Navigating offshore green hydrogen production - the AmpHytrite project

Gertjan Jobse | Pondera Consult

Wind Finland Offshore | 14. May 2024

PONDERA

Planning & Development Consultancy

At Pondera, we envision a world powered solely by renewables.

Together we push for new frontiers in sustainable energy generation, transport, conversion, and storage.

We are Pondera – Pursuing new horizons in renewable energy.

PONDERA

Planning & Development Consultancy

Early-stage development

- Technical Due Diligence
- WRA and AEP calculations
- EYA analysis, LES-modelling
- Layout optimization
- Grid connection and landing studies
- Environmental Impact Assessment (EIA)
- Permitting / consenting
- Stakeholder engagement
- Market entry assessment

Tender Support

- Tender / contract strategy
- Strategy storyline
- Capex/Opex calculations
- Energy system integration
- Non-price criteria
- Bid writing
- Manage tender processes
- Compliance checks
- Procurement / contracting

Project Delivery

- Risk Management
- Contract management
- Owners' Engineering
- Permit management
- Package management
- Execution planning
- Construction management
- Works supervision
- Key personnel

EIK ISO 9001:2015 gecertificeerd

Hydrogen as an energy carrier

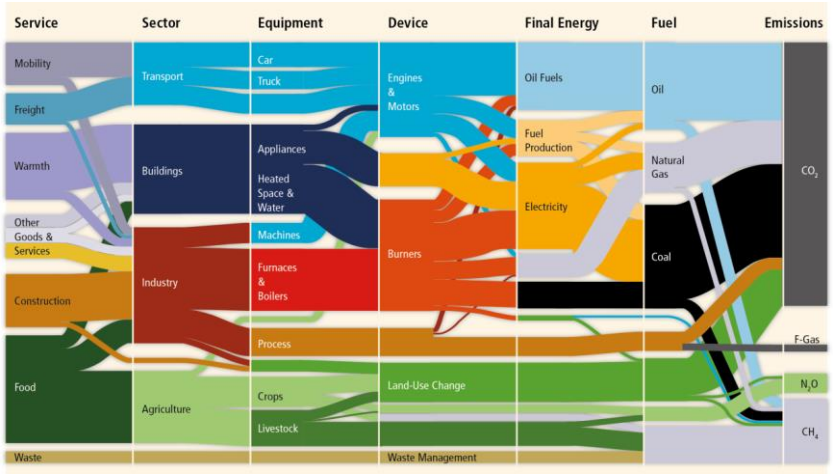
- H_2 = most abundant, essential element for de-carbonization, burns cleanly and we use it a lot!
- H_2 for decades has been hailed as a critical fuel for the future, potential never realized, now cheaper Renewable Energy

Le Lenoir Hippomobile 1863

"I believe that water will one day be employed as fuel, that hydrogen and oxygen which constitute it […], will furnish an inexhaustible source of heat and light, of an intensity of which coal is not capable."
Jules Verne, The Mysterious Island (1874)

Hydrogen key in decarbonization

IPCC



Source: Intergovernmental Panel on Climate Change. (2014). AR5 Climate Change 2014: Mitigation of Climate Change

1. **Electrification** of our energy system is in full effect, but electrification is not always the right choice;
2. Some sectors harder to decarbonise than others, full direct electrification is not expected to be feasible: **need for renewable fuels**;
3. Energy-carrying **molecules are essential** for transport and industry, need for sustainable molecules by renewable energy.

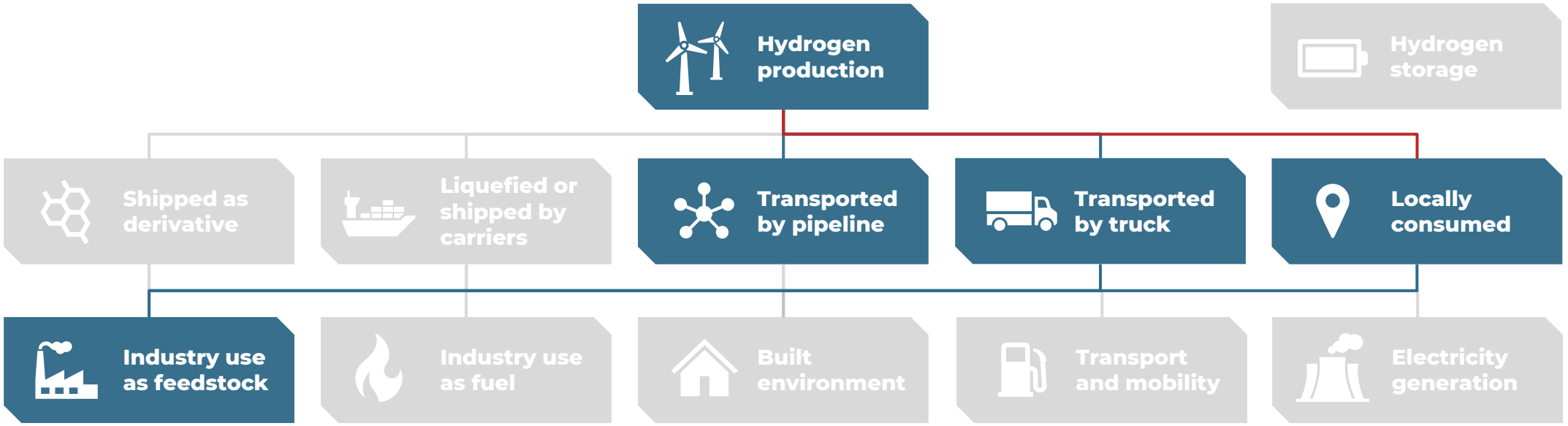
H_2 has the potential to decarbonise hard-to-abate sectors

Heavy duty transport

High heat processes in industry

Chemical industry (feedstock)

The hydrogen economy already exists !



The European hydrogen market landscape

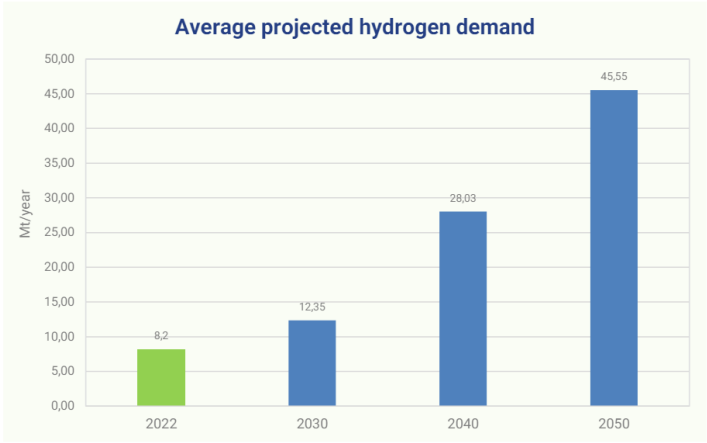


Figure 41. Average hydrogen demand projections of different scenarios in Europe for the years 2030, 2040 and 2050

Renewables Energy Directive (RED):

42% by 2030 (60% by 2035) of the **hydrogen** used in industry should come from **renewable fuels of non-biological origin** (RFNBOs).

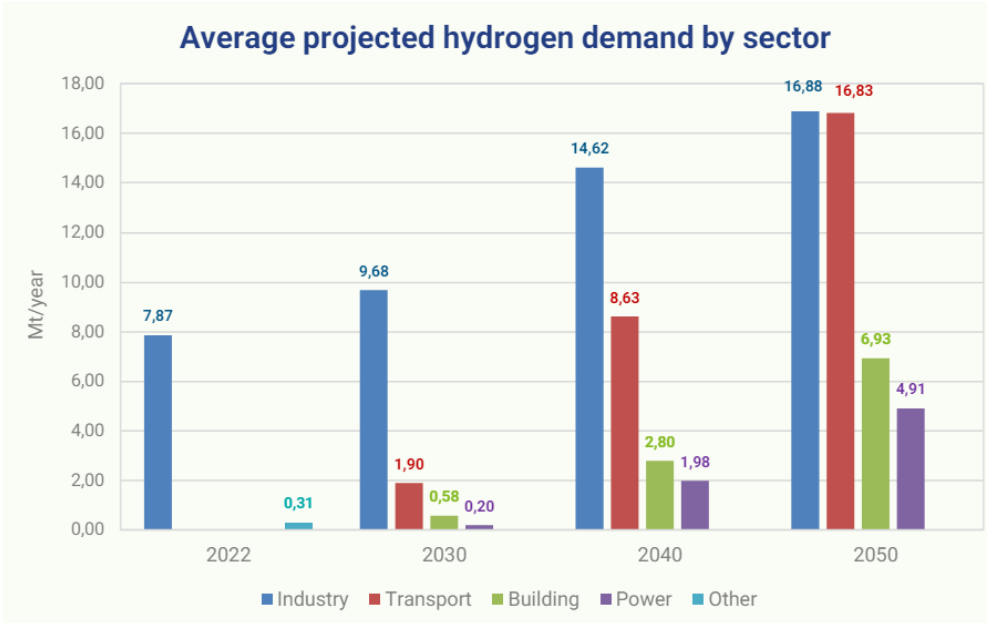


Figure 42. Average projected hydrogen demand of different scenarios by sector for the years 2030, 2040 and 2050

industrial feedstock will remain the largest H_2 market for years to come

Source: The European hydrogen market landscape, European Hydrogen observatory (November 2023)

Offshore Wind Finland

- Offshore wind energy target **12 GW in 2050** (but a much larger pipeline and potential).
- Supporting conditions:
  - Excellent wind power resources
  - Competitive electricity price
  - Advanced energy networks
- *What to do with surplus?*
- *Can hydrogen help unlock the potential?*

Map source: Fingrid, 27.10.2023

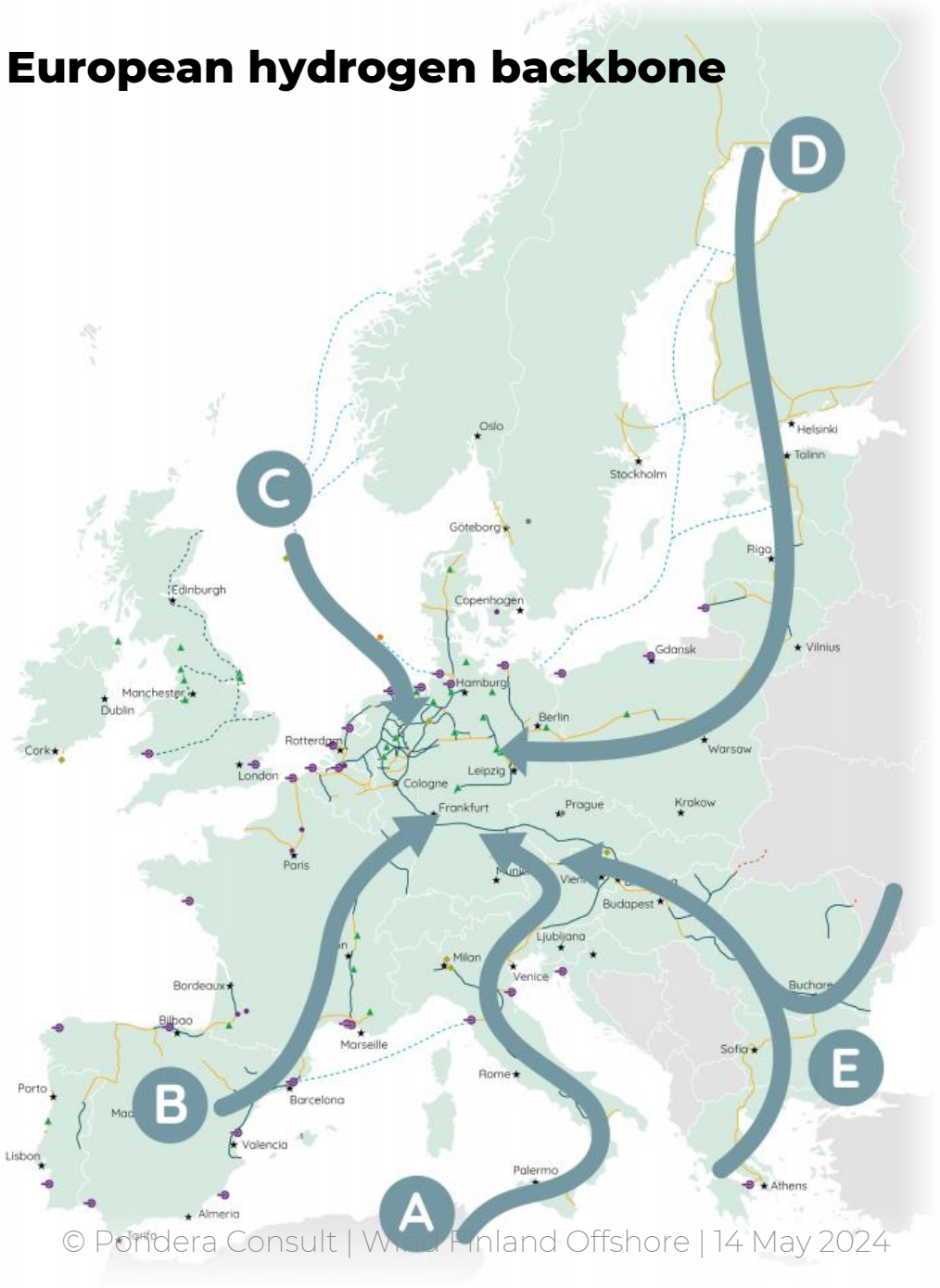
Finland's hydrogen objectives

- Cost-competitive wind power key in unlocking Finland's potential for green hydrogen production
- Resolution Finnish Government (February 2023):
  - Finland aims to become the European leader in the hydrogen economy in the entire value chain.
  - Finland has the capacity to produce at least 10 per cent of the EU's emissions-free hydrogen in 2030.

1. supply for domestic industry, transport and energy sector
2. export of hydrogen, e-fuels and green steel

Hydrogen transmission

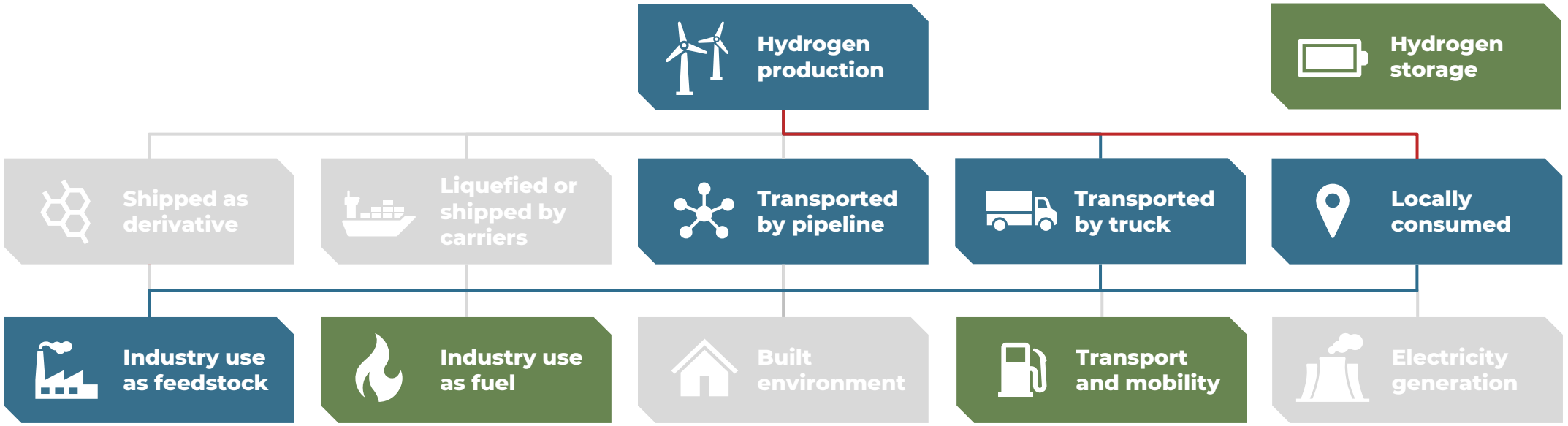
- Variability in supply and limitations of the grid: conversion into molecules (green hydrogen / ammonia) for storage and transport
- For whom? Regional economy and export to demand centers (heavy industrialized regions in Europe)
- Central hydrogen infrastructure (interconnectors): pipeline for efficient transport of hydrogen



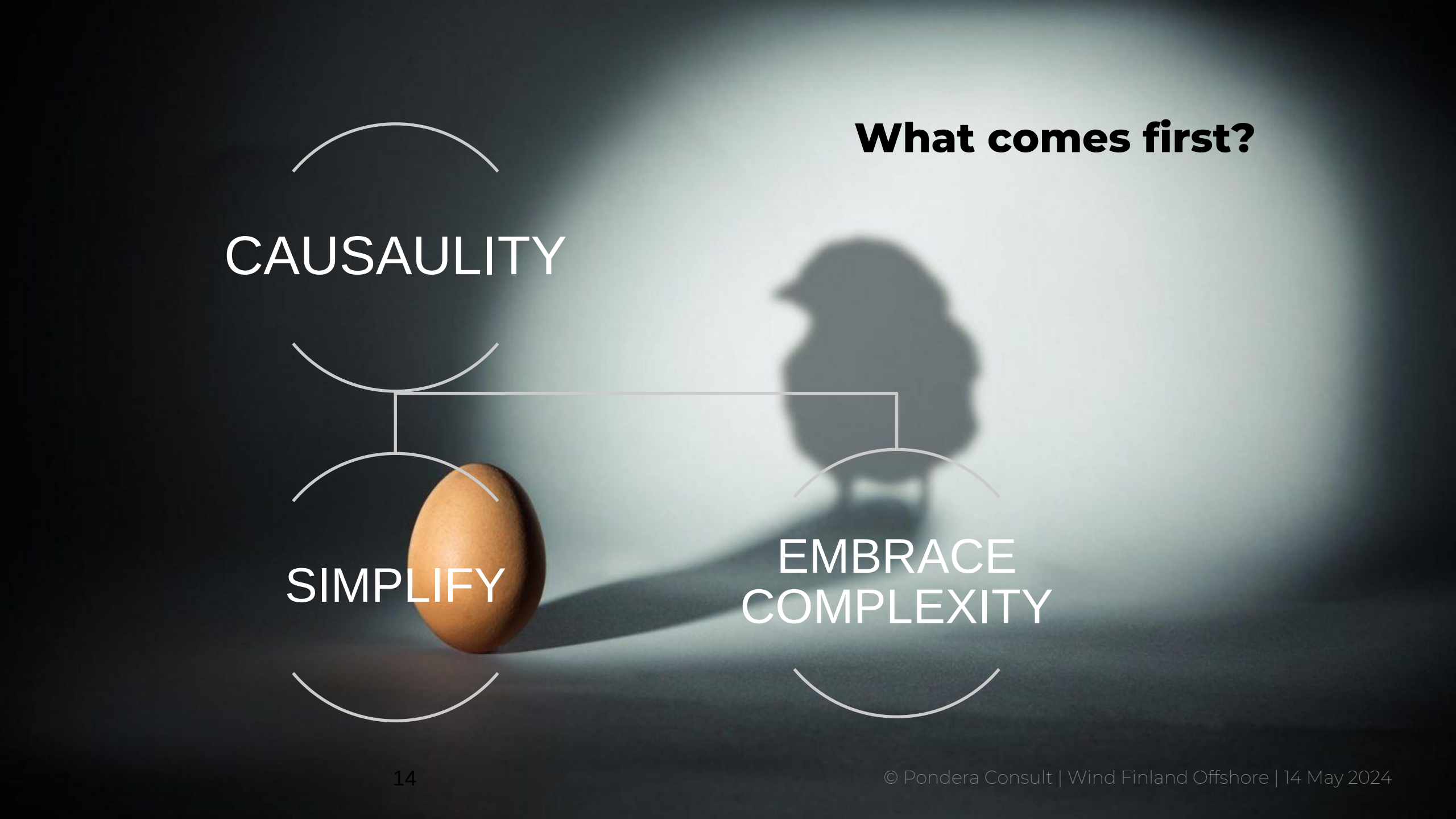
Future hydrogen infrastructure

- National hydrogen network
- Nordic Hydrogen Route (Bothnian Bay) (2030), wind power to industrial customers
- Nordic Baltic hydrogen corridor & Baltic Sea Hydrogen collector, to connect wind power areas in the Baltic Sea to Central European markets

Future hydrogen economy



What comes first?



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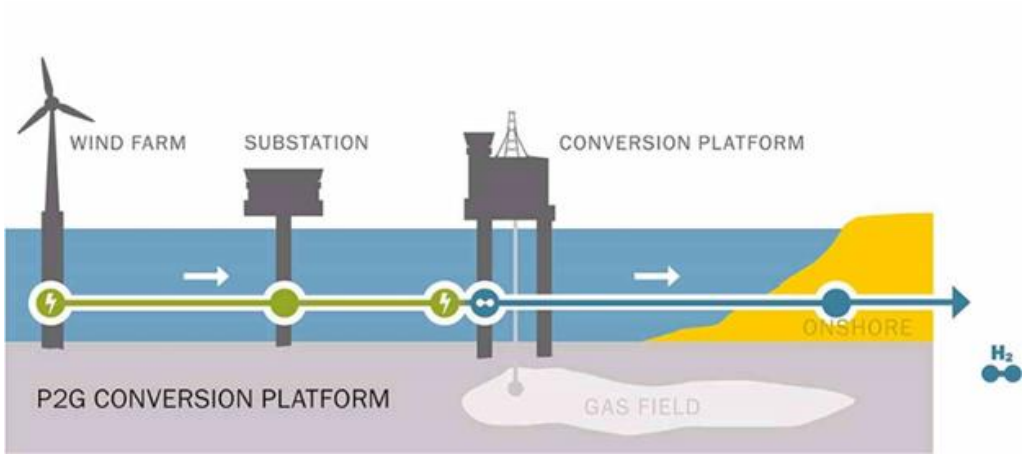
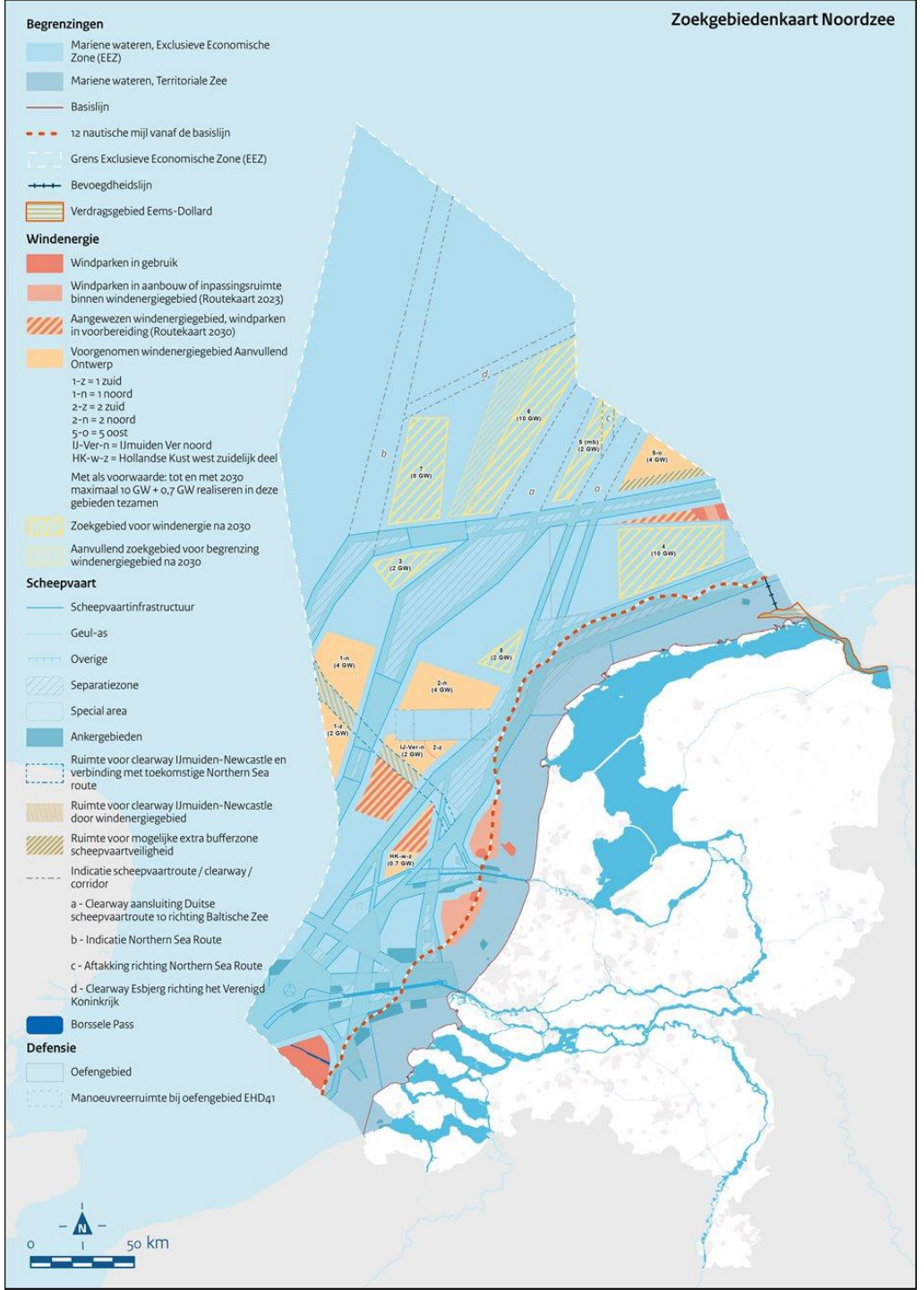
Netherlands Offshore Wind Energy after 2030

- Current and possible future areas for offshore wind energy in the North Sea
- Roadmap: 21 GW in2030 > 70 GW in 2050
- Hydrogen infrastructure & system integration

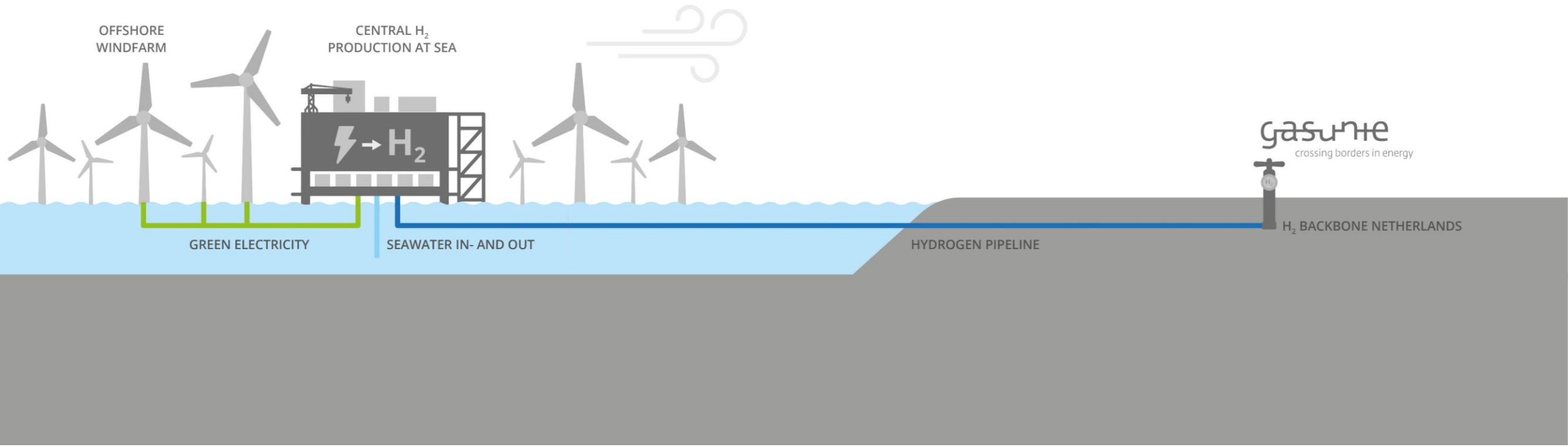




Map: Ministry of Economic Affairs and Climate Policy / Rijkswaterstaat

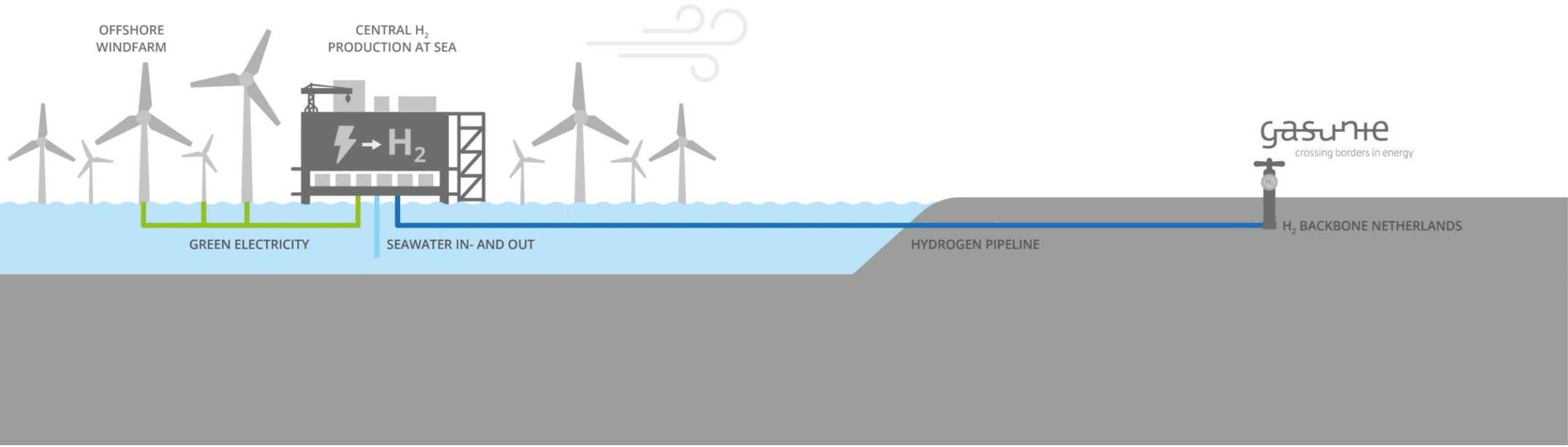
Central Hydrogen production

OFFSHORE



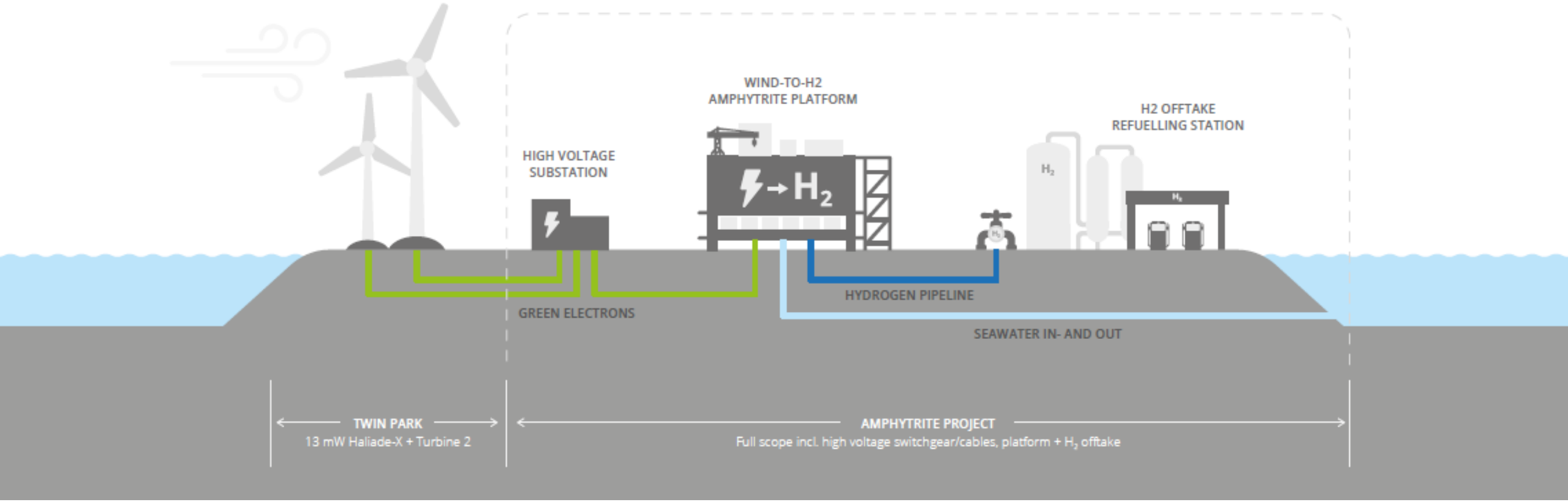
But risks are high…

- New combination of technologies
- Offshore
- Large scale
- Immature supply chain



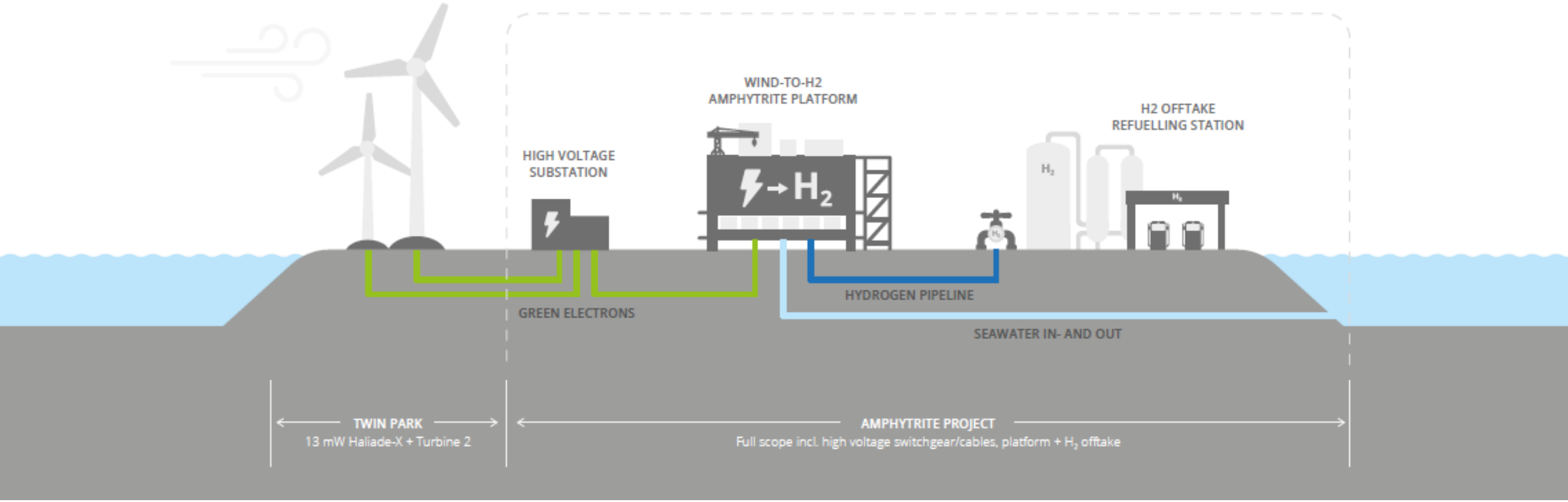
AmpHytrite Demonstrator

SIF YARD | MAASVLAKTE



Why develop AmpHytrite?

- De-risk GW scale offshore production
- Mobilise the supply chain
- Learn during the process with partners



AmpHytrite timeline

Building the right team for the task

Special purpose company (employer)

SIF – Owner of the building site / investor
Pondera – Owners engineering, funding and green H_2 offtake / investor
KCI the Engineers – EPC & Integration
GE – Wind turbine OEM and off-grid control

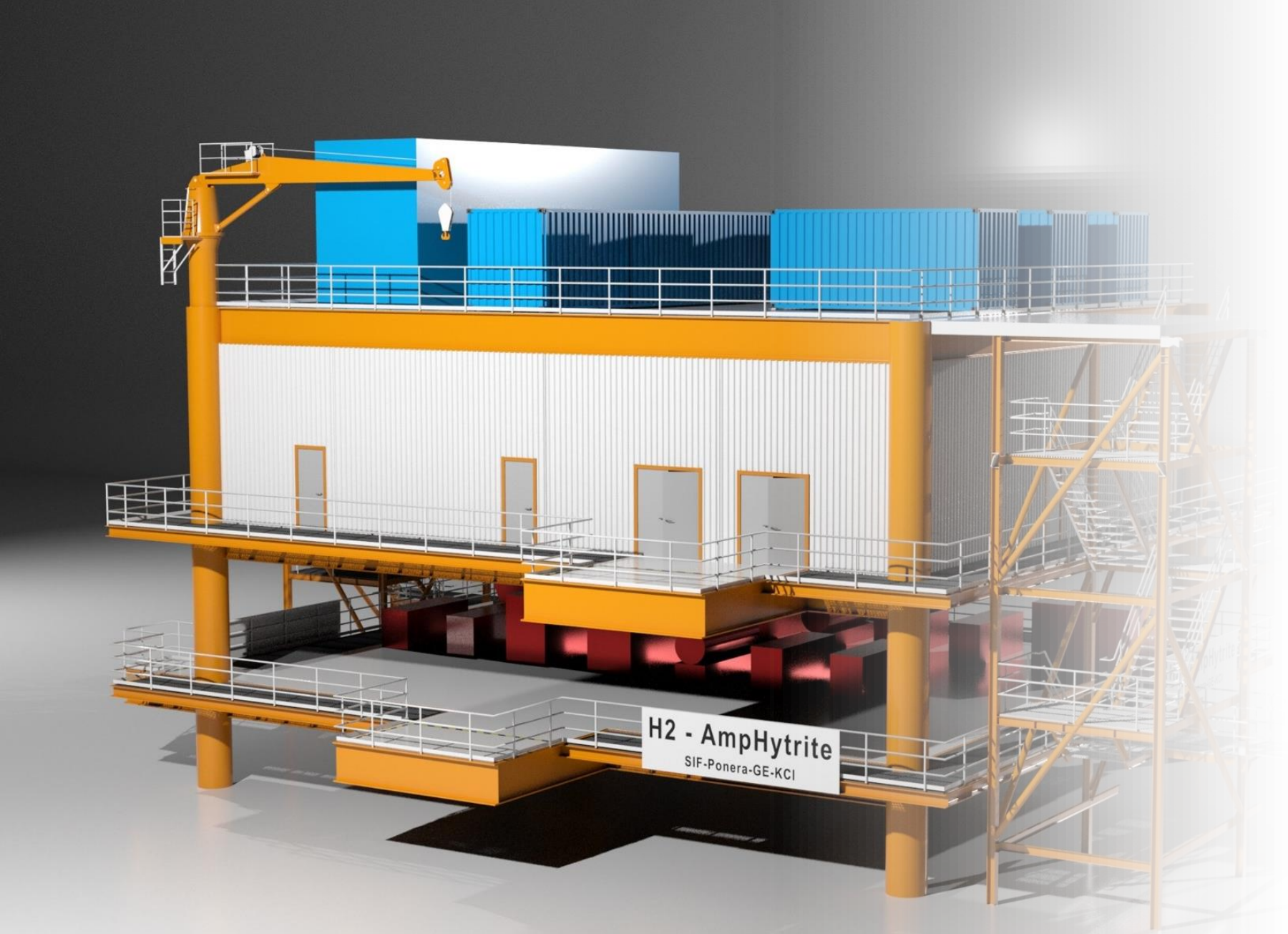
Engineering, Procurement, Construction & Installation (EPCI)

KCI the Engineers
Smulders

Owner's engineer

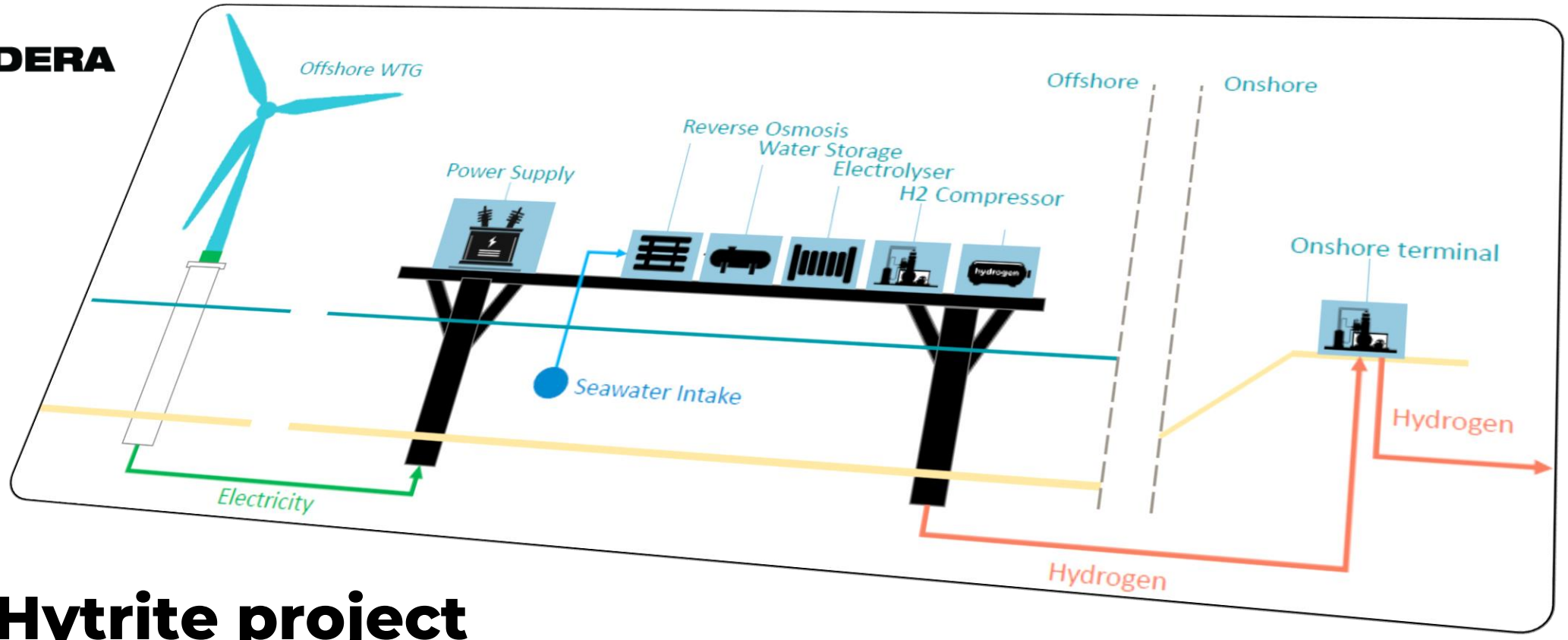
Pondera

Technology partners



AmpHytrite H_2 production demonstrator

- Offshore wind to hydrogen conversion
- Existing technologies into combined demonstrator



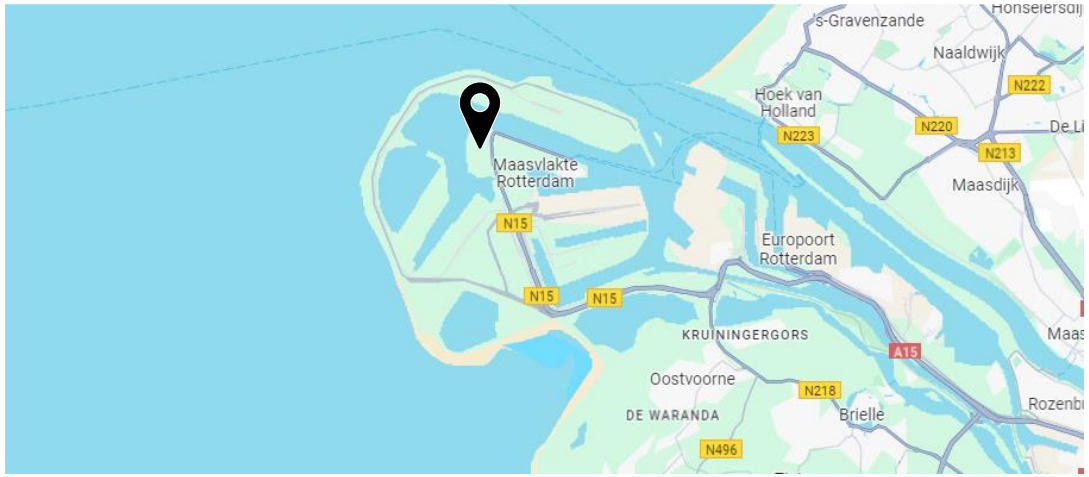
AmpHytrite project

- 10 MW PEM electrolyser
- Offshore platform (built onshore)
- Seawater as system input
- Connected directly to offshore WTG
- Capable of running off-grid mode
- 770 tons of green hydrogen annually

AmpHytrite site

Ideal test site at Maasvlakte, Rotterdam:

- Offshore turbine installed on site (12MW Haliade-X)
- Offshore conditions (e.g. wind)
- Seawater nearby
- Easy access



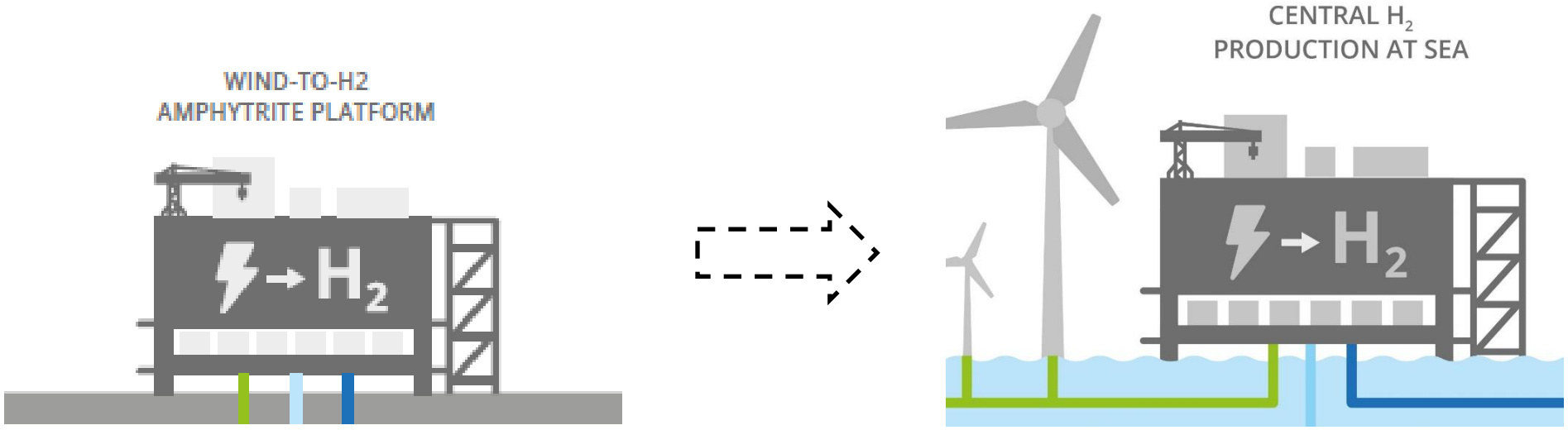
Why develop AmpHytrite?

Short term

translating uncertainty into risk towards feasible multi-GW green H_2 projects

Long term

large scale offshore hydrogen production plant operational at sea



Why develop AmpHytrite?

Short term

- **Pains**
  - Uncertainty (influences costs)
  - Exposure to ETS
  - Financing
- **Gains**
  - Early mover advantage
  - Learnings on scalability
  - Eco-system activation
  - Translate policy into business models (i.e. RFNBO)

Long term

- **Pains**
  - Infrastructure
  - Electron availability
  - Technology
  - Hydrogen offtake
- **Gains**
  - Long-term decarbonization
  - Policy compliance
  - ETS Exposure under control

Looking at lessons learned

- Demonstrating an integrated approach **to learn and de-risk** projects
- High **Technology Readiness Levels** TRL promising
- **Large scale** hydrogen requires technology development
- Develop project and technology in **ecosystem** with partners

Questions:

- **Decentralized** hydrogen production at source or **centralised** offshore facilities?
- **Environmental impacts** of offshore hydrogen production to be addressed
- **Causality: off-takers are awaiting** regulation and maturity of H_2 market

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Kiitos !