December 2021

POWER

for today and tomorrow

Bureau Veritas H2

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Our mission
Shaping a world of trust

CREATED IN 1828

190+ years in business

BUSINESS TO BUSINESS TO SOCIETY

Quality, health & safety, environmental protection & social responsibility

FACT BASED UNDERSTANDING

Testing, inspection, certification & technical services

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in the energy transition

Years in the power sector
100+

7,500+
Power experts

18
Global power centers of expertise

4,000+
Power clients

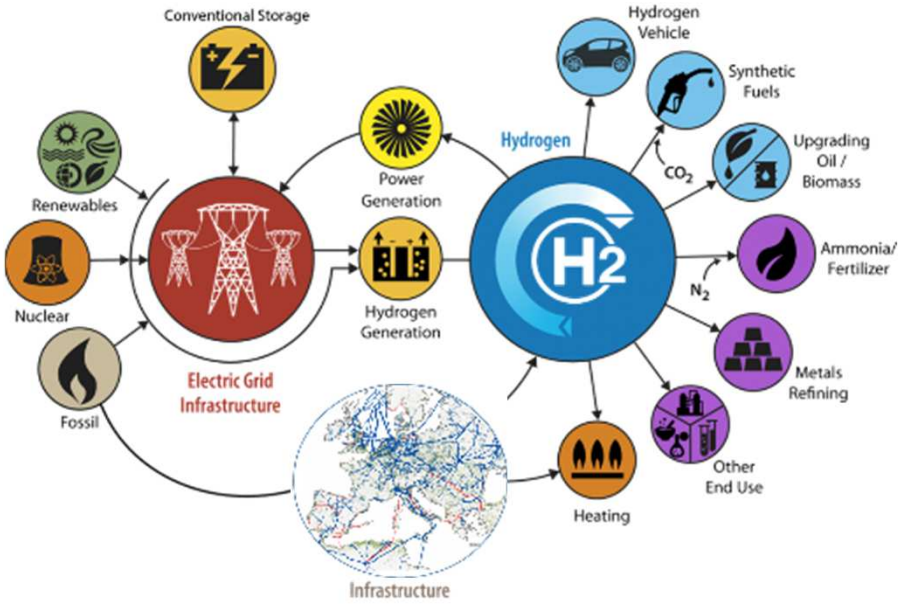
Power references in
100+
countries

Hydrogen Potential

Why is Offshore Renewable Hydrogen Important for Europe

- Targeting energy independency and stabilization of energy price
- Interconnecting Transmission System Operators (TSO) Gas grid and Electrical grid
- Providing a ZERO emission solution for different sectors

  (High temperature heat; Heavy transport; Marine Transport)
- Acceptable overall efficiency and still growing (Electrochemical process)
- New sustainable industry based on renewables
- Complementary with other technologies (e.g. battery storage systems)



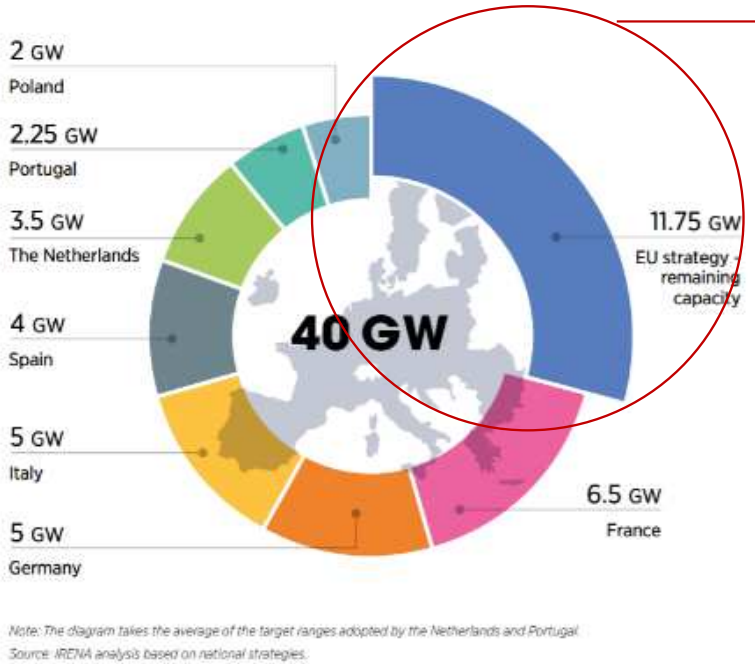
Source: H2 scale; DOE modify with European gas network

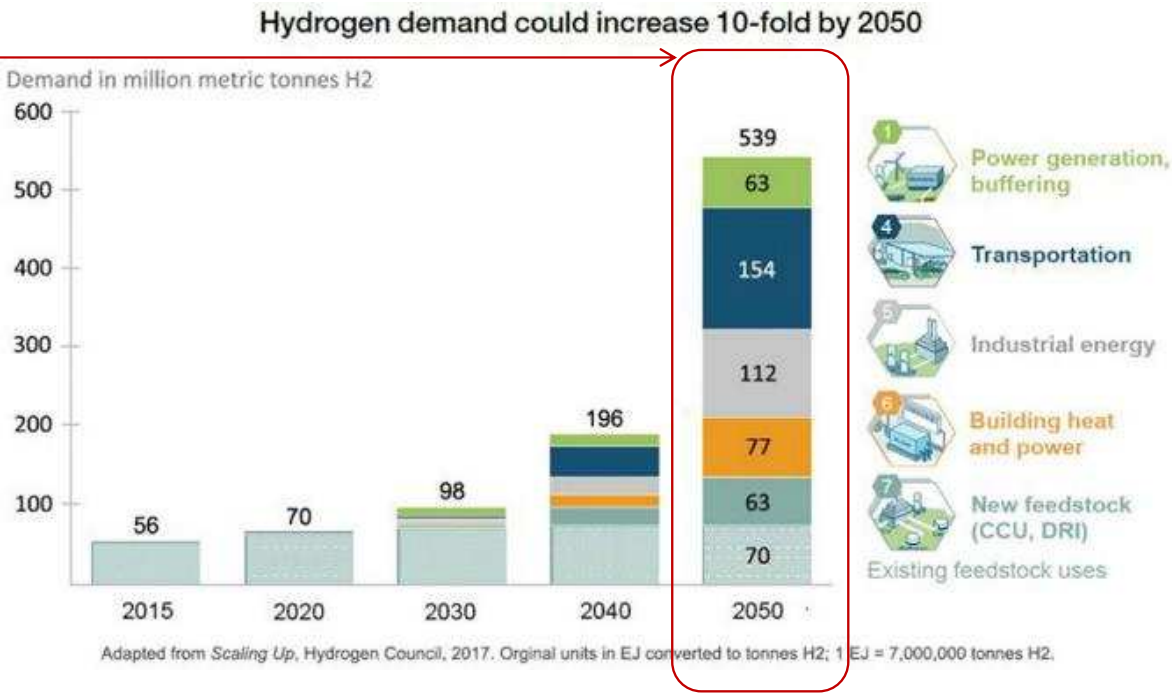
Hydrogen Potential

Synergies between Hydrogen and Wind Power

- Increasing load factor
- Harnessing full potential of wind resource
- Partial load
- Simplicity wind generators – Grid codes
- Simplicity in regulation - Grid codes
- Hydrogen offshore storage

Hydrogen Potential
Trend for Next Decades



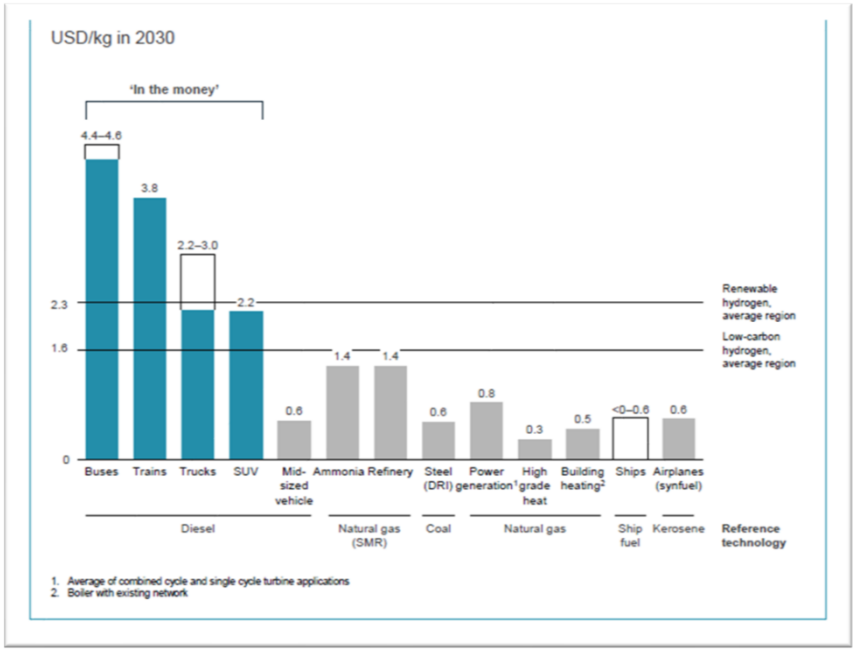


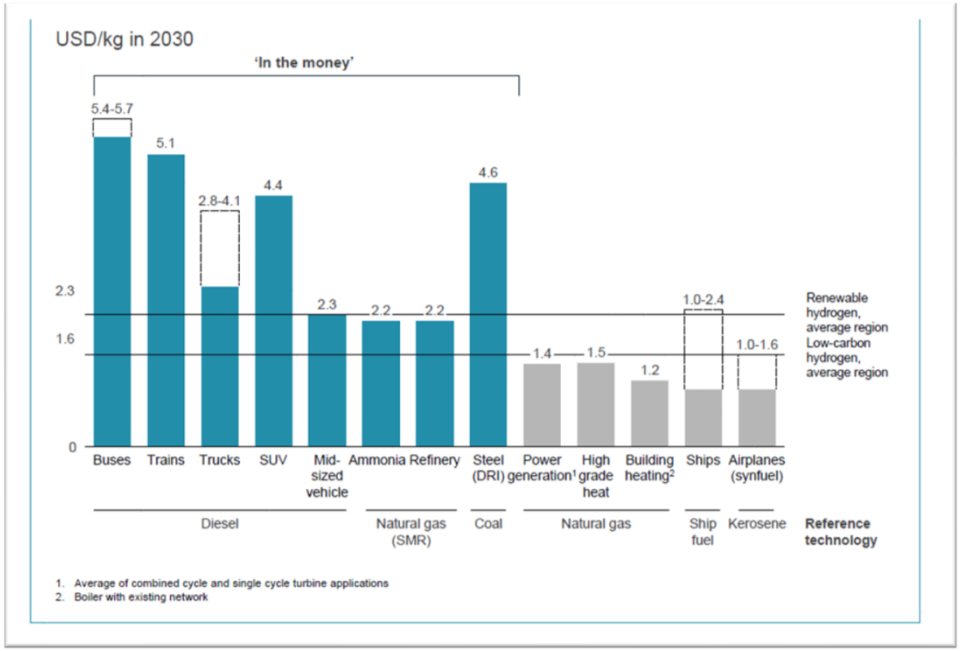
* With an assumption of 3000 Hours per year.

Key Decisions
Main H2 Market

H2 MARKETS AND TARGETS FOR HYDROGEN.

- Offshore use: Vessels, add new variable (H2 liquid, Ammonia...)
- Inland uses (direct distribution by pipeline, CH2 ships).





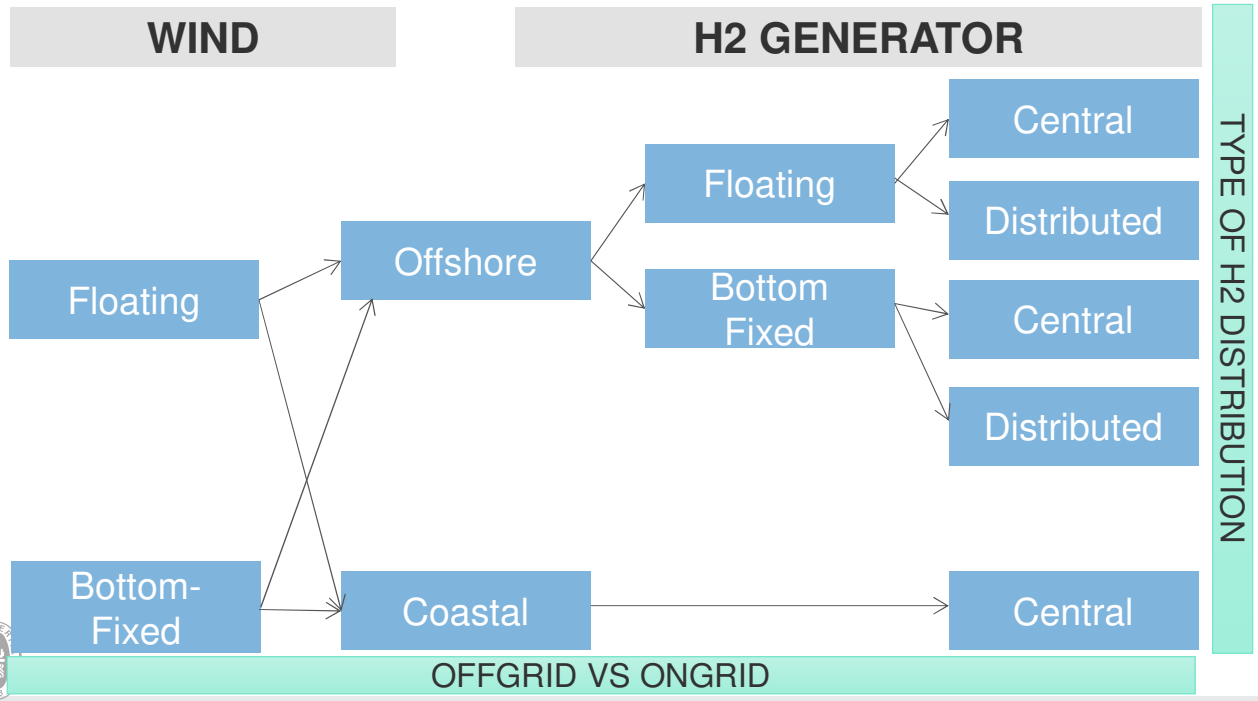
Ref:Hydrogen council

Key Decisions
Offshore Technologies & Configuration

Offshore Technologies
- Floating
- Bottom-fixed

Type of Production
- Central
- Distributed

Location of Hydrogen Generation
- Offshore H2 production
- Onshore-Coast H2 production



Key Decisions
Offshore Technologies & Configuration

OFFSHORE TECHNOLOGIES - CONCEPTUAL OR PRELIMINARY STATUS:

To define more accurately the Levelized Cost of Hydrogen (LCOH) of your assets, it is necessary to decide and identify the different scenarios related to:

- Market objectives
- Typology of installation

Figure 1: $LCOH_2$ range for an onshore electrolyzer powered by offshore wind or onshore wind

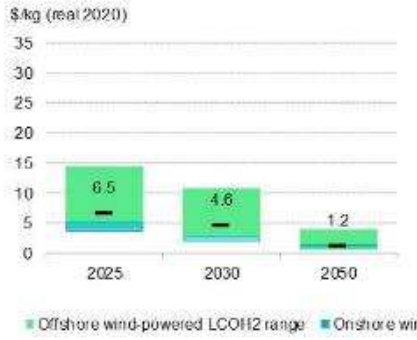
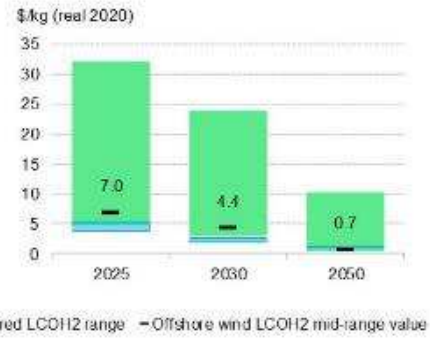
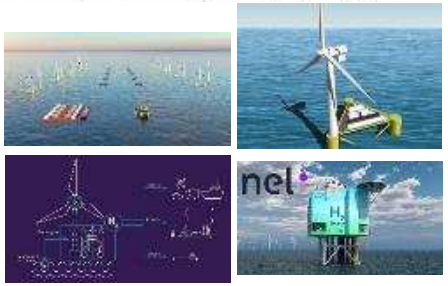


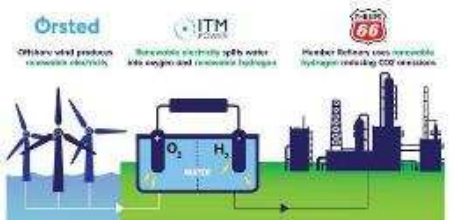
Figure 2: $LCOH_2$ range for an offshore electrolyzer using offshore wind, vs. onshore wind plus onshore electrolyzer



Offshore wind-powered LCOH2 range Onshore wind-powered LCOH2 range Offshore wind LCOH2 mid-range value

Source: BloombergNEF. Note: All hydrogen cost estimates are calculated based on western proton exchange membrane (PEM) electrolyzer costs. The green range represents the calculated $LCOH_2$ based on a wide range of assumptions: transport distance ranging between 10km and 300km, offshore wind capacity factor ranging between 35% and 60%, electrolyzer/wind farm size ranging between 100MW and 3GW. The blue range represents the $LCOH_2$ for Northwest European onshore wind-powered systems, assuming wind capacity ranging between 30% and 50%.

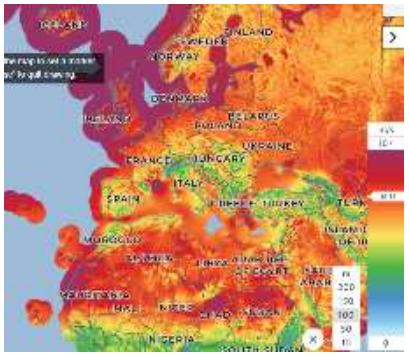


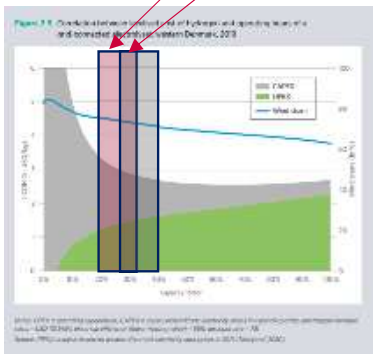


Key Decisions
Hybridization

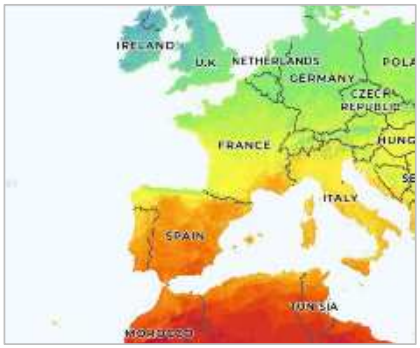
HYBRIDIZATION

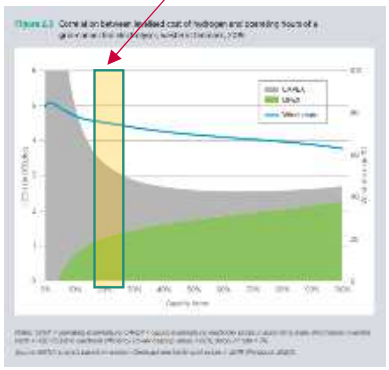
Wind



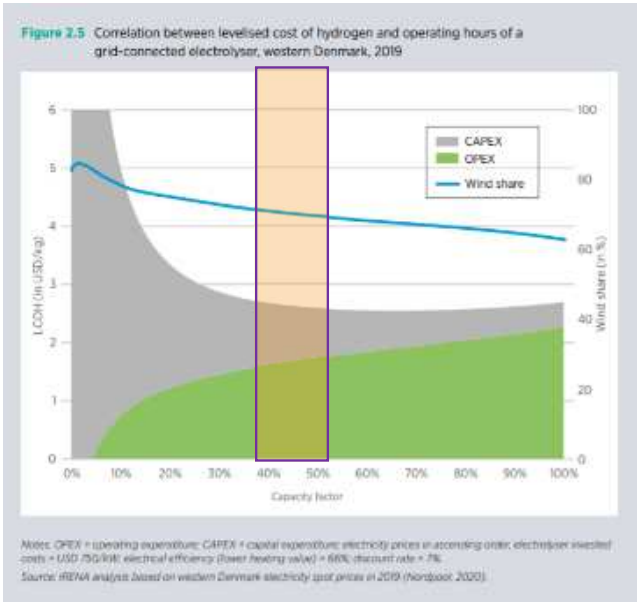


Solar Map





Increased capacity factor reduces CAPEX impact in the final price of hydrogen



Key Decisions
H2 Technologies

ELECTROLYSER TECHNOLOGY.

One of the most critical decision at this stage, there are other commercial alternatives AEL, PEM; and future technologies SOE; AEM.

TRANSPORT OF HYDROGEN.

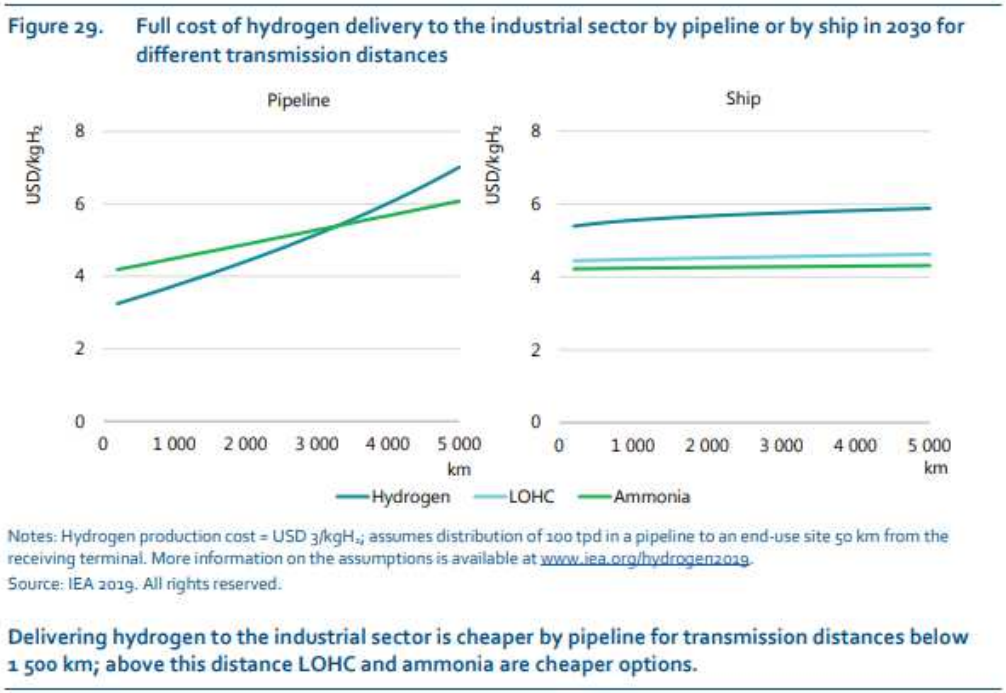
Second important decision: how to transport energy?

And How to transport hydrogen? Electricity or H2? If its H2 – then Pipeline, liquid H2Ship, GasH2 Ship, Ammonia or other?

Key Decisions
H2 Distribution

REQUIRES IN-DEPTH STUDIES TO DEFINE H2 DISTRIBUTION.

- Pipelines
- Ships
  - Gas
  - Liquid
  - Ammonia
  - LOHC



In Detail
Safe and Reliable

Currently there are a lot of gaps related to standards and safety for Hydrogen related assets/ installations. Best approach is to work with an experienced team with multidisciplinary knowledge. Engineering and Design stage shall take into account all requirements and set clear objectives for a safe and reliable operation.

IN DESIGN PHASE SOUND ENGINEERING DECISIONS ARE REQUIRED IN RELATION WITH:

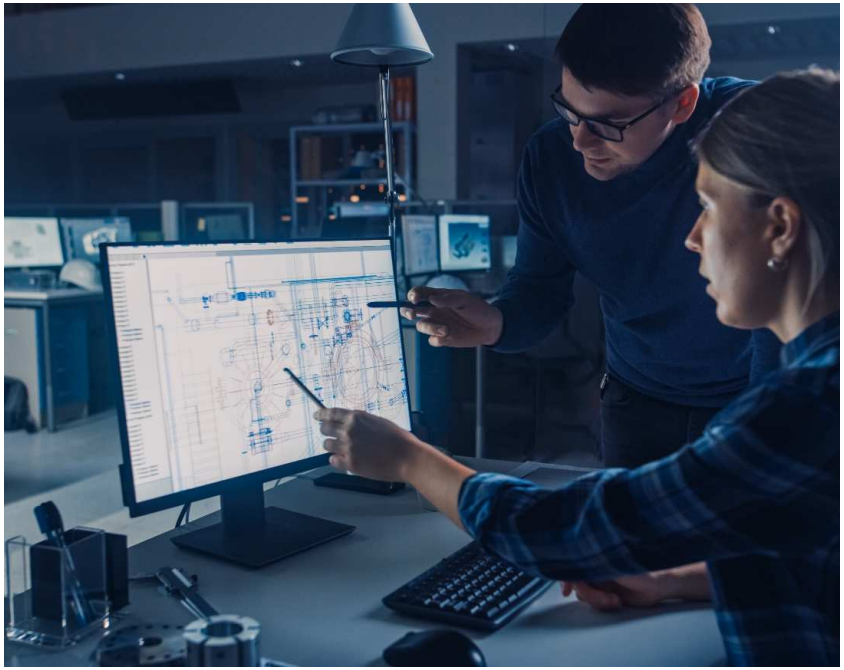
- Performance of equipment and control operation.
- Risk Assessment and safety procedures.
- Knowledge and understanding of the different sectors (hydrogen, renewables, oil and gas, offshore and marine platforms).

Conclusions
BV Owner's Engineering

Bureau Veritas OE Services aim at assisting clients in the identification of technological aspects that are key in conception to ready to build phases.

This solution includes works related to:

- Feasibilities studies
- Hydrogen market analysis
- Technical & operational studies of all technologies involved
- Integration between hydrogen and wind power studies
- Risk and safety analysis
- Assistance in all potential gaps in different engineering phases
- …
- And all services involved in future phases: procurement, construction, commissioning…



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