



KEYNOTE: Status and plans on future developments from the technical perspective

Timo Kahl
TenneT | Large Projects Offshore

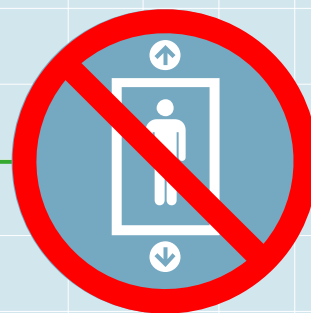
A moment for safety

Together we provide a safe working environment. We learn from mistakes and sharing ideas, concerns and asking questions are a matter of course.

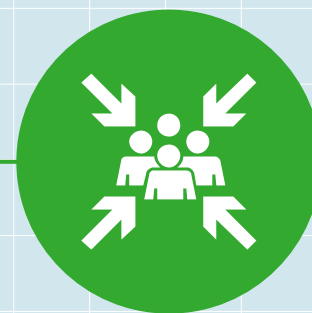
We also draw attention to the following safety measures in case of evacuation of the premises



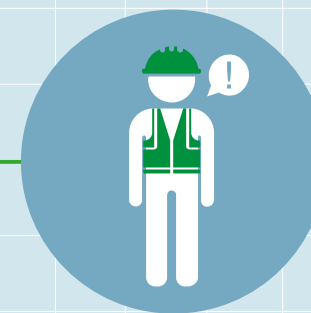
Follow the escape route as indicated



Use the stairs instead of the lift



Go to the assembly point



Follow the instructions of the in-company emergency responder

Our role - TenneT (offshore) at a glance

TenneT at a glance

2023



Workforce

8,300

Employees



EBIT

1,817

EUR million



Assets

45

EUR billion



Investments in 2023

7,7

EUR billion



Grid

99,99%

Availability



Grid length

25,000

Km



Dutch State

100%

Shareholder



Footprint

33%

Greened

Our mission – Safe and sustainable integration of offshore wind energy in Europe

Meeting the offshore goals

North Sea as Europe's green powerhouse

We believe that the **North Sea** holds the key to achieving Europe's offshore energy goals.

No other place in Europe offers so much **potential for green, safe and independent energy supply: 300 GW** of clean wind energy could be generated.

The corresponding 1,500 TWh per year could cover the annual **electricity demand in Germany, Denmark, the Netherlands and the UK.**

Offshore goals across Europe

Challenges for the coming decade alone

Ostende Declaration (2023)*



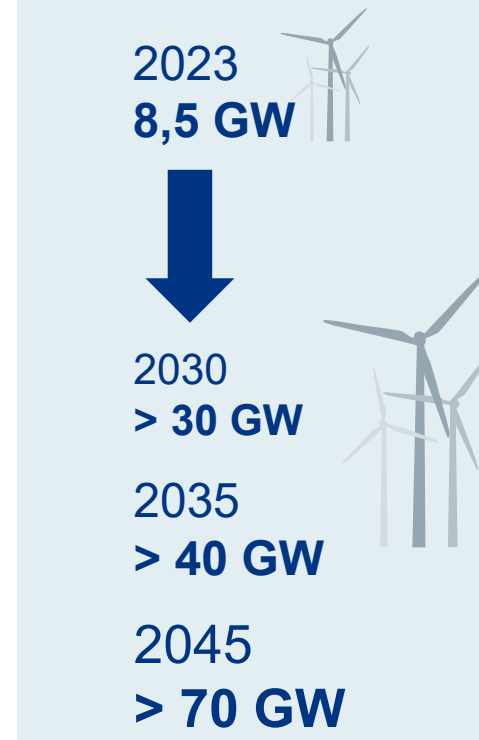
(*) GER, NED, BEL, DEN, FRA, IRL, LUX, NOR, GBR

Esbjerg Declaration (2022)**

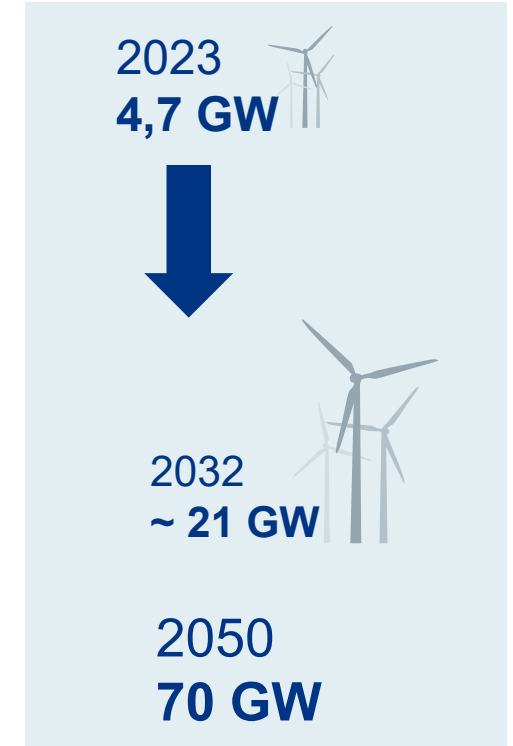


(**) GER, NED, BEL, DEN

Germany



The Netherlands

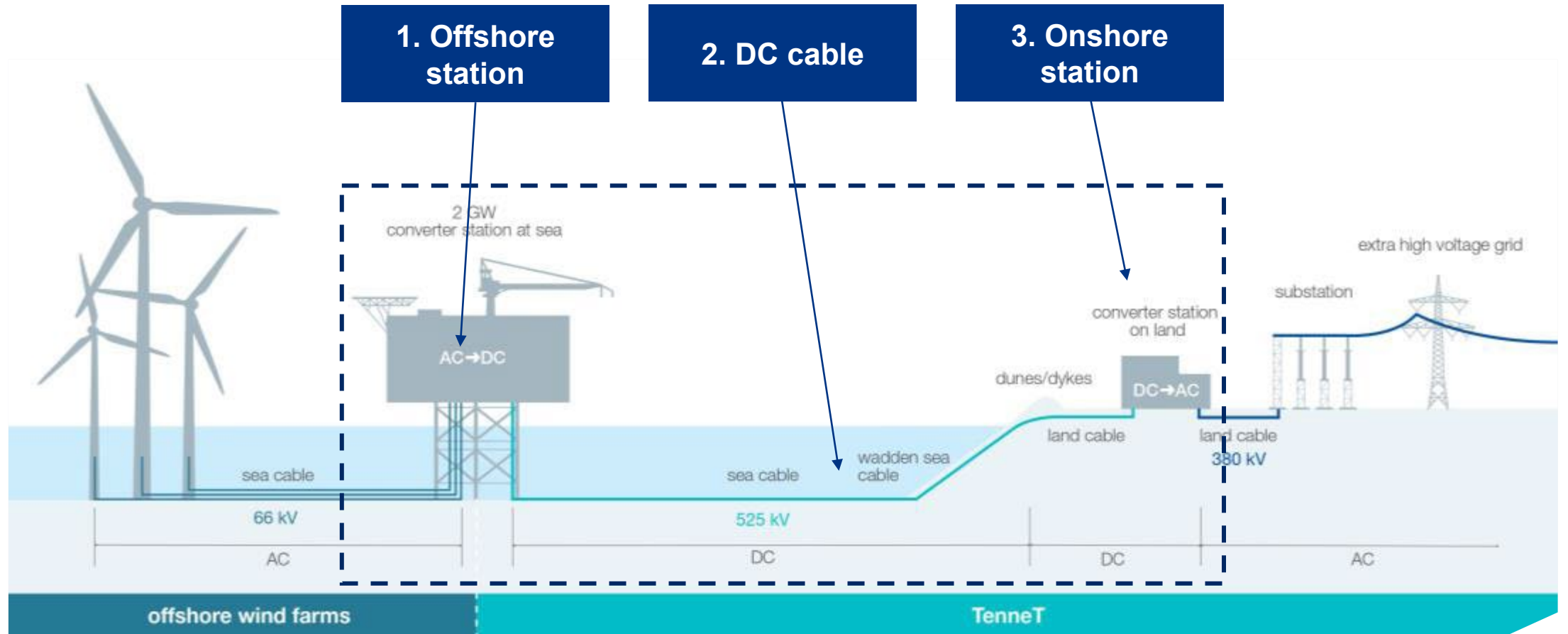


Our innovations - Future developments from grid perspective



Technical scope of an offshore grid connection system

Interface between OWF* operator and TSO*



(*) TSO: Transmission System Operator // OWF: Offshore Wind Farm

Evolution of different concepts Offshore grid connection systems

Direct Current

Increase of transmission power to 900 MW DC for offshore systems with greater distance to shore

DirectLink

Direct connection of OWF via 66 kV AC cables, substation platform and AC cables



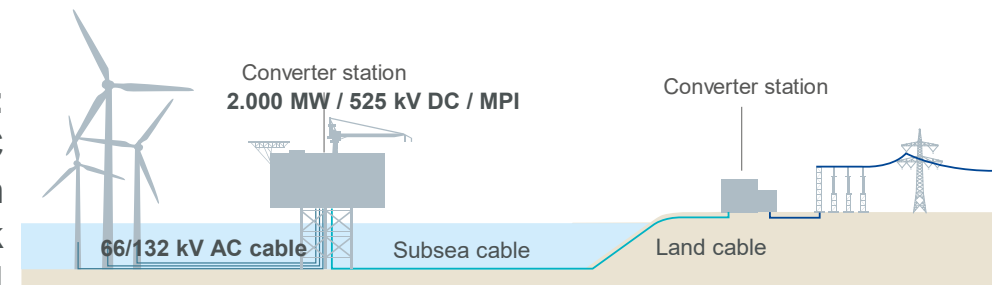
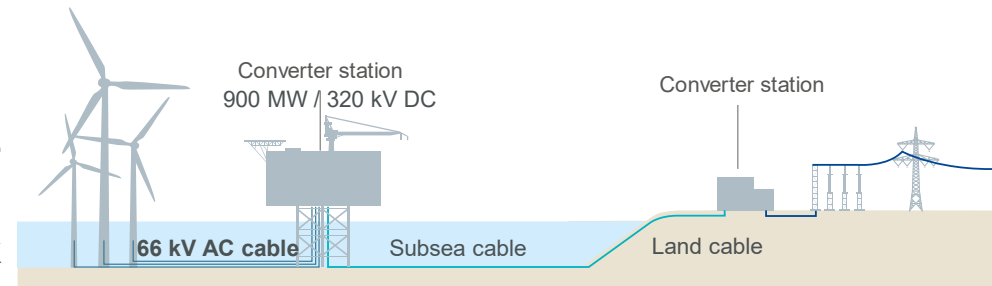
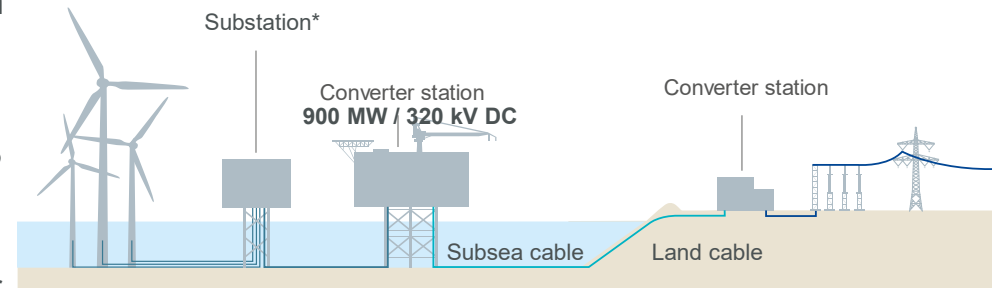
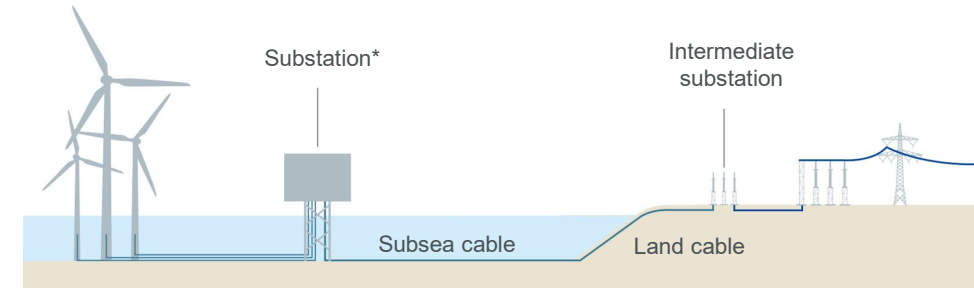
2GW Program
1 platform, 1 cable and 1 contract design

2008 & Nearshore
AC connection with substation

2010-2023
DC connection with substation and converter

2025-2027
DC connection with direct link

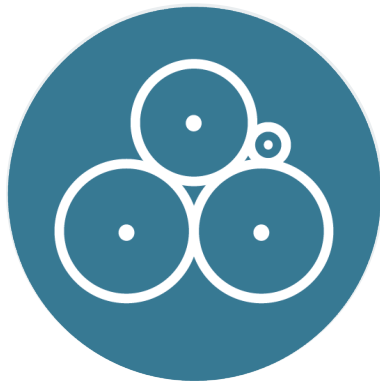
2029 onwards:
High Power DC connection with direct link and MPI



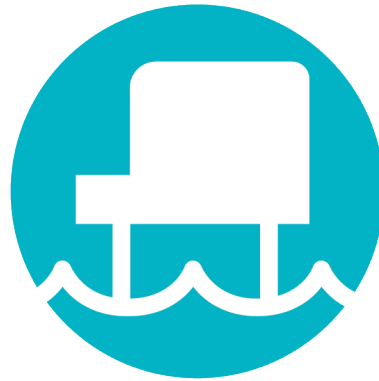
* In Germany, wind park operator's responsibility

Innovative technologies in our 2GW Program

The evolution of standards



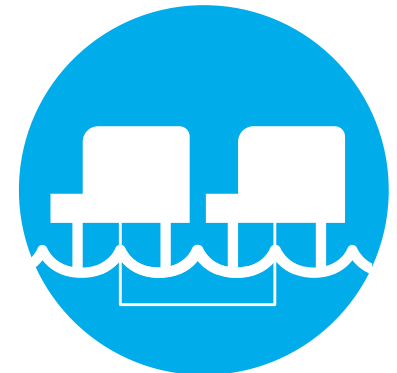
525 kV cable system



2 GW HVDC platform standard



66 kV direct link to offshore wind park



Multi-terminal readiness

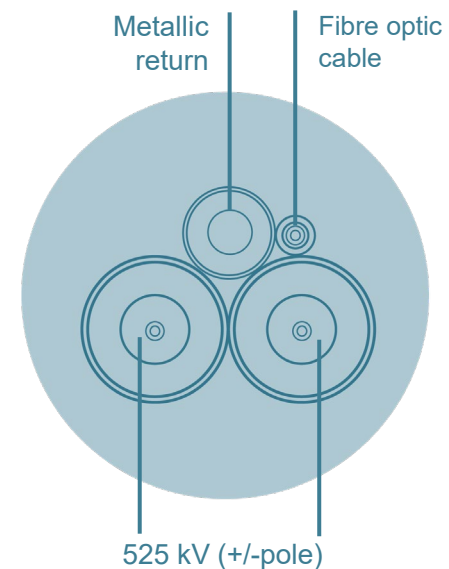
525 kV cable system

A bundle of energy

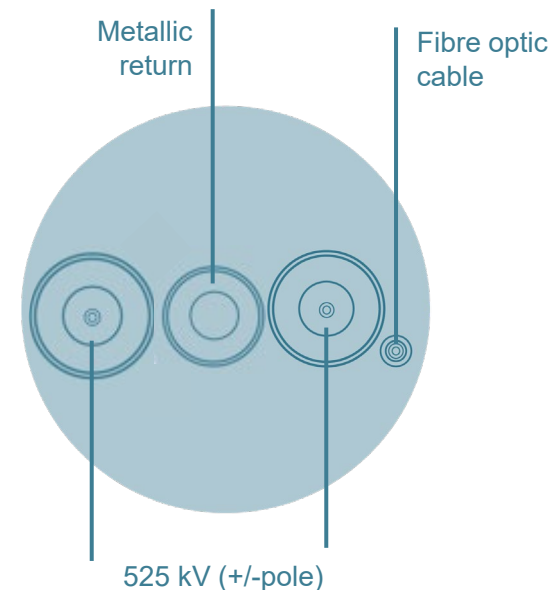
Our new cable system consists of a bundle of **four cables**. This system...

- has a significantly higher capacity than its predecessors and enables a more cost-efficient transmission over long distances.
- reduces environmental impact because fewer cables are needed to transmit the same amount of energy.
- can continue to operate at 50% of its capacity even in the event of a cable fault.

Sea cable



Land cable



2 GW HVDC platform

The new platform standard

Platform

Standardized topside design
Approx. 30.000 tonnes

Jacket

Flexible design, depending on
water depth and soil condition
Approx. 8.000 – 11.000 tonnes

Together with partners from our sector, we successfully developed an innovative and standardised multi-vendor HVDC platform model featuring technology that will ultimately enable us to guarantee a **transmission capacity of 2 GW – or more than twice the capacity of previous systems.**

We are setting course for a meshed offshore grid

Our new 2 GW standard



With a high degree of harmonization, our **new 2 GW standard** lays the foundation for an even stronger integration of energy systems in Europe: **a fully meshed and cross-border offshore grid.**



International energy network Future Offshore



The innovation

Flexible international offshore network



The principles

Meshing

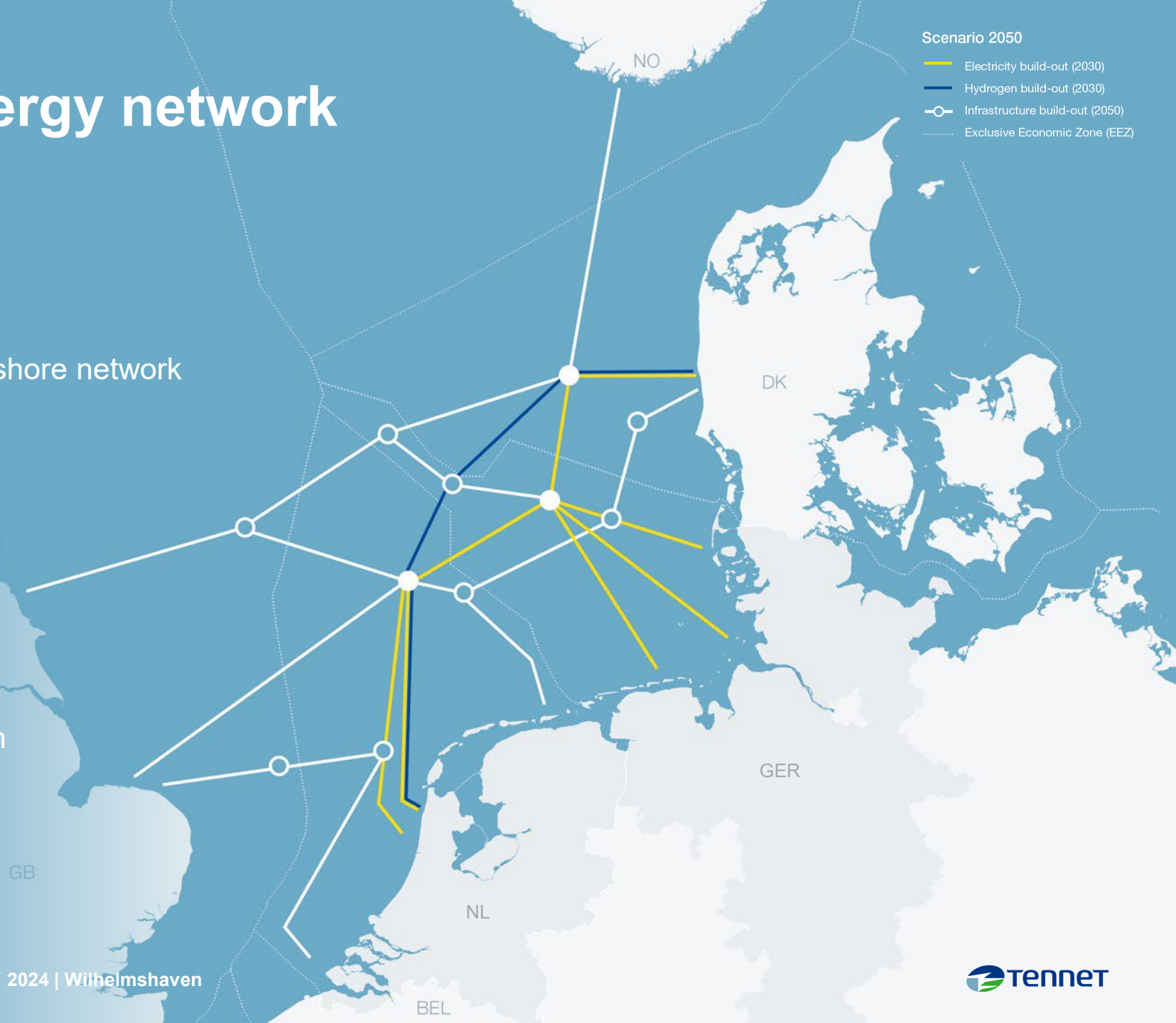
Standardisation

System integration

International cooperation

Scenario 2050

- Electricity build-out (2030)
- Hydrogen build-out (2030)
- Infrastructure build-out (2050)
- Exclusive Economic Zone (EEZ)



Optimizing offshore potential: nationally and across borders



Tapping the North Sea's potential



Challenges

- Wake effects
- Rising costs



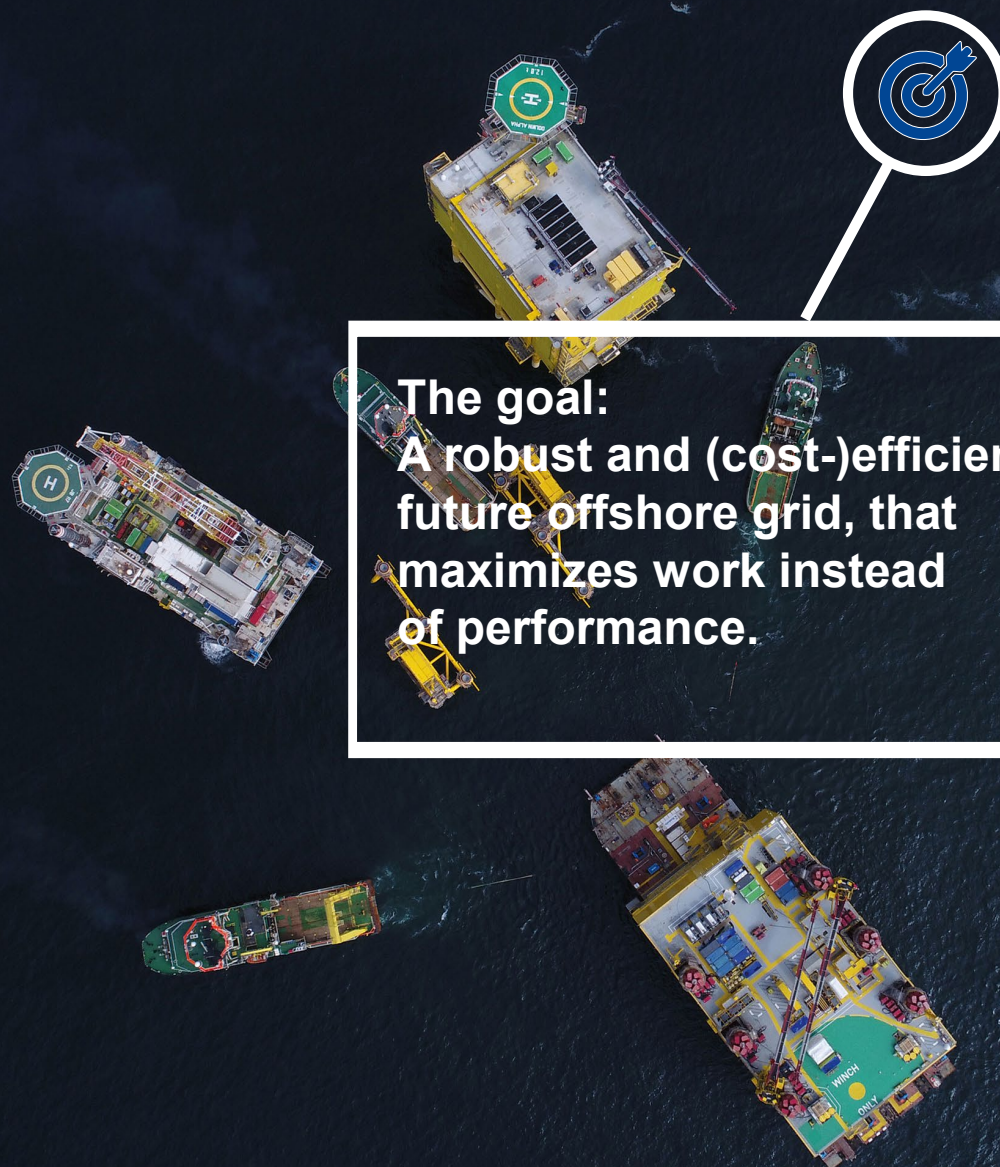
Solutions

- Peak shaving
- Optimized spatial layout (nationally and across borders)
- Higher utilization of grid connections



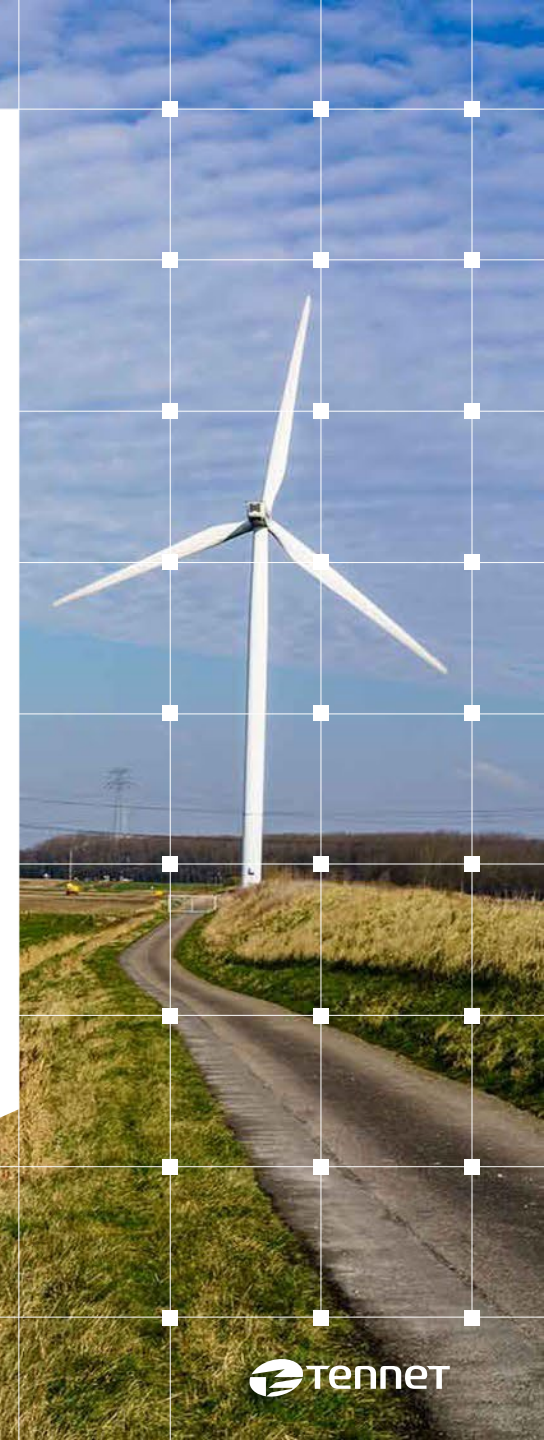
The goal:

A robust and (cost-)efficient future offshore grid, that maximizes work instead of performance.



TenneT is a leading European grid operator. We are committed to providing a secure and reliable supply of electricity 24 hours a day, 365 days a year, while helping to drive the energy transition in our pursuit of a brighter energy future – more sustainable, reliable and affordable than ever before. In our role as the first cross-border Transmission System Operator (TSO) we design, build, maintain and operate over 25,000 kilometres of high-voltage electricity grid in the Netherlands and large parts of Germany, and facilitate the European energy market through our 17 interconnectors to neighbouring countries. We are one of the largest investors in national and international onshore and offshore electricity grids, with a turnover of EUR 9.2 billion and a total asset value of EUR 45 billion. Every day our 8,300 employees take ownership, show courage and make and maintain connections to ensure that the supply and demand of electricity is balanced for over 43 million people.

Lighting the way ahead together



Disclaimer

This PowerPoint presentation is offered to you by TenneT TSO B.V. ('TenneT'). The content of the presentation – including all texts, images and audio fragments – is protected by copyright laws. No part of the content of the PowerPoint presentation may be copied, unless TenneT has expressly offered possibilities to do so, and no changes whatsoever may be made to the content. TenneT endeavours to ensure the provision of correct and up-to-date information, but makes no representations regarding correctness, accuracy or completeness.

TenneT declines any and all liability for any (alleged) damage arising from this PowerPoint presentation and for any consequences of activities undertaken on the strength of data or information contained therein.