

# Wind industry in the green Hydrogen revolution

Siemens Energy Hydrogen Day

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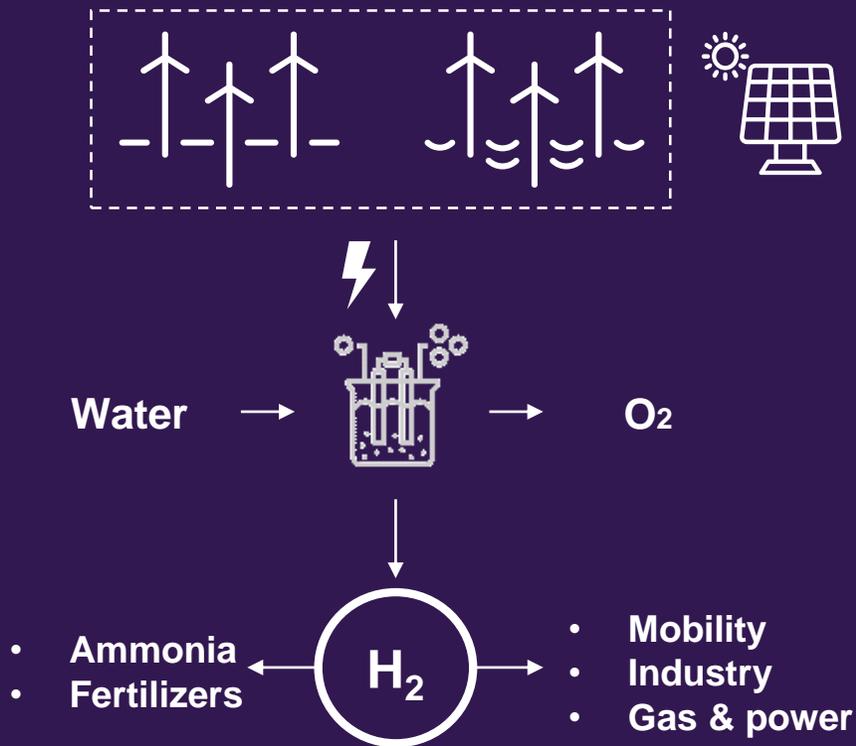
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# Wind will be at the center of green Hydrogen revolution

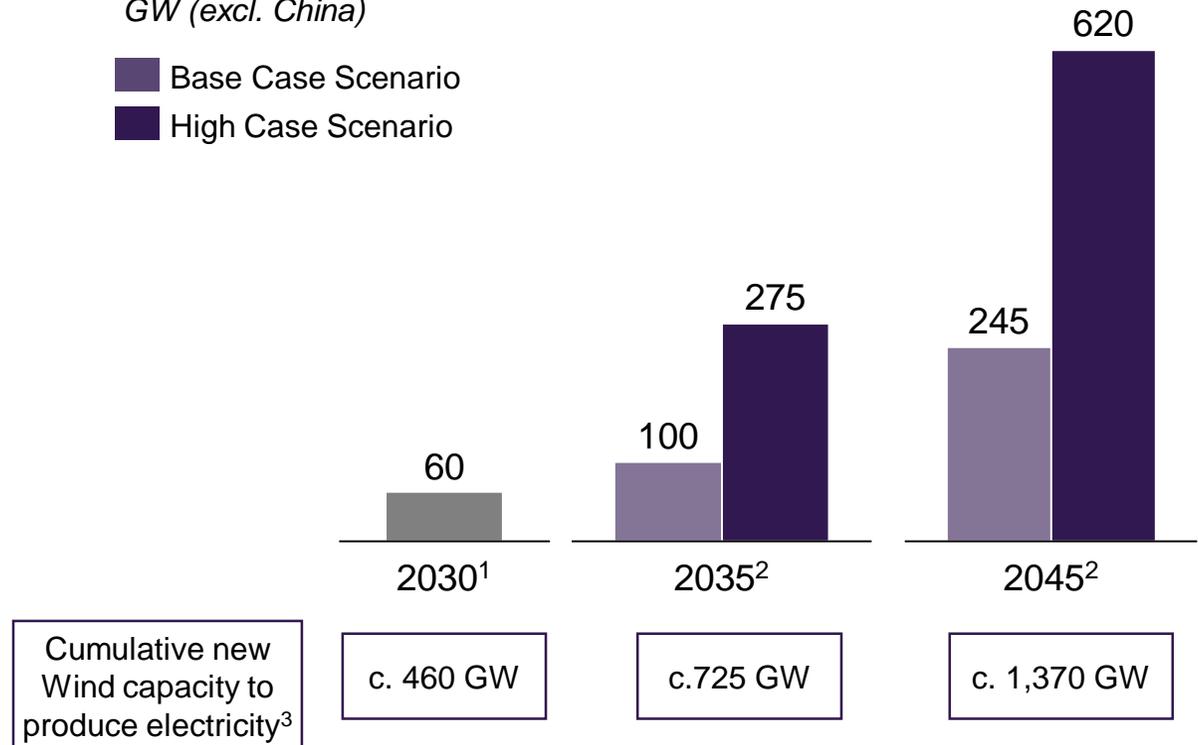


# Hydrogen will unlock additional demand potential for Wind installations

## Global cumulative Wind capacity installed to produce green Hydrogen

GW (excl. China)

- Base Case Scenario
- High Case Scenario



(Since 2020, excl. China)

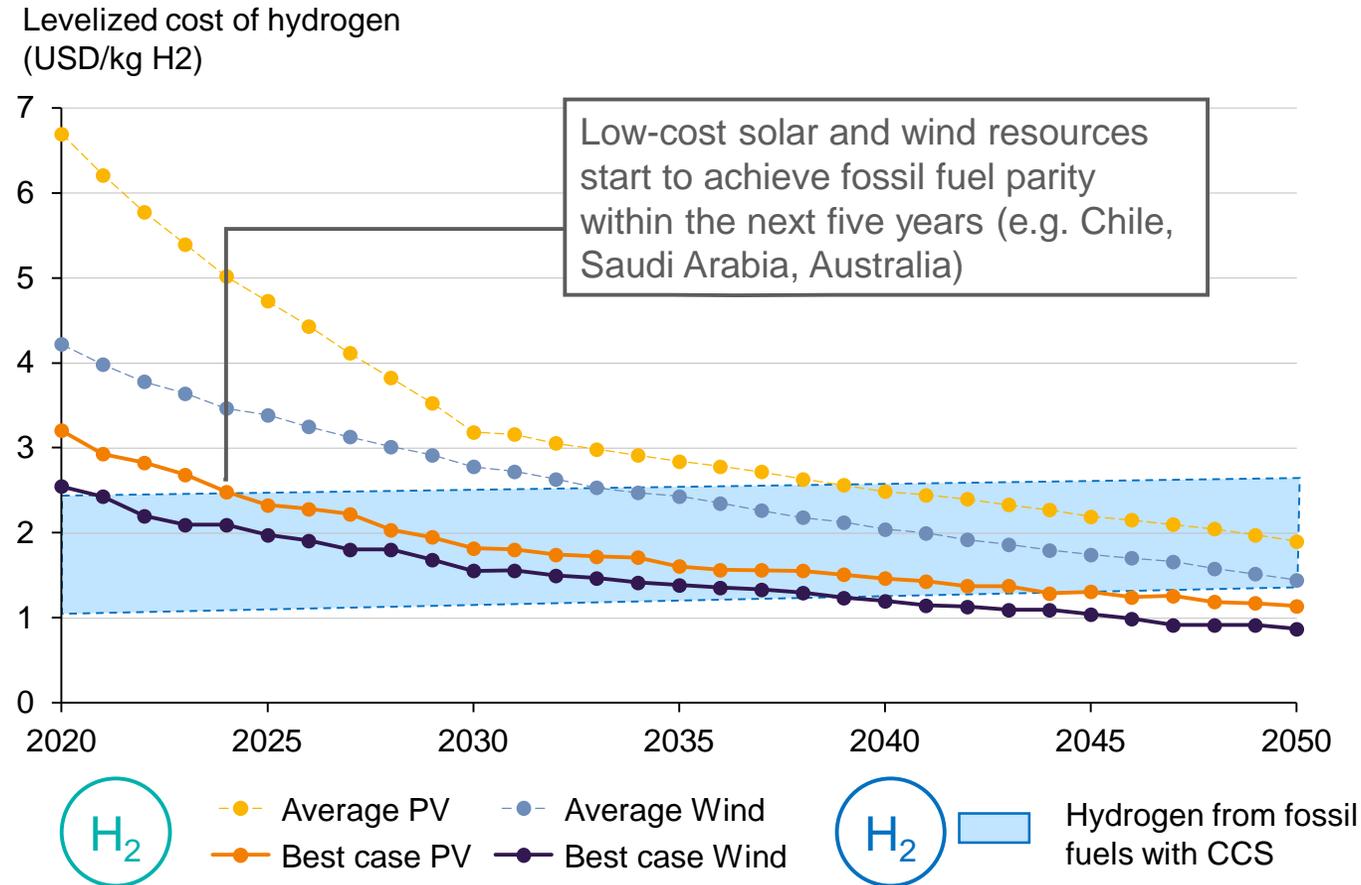
1) Based on analyst reports and Hydrogen EU.

2) Source: IHS report "Outlook for the role of hydrogen in the global energy mix" (Nov 2020). New wind capacity required for H<sub>2</sub> production

3) Source: IHS "Global Wind Power Market Outlook" (March 2020)

# Cost of green H2 falling rapidly, with Wind as key enabler of future competitiveness

## Future cost of green H2 will be below those for blue H2 fossil fuels



## Highlights

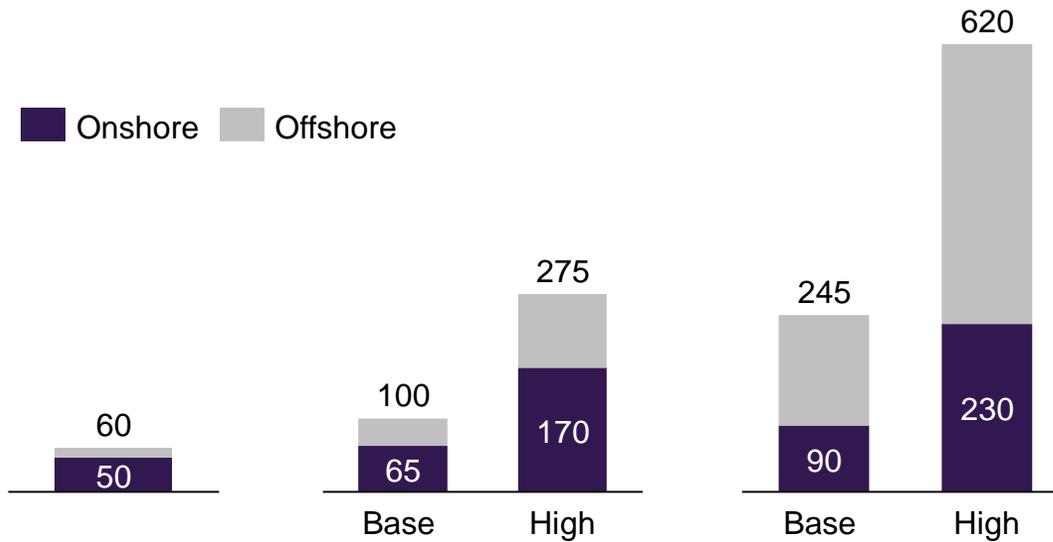
- **Green H<sub>2</sub>** is currently more expensive than conventional H<sub>2</sub> production from fossil fuels
- **Cost of green H<sub>2</sub> falling rapidly** due to combined effects of reduced electrolyzer cost and cheaper renewable power
- **Pricing of CO<sub>2</sub> emissions** from fossil fuels could further **improve competitiveness of green H<sub>2</sub>**
- In the **best locations**, renewable H<sub>2</sub> is **competitive in the next 5 years** compared to fossil fuels



## Onshore: source of green H2 production in the near future, with large scale projects from 2026 onwards

### Global cumulative capacity of Wind Onshore for H2 production

GW (Excl. China)



% Wind Onshore

2030<sup>1</sup>

80%

2035<sup>2</sup>

65%

2045<sup>2</sup>

40%

1) Based on analyst reports and Hydrogen EU.

2) Source: IHS report "Outlook for the role of hydrogen in the global energy mix" (Nov 2020). New wind capacity required for H2 production

3) Based on public announcements

- Onshore large scale projects expected from 2026 onwards
  - Prototypes already before 2025
  - Small-scale projects for **mobility applications or existing H2 use cases** (e.g. fertilizers) expected from 2023 onwards
- **Large-scale Hybrid projects** (Onshore Wind + PV) in countries with favorable resources (Australia, Chile) also constitute a **low-cost source for H2 export**

+ 30  
GW

Globally announced Onshore Hydrogen projects<sup>3</sup>

Key markets (with announced projects)

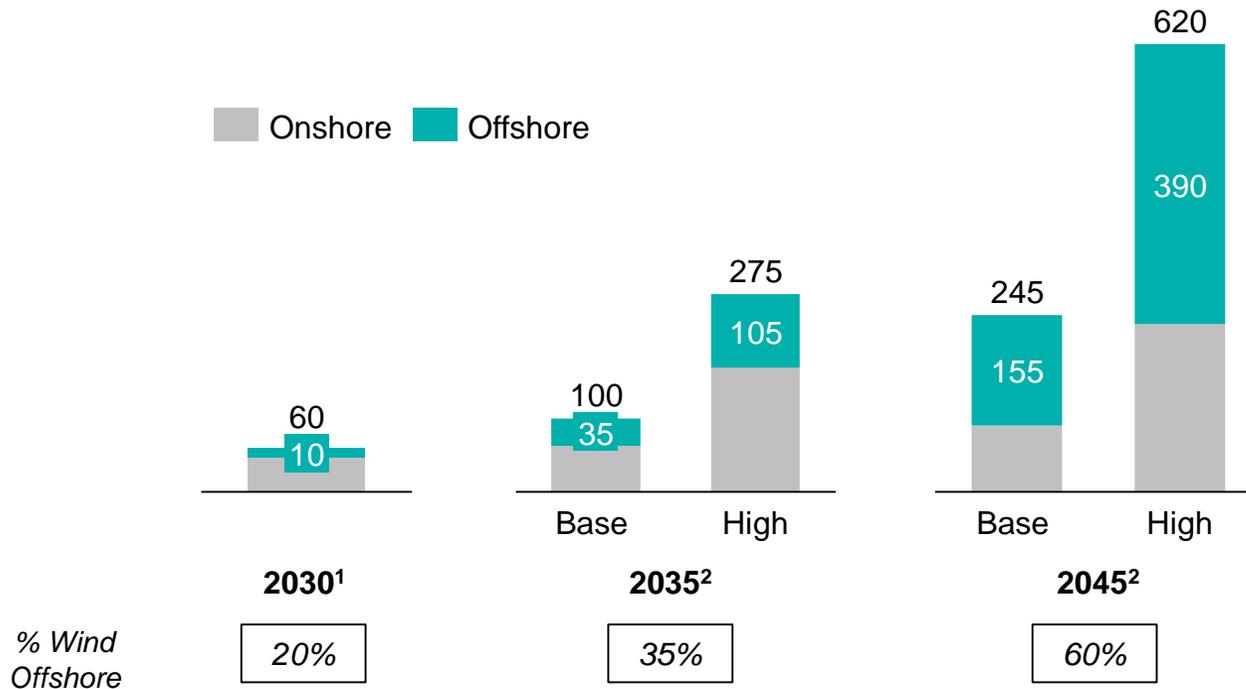




## Offshore: strong growth expected from 2030 onwards, with significant potential

### Global cumulative capacity of Wind Offshore for H2 production

GW (Excl. China)



1) Based on analyst reports and Hydrogen EU.

2) Source: IHS report "Outlook for the role of hydrogen in the global energy mix" (Nov 2020). New wind capacity required for H2 production

3) Based on public announcements

- First offshore large scale projects planned before the end of the decade
- North Sea initially as the most promising area, combining both **good wind resources and strong potential demand for H2** (rest of the world to follow with further potential)
- Offshore Wind **scalability, capacity factors and availability** optimal for large scale deployment in the longer-term

+ 20  
GW

Globally announced Offshore Hydrogen projects<sup>3</sup>

Key markets (with announced projects)



## **Brownfield: Adding an electrolyzer into existing Wind farms could also have substantial potential**

### Key uses cases for brownfield H2 production

Wind farms with **expiring feed-in tariffs/ incentives**, willing to identify new revenue streams...

... in markets with **decreasing/ low electricity prices** and/or **high volatility**

... and located **close to large Hydrogen demand hubs** (e.g. harbors, ammonia clusters, etc.)

**Brownfield H2 production expected to have strong growth**, allowing existing assets to contribute even further to the energy transition



- **First brownfield** projects expected **already before 2025**, with some demonstrators currently being deployed
- **Brownfield Hydrogen sites can yield significant benefits vs. Greenfield**
  - Existing plants' life extension implies **lower CAPEX requirements** and thus **more competitive LCOH**
  - **Simplified project development and feasibility analysis** as the plant is already known (real data availability)

### Sample markets for brownfield H2 production



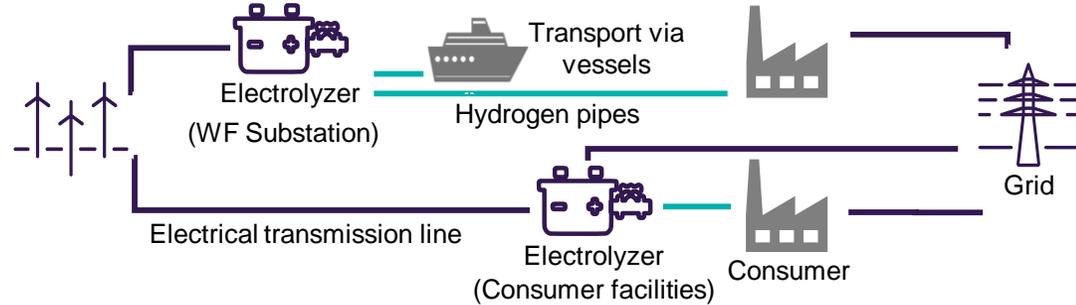
# SGRE exploring different business models by Business Unit

## Business Model

**Onshore**

### Centralized solution *(at least for first phase)*

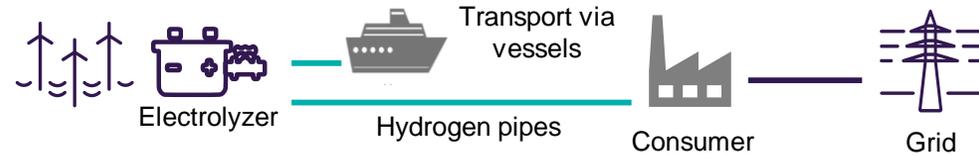
- Electrolyzer located at substation level or close to consumer facilities
- No significant hydrogen specific Wind turbine development required in the short-term



**Offshore**

### Decentralized solution

- Electrolyzer integrated on the WTG
- Wind turbine adaptations required



**Service**

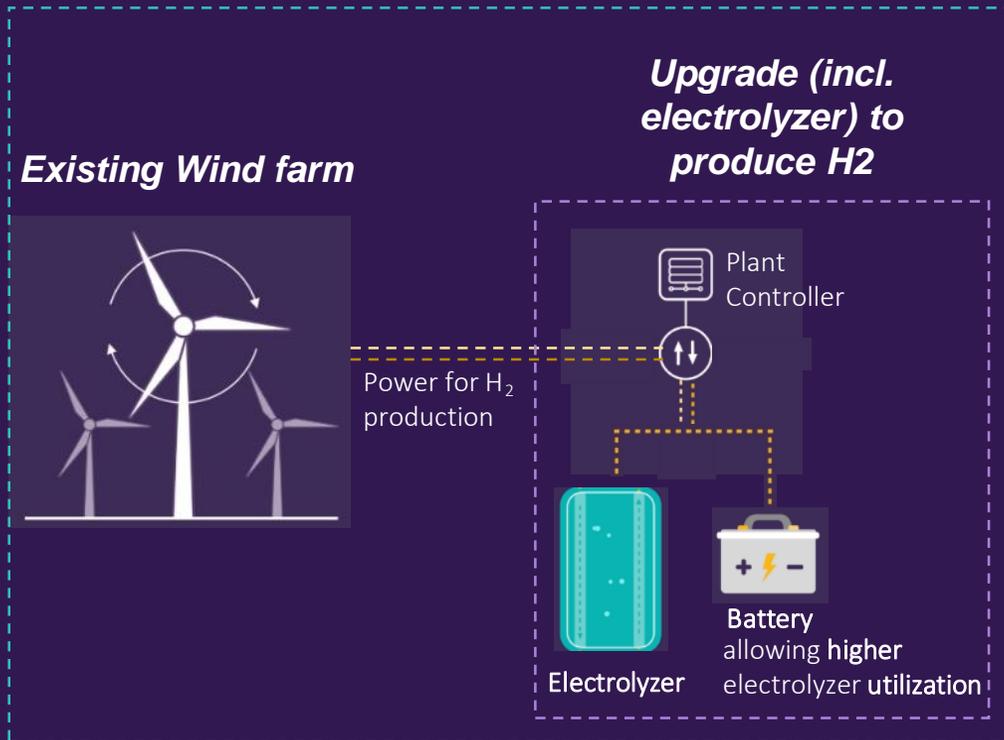
**Greenfield and brownfield opportunities with potential opportunity for expanded scope**



## SGRE already taking significant steps in shaping the industry: Brownfield Concept

*Renewable H2 Upgrade product integrates an electrolyzer into an existing Wind farm...*

### Product concept description



*... providing sound benefits to existing assets*

### Benefits

- 1** Adds a **new value stream** by enabling the generation of **green Hydrogen**
- 2** **Increases the value of Wind power** by using it **before** it goes to grid
- 3** Makes the plant **flexible**, allowing the assets to contribute even more to the energy transition

### Pilot project

Brande (DK) demonstrator:

**3MW onshore turbine**  
**300kW electrolyzer**

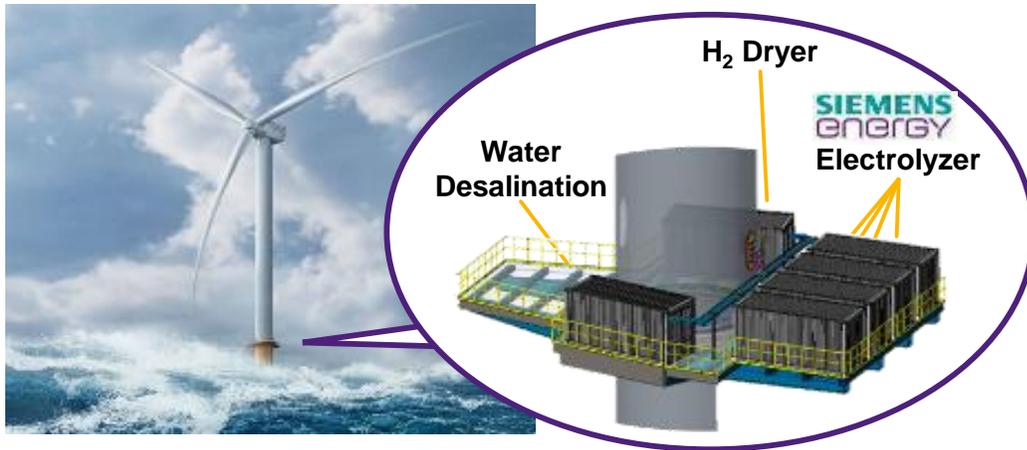
H<sub>2</sub> output to be used **to fuel Copenhagen taxis**



## SGRE already taking significant steps in shaping the industry: Decentralized offshore solution

*Offshore decentralized solution integrates SE Electrolyzer into the Wind turbine...*

### Offshore decentralized solution description



**SIEMENS Gamesa**  
RENEWABLE ENERGY

Wind turbine

**Modified WTG** to produce H<sub>2</sub>  
at turbine level

**SIEMENS**  
energy

Electrolyzer

**Plug & play containerized solution** on a platform  
located at sea level

*...with clear benefits and value-add potential*

### Benefits (vs. centralized solution)



- **CAPEX reduction** by replacing high cost HV infrastructure with pipes network



- **Increase of system efficiency** due to lower HV electrical losses



- **Increase of plant load factor** as electrolyzer load more flexible than electrical network requirements

# SGRE already taking significant steps in shaping the industry: Partnership with Siemens Energy combines the strengths of the two companies

## Collaboration Strengths



**First Wind OEM** announcing a **H2 integrated solution**



**Global market leader in Offshore Wind**



**Multi-MW electrolyzer with presence in the whole Hydrogen value chain**



**Leader in PEM electrolysis technology**

## Scope of collaboration in Product Development



- **Adaptation of largest offshore turbine (SG14-222)**
- **Full integrated Wind+Electrolyzer solution**



- **Commercial scale electrolyzer with specific design for offshore use case**
- **Containerized, modular, scalable and pressurized plug & play platform solution**

