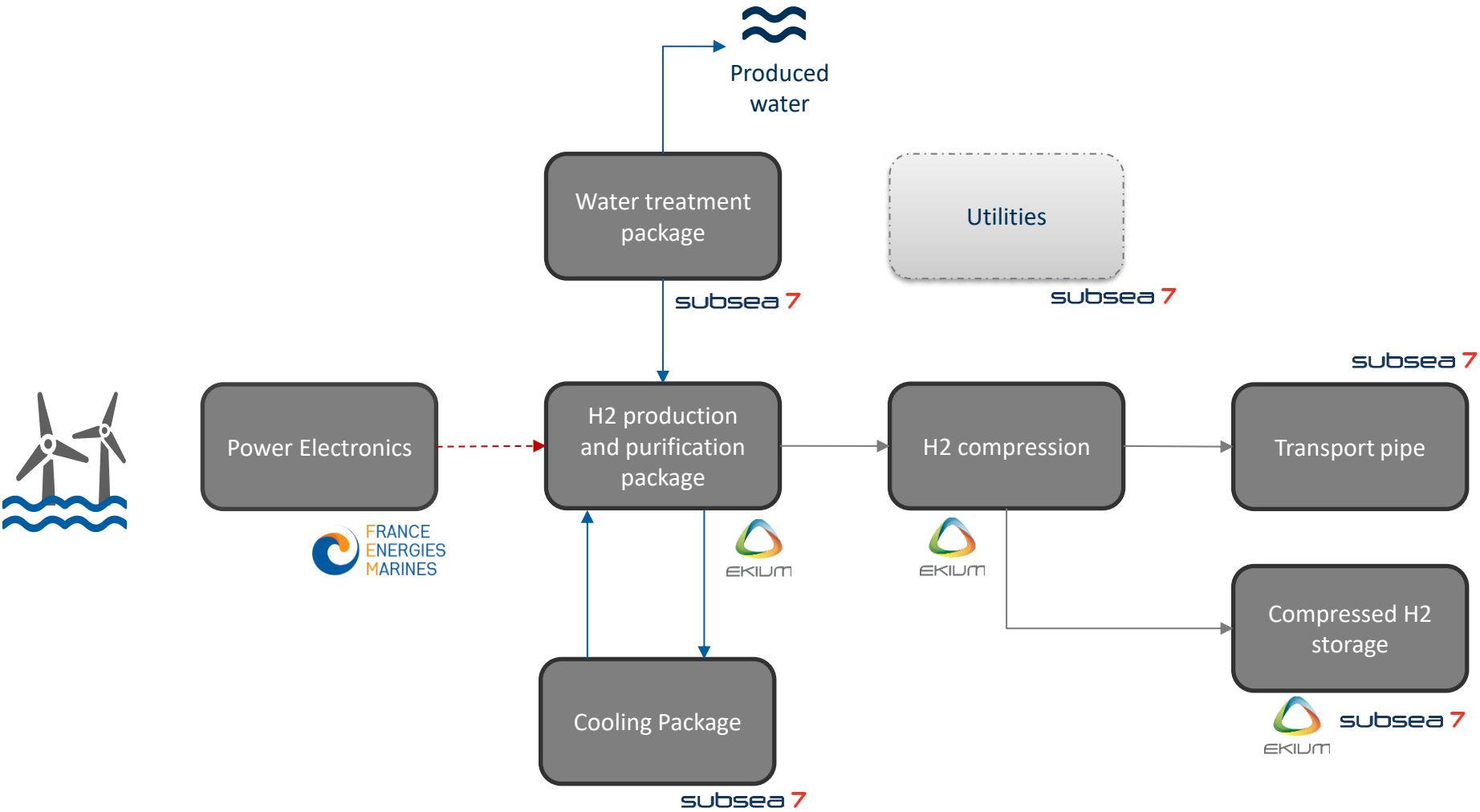
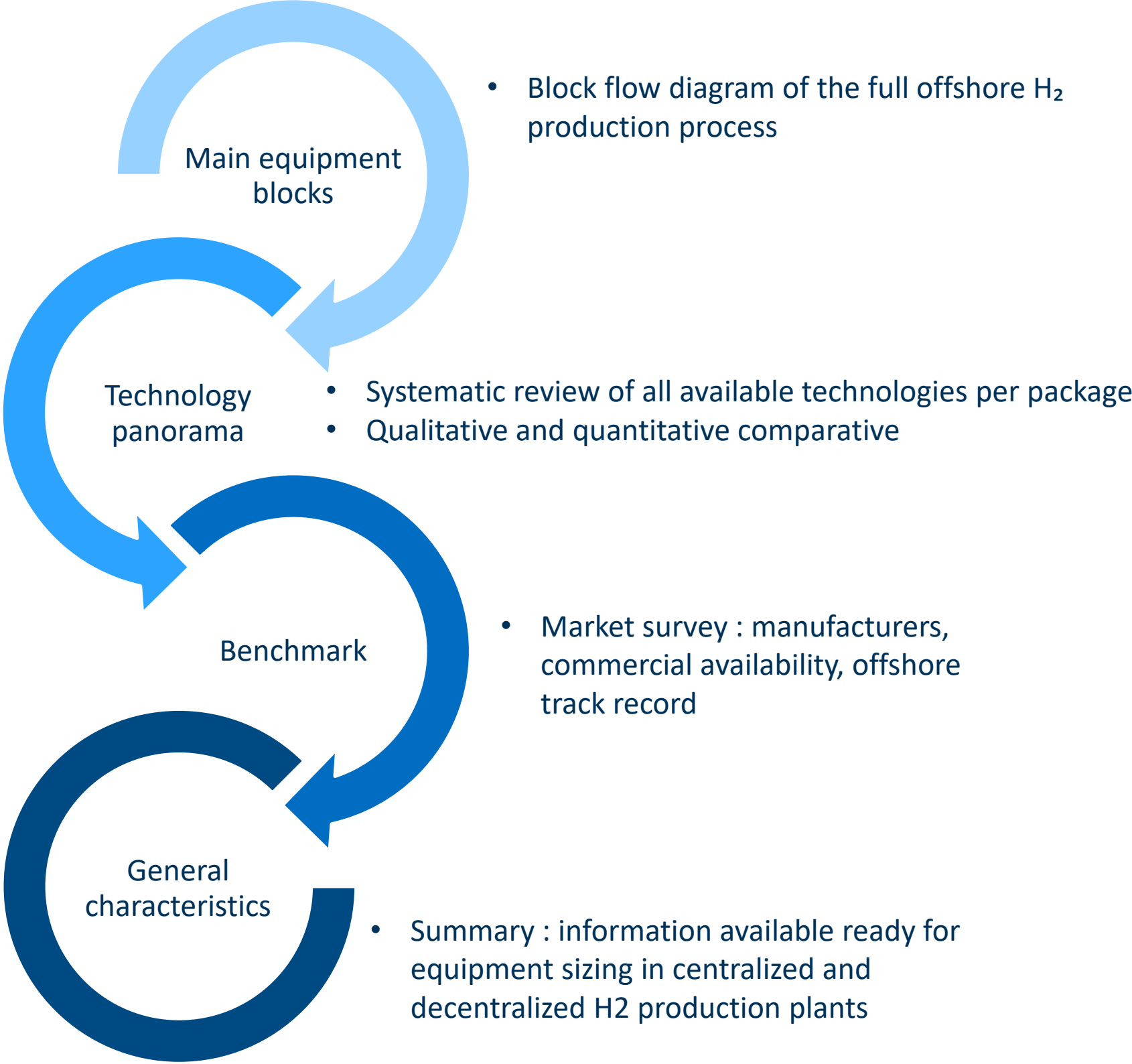


Design of a decentralized H₂ production unit

Technology Parametric Study *Equipment screening and selection*

Caroline MEVEL – EKIUM - Innovation Technical Manager

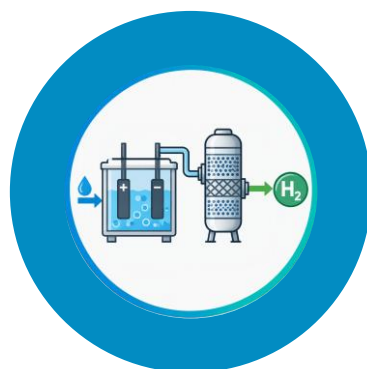
- The OPHARM 2 project aims to address a series of complementary aspects of renewable H2 production from OWF
- A technology assessment is necessary, not only for the water electrolysis process, but for the complete plant
- Develop a methodology to select the equipment for offshore hydrogen production
 - Centralised
 - Decentralised
- Definition of the interfaces and identify the main building blocks required to guarantee an H2 production offshore



skyborn Reviewer on all packages

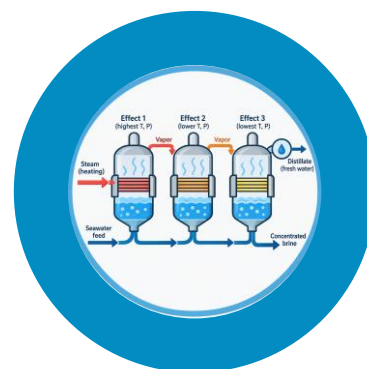
Persee Contributor on H₂ production, Compression, Storage

Main packages studied



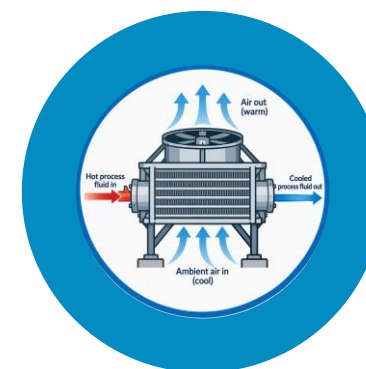
Hydrogen production and Purification

PEM electrolyser selected:
dynamic response; compactness;
plug&play solutions



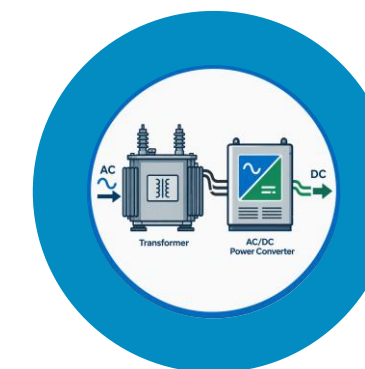
Water treatment package
(water desalination)

Multi-effect distillation
Lower chemical level on pre-
treatment, waste heat recovery



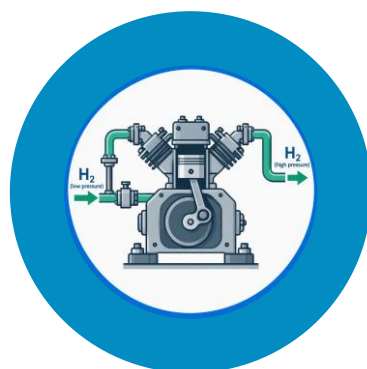
Cooling Package

Plate heat exchanger
More compact footprint



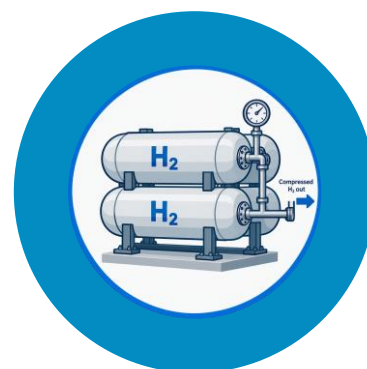
Power Electronics

Power Electronics
Transformer, SF6-free GIS, Li-Ion
batteries



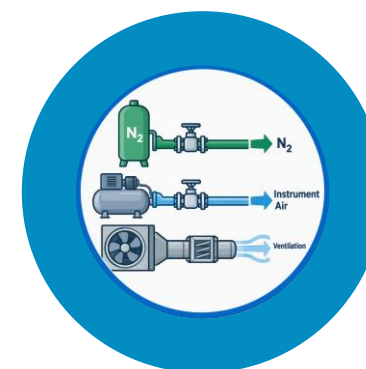
Compression

**Reciprocating piston
compressor selected:**
Mature technology (TRL 9),
adaptable flow rates



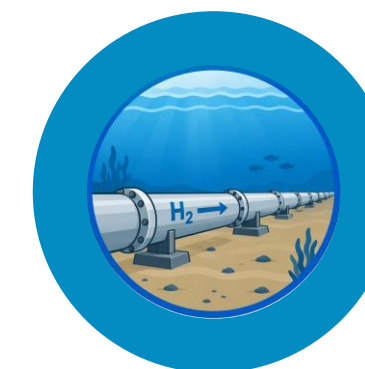
Compressed H2 storage
(topside & subsea)

Type III & IV composite vessels
Offshore track record available;
bundled MEGC solutions



Utilities

Utilities
PSA for N2 production
IA skid mounted



Transport Pipe

Transport Pipe
Carbon steel rigid pipe are cost
effective solution

- Main criteria evaluated:

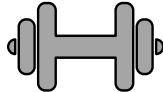
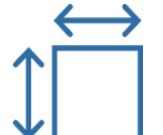
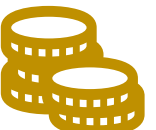
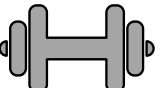
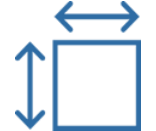
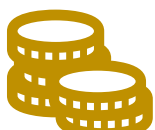
- Process adaptation
- Offshore environment suitability
- Technology maturity and availability

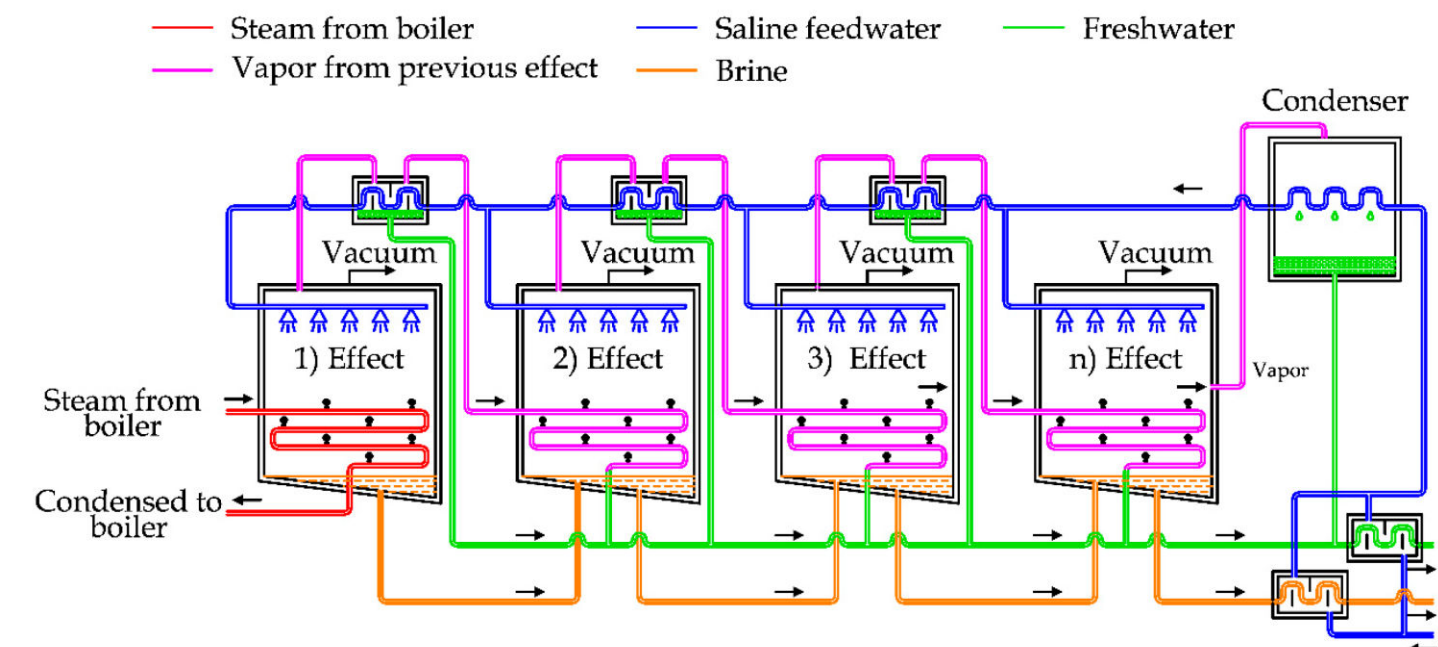
- Main equipment characteristics normalised (footprint, CAPEX, energy consumption)

- Ease the technology selection

Practical example:

Water package: discussions between environmental and technical specialists defined that the most suitable option would be the Multi-effect Distillation (less chemical products and allows for waste heat valorisation)

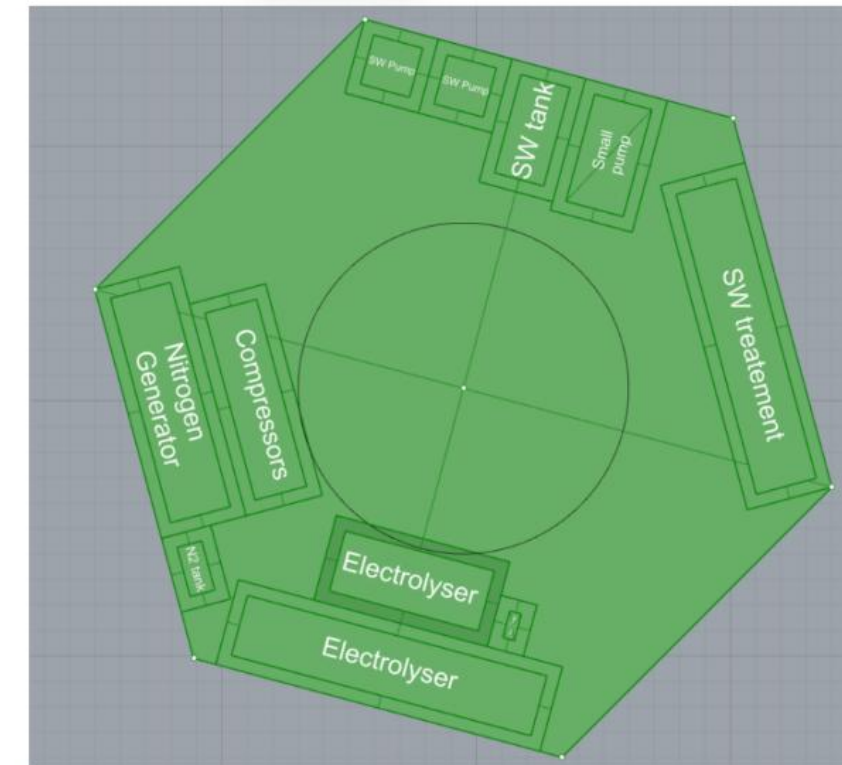
Technology	Type I	Type IV
General characteristics (NOTE 1)	 x 8  x 10  x 1	 x 1  x 1,4  x 3,7



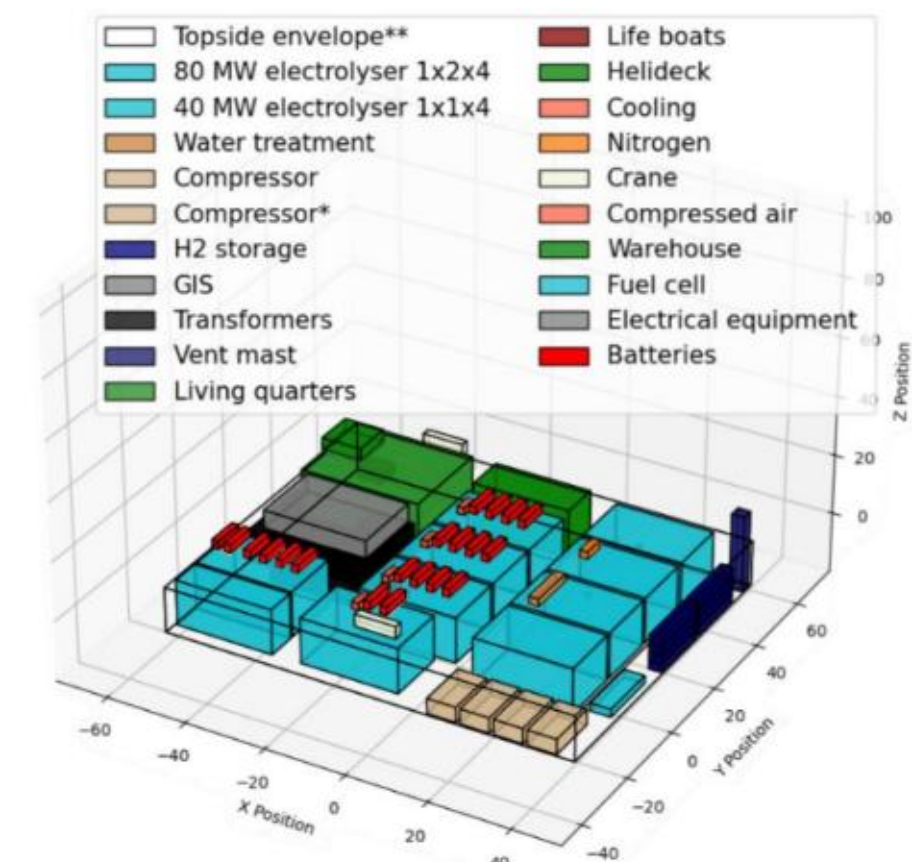
Domenico Curto , Vincenzo Franzitta and Andrea Guerri, A Review of the Water Desalination Technologie, Appl. Sci. 2021, 11, 670. <https://doi.org/10.3390/app11020670>

- The methodology enabled the **sizing of the main equipment** for both **centralized** and **decentralized** H2 production facilities.
- A **collaborative approach** leveraging a **multidisciplinary team of experts**.
 - Ability to **critically assess and challenge technology** selections.

Decentralised H2 Facility (Credits: Subsea7)



Centralised H2 Facility (Credits: FEM)



- **Utilities — Nitrogen Generation**
 - Pressure Swing Adsorption (PSA) — selected
 - High nitrogen purity: $\geq 99.99\%$ → prevents explosive H_2/O_2 atmospheres during venting
 - Field-proven technology; containerisable
 - Low operational cost and low environmental impact
 - Preferred over polymer membrane (insufficient purity) and cryogenic distillation (high CAPEX, energy-intensive, not qualified for offshore small-scale generators)
- **Utilities — Instrument Air Package**
 - Skid-Mounted Instrument Air Package — selected
 - Proven solution in offshore environment
 - Integrates air compressors, dryers, filtration, air receivers and nitrogen generators in one unit
 - Containerisable for easy offshore integration
 - Key design choice: rotary screw vs. centrifugal compressor depending on flow requirements
 - For decentralised applications, nitrogen can substitute instrument air to save space
- **Carbon steel rigid pipe — selected for export line**
 - Most cost-effective solution for long-distance offshore H_2 export
 - Proven technology in Oil & Gas, adaptable to hydrogen service
 - Operating pressure up to 200 bar; pipe diameter up to 36 inches OD
 - Key challenge: hydrogen embrittlement → several steel grade qualification programmes currently ongoing
 - Flexible pipeline preferred for infield lines and dynamic risers (2 to 22 inches, up to 350 bar)
 - Non-metallic composite pipe (TCP) viable for infield lines: up to 7.5 inches ID, 42–690 bar — good corrosion resistance but limited diameter
 - Coiled tubing suitable for infield lines only (up to 5 inches ID, 350 bar)
 - CRA rigid pipe not applicable for dynamic riser sections