Offshore AC Substations and HVDC Converter Stations

Technology Overview and Engineering Issues

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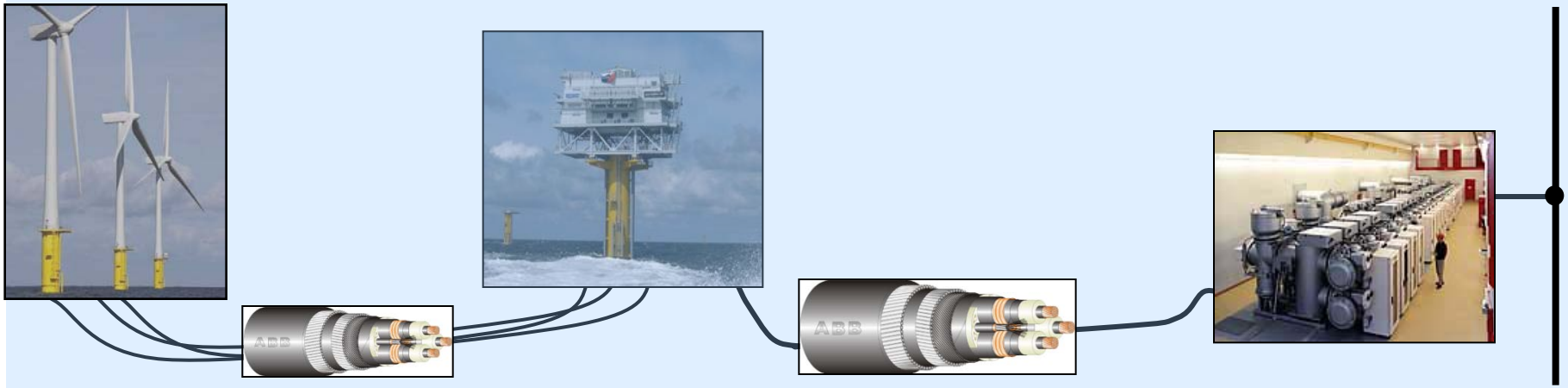
Company name: ABB PSG – Raleigh, NC

Typical Interconnection Arrangement for Medium Size Facility

54 turbines



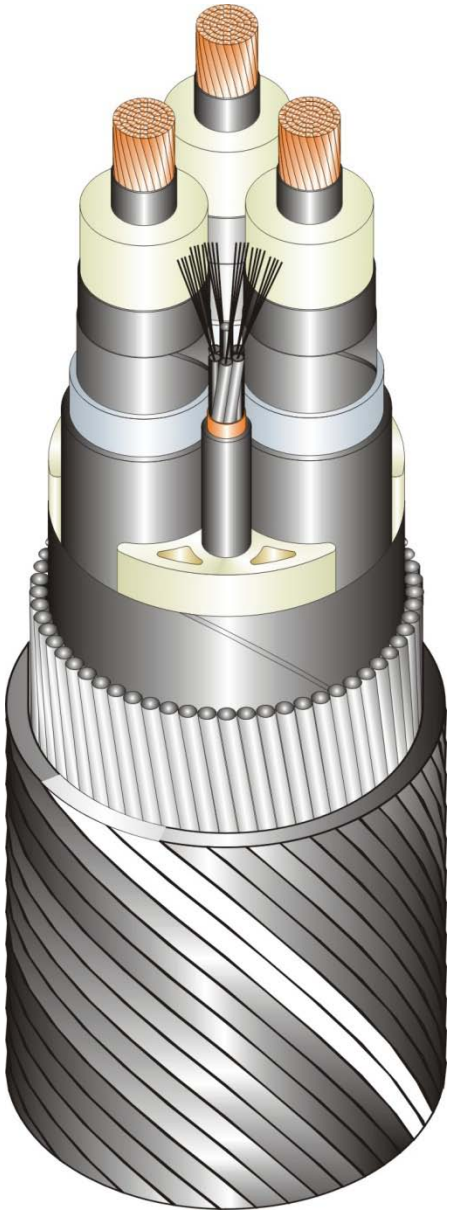
MV Collection grid

Offshore AC substation

Export Cable(s)

Onshore substation

Typical EHV AC Submarine Cable Design



Conductor material:	Copper
Conductor screen material:	Conductive PE
Insulation material:	Polymer (XLPE)
Insulation screen:	Conductive PE
Longitudinal water seal:	Swell able tapes
Metallic sheath material:	Lead alloy
Inner sheath material:	Conductive PE
Assembling:	Polymeric profiles
Cable core binder:	Polymeric tape
Bedding:	Impregnated tape
Armor material:	Galvanized steel
Outer serving material:	Polypropylene yarn

Typical EHV AC Submarine Cable Design

Conductor material:	Copper
Conductor screen material:	Conductive PE
Insulation type/material:	Dry cured triple extruded XLPE
Insulation screen:	Conductive PE
Longitudinal water seal:	Swelling tapes
Metallic sheath material:	Lead alloy
Inner sheath material:	Conductive PE
Armor material:	Copper wires
Outer serving material:	Polypropylene yarn

Princes Amalia 120 MW Wind Farm

Project	**Q7 for Princes Amalia off-shore wind park, Netherlands**
Client	**Q7 holding** **(*Econcern, Energy Investments Holding and ENECO Energie)***
ABB Scope	**Electrical System including 120 MW, 150/22 kV Off-Shore Substation, 18 miles of 150 kV Export cable and 29 miles of 22 kV Array cables**
Delivery	**2007**

Princes Amalia 120 MW Offshore Substation

Offshore Wind Power Interconnections
Platform fabrication

Typical weights of platform topsides:

- 100 MW AC-substation: <1000 tons
- 200 MW AC-substation: 1500 tons
- 300 MW AC-substation: 2000 tons

Key issues

- Yard loading - availability at “short notice”
- Offshore wind platforms competing for capacity with oil & gas platforms
- Coordination with offshore installation works
- Health and safety for offshore works
- Minimize offshore commissioning and maintenance
- Compact solutions

Technical Challenges for HV and EHV Cable Systems

- Charging current in AC cables increases cumulatively with voltage rating and distance. (For example, 25 miles of 345 kV XLPE cable requires approximately 600 Amps. charging current.)
- Capacity to transmit real power diminishes with distance, limiting the practical length of AC underground and submarine cable transmission circuits.

History of Solid Dielectric Cable Systems for Transmission

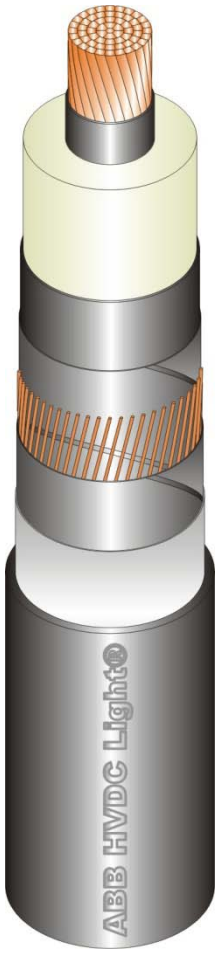
1970's: Deliveries of solid dielectric ("XLPE") cable systems for voltage ratings up to 145 kV.

1980's: XLPE transmission cable systems rated 230 kV.

1990's: XLPE transmission cable systems rated 420 kV and 500 kV.

1999: The world's first polymer insulated cable system for direct current transmission.

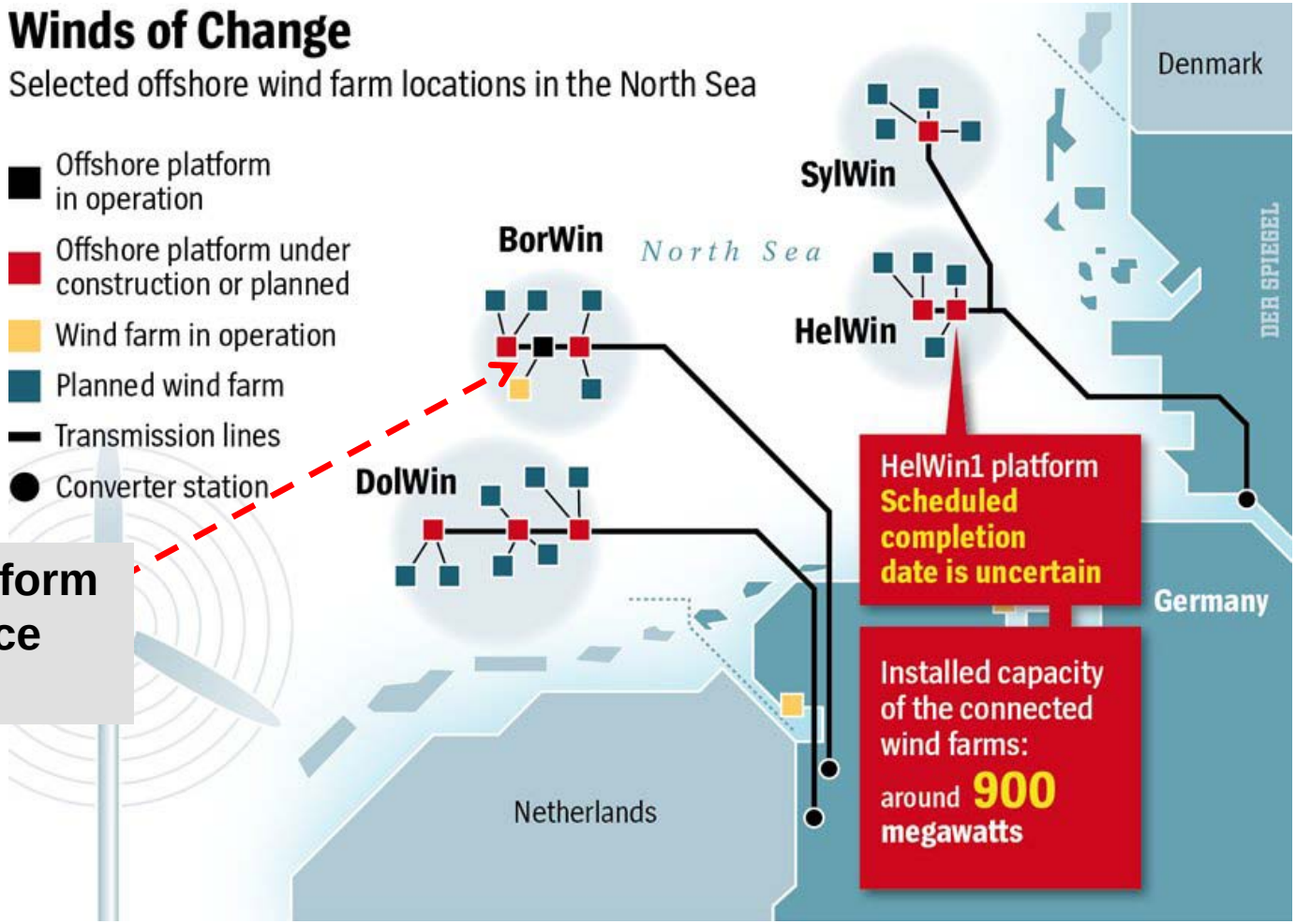
DC cables carry charging current only when energized. There are no technical issues that limits the practical length of HVDC cable transmission circuits.



1999
Gotland
160 kV (ø80 kV)
50 MW
43 miles

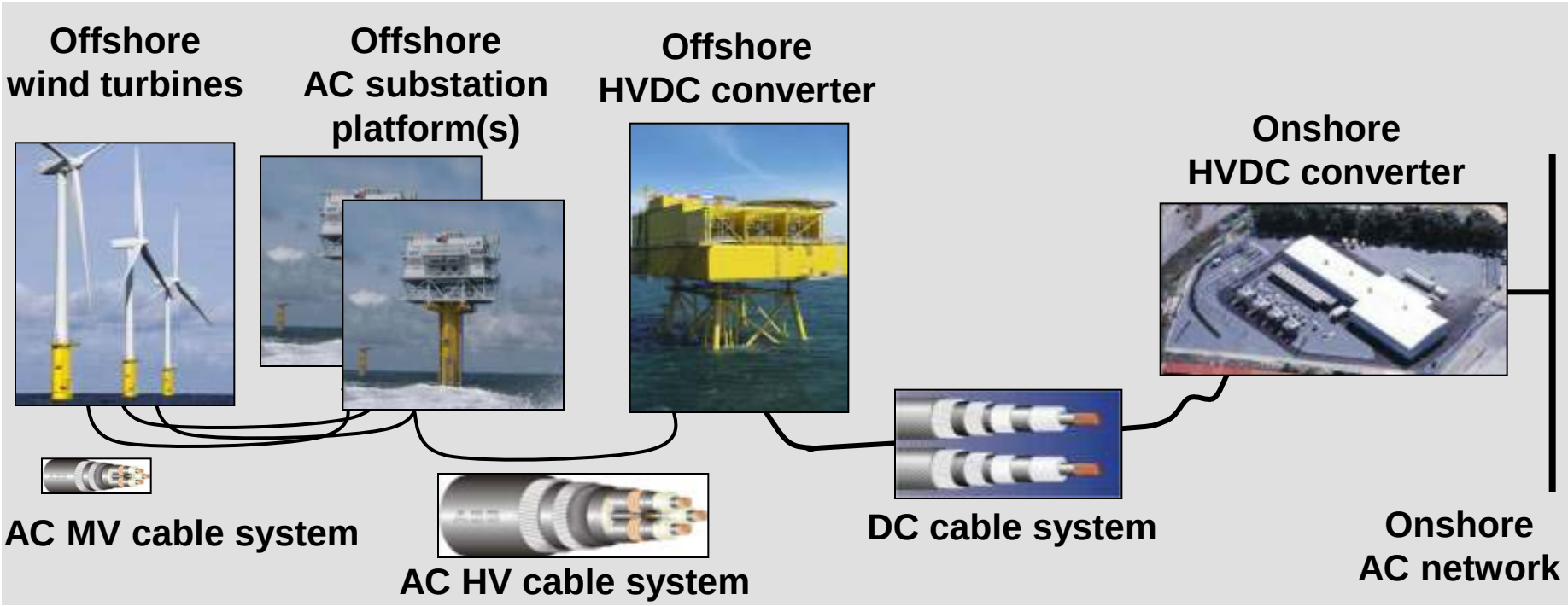
2000
Direct Link
160 kV (ø80 kV)
3

Existing and Planned HVDC Cable Interconnections in Germany



BorWin 1 Platform
In service since late 2009

Typical Interconnection Arrangement for Large Offshore Project

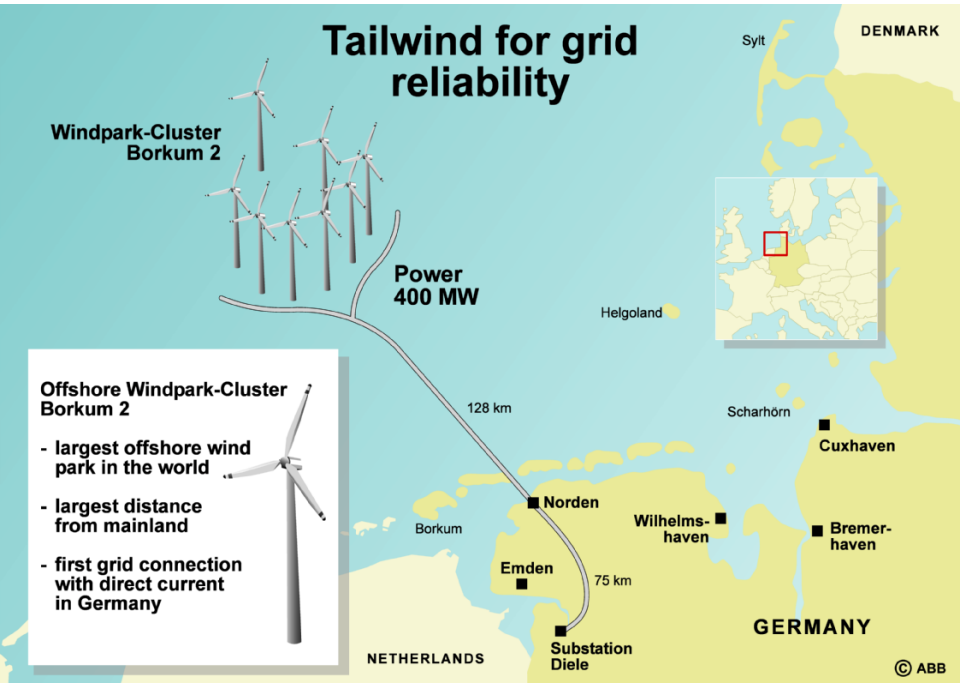


100 - 300 MW:	160 kV (±80 kV) HVDC
300 - 500 MW:	300 kV - 400 kV (±150 kV - ±200 kV) HVDC
500 - 1000 MW:	640 kV (±320 kV) HVDC

Typical HVDC Light Submarine Cable Design

Conductor material	Copper
Conductor screen material	Conductive PE
Insulation type/material	Dry cured HVDC polymer (XLPE)
Insulation screen	Conductive PE
Longitudinal moisture barrier	Swelling tapes
Metallic sheath material	Lead alloy
Inner sheath material	Polyethylene
Armor material	Galvanized steel wires
Outer serving material	Polypropylene yarn

BorWin HVDC Cable Project



Application

Interconnection of large off-shore wind generation facility to the German electric power transmission grid.

Solution

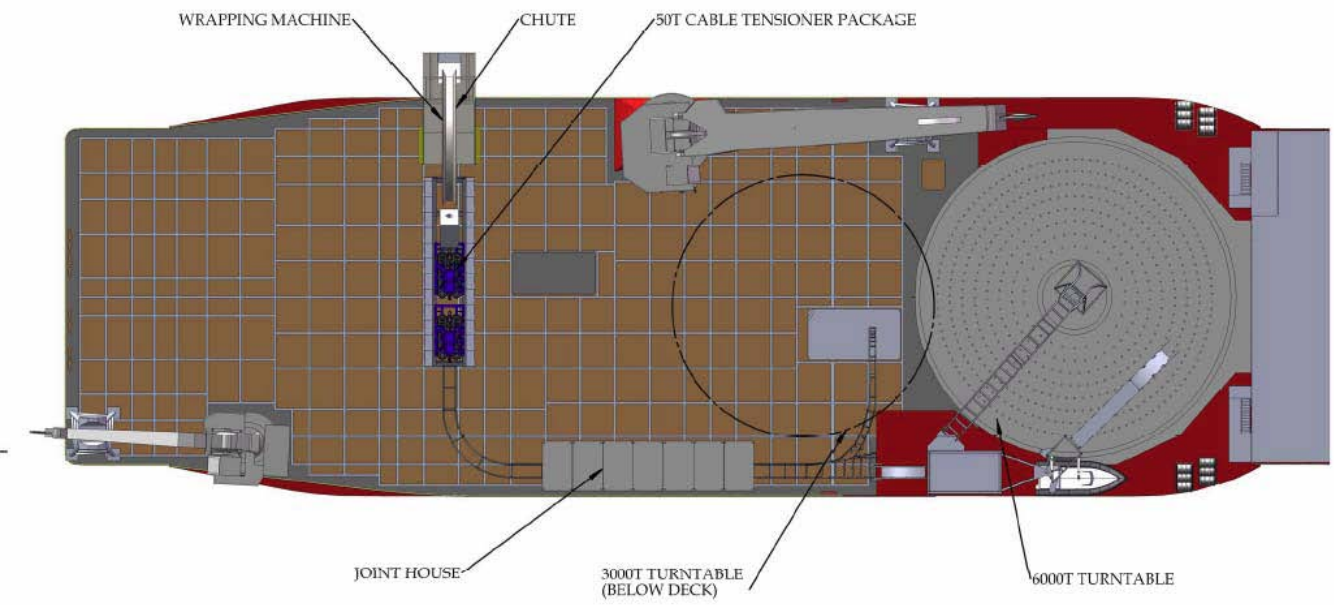
127 miles long, 300 kV (œ150 kV), 400 MW, submarine (80 miles) and underground (47 miles) HVDC cable circuit.

Compact off-shore and on-shore HVDC voltage source converters.

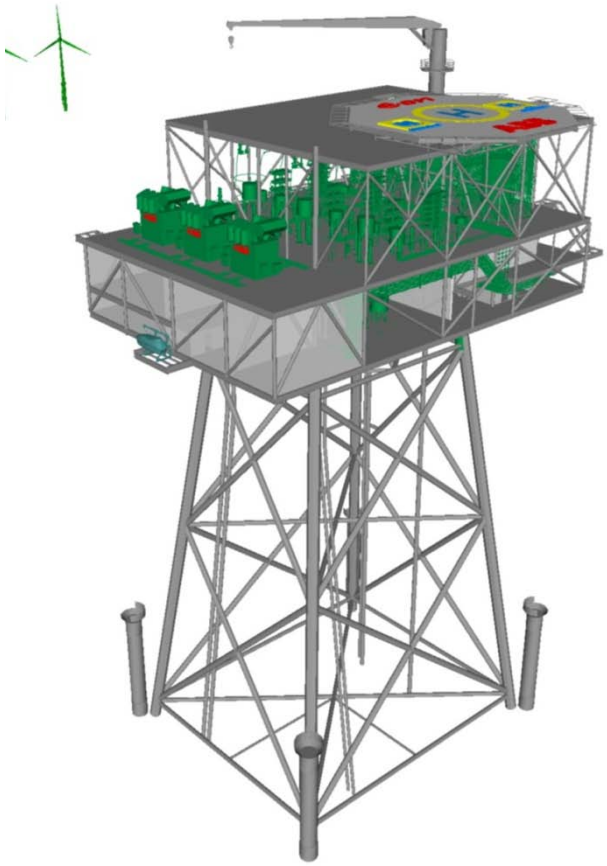
In-Service Year: 2009

Vessel particulars:

- Length overall: 156.9 m
- Breadth moulded: 32.0 m
- Depth, main deck: 12.0 m



BorWin 1 Offshore Converter Station Platform Data



Approximate weight:

- Topside: 3300 metric tons, including 800 tons of electrical equipment
- Jacket: 1500 metric tons

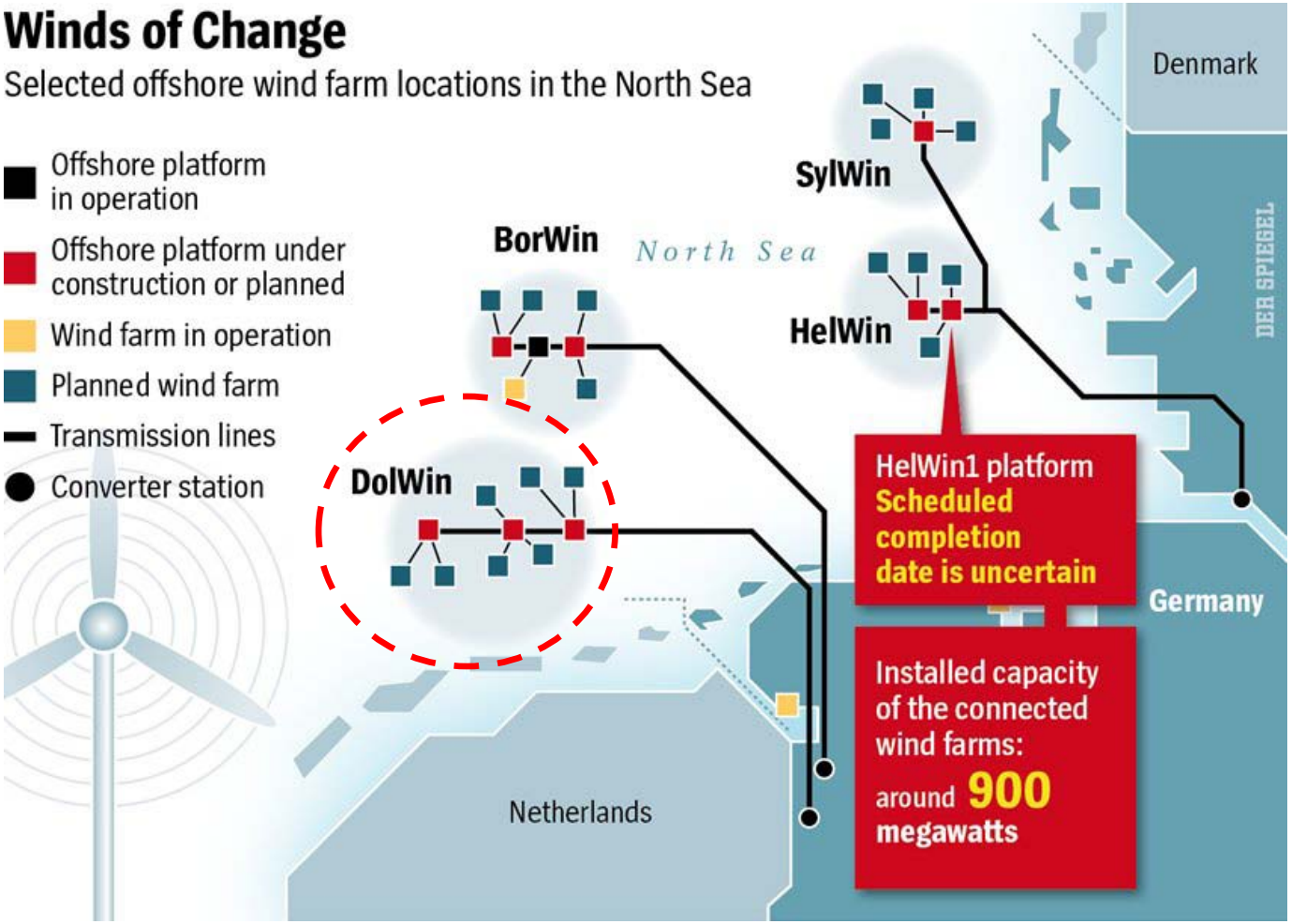
Approximate dimensions:

- Topside: 50×33.5×22 meters (164×110×72 ft.)
- Jacket: 62 meters (203 ft.) height; topside is approximately 20 meters (66 ft.) above sea level

Offshore Platform Under Construction at Heerema, Vlissingen, NL

BorWin 1 Offshore Platform Installation

Other HVDC Cable Interconnections under Construction in Germany



DolWin1
North Sea to Northern Germany

Application

Interconnection of large off-shore wind generation facility to the German electric power transmission grid.

Solution

107 miles long, 640 kV (≈320 kV), 800 MW, submarine (47 miles) and underground (60 miles) HVDC cable circuit.

Compact off-shore and on-shore HVDC voltage source converters.

In-Service Year: 2013

DolWin 2
North Sea to Northern Germany

Application

Interconnection of large off-shore wind generation facility to the German electric power transmission grid.

Solution

84 miles long, 640 kV (œ320 kV), 900 MW, submarine (28 miles) and underground (56 miles) HVDC cable circuit.

Compact off-shore and on-shore HVDC voltage source converters.

In-Service Year: 2015

Offshore Wind Power Interconnections
Platform fabrication

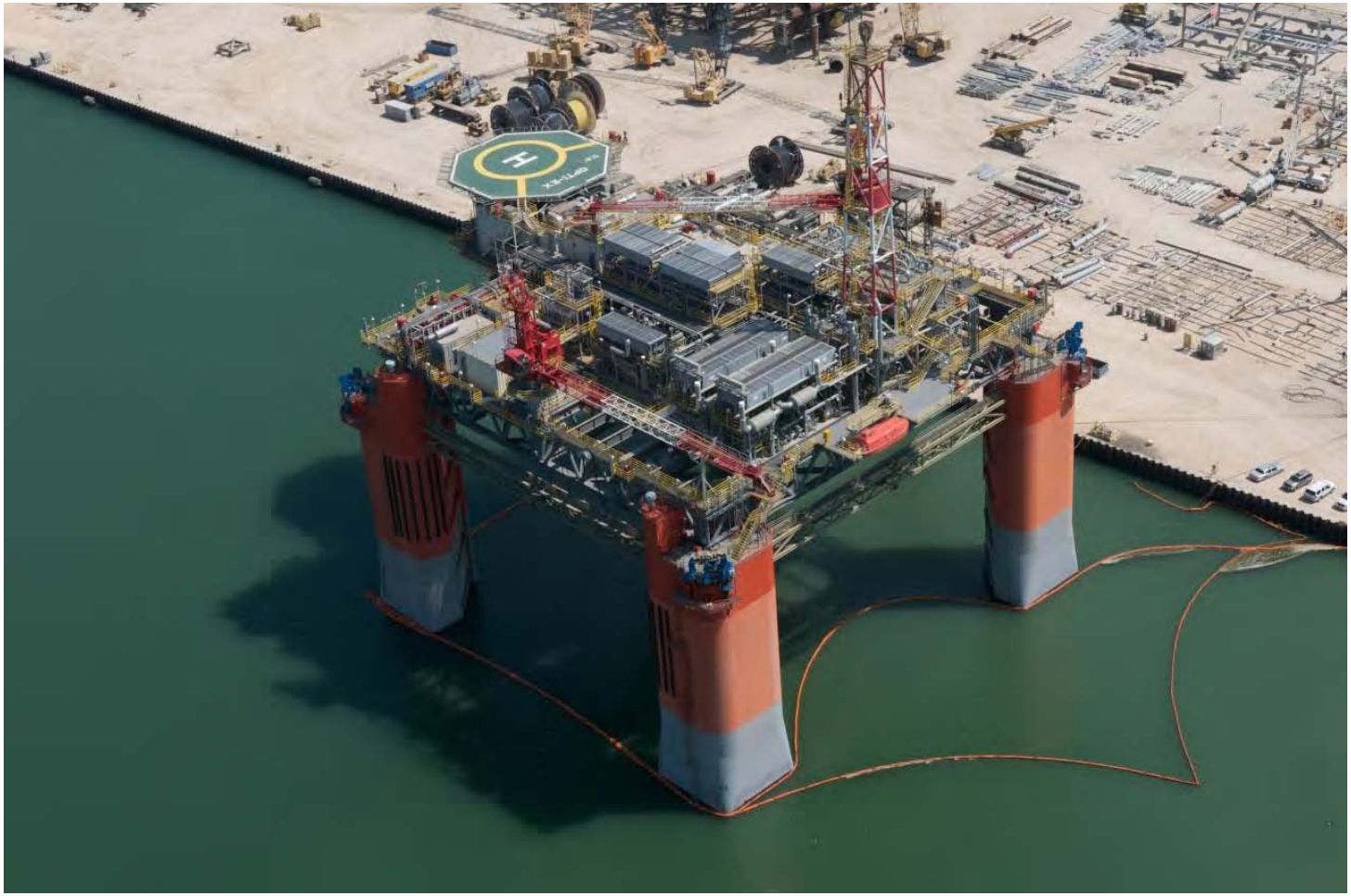
Typical weights of platform topsides:

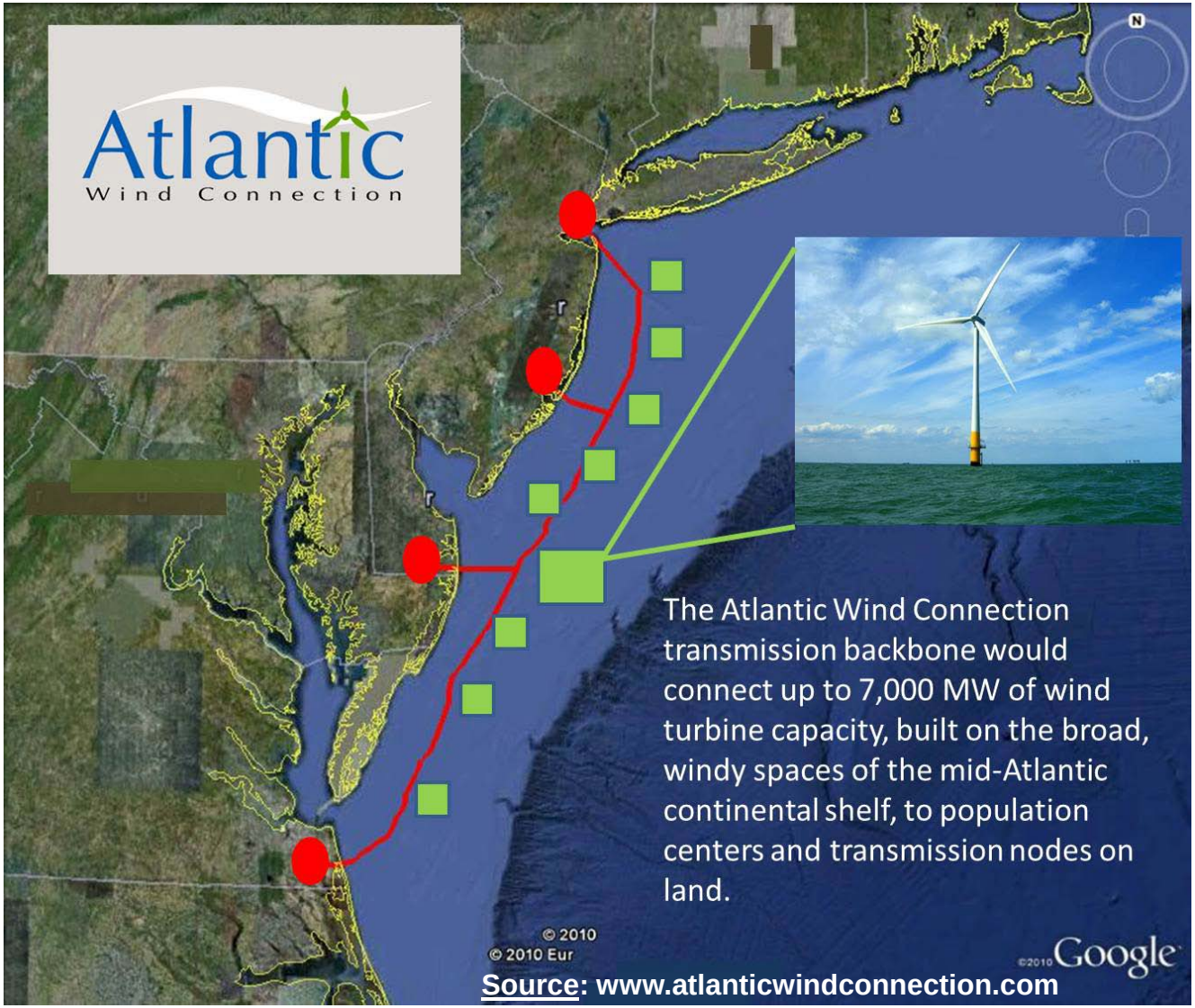
- 100 MW AC-substation: <1000 tons
- 200 MW AC-substation: 1500 tons
- 300 MW AC-substation: 2000 tons
- **400 MW HVDC station: 3000 tons**
- **1000 MW HVDC station: 8000 tons**

Key issues

- Yard loading - availability at “short notice”
- Offshore wind platforms competing for capacity with oil & gas platforms
- Coordination with offshore installation works
- Health and safety for offshore works
- Minimize offshore commissioning and maintenance
- Compact solutions

Floating Platform Design





Source: www.atlanticwindconnection.com

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