POSHYDON

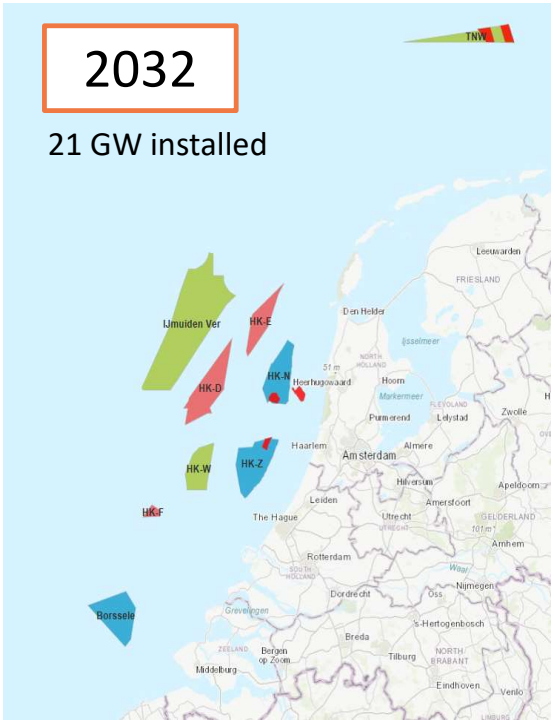
PosHYdon offshore hydrogen production

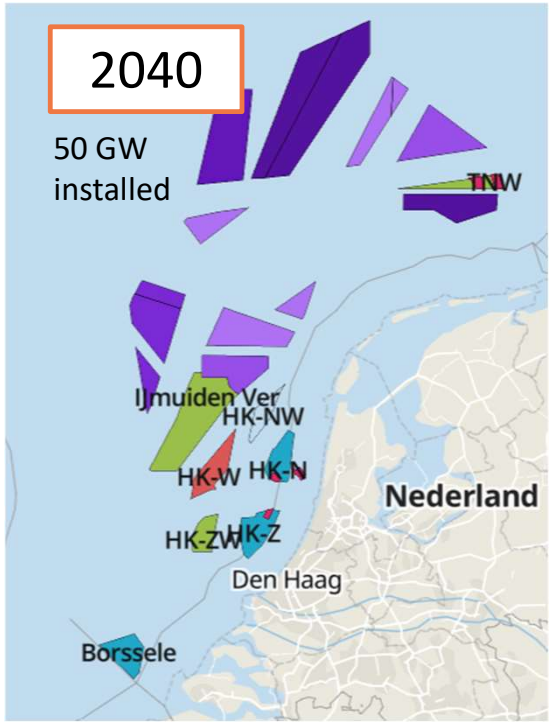
Rene Peters – TNO – May 13

Hydrogen Tech World Conference 2025

Offshore wind development The Netherlands

Acceleration of wind deployment increase the need for H2 production





From 5 to 70 GW in 2050

Future Challenges:

- Connections to land
- Onshore grid capacity
- Installation time cables
- Cost increase infra
- System stability
- Ecological impact
- Space limitations

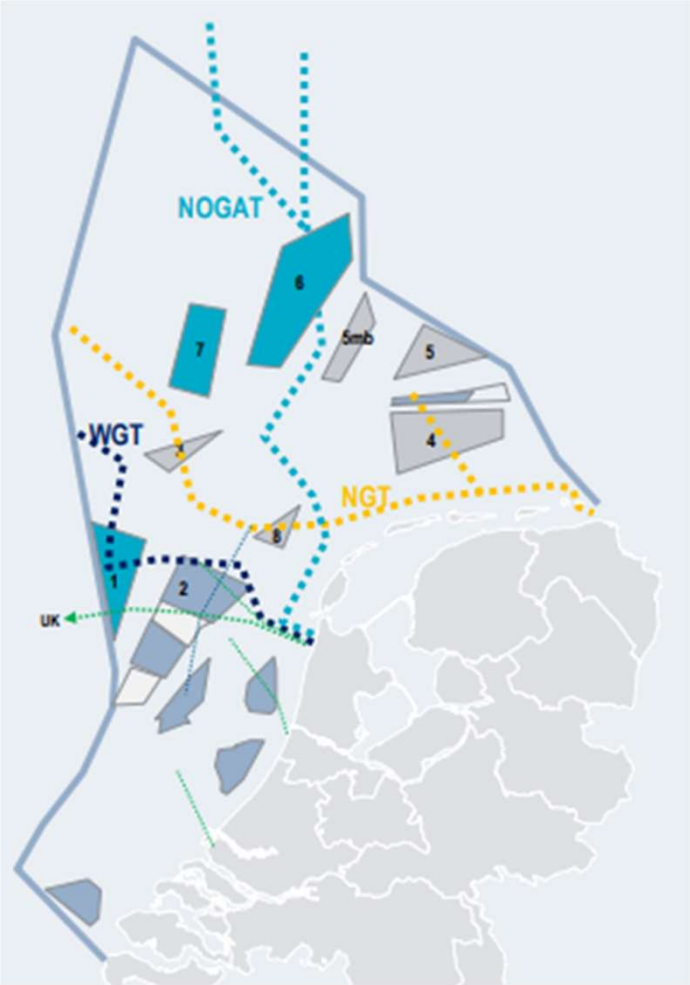
Potential Solutions:

- Conversion to H_2
- Re-use existing infra
- Large scale storage H_2
- Direct use of H2 at industrial clusters near shore
- Feed-in to onshore H2 backbone Gasunie

https://www.north-sea-energy.eu/atlas.html

Why offshore hydrogen production?

- Future wind parks are developed further offshore (> 100 km)
- Energy transport via electricity from HVAC > HVDC (525 kV) costly
- Landing capacity of power cables increasingly more complex
- Capacity of onshore electricity grid is limited
- Grid balancing with increasing intermittent production is challenging
- Offshore pipelines available for reuse for H2 from 2030 onwards
- Cost saving in offshore H2 production and transport significant
  - Distance > 100 km or when HVDC is required
  - Scale > 2 GW, as capacity of trunk lines well beyond 10 GW
- Benefits: pipelines are cheaper, faster to implement, have lower ecological impact and are more reliable than HVDC cables

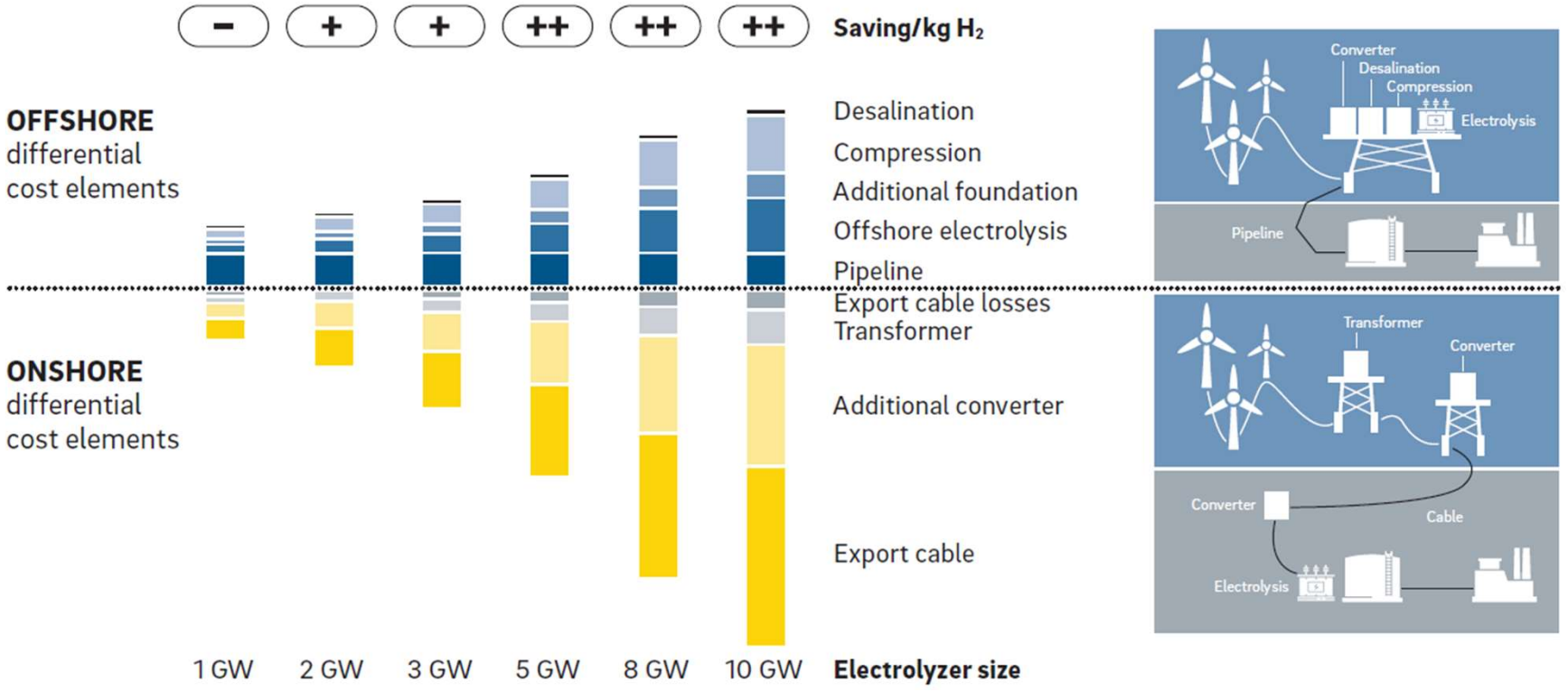


Ref: www.north-sea-energy.eu, NSE(2020), Roland Berger (2021), AFRY (2022)

Cost comparison on- and offshore hydrogen

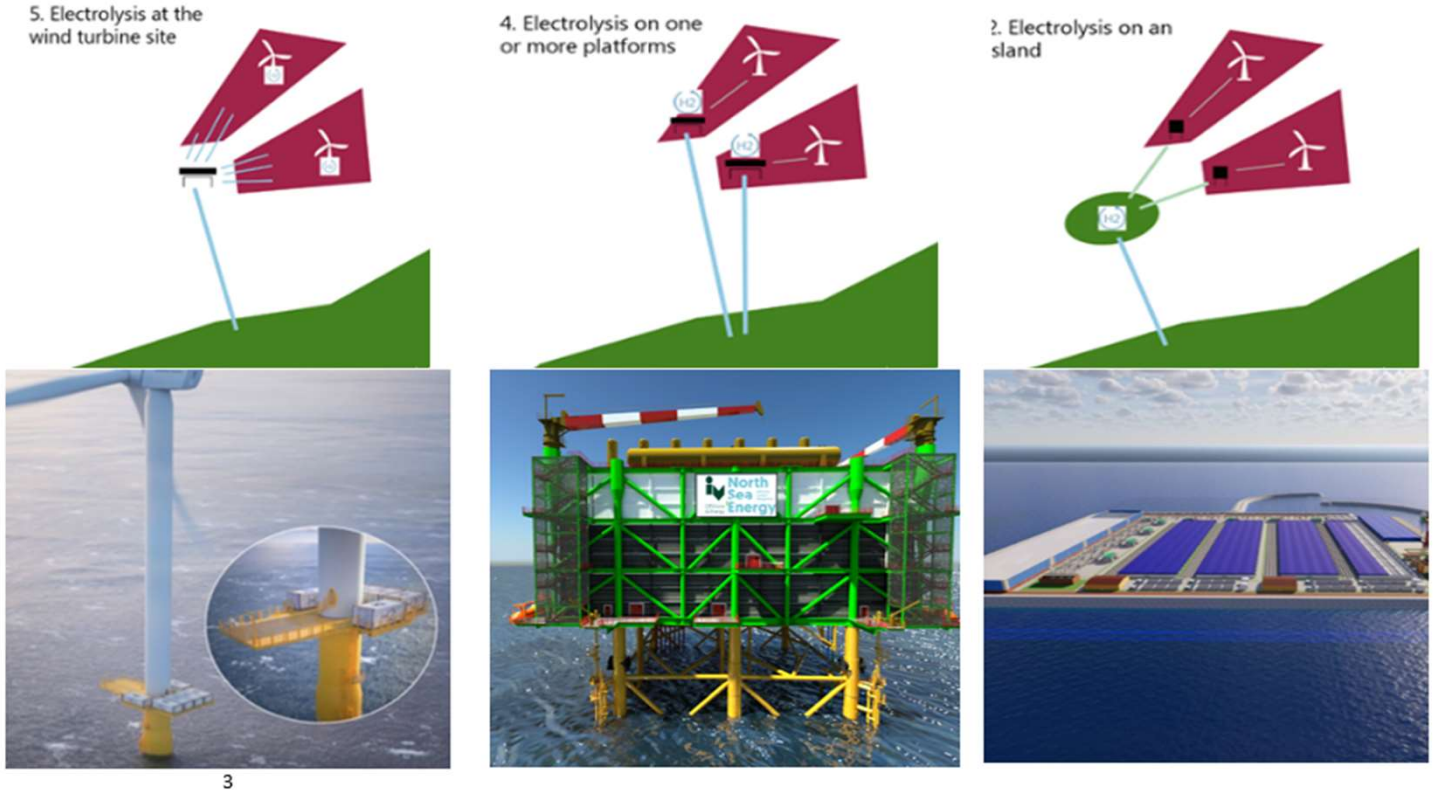
At larger scale, offshore hydrogen electrolysis is cheaper than onshore hydrogen electrolysis

INDICATIVE



Source: Roland Berger (2021)

Offshore Hydrogen production concepts

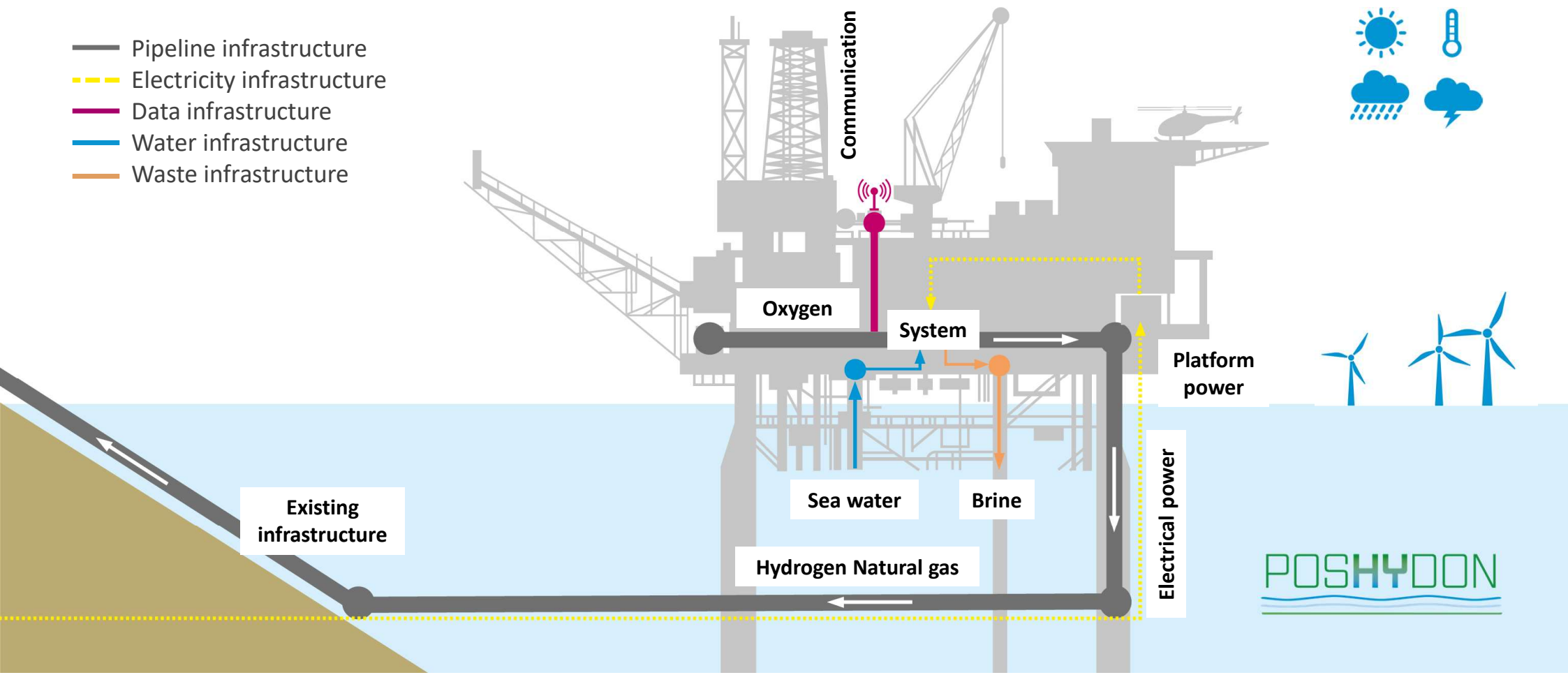


A) Electrolysis at the turbine, scale 15 – 20 MW

B) Electrolysis on wind farm level, scale 300 – 500 MW

C) Electrolysis on energy island, scale Multi GW

PosHYdon (Pilot for Offshore Hydrogen Production)



It takes 5 years from concept to operation…..

Nexstep Re-use Workgroup
Concept development

22 July 2021
DEI+ subsidy was granted

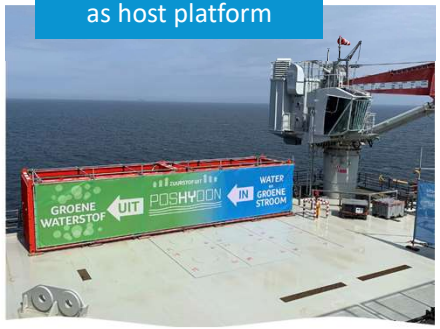
22 July 2021
The consortium of 14 parties kicked-off

18 December 2023
Dutch State joined the consortium via EBN

May 2024
Part of pilot HyXchange / Green Hydrogen Guarantees of Origin

2019 2020 2021 2022 2023 2024 2025

04 July 2019
Q13a-A was selected as host platform



25 Augustus 2022
His Majesty the King Willem-Alexander visited PosHYdon

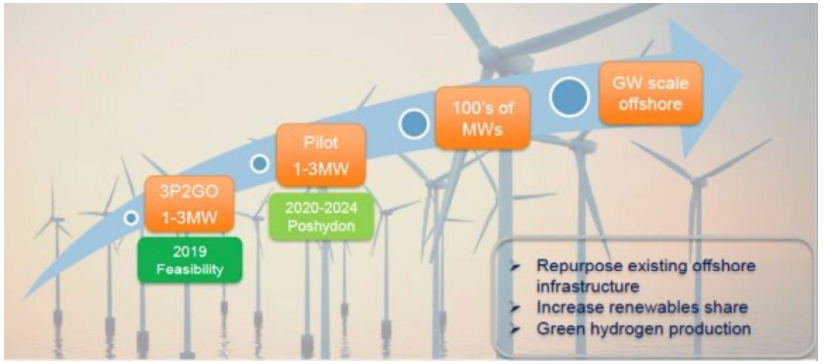
11 April 2023
Visit Prime Minister Mark Rutte

June 2024
Start Onshore test of complete system

November 2024
Offshore installation and start of PosHYdon

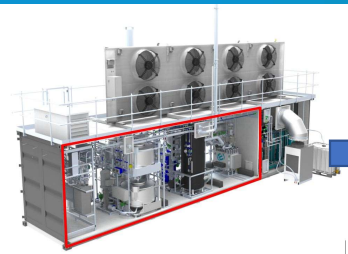
PosHYdon – Why & What

- 1-year **offshore pilot** project with start H2 production beginning 2025
- Pilot of the **first 1MW seawater-based electrolysis system** to demonstrate that H_2 can be produced and processed offshore with transport via an existing pipeline to shore
- Demonstrate the overall **feasibility of blended H_2** (safety, stakeholders, technical, commercial, legal aspects etc.)
- Prove **repurposing/ co-using** of existing infrastructure for blended H2 (offshore platforms, pipelines, reception facilities and onshore systems)
- Evaluate the **impact of offshore conditions** on the integrity, reliability and performance of the electrolysis system using a simulated wind power profile
- Provide H_2 research and **system performance** outputs to support **assessment of economics** for large scale offshore H_2 production



This project is supported by the Demonstration Energy and Climate Innovation (DEI+) scheme that the Netherlands Enterprise Agency (RVO) carries out on behalf of the Ministry of Economic Affairs & Climate Policy.

PosHYdon consortium and planning



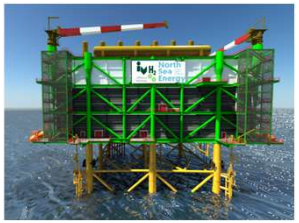
1 MW Electrolyser module

1 MW Electrolyser system for offshore operation

1MW Testing onshore

1MW Testing offshore

Upscaling



1MW to 100 MW

2021 2022 2024 2025 >2025

nexstep

NEPTUNE ENERGY

TNO

ebn

Eneco

nel

Offshore & Energy

gasunie new energy

TAQA

NOGAT NORTHERN OFFSHORE GAS TRANSPORT

NGT NOORDGASTRANSPORT

INVESTA EXPERTISE CENTRUM

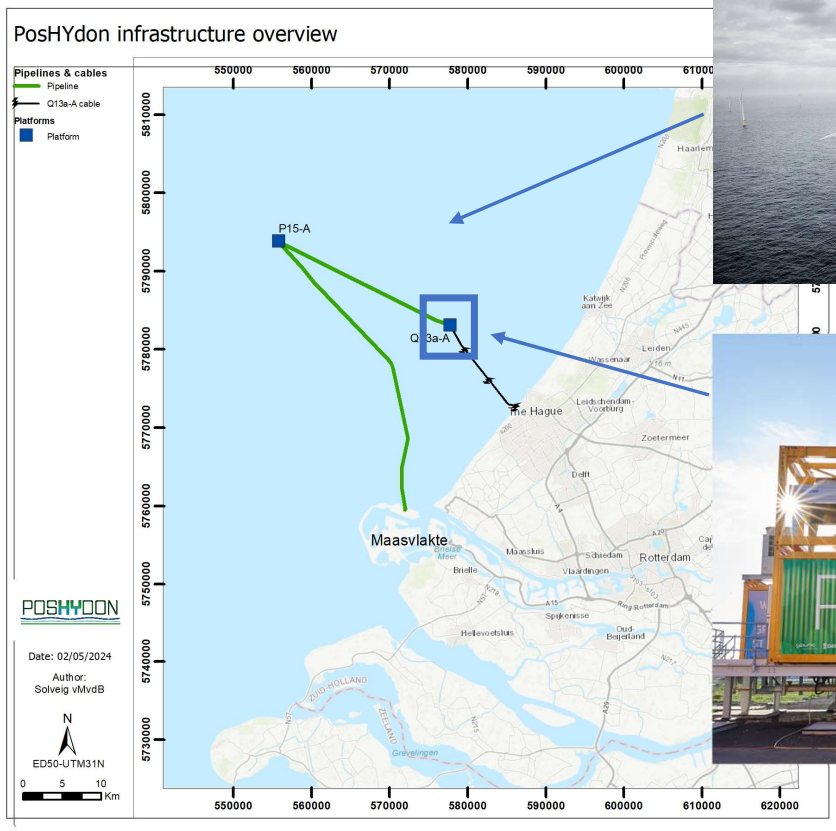
EMERSON

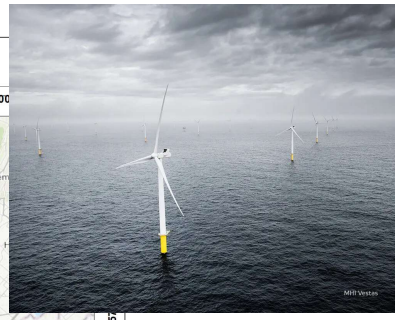
DEME

HATENBOERWATER
Fresh in water since 1906.

The route of the green molecules

- Production via wind profile Luchterduinen
- Flow meter H2 -> Guarantees of Origin
- Blend H2 with natural gas to Rotterdam
- Transport via existing pipeline to P15-A
- From P15-A via existing pipeline to Euromax onshore
- Offtakers in Rotterdam industrial cluster



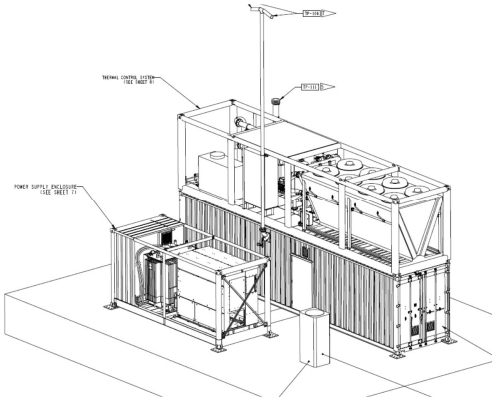


Luchterduinen windpark (Eneco)

Project successes

- Secured Ministry of Economic Affairs & Climate Policy agreement to **amend gas entry specification** from 0.02% to 0.5% Hydrogen blend
- Completed integrated Hydrogen Generation System engineering with all Technology Partners. **FATs completed**
- **Completed HAZOP** for HGS integration on Q13a-A Platform
- **Wide recognition** for the project, both in the industry and beyond, leading position of the Netherlands offshore sector
- Consortium **strengthened with EBN** on behalf of the dutch government
- Successful **onshore test** at Investa Q3 2024
- Offshore installation at Q13a platform Q4 2024
- First hydrogen production offshore in Q1 2025

Onshore



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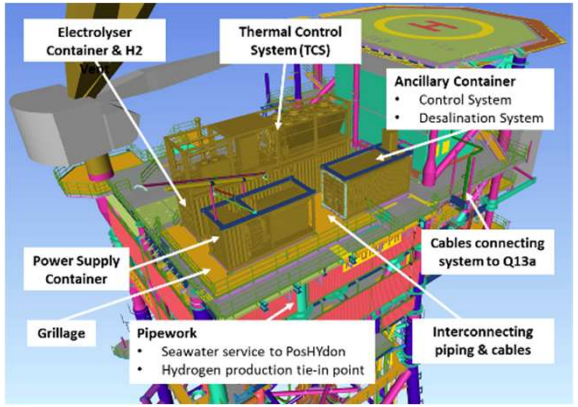
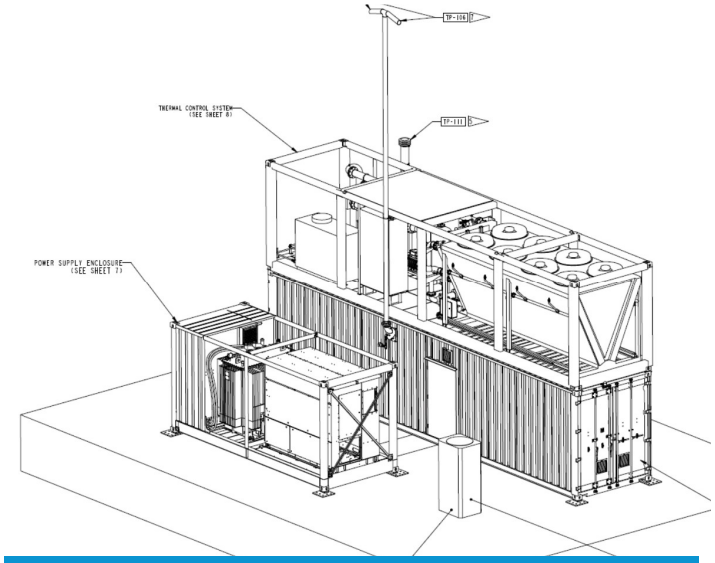
Offshore



Design strategy – keep design as similar as possible to maintain configuration management

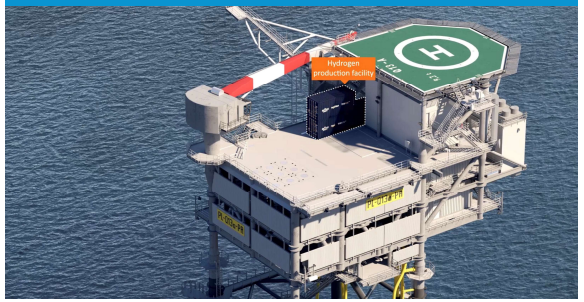
Key lessons learnt so far

- Breadth and depth of stakeholder engagement required to be successful (p.e. EZK, end consumers of gas/H2 blend!)
- Current legal frameworks can now accommodate blended Hydrogen
- Repurposing/co-using existing oil and gas facilities is possible; but requirements are site-specific and must be assessed as such
- Large consortia present a different management model to what is familiar in the offshore sector

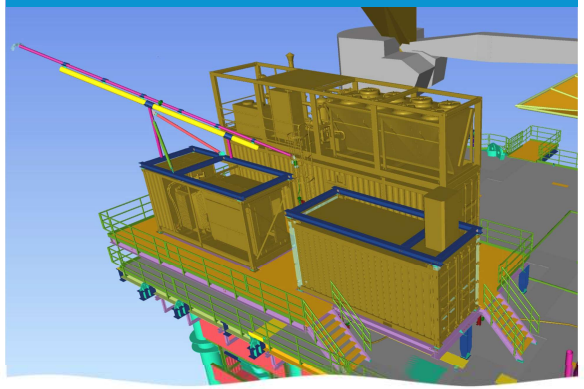


Typical Onshore Electrolyser Design

Original concept design 2019



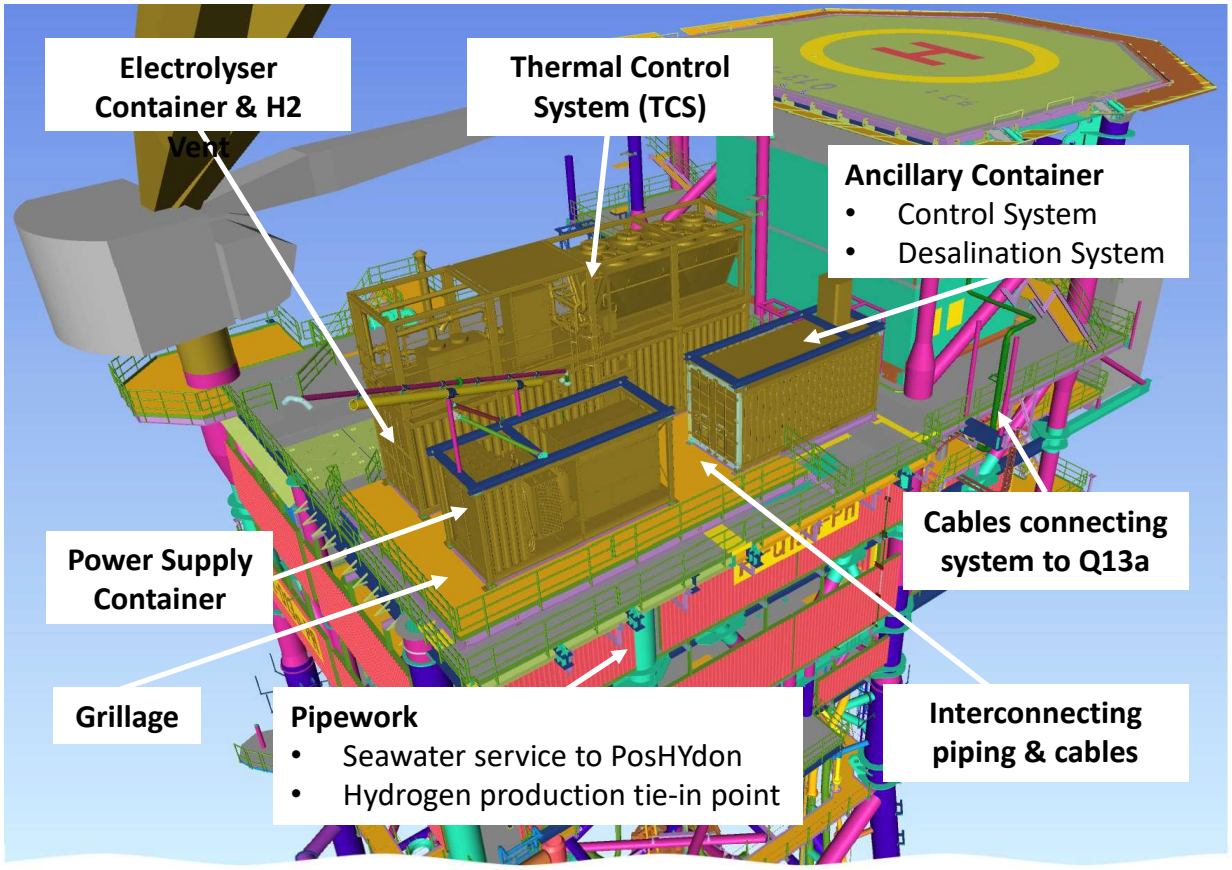
Final PosHYdon Offshore Electrolyser Design 2024



Onshore mechanical and system test Q3 2024

What's next …

- √ Onshore System Acceptance Tests (Q2/3 2024)
- √ Q13a-A modifications (Q3)
  → Offshore construction
- √ P15 modifications (Q3)
  → Offshore construction
- √ Q13a-A & P15 preparatory activities requiring shutdown → modifications planned on both assets during planned shutdowns
- √ Guarantees of Origin pilot – HyXchange
- √ Offshore commissioning on Q13a platform
- Hydrogen production startup → 2025



Offshore installation on Q13a platform Q4 2024

Roadmap towards large scale offshore electrolysis

- Accelerate far offshore wind deployment
- Produce green hydrogen at scale
- Integrate offshore wind & hydrogen
- Transport hydrogen via existing & new pipelines
- Store intermittent wind energy in hydrogen

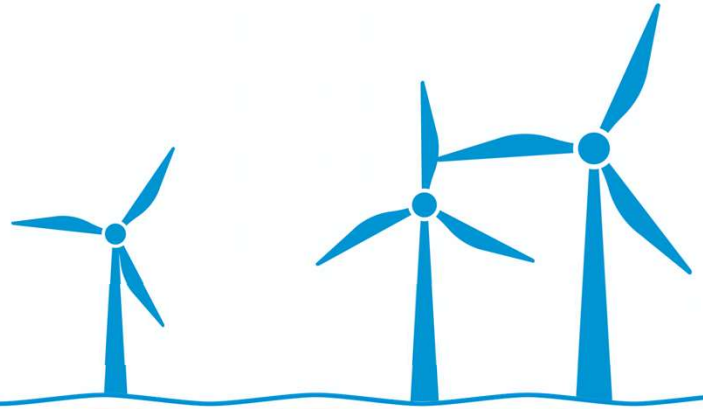
3P2GO
1 MW
2019
Feasibility

PosHYdon
1 MW
2020-2025
Demonstration

BLPH / N-05
2,5 – 5 MW
2025-2027
Upscaling

DEMO-1
20 - 50 MW
2027-2030
Demonstration

DEMO-2
500 MW
2030-2035
Commercialisation



Demo 1

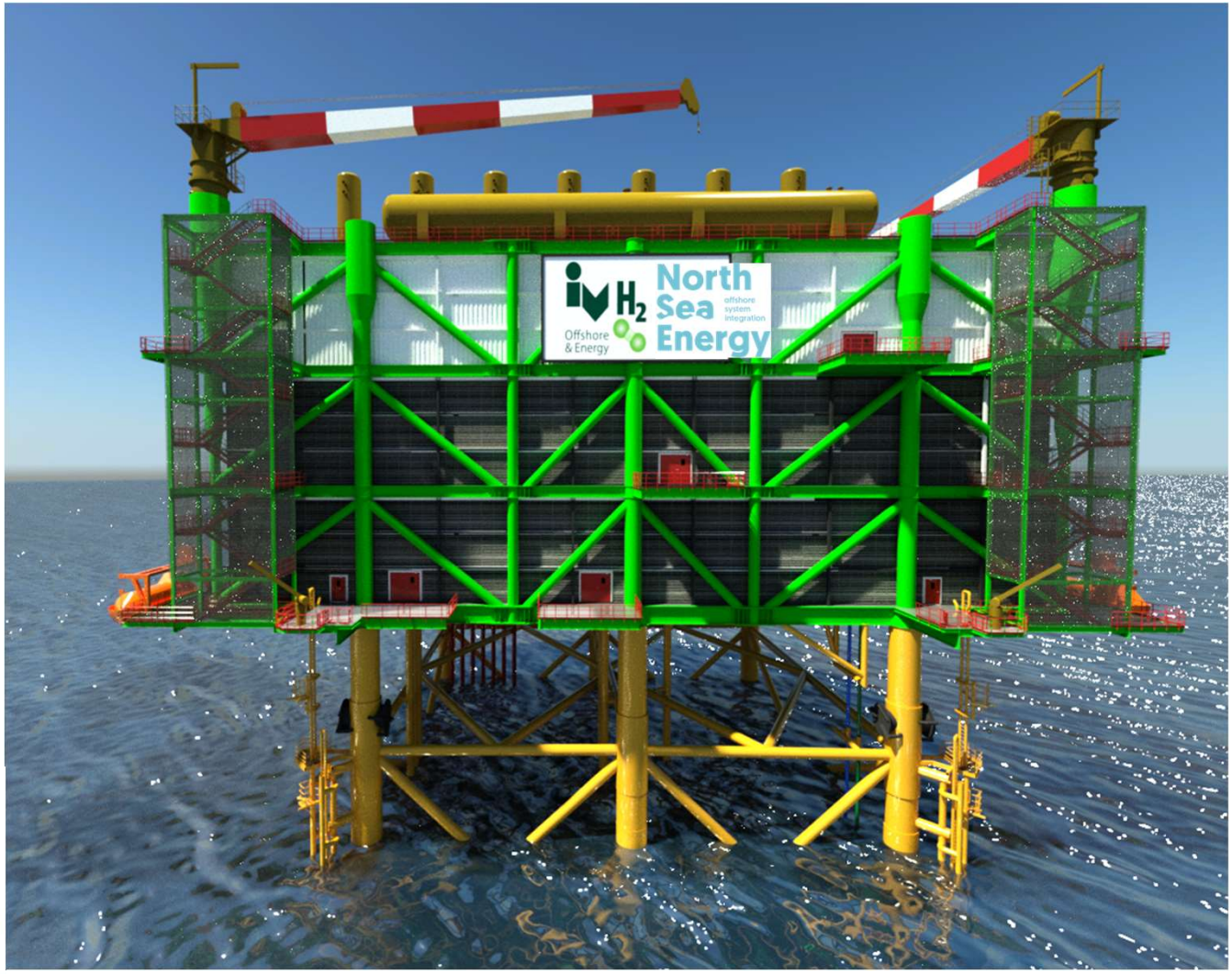
Capacity	< 20 - 50 MW
Design	Additional electrolyser near existing windfarm
Transport	New or re-use
Where	Near wind farm Hollandse Kust Noord
When	Approx. 2030
Budget	380 Meuro

Demo 2

Capacity	Approx. 500 MW
Design	New wind farm + electrolyser
Transport	New or re-use (overdimensioned)
Where	Ten Noorden van de Waddeneilanden (TNW)
When	Approx. 2033
Budget	1400 Meuro

Full-scale offshore green hydrogen production

- Concept design ready
- Capacity 500 MW electrolysis
- H2 production 50 kton/yr
- Target realisation 2033 (DEMO-2)



North Sea offshore system integration Energy

Thank you!

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North Sea Energy offshore system integration

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POSHYDON

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