

CDTI-NEDO online Joint Workshop on Hydrogen Technology  
- Green Hydrogen Production & Mobility -



OCEANH2  
Generation, Storage and Distribution  
of Offshore Green Hydrogen

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UNE Industrial. Construcción. ACCIONA





- ✓ **ACCIONA Industrial** is a specialist in high-tech EPC/turnkey projects.
  - We carry out our activities along **eight Business Units**:

THERMAL POWER GENERATION



PHOTOVOLTAIC POWER GENERATION



HYDROELECTRIC POWER GENERATION



WIND



OIL & GAS



TRANSMISSION GRIDS AND SUBSTATIONS



FACILITIES



ALTERNATIVE ENERGIES



- We lead each stage of these **EPC** projects: basic and detailed engineering, procurement, construction, assembly, launch, operation and maintenance.
- *We innovate and execute with the highest standards of **quality** and respect for the **environment** in all the projects in which we participate.*

**+20**  
countries with activity

*Highlighting Spain, Mexico, South Africa, United Arab Emirates, Singapore, Australia, Morocco, Brazil*

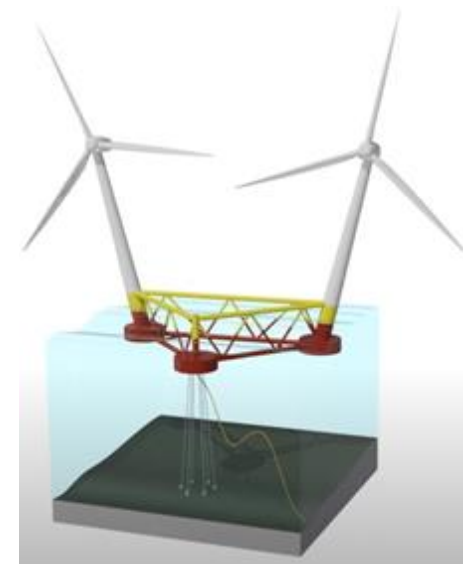


# Innovative Solutions in OCEANH2



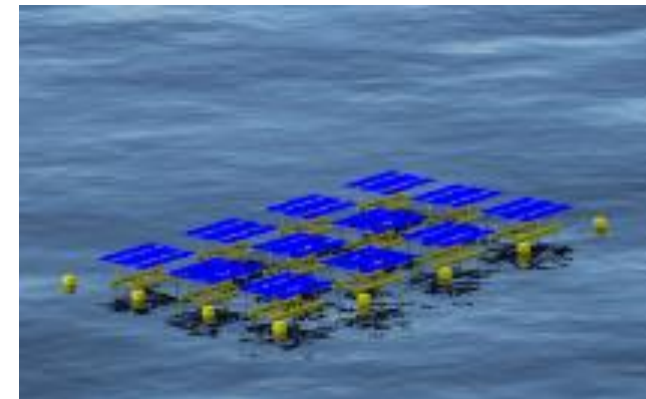
✓ **Floating wind platform** following criteria of scalability, modularity (simplification and cost reduction of construction and maintenance processes)

- Study of new materials: composites
- Design to produce and storage hydrogen on the floating platform.



✓ A competitive Floating PV platform compared to other alternatives for electric power generation in oceanic environments, based on criteria of simplicity, high efficiency, flexibility, modularity, robustness and scalability

- Structural design of the **floating catamaran configuration** to withstand metocean conditions





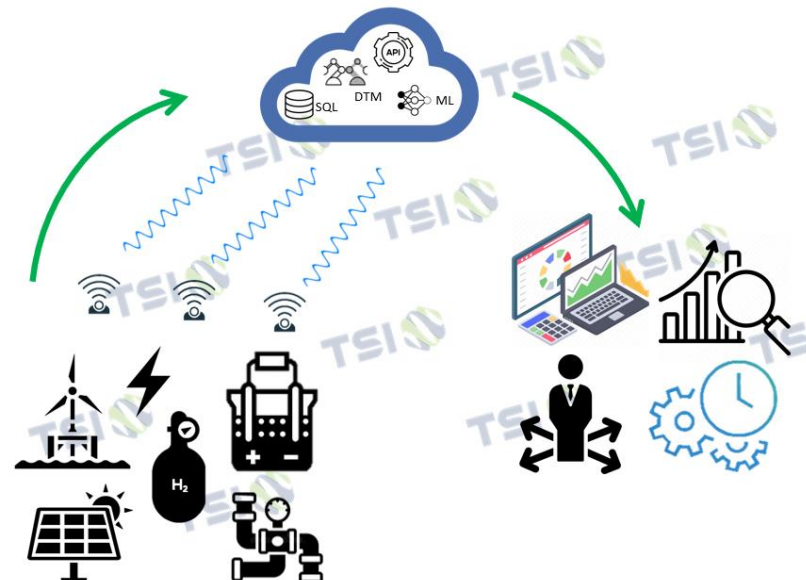
✓ A new type of electrolyzer

- **Electromechanical design of the stack adapting its operation on a mobile platform and the marine environment:** new geometry that allows minimizing the difference in concentrations of liquid and gas at different points in the system caused by oscillations in the marine environment.
- **Improved** with alkaline-based operation that will study the possibility of incorporating a new system of polymeric exchange membranes, which also allows incorporating some of the advantages of PEM electrolysis



✓ Monitoring, control and operation system applicable to the hybrid generation infrastructure of green H2 from renewable offshore photovoltaic-wind energy.

- **Based on IoT technologies** that allow efficient assets and components monitoring of the global generation, storage and distribution infrastructure.
- **The objective is to control the operation and maintenance of the components**, allowing to predict malfunctions from the analysis of data in the cloud thanks to the application of machine learning algorithms.
- Definition of the application strategy of **industry 4.0 tools** to the offshore sector for the implementation of **performance models, Digital Twins and predictive maintenance techniques**



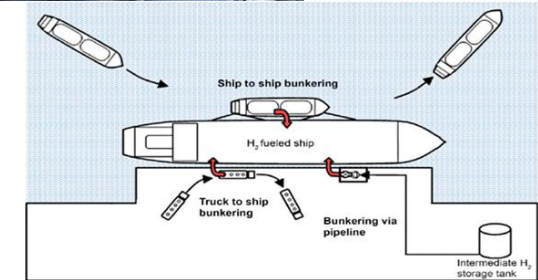




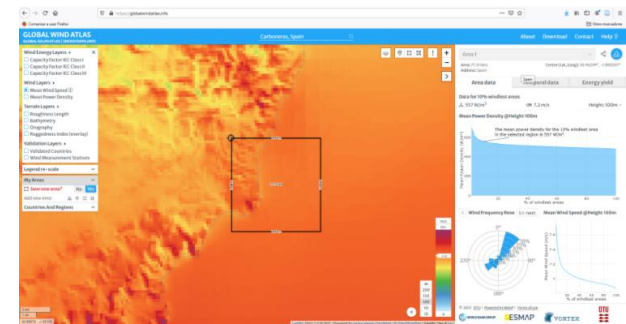
# Innovative Solutions in OCEANH2



- ✓ Design of subsystems for the transport of hydrogen by pipeline taking into account meta-oceanic conditions, construction technologies and estimated foreseeable investment and operating costs
- ✓ Conceptual design of subsystems for loading, transporting and unloading hydrogen by ships such as storage as compressed gas, diluted in solid or liquid materials or liquefied
- ✓ H2 bunkering subsystem design:
  - Platform-to-ship, ship-to-ship, port-to-ship, track-to-ship




- ✓ Combined Resource Assessment and Prediction Tool
  - Combined Resource Assessment and Prediction Tool applicable to hybrid infrastructure for the generation of green H<sub>2</sub> from renewable offshore photovoltaic-wind energy
  - Combined with techno-economic modeling, it allows to guarantee the H<sub>2</sub> production of an OCEANH2 type plant

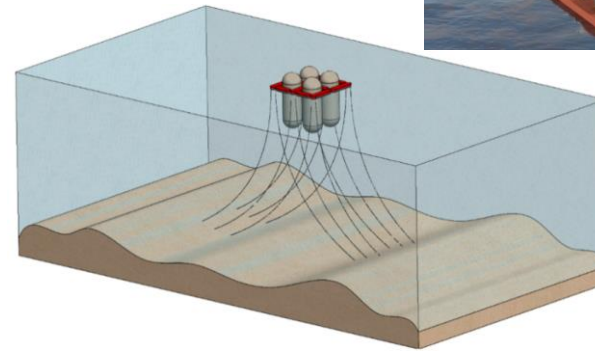





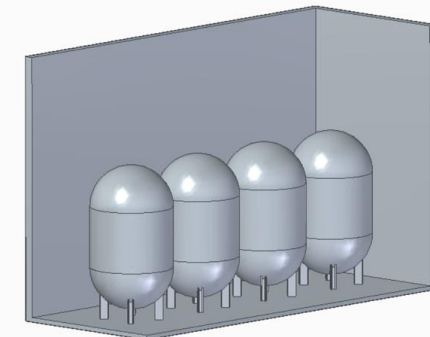
# Innovative Solutions in OCEANH2



-  **acciona** ✓ Large-scale pressure floating storage for hydrogen gas
- Possibility of installing all the necessary equipment for the generation, storage and distribution of hydrogen (central island)
  - Depths > 50 meters
  - Research in new materials for pressure applications: concrete, metal



-  **acciona** ✓ Bunker-type concrete storage at high green hydrogen pressure (> 100 bar)
- Storage for quantities greater than 10 tons of hydrogen / GBS
  - mooring for loading and unloading of vessels H2. Hydrogen Ship Refuel Station
  - Superstructure for auxiliary installations: electrolyzer, compressors, electrical substations.
  - Depths < 35 meters

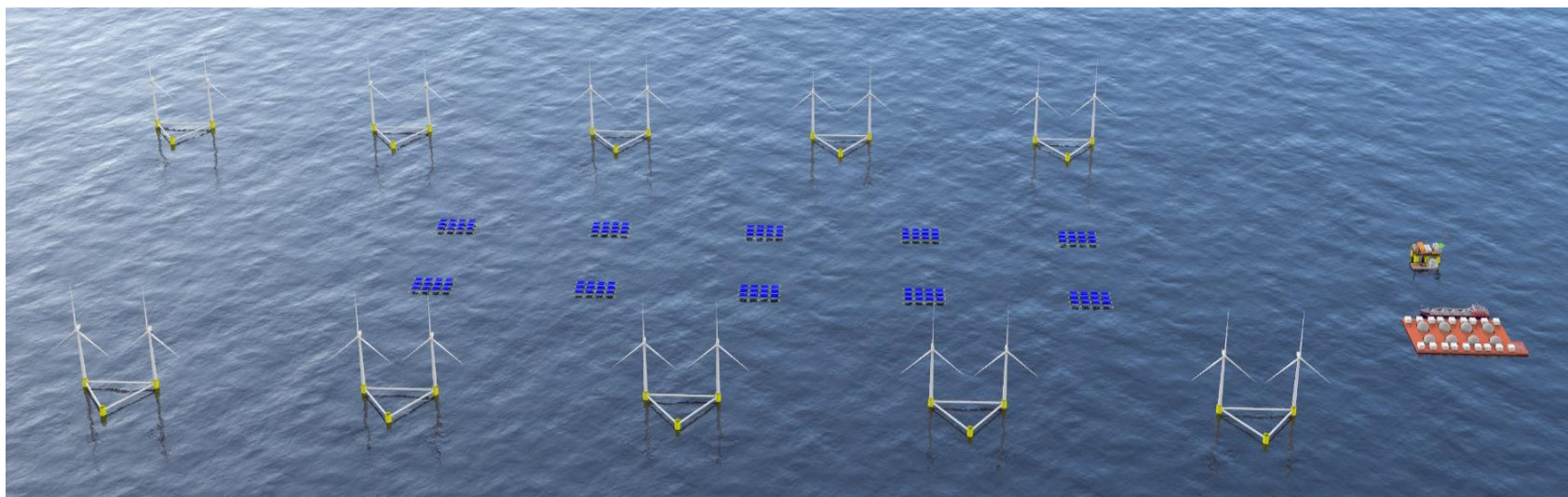




# Main challenges and solutions in OCEANH2: OBJECTIVES:



- ✓ Design and optimization of a modular, flexible and intelligent **offshore green hydrogen generation, storage and transport plant** based on offshore renewable electricity generation, hybridizing wind and photovoltaic floating Technology



- ✓ **Modularity** of the plant analyzing **the feasibility of small (10-20 MW) and large-scale (0.5-1 GW)** solution in order to position itself as a potential energy vector of the ecological transition.



# Main challenges and solutions in OCEANH2: ALL VALUE CHAIN OF H2

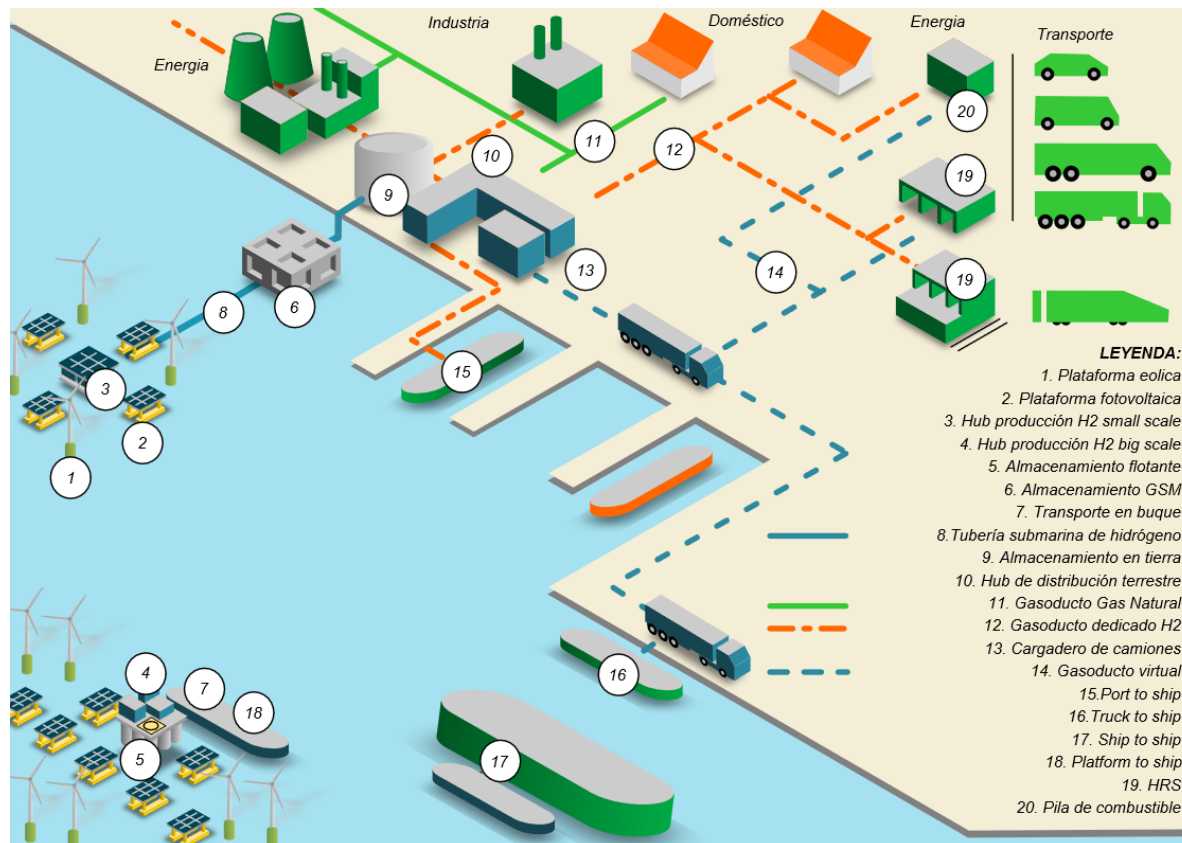


1. Hybrid offshore floating renewable energy generation sources: wind and solar fotovoltaic.

2. Generation system of offshore hydrogen by electrolysis of water.

3. Offshore chemical storage in hydrogen for two depths: **floating** for offshore use at depths greater than 50m and **fixed** (Gravity Based Structure, GBS) for use at depths up to 35m.

4. Distribution and transport systems through the flexible and intelligent integration in other existing and future hydrogen distribution networks, both at the point of view of energy production and discharge or use.







# Main challenges and solutions in OCEANH2: MOTIVATION



- ✓ Cost Reduction in all the value chain of the green hydrogen
  - How?
    - Increasing Operation hour of electrolyzers
      - Hybridation of renewables energies
      - Offshore wind farm > 3500 equivalent operation hour
    - Decreasing LCOE -> New Designs, Optimization and modularity.
    - Hydrogen and green energy generation duality
    - Generating H2 next to the consumer – Hydrogen Ship Refuel Station // Pipeline Distribution
    - Scaling - Up
  
- ✓ Positive Impact
  - How?
    - Use renewable energy and decrease of the CO2 emissions during manufacturing, construction and start-up phases
    - Increasing the Utilization Factor of marine space



# Main challenges and solutions in OCEANH2: Key Points: SCALE UP & OPERATION HOURS



- ✓ LCOH for a 100MW electrolyzer for industrial use (ALK & PEM)

## 1. LCOH Alcalino

LCOH		PRECIO DE LA ELECTRICIDAD (€/MWh)								
		40	37.5	35	32.5	30	27.5	25	22.5	20
HORAS DE FUNCIONAMIENTO (h)	2000	4.674	4.529	4.315	4.170	4.011	3.832	3.644	3.445	3.234
	2500	4.165	4.020	3.851	3.674	3.468	3.269	3.123	2.977	2.831
	3000	3.865	3.683	3.505	3.295	3.149	3.003	2.857	2.710	2.564
	3500	3.629	3.400	3.254	3.107	2.961	2.814	2.667	2.521	2.374
	4000	3.409	3.262	3.115	2.968	2.821	2.674	2.527	2.380	2.233
	4500	3.302	3.155	3.008	2.860	2.713	2.565	2.418	2.271	2.123
	5000	3.219	3.071	2.923	2.775	2.627	2.480	2.332	2.184	2.032
	5500	3.151	3.003	2.855	2.707	2.558	2.410	2.262	2.110	1.961
	6000	3.096	2.948	2.799	2.650	2.502	2.353	2.201	2.052	1.903
	6500	3.051	2.902	2.753	2.604	2.455	2.302	2.153	2.004	1.855
	7000	3.012	2.863	2.714	2.564	2.411	2.262	2.113	1.963	1.814
	7500	2.980	2.830	2.681	2.528	2.378	2.228	2.078	1.928	1.779
	8000	2.953	2.803	2.649	2.499	2.349	2.199	2.049	1.898	1.748

## 2. LCOH PEM

LCOH		PRECIO DE LA ELECTRICIDAD (€/MWh)								
		40	37.5	35	32.5	30	27.5	25	22.5	20
HORAS DE FUNCIONAMIENTO (h)	2000	5.933	5.778	5.623	5.467	5.312	5.157	5.002	4.752	4.596
	2500	5.270	5.114	4.958	4.802	4.570	4.414	4.243	4.070	3.872
	3000	4.832	4.675	4.519	4.298	4.142	3.958	3.745	3.539	3.321
	3500	4.522	4.349	4.152	3.984	3.784	3.566	3.356	3.199	3.041
	4000	4.285	4.086	3.918	3.723	3.465	3.307	3.149	2.991	2.833
	4500	4.084	3.914	3.713	3.465	3.307	3.148	2.989	2.831	2.672
	5000	3.938	3.771	3.500	3.341	3.182	3.022	2.863	2.704	2.544
	5500	3.829	3.592	3.401	3.241	3.081	2.921	2.761	2.601	2.441
	6000	3.741	3.480	3.320	3.159	2.998	2.838	2.677	2.516	2.356
	6500	3.639	3.414	3.252	3.091	2.930	2.768	2.607	2.445	2.284
	7000	3.520	3.358	3.196	3.034	2.872	2.710	2.548	2.386	2.224
	7500	3.473	3.311	3.148	2.985	2.823	2.660	2.497	2.335	2.172
	8000	3.434	3.271	3.107	2.944	2.781	2.617	2.454	2.291	2.127

- ✓ Cost out of this scope
  - Renewable power plant cost and conection to guarantee a Green hydrogen production
  - Modifications in industry for the use of the Green hydrogen
  - Big Storage due to industrial use of hydrogen
  - Transport of this hydrogen due to industrial use of hydrogen



# Ideas for a Japan – Spain collaboration



- ✓ Feasibility studies of locations and different scenarios (onshore and offshore)
  - Japan Meteoceanic conditions
  
- ✓ Scaling up of innovative solutions of OCEANH2
  - Proof of Concepts (TRL5 to TRL7)
  - Commercial projects incorporating individual solutions in all the value chain of the green H2.
  
- ✓ Help each other and advance together
  - OCEANH2 can help in the management of the space in saturated ports with the transport of hydrogen
  - JAPAN companies or institutions can help us in the conceptual design of offshore hydrogen transfer to vehicular use including heavy vehicles (ships)
  
- ✓ Spain can sell and export Green Hydrogen to Japan as a country with a great solar and wind resource.



# Ideas for a Japan – Spain collaboration



¡Muchas gracias!

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