



WHEN TRUST MATTERS

# Hydrogen as fuel

Donsø Safety Meet

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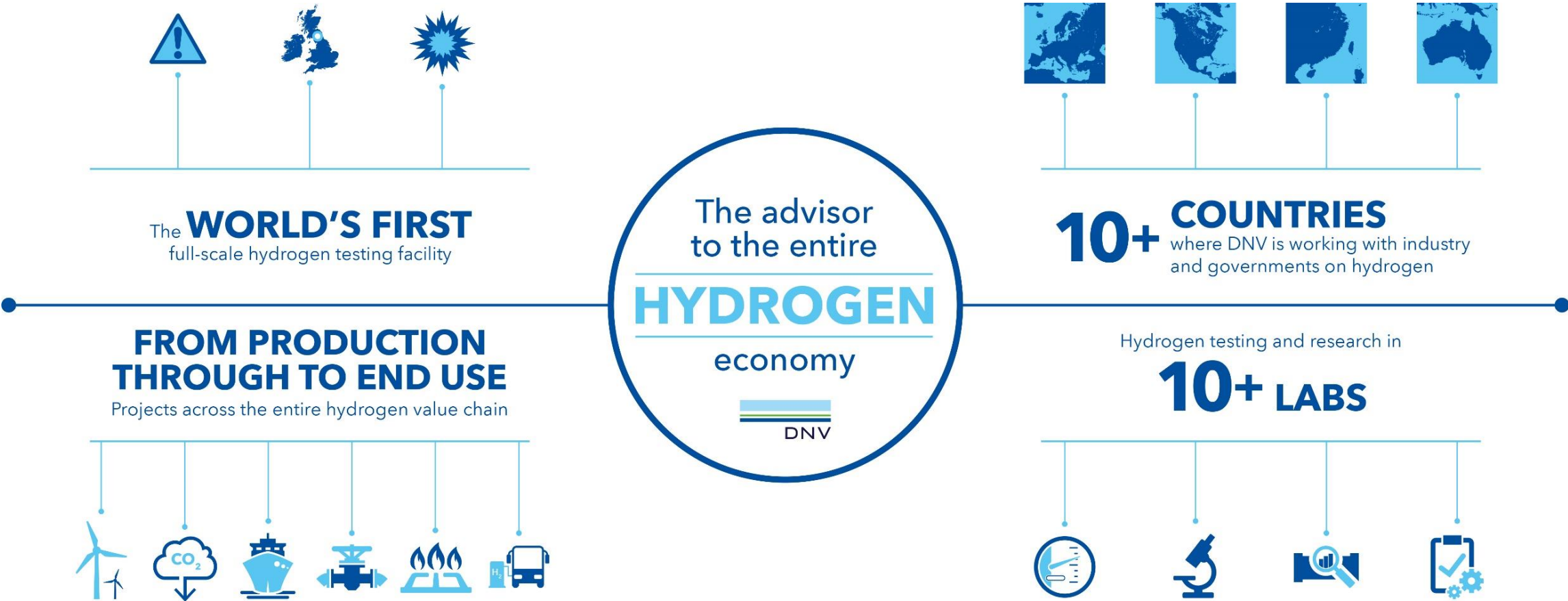
# So why hydrogen?

## decarbonization

- Shipping faces major challenges adjusting to zero emissions over the next decades
- Maritime will compete with other sectors to get access to the available and green fuels
- We will have a future with a huge degree of fuel mix – not a “one size fits all” solution
- Hydrogen is one of few zero-emission solutions with a promising potential for scalable use for the longer distances and larger energy needs in shipping



# DNV is working as advisor to the entire hydrogen economy...



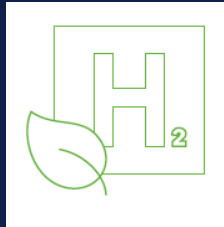
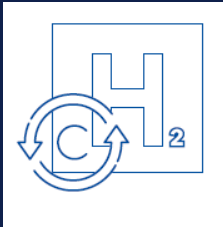
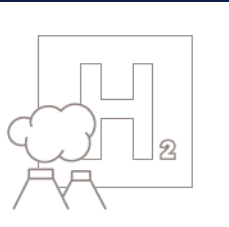
# Hydrogen value chain for shipping

## PRODUCTION

GREY

BLUE

GREEN



## TRANSPORTATION and STORAGE



## UTILIZATION

- Directly as fuel (liquid or compressed)
  - ICE
  - Fuel cell
- Building block in production of ammonia or other synthetic fuels

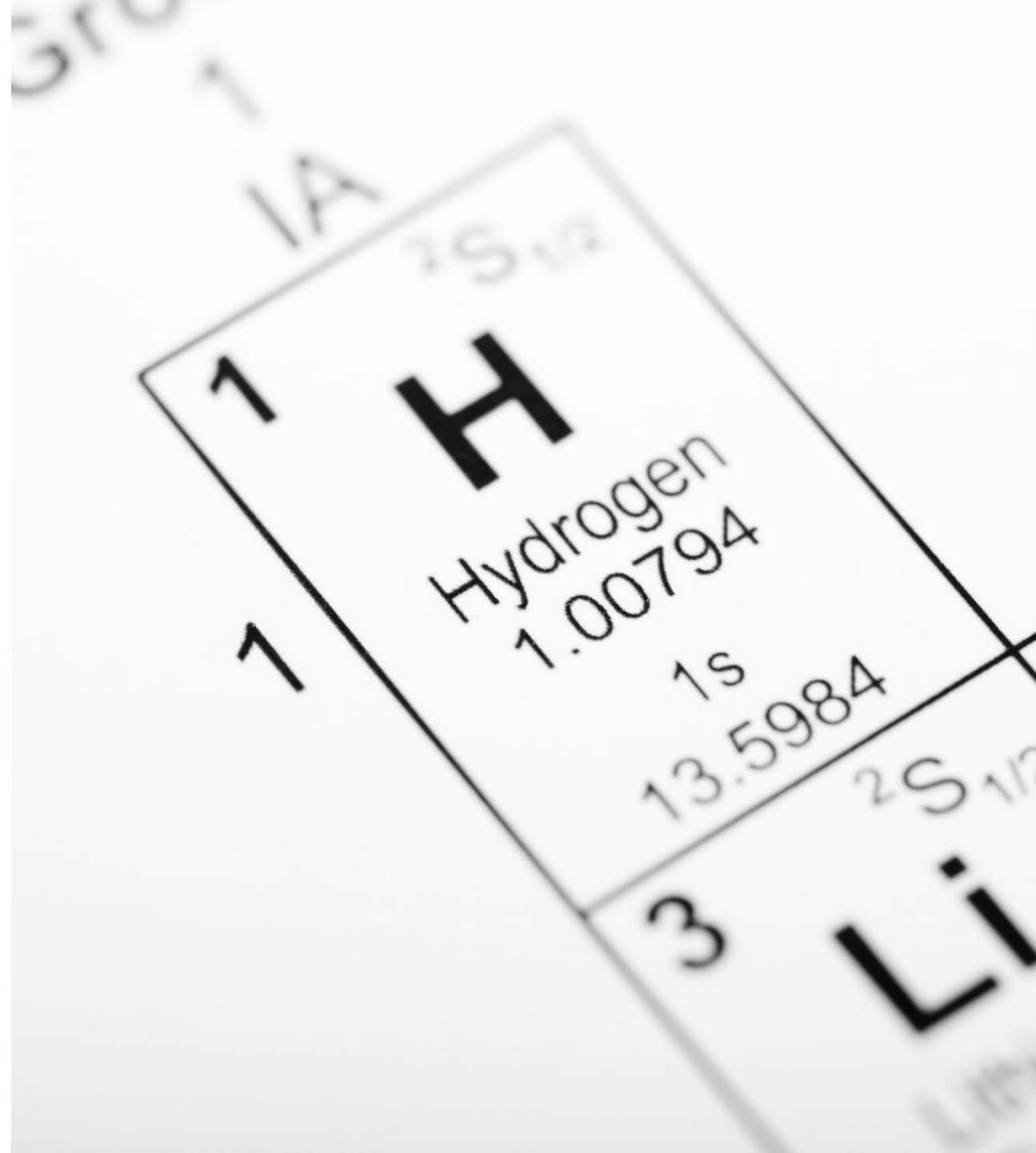
# Compared to other fuels – hydrogen needs to overcome some challenges...

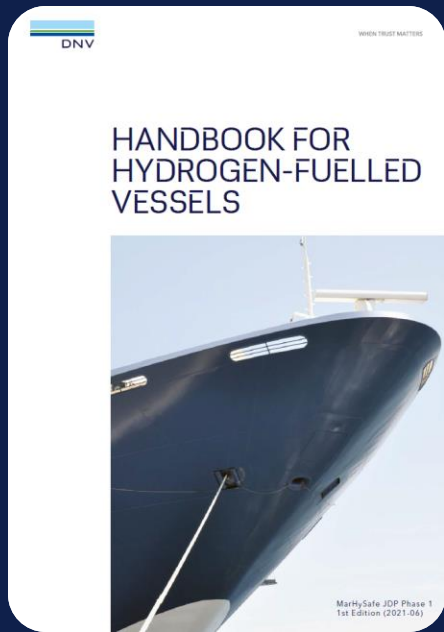


	Availability	Infrastructure & Storage	Maturity of technology	Energy density	Price	Green credentials
VLSFO/MGO	✓	✓	✓	✓	✓	✗
LNG	✓	✓	✓	✓	✓	✓
LPG	✓	✓	✓	✓	✓	✓
Methanol	✓	✓	✓	✓	✓	✓
Biofuels	✗	✓	✓	✓	✗	✓
Hydrogen	✗	✗	✗	✗	✗	✓
Ammonia	✗	✓	✗	✓	✓	✓

# Physical properties

- Main component in methane ( $H_2$ )
- Liquid at  $(-253^\circ\text{C})$  at 1 bar to  $(-240^\circ\text{C})$  at 13 bar
- Lighter than air
- Flammable, but high self ignition temperature: approx.  $500^\circ\text{C}$  ( $\sim 210^\circ\text{C}$  for diesel)
- Ignitable by sparks in mixture with air: 4-75%
- Requires 5 and 10-15 times the volume compared to the same energy stored in the form of HFO, for LH2 and CH2 respectively

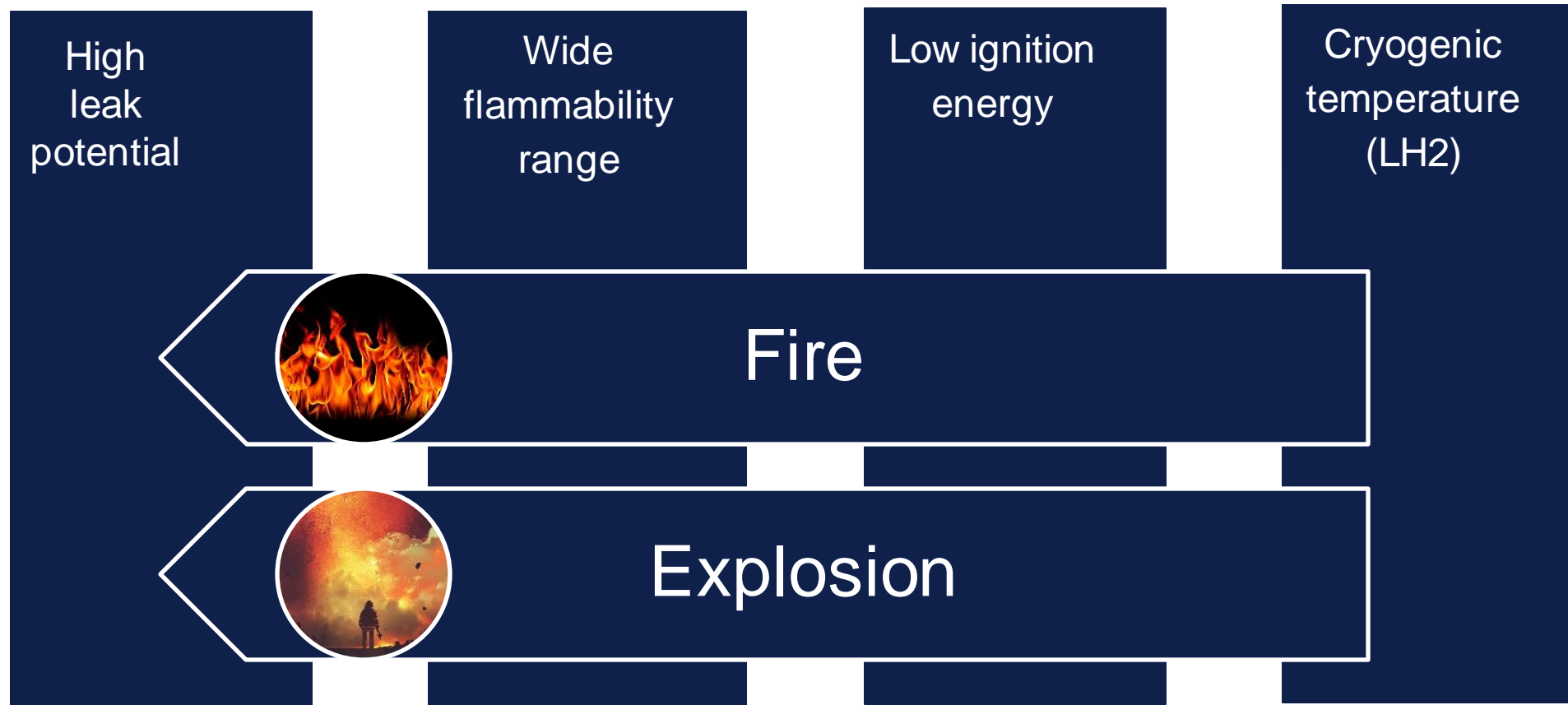




# Marinizing Hydrogen means further risks compared to the use on shore

- External hazards collisions, grounding etc.
- The risk frequency and consequence increases
- Confined and enclosed spaces
- Containerized swappable solutions
- Lack of H<sub>2</sub> experience in maritime
- Crew competence

# The main Safety Challenges





# The main safety challenges – and the mitigating designs...



Fire



Explosion

## Segregation

Protect gas fuel installation from external events

## Double barriers

Protect the ship against leakages

## Leakage detection

Give warning and enable automatic safety actions

## Automatic isolation of leakages

Reduce consequences of a leakage

# DNV Rules

- DNV has had **Rules for Fuel Cells** since 2008. Relevant class notations are FC(Safety) and PC(Power)
- **Rules for Hydrogen** as fuel are currently in the making



## IMO

- **IGF Code** – Part A (2.3) - Alternative design approach for ships using low flashpoint fuels
- **SOLAS Ch. II-1 Regulation 55** provides a methodology for alternative design and refers to “Guidelines for the approval of alternatives and equivalents as provided for in various IMO Instruments” MSC.1/Circ.1455

# DNV are involved in several projects...



Damen SY – NB ongoing  
Source: CMB.Tech

## Compressed hydrogen



HySeas III – AiP  
Source: HySeas III



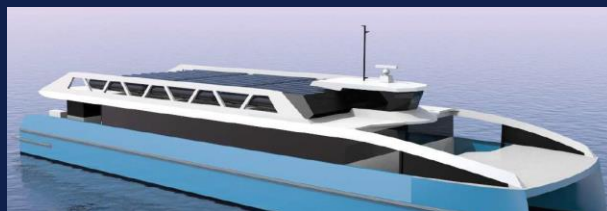
Zero Coaster - JIP  
Source: Vard



HYDRA – delivered  
Source: Norled



Salmar – NB ongoing  
Source: Moen shipyard



Sealink Group – AiP  
Source: Sealink

## Liquified hydrogen



# Some reflections on uptake of hydrogen in the Maritime industry...

## **The business case**

- Green and affordable production of H<sub>2</sub> is key for any uptake
- Infrastructure have to be in place

## **The application**

- Short sea and small vessels will be the first (only?) adopters for CH<sub>2</sub> and LH<sub>2</sub>
- Hydrogen will likely be used to process Ammonia and as synthetic fuels
- H<sub>2</sub> released from LOHC onboard for use as fuel

## **The technology**

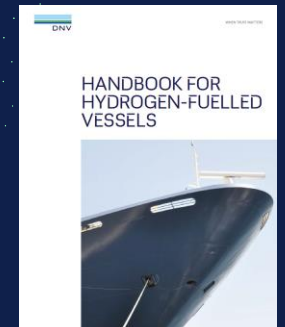
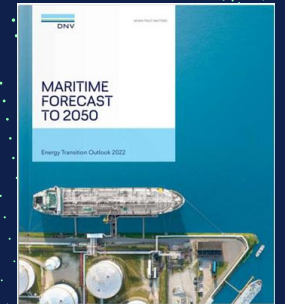
- Industry cooperation and knowledge sharing through pilot projects is essential to ensure development of safe solutions for the use of hydrogen

## **The regulatory framework**

- Process and storage safety rules and framework needs to be in place

# Thank you for listening!

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