



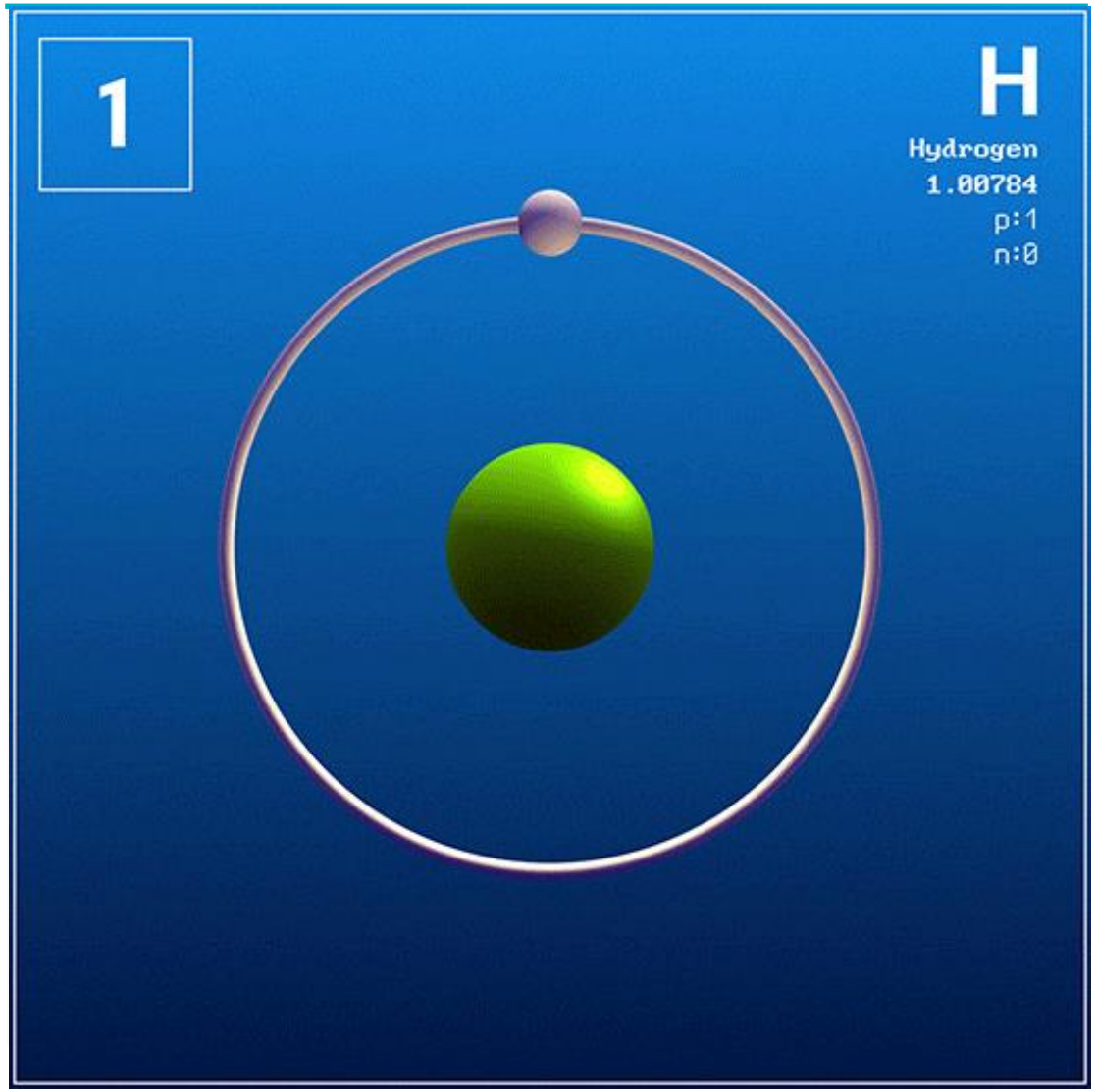
https://www.h2carrier.com/

P2X Floater

Education in Hydrogen Technology

- Class in **Hydrogen technology (MAS539)**
  - Offered to engineering-, master- and PhD students
- First time offered fall of 2019
- 13 → appr 50 students
- 8 guest lecturers from industry and research institutions
- Will be part of the new masters program in Sustainable Energy Technology (2023)

- For more information:
- https://www.hvl.no/studier/studieprogram/emne/41/mas539



Life long learning courses in Hydrogen Technology

Three courses offered to industry and public sector:

- **Introduction to hydrogen**
  - General knowledge about hydrogen technology
- **Hydrogen technology I and II**
  - More in-depth course, requires technical or science background

- Flexible modules that may be taken in combination with work

- For more information:
- https://www.hvl.no/studier/studieprogram/kurs-i-hydrogenteknologi/

Production

Storage and transport

Use

Safety and regulations

HYD800

HYD801

HYD802

Selected bachelor projects in hydrogen

- Concept analysis for zero emission tug boats
- Effciency by use of ammonia in different maritime energy systems
- A study of renewable energy for an offshore ammonia production platform
- Mapping of future hydrogen demand in the Florø region

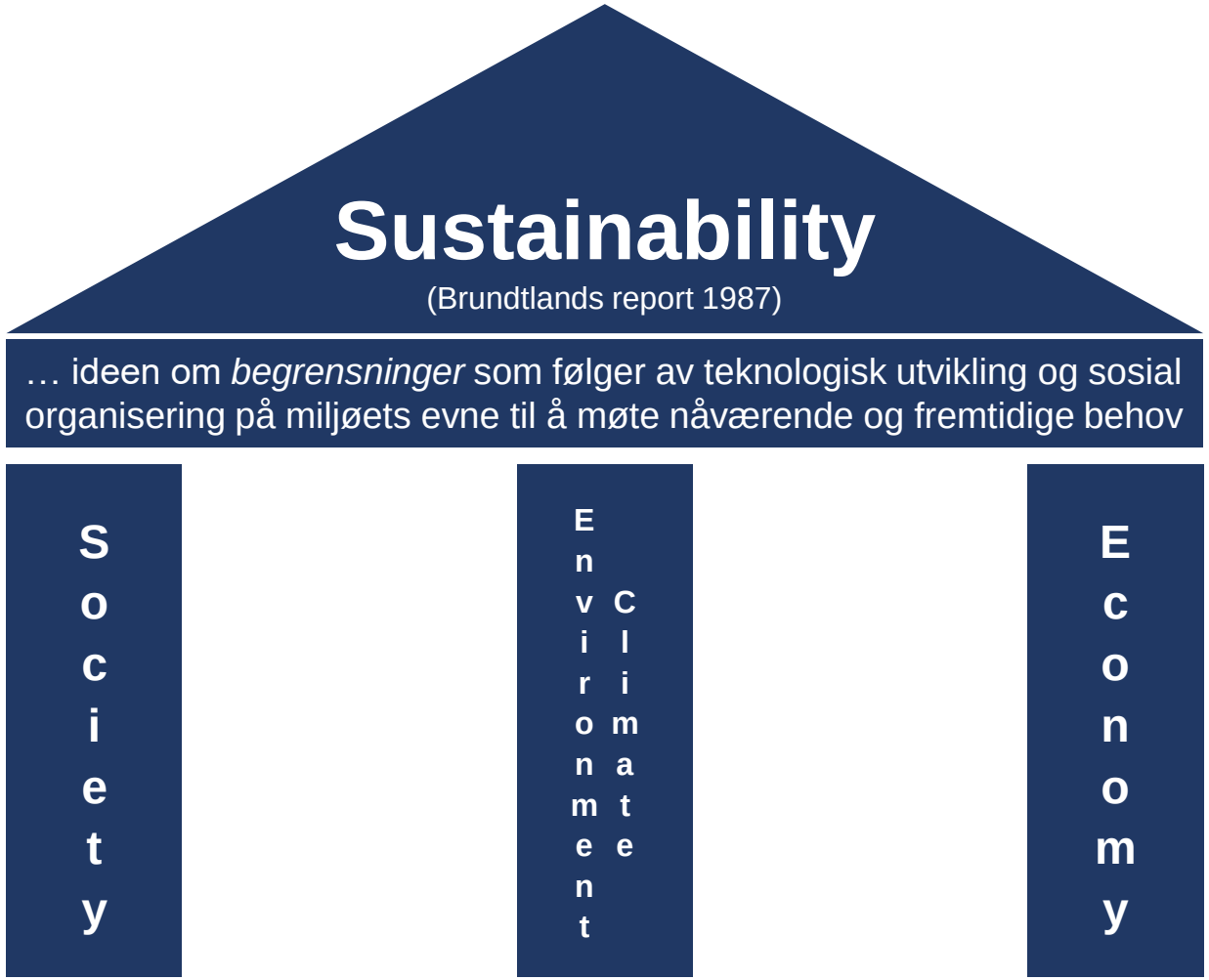
PhD projects in:

- Novel materials for hydrogen production
- Hydrogen production from offshore wind

Selected masters projects in hydrogen:

- The challenge of hydrogen storage- a feasibility study of large-scale hydrogen storage solutions
- Social acceptance and barriers of implementing hydrogen production from onshore wind in Norway
- Offshore hydrogenproduksjon fra vindkraft- En analyse av konsept for flytende og faste marine installasjoner
- Hydrogen production from UNITECH Zefyros offshore wind turbine
- Zero emission off-grid facility powered by wind power and hydrogen
- Wind power and hydrogen for platform electrification

New masters program in Sustainable energy technology- from fall 2023



- Digitaliserte og integrerte energisystemer
- Havvind
- Vannkraft
- Solkraft
- Klimavennlige energiteknologier til maritim transport
- Klimavennlig og energieffektiv industri (inkl. CO_2-håndtering)

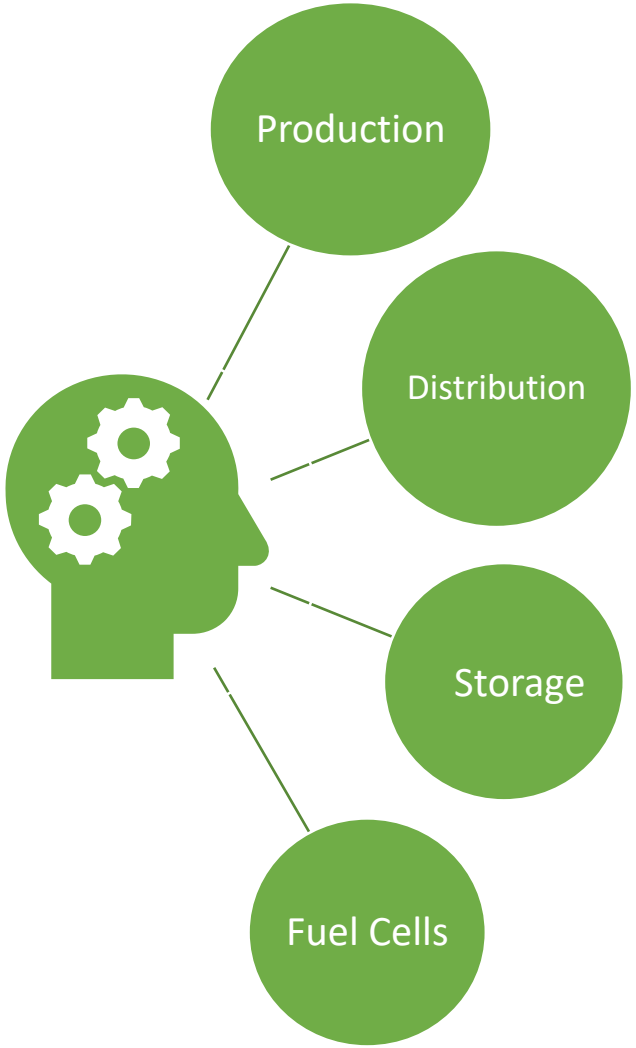
Kilde: Energi21

Hydrogen HVL-research and development

HVL Campus Sogndal, Mohnsenteret (Bergen):
Societal, political, environmental and innovation aspects of hydrogen and energy transition

HVL Campus Haugesund:
Human design in maritime operations
Fire and safety

HVL Campus Bergen:
Hydrogen production – solar, wind (off-shore, on-shore) and from waste
LOHC, ammonia in combustion engines
Small scale liquefaction of hydrogen using a Stirling cryo cooler



HVL's β-Stirling ved -164°C

Modelling and simulation of solid oxide fuel cell systems for maritime applications

- 4 year PhD-project financed by HVL and Bergen's Ship Owners Association
- Cooperation with Alma Clean Power who deliver testdata from their 100 kW SOFC-fuel cell running on ammonia at Energy House on Stord

- The aims and objectives of the project are
  - Development of simulation models for establishing architectures for controlling a solid oxide fuel cell (SOFC) system, which is part of a maritime energy system.
  - Use big data analysis and machine learning with data from a test facility where a 100 kW SOFC will be running on renewable fuel as part of a prototype of a maritime propulsion system.
  - The simulation models and control architectures shall aim for optimal operation of the fuel cell with respect to parameters like cell voltage, load, degradation, and environmental conditions.
  - The simulation models shall be able to help with planning predictive maintenance of the fuel cell stack and its subsystems as well as be usable in simulations of hybrid maritime energy systems.

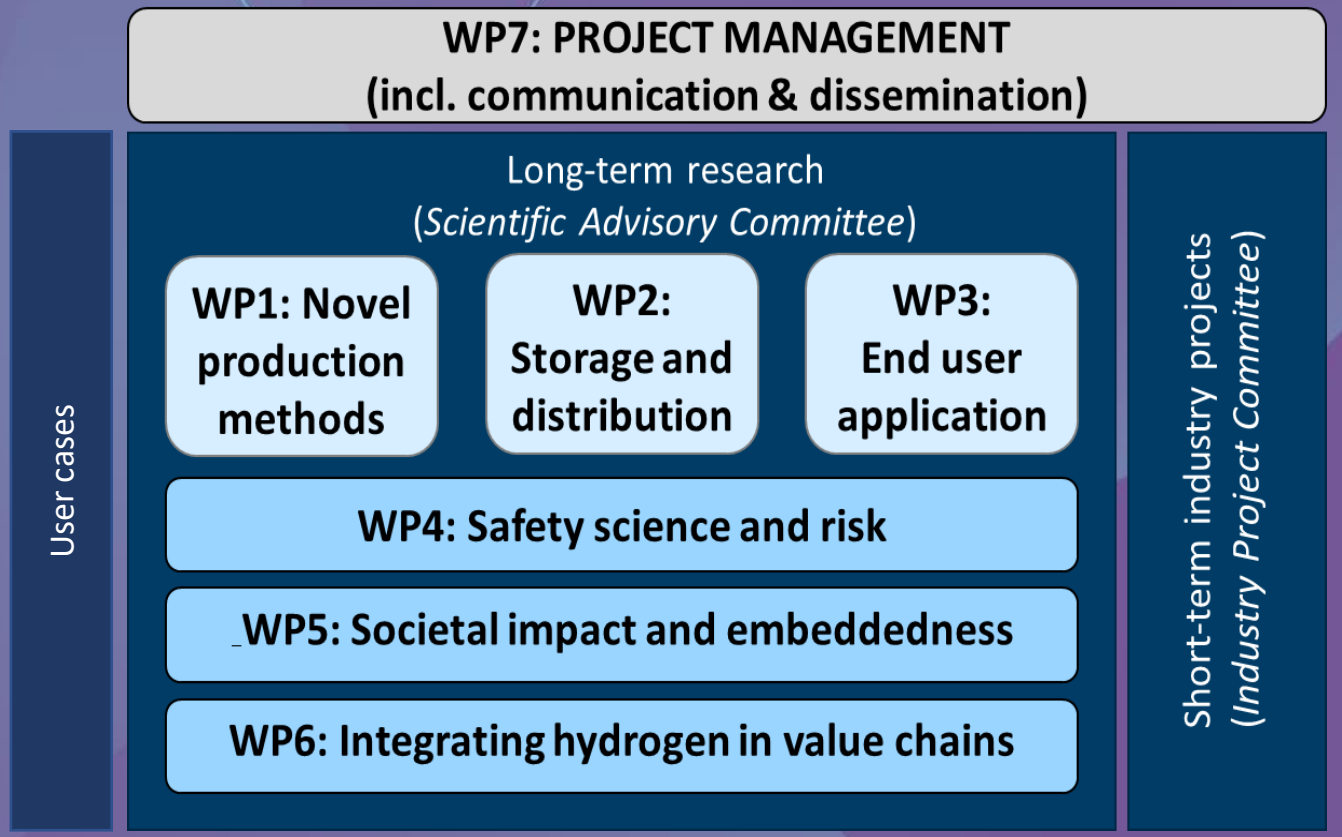
FME HyValue – Norwegian Center for Hydrogen Value Chain Research

- Duration: 2022-2030
- Total budget: 370 mill NOK
- More than 30 PhD/post docs
- 7 national research partners. Lead by NORCE.

- 3 technical work packages and 3 interdisciplinary workpackages

- HVL has center deputy, and is involved in WP1, 3, and 5.

HyValue



HyValue partners

National research partners

International research partners

User partners

Thank you for your attention!

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