

Hydrogen in the Netherlands



Orsted

The Ørsted Way
Let's create a
world that runs
entirely on green
energy

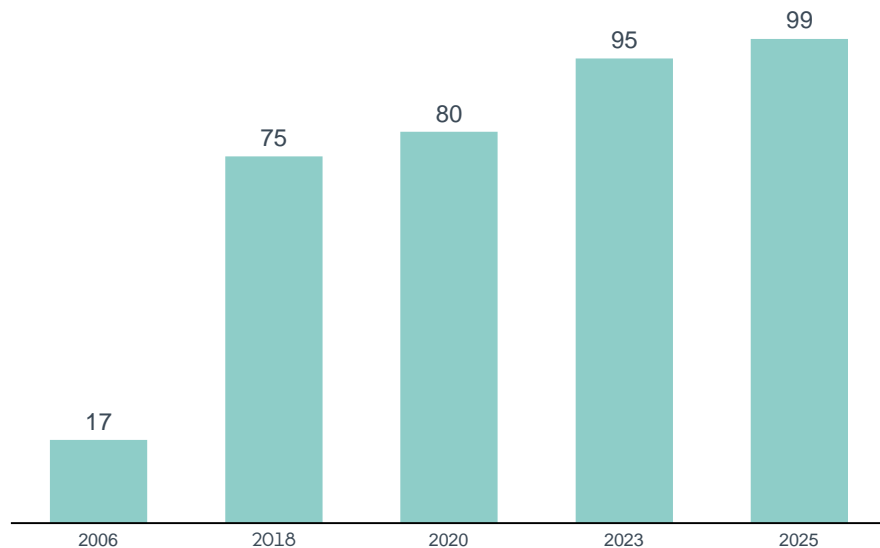


Ørsted strategic transformation to a sustainable company:

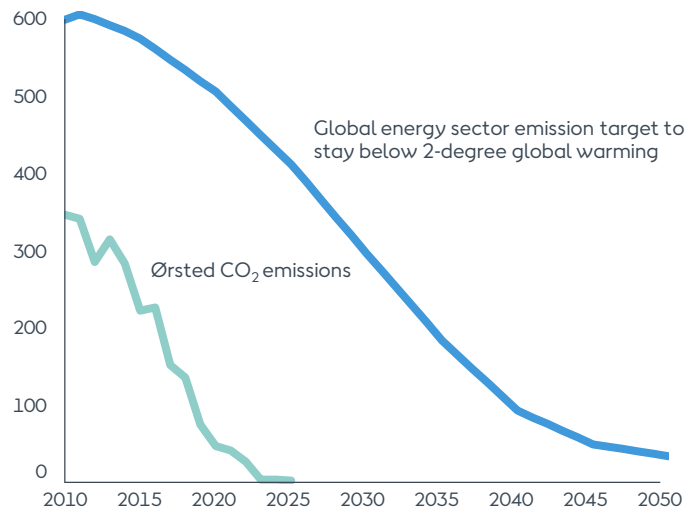
Green share of energy generation ~99% in 2025, approximating zero emissions

Ørsted share of green power and heat

%



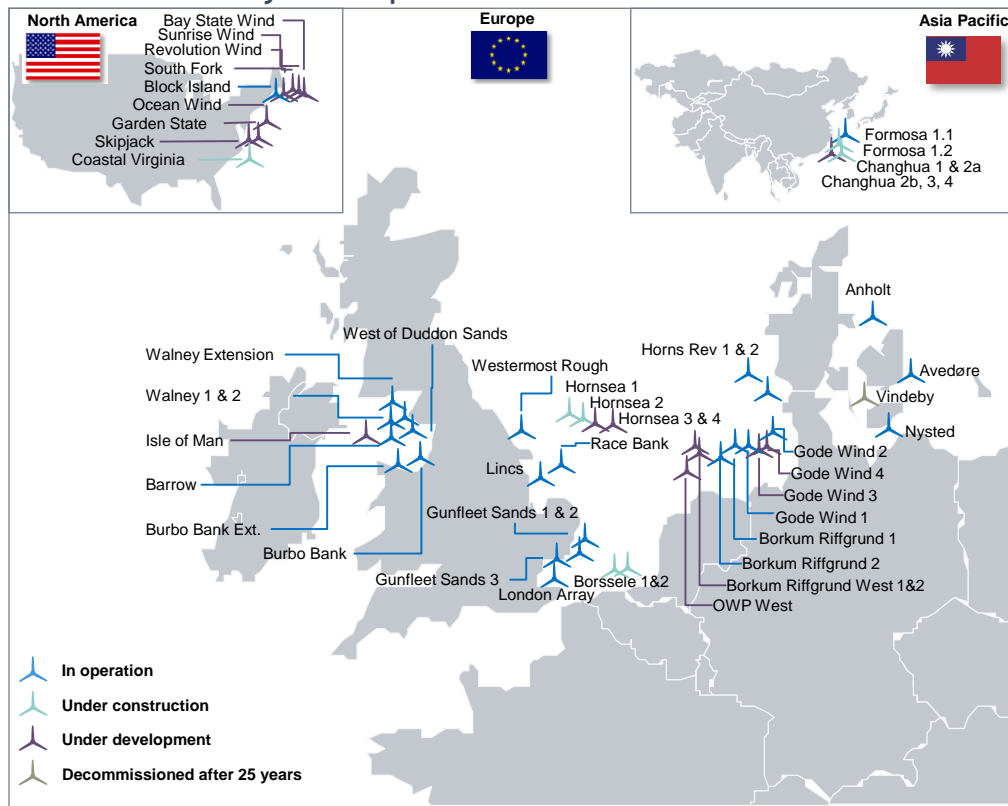
gCO₂e/kWh



Ørsted Offshore overview

Global market leader in offshore wind with 25+ years of experience

Ørsted offshore wind global footprint



Unparalleled experience and track record

1991 25+ years of experience and track record in the offshore wind power sector 2019

25 offshore wind farms in operation

4 offshore wind farms under construction ¹

5.6 GW
Constructed capacity

4.3 GW
under construction

~ 2,450
Dedicated employees

13 million
people with clean electricity

~ 1,150
turbines
World's leading operator

23
Partnerships

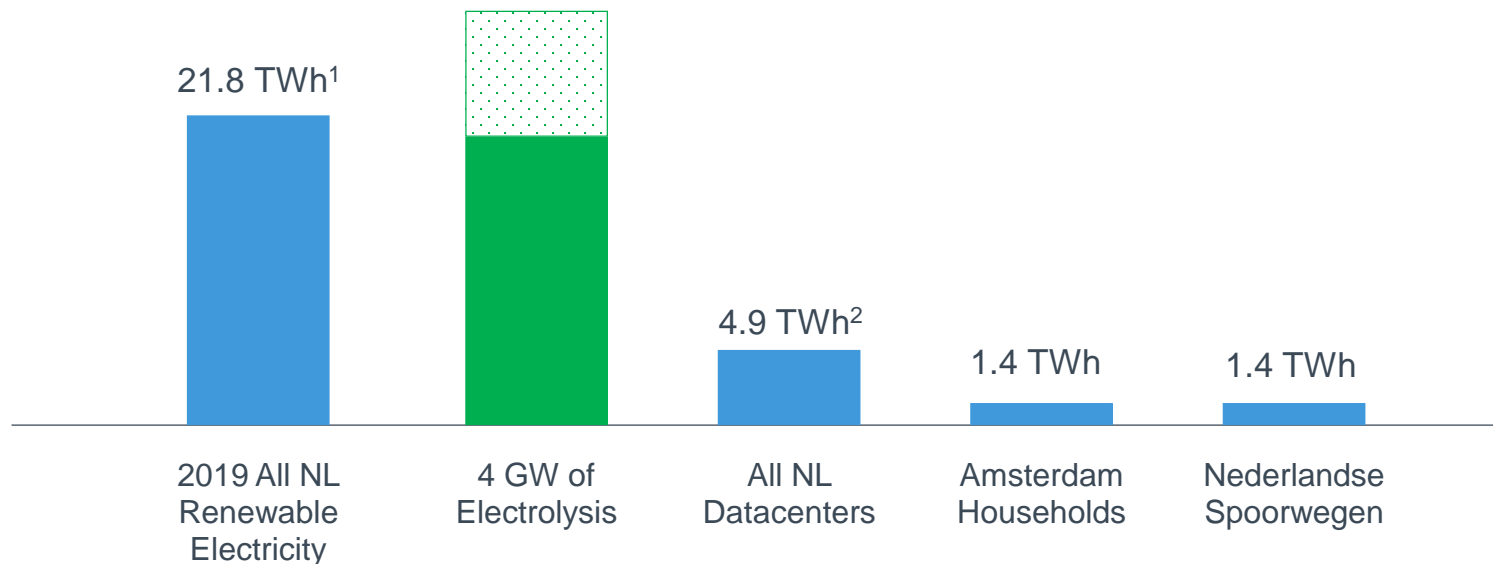


www.orsted.nl/borssele



Putting it in Perspective

4GW of electrolysis vs. major electricity users



¹ CBS – hernieuwbare energie in Nederland 2019

² Dutch Data Center Association - State of Dutch Data Centers

Putting it in Perspective

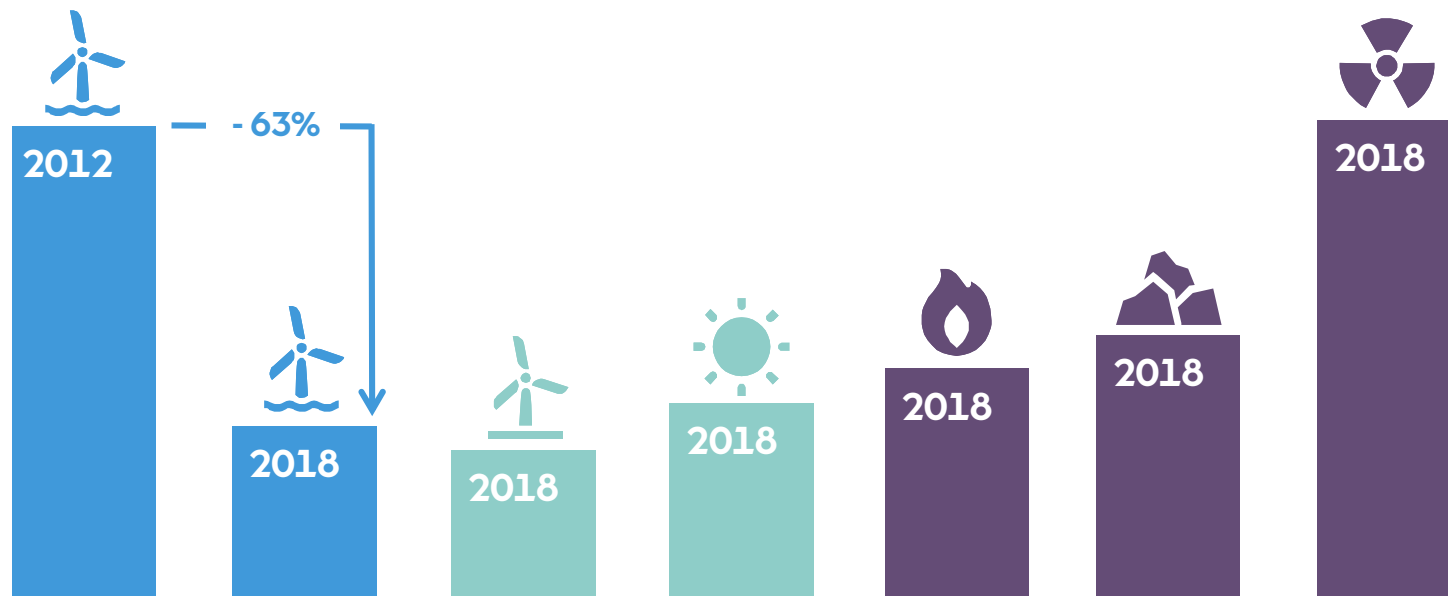
Our current Energy Consumption



Levelized Cost of Energy: Rapid cost reductions in the Offshore Wind industry

Offshore wind power competitive relative to conventional fossil power generation

EUR/MWh, 2018 prices, Northwest Europe



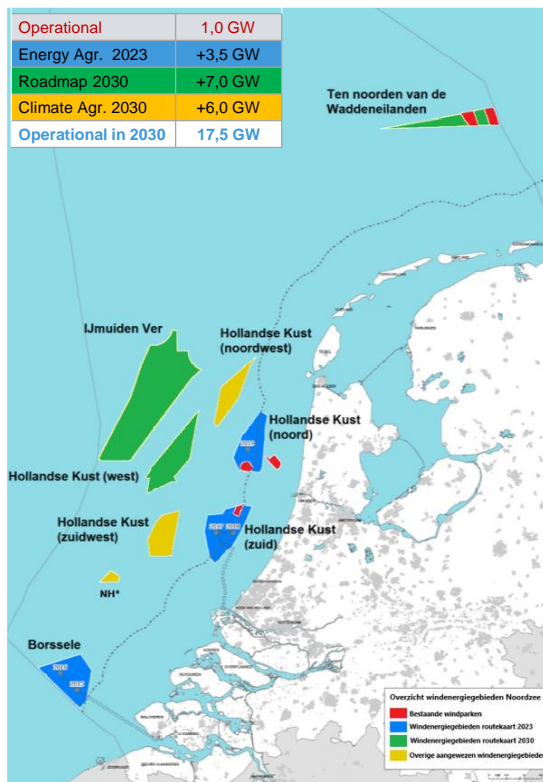
Source: Bloomberg New Energy Finance – 2H 2018 LCOE Update, current LCOE.






Onshore wind: average of DE, DK, NL and UK mid-scenarios. Solar PV, Gas: average of DE, UK mid-scenarios. Coal: DE mid-scenario. Nuclear: UK mid-scenario. Offshore wind: 2012 generic offshore wind, Northwest Europe, FID 2012. In 2012 our goal was to reduce offshore wind costs to EUR 100 per MWh in 2020. 2018: average of relevant projects in NL, UK and DE with COD 2022-2024. NL: Hollandse Kust (zuid) I&II, UK: CfD Round 2, DE: OWP West, BRW I, BRW II. For DE and NL, additional EUR 15 per MWh assumed as transmission cost.

Exchange rate EUR:USD: 0.88, YoY inflation 2017-2018: 1%.

In 2030 the Dutch North Sea will host a minimum of 11,5GW operational Offshore Wind

Due to the current climate agreement discussions it is likely to become 15,5-17,5GW



	Location	Capacity	Tender	COD	Grid	Comments
Energy Agreement 2023	Borssele 1+2	752 MW		2020	TenneT AC Borssele	94x SG 8.0-167 DD
	Borssele 3+4	732 MW		2021	TenneT AC Borssele	77x V164-9.5
	Holland Coast South 1+2	760 MW		2022	TenneT AC Rotterdam	76x SG 10-193 DD
	Holland Coast South 3+4	760 MW		2022	TenneT AC Rotterdam	76x SG 10-193 DD
	Holland Coast North	760 MW		2023	TenneT AC IJmuiden	69x SG 11-200 DD
Roadmap 2030	Holland Coast West	~1,4 GW	Q3 2021	2024/2025	TenneT AC IJmuiden	Potential of 8GW; close to UK border (East Anglia)
	North of the Wadden	~0,7 GW	Q4 2022	2026	TenneT AC Eemshaven	
	IJmuiden Ver 1	~2 GW	Q4 2023	2027/2028	TenneT 2xDC Rotterdam	
	IJmuiden Ver 2	~2 GW	Q4 2025	2029/2030	TenneT 2xDC Zeeland	
Climate Agreement Additions Potential Combined Tenders		+6 GW	Combining Demand (H ₂) and Supply (OFW) is prerequisite In 2021 up to 8GW can be added to the rollout <i>Potentially as combined OFW and H₂ tenders (lowest EUR/kg H₂)</i>			

But we would like to host much more Offshore Wind— at least 60GW is possible

Various studies confirm opportunity



60 GW

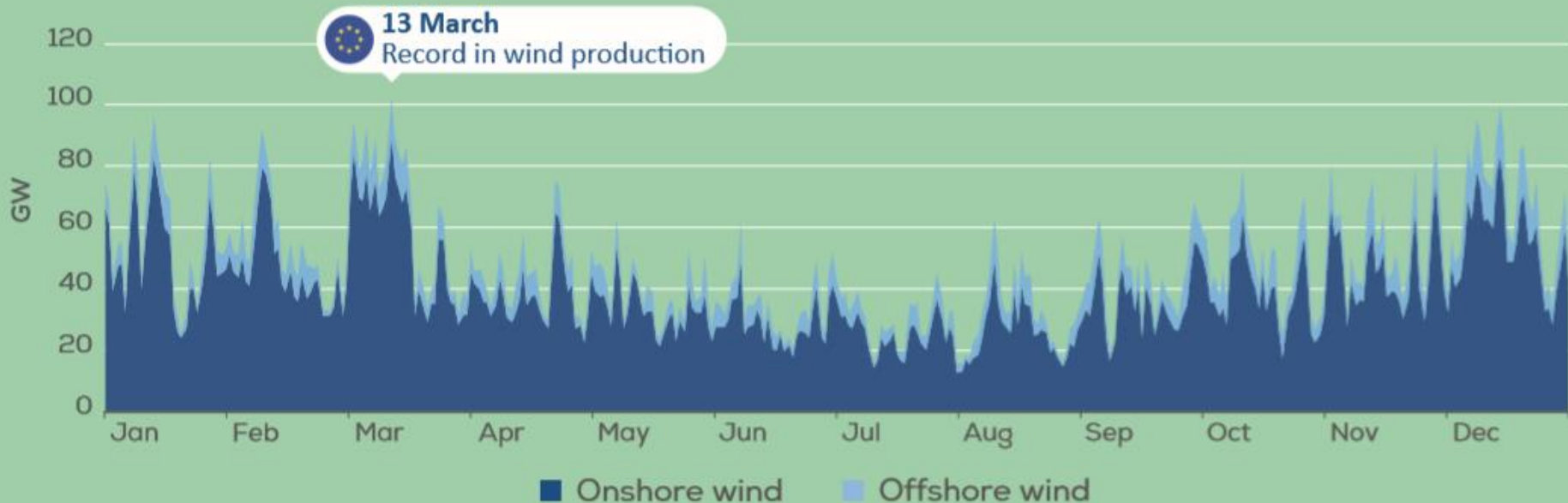


180 GW

But we have to embrace the variability of nature

We are going from our current 'demand-driven' towards a 'supply-driven' energy market

European wind energy generation in 2019



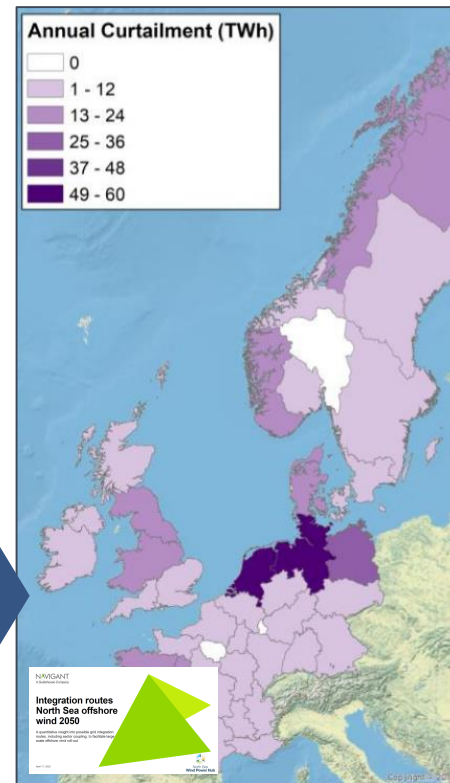
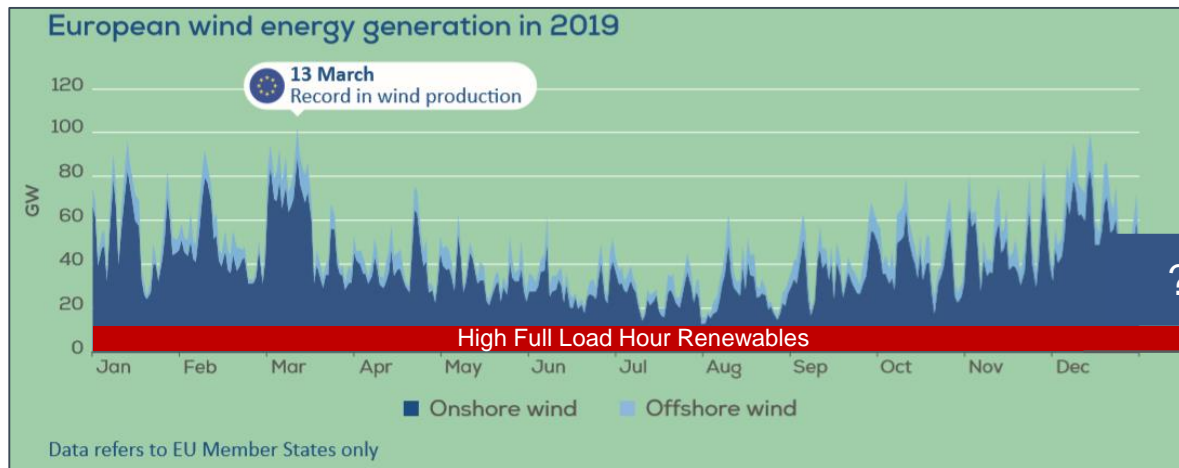
Data refers to EU Member States only

Large capacity installed will bring 'a base of renewables' throughout the year

But there is no business case for building windfarms that mostly will be curtailed

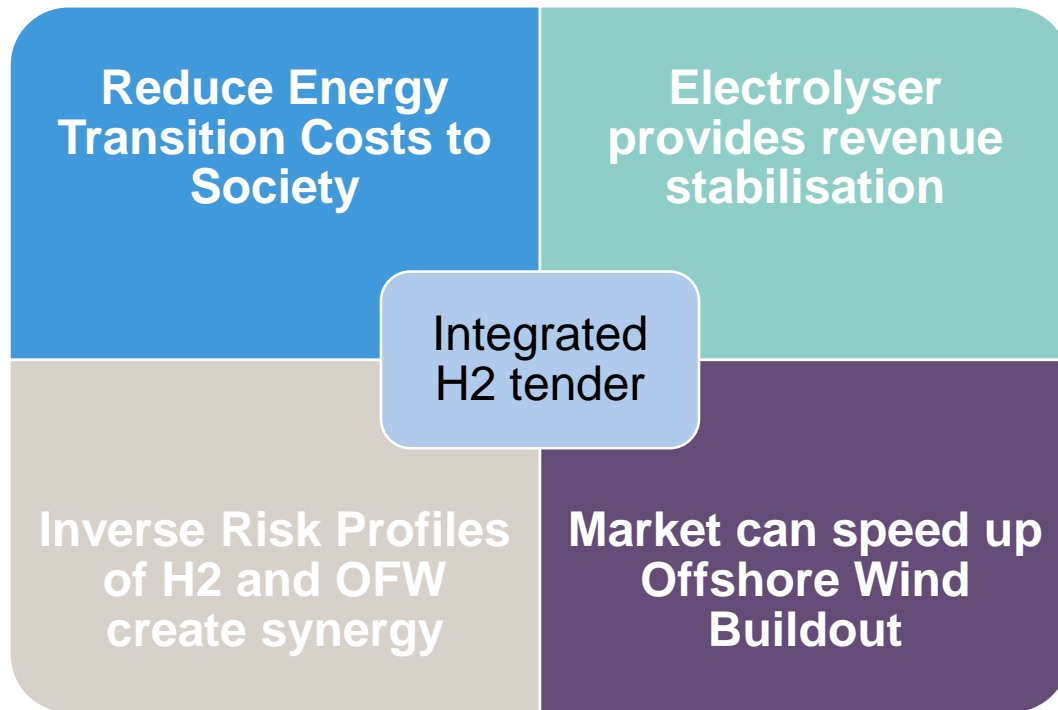
We are currently approaching a deadlock:

- **New Investments in Merchant Renewables are rather risky / uncertain**
Already towards 2030 large moments of oversupply expected
- **Investments in Electrification / Hydrogen seen to increase CO₂ / costly**
'CO₂ grid intensity' perspective versus 'REDII traceable green electricity'



Integrated Offshore Wind & Hydrogen Tenders are a sound solution to meet 2030 goals

Arbitrage between Electricity and Hydrogen creates synergy

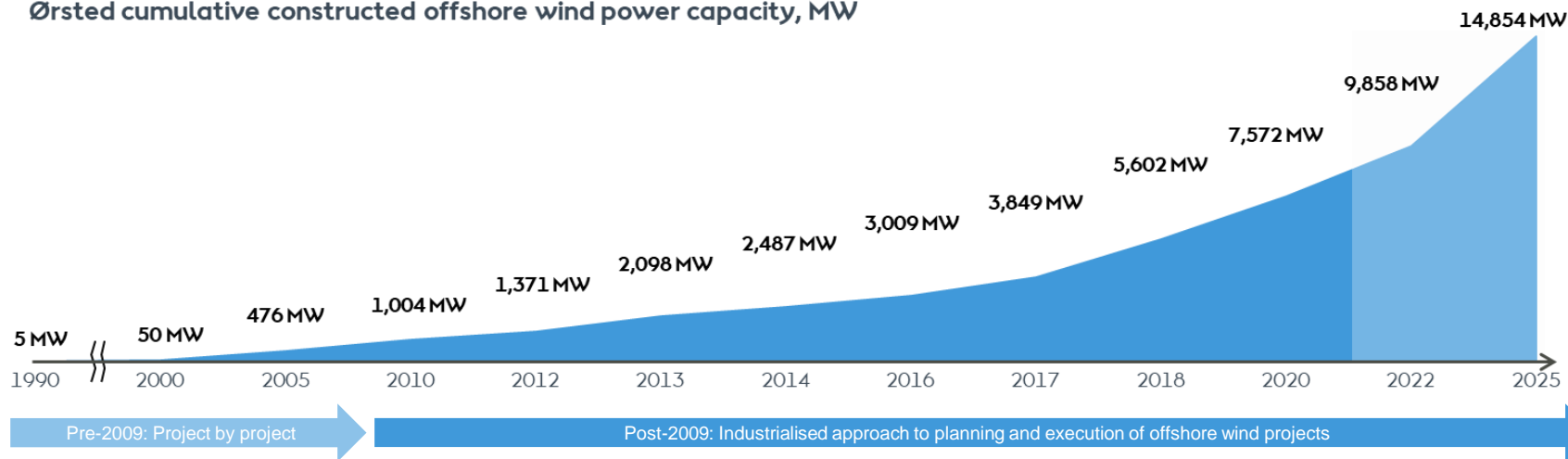


A leading position for NL in green hydrogen is within reach

- **3~4GW of Installed Electrolysers in 2030**
Potentially site and permitting provided by Government
- **Subsidy Instrument to be developed**
Potentially as €/kg H₂ revenue top up
- **Market to reduce CAPEX of electrolysers**
From 1000kEUR/MW to 350kEUR/MW

We have already taken one industry from demo to GW-scale

Ørsted cumulative constructed offshore wind power capacity, MW



Selected projects

Vindeby

First offshore wind farm in the world



5 MW

Turbine capacity	0.45 MW
Nr. of turbines	11
Rotor diameter	35 m
Distance to shore	1.8 km

Horns Rev 1

First large scale offshore wind farm in the world



160 MW

Turbine capacity	2 MW
Nr. of turbines	80
Rotor diameter	80 m
Distance to shore	18 km

Walney Extension

Previous the largest operational offshore wind farm in the world



659 MW

Turbine capacity	7-8.25 MW
Nr. of turbines	87
Rotor diameter	154-164 m
Distance to shore	19 km

Hornsea 1

The world's largest offshore wind farm



1,218 MW

Turbine capacity	7 MW
Nr. of turbines	174
Rotor diameter	154 m
Distance to shore	120 km

Three phase approach towards a economically viable Hydrogen Economy

A level playing field and structural rollout plan

1 GW
Onsite
Electrolysers



Rijksdienst voor Ondernemend
Nederland

V1.0 First industrial-scale

Construction 2020-2025
Already progressed Projects

- On site Electrolyser
- High voltage grid required, but grid exemptions needed
- Support towards market parity

4x 1GW
'Waterstof
Kavels'

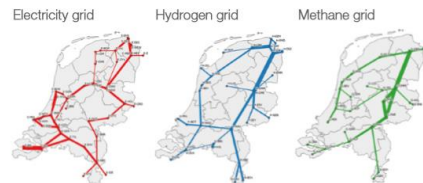


Hydrohub

V2.0 Centralized Locations

Construction 2025-2030
Central H₂ production in harbours

- Local H₂ grid around the 1GW Electrolyser concept
- Connection with storage to provide baseload H₂
- Support towards market parity



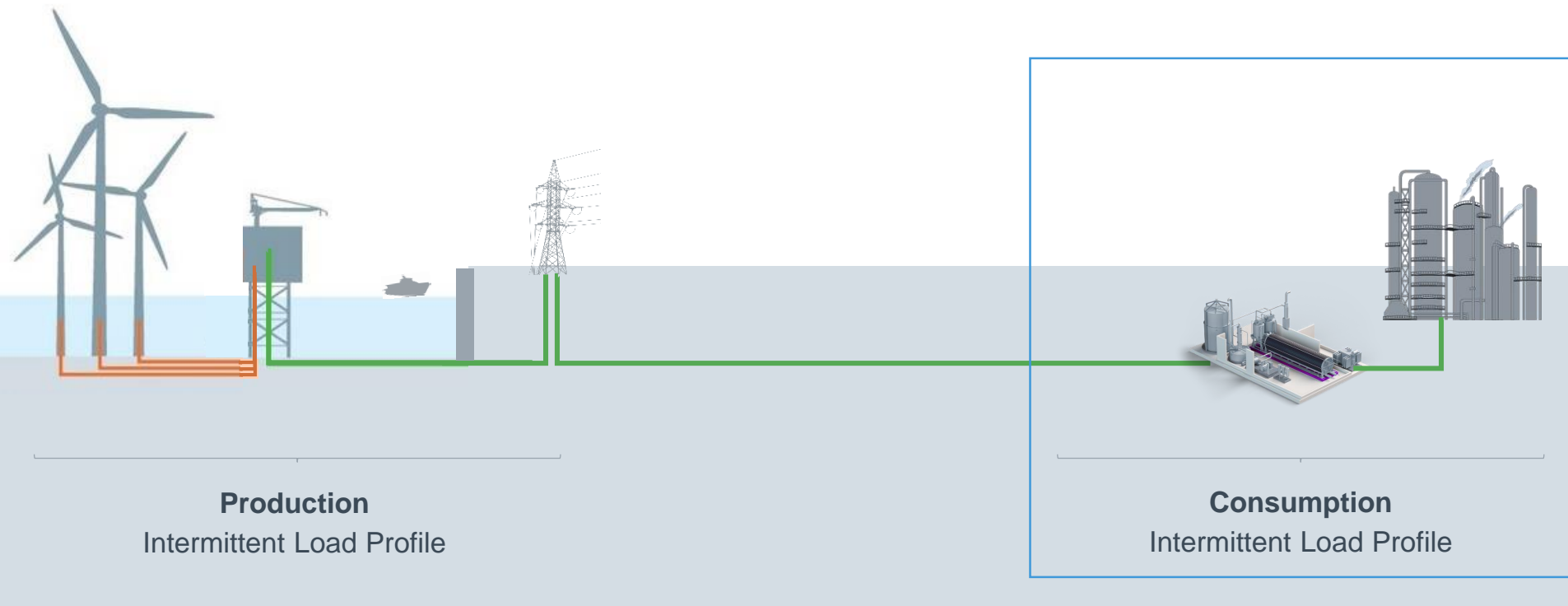
V3.0 International Rollout

2030-2050
Regional Grids Connected

- National Hydrogen grid
- North West European H₂ Interconnectors
- Potential Offshore H₂ Production






How to get started: Onsite Renewable Hydrogen 2020-2025

Scaling of the Supply Chain and expertise towards GW electrolysis

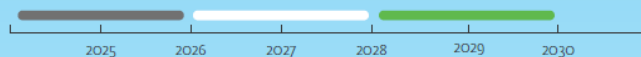


Waterstofbackbone Gasunie

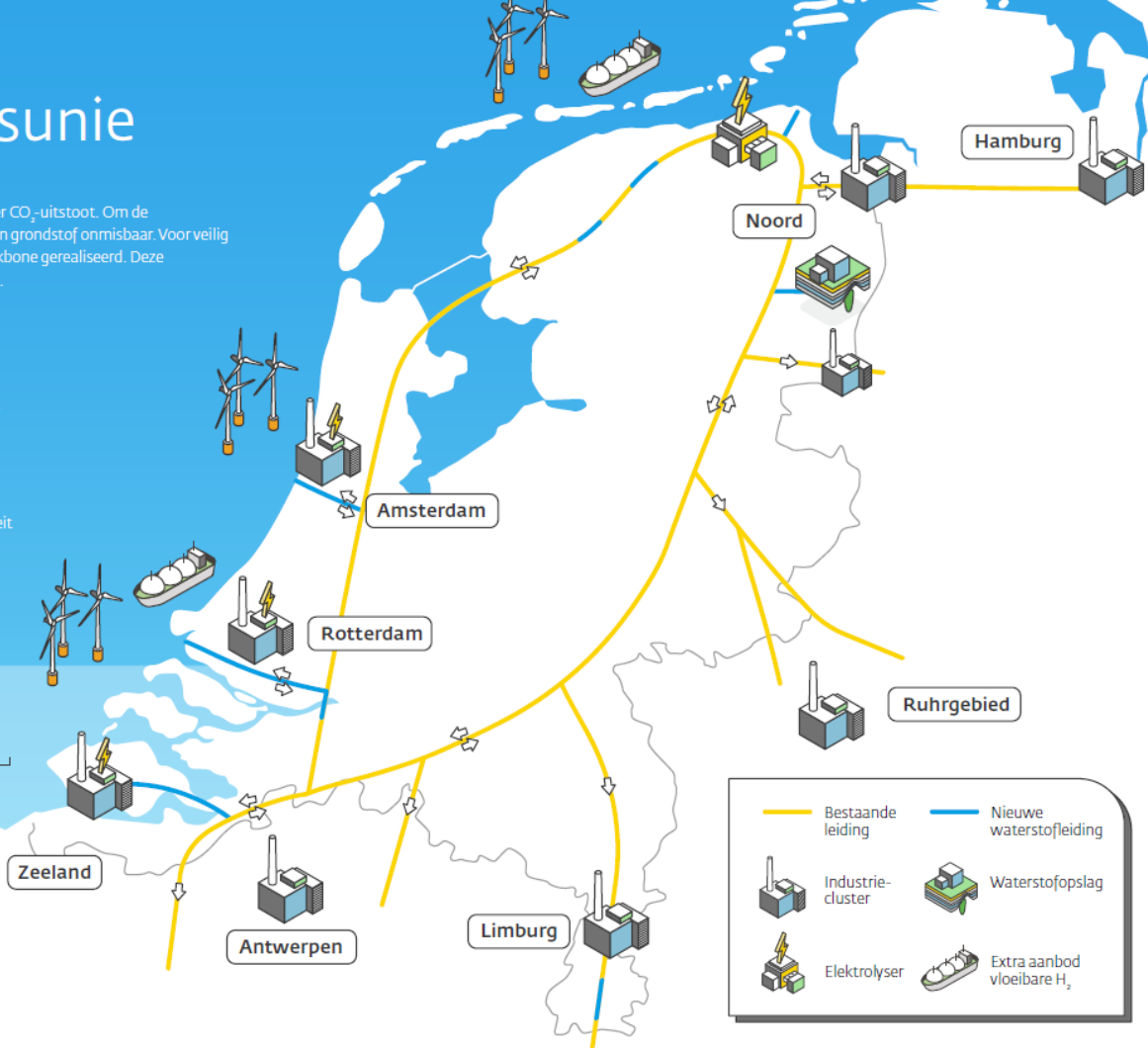
Gasunie werkt aan een duurzame energievoorziening voor Nederland en Europa met minder CO₂-uitstoot. Om de uitdagingen uit het Klimaatakkoord te realiseren is duurzame waterstof als energiedrager en grondstof onmisbaar. Voor veilig en betrouwbaar transport en opslag van deze CO₂-vrije moleculen wordt een waterstofbackbone gerealiseerd. Deze backbone brengt vraag en aanbod bij elkaar en bestaat grotendeels uit bestaande leidingen.

-  Gasunie waterstofbackbone verbindt regionale backbones met elkaar, het buitenland en waterstofopslag.
-  Grootchalig hergebruik bestaande infrastructuur (85%) maakt waterstoftransport betaalbaar, goed inpasbaar en snel beschikbaar.
-  Koppeling met waterstofopslag vangt fluctuaties op in vraag industrie en aanbod duurzame energie.
-  Grootchalige capaciteit maakt verduurzamings industrie mogelijk; 10 GW capaciteit maakt ± 10 Mton CO₂-reductie mogelijk (70% van 2030-doelstelling industrie).
-  Landelijke dekking in 2030 met 1400 km leiding (dit is gelijk aan de afstand van Groningen naar bijvoorbeeld Marseille).

Fasering

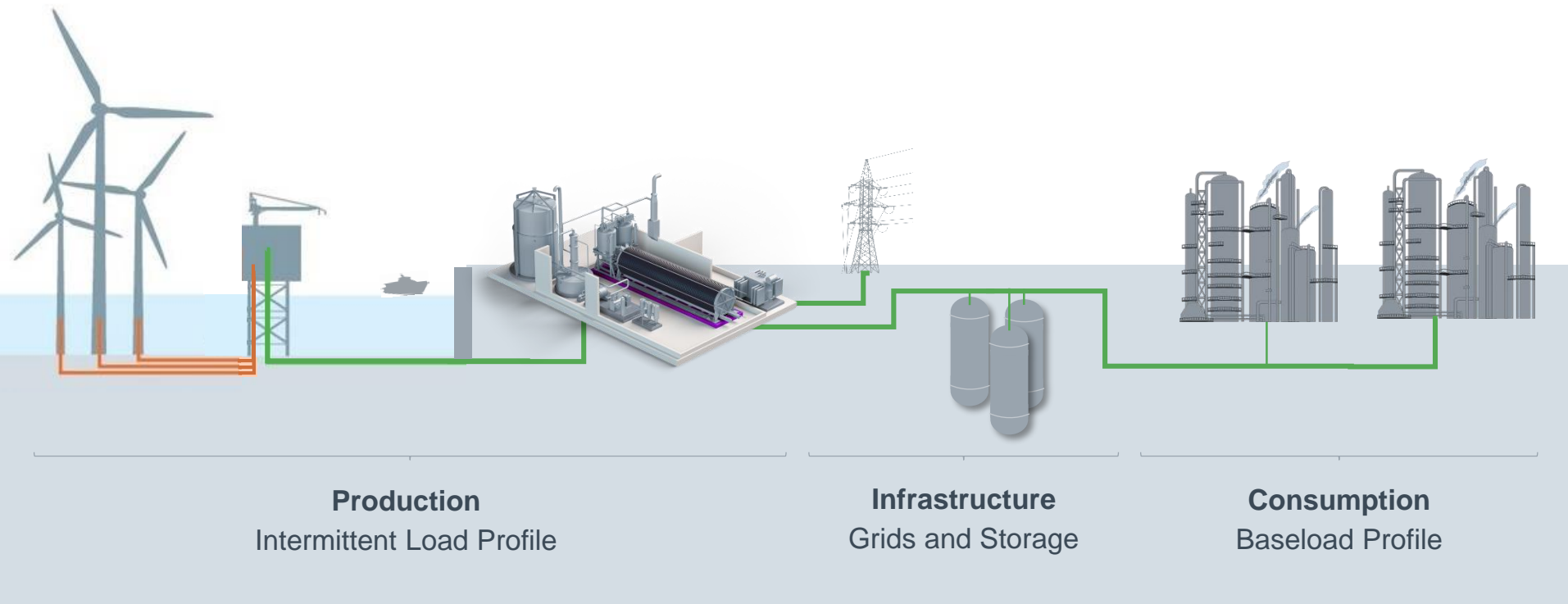


- Ontwikkeling regionale backbones, inclusief verbinding met Duitsland en Noord-Nederland
- Industriële clusters verbonden met elkaar en met waterstofopslag
- Backbone verbonden met Europese waterstofbackbone



Full Value chain of Renewable Hydrogen towards GW level in 2025 - 2030

Storage converts intermittent production to baseload consumption profiles



Regulatory: Scaling Hydrogen towards market parity

A level playing field and structural rollout plan

Create a level playing field

- **Dynamic Grid Pricing - 'Free Landing Zone'**
Fair priced grid fees in order to level the playing field
- **EU ETS**
Align for Fossil Feedstock replacement
- **Hydrogen Certificate System**
Create a market for renewable (and fossil-based with CCS) H₂
- **RED II implementation**
Ensure national implementation supports demand for renewable H₂

Programmatic Approach

- **Stable Rollout Plan**
Long year plan towards 4GW in 2030
Similar to offshore wind
- **Standardization + Economies of Scale**
Start with ~100MW sites and grow further.
Electrolyser Technology Neutral,
infrastructure standardization and permits provided
- **Sector Deal - tripartite**
(1) H₂ market players, (2) Infrastructure partner, and (3) Gov't for support on price gap between green and grey towards market parity in 2030

The background image shows the interior of a wind turbine nacelle. On the left, a large white door is open, revealing a blue sky and the ocean. In the center, a large white cylindrical structure, likely a nacelle component, is visible. On the right, a white panel with a black and white checkered pattern is mounted. Below the panel, a blue mechanical arm or cable is visible. The entire scene is overlaid with a semi-transparent blue rectangle containing text.

Questions?

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