



Learning from the Experts Webinar Series

Mini-Series: Offshore Construction Substation Installation



Guido de Groot
Project Manager
Ventolines

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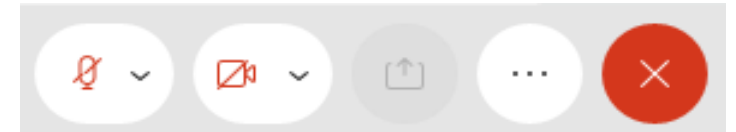
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Learning from the Experts

This webinar series is hosted by NYSERDA's offshore wind team and features experts in offshore wind technologies, development practices, and related research.

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NYSERDA – Learning from the Experts – September 2026



Offshore Substations

We guide our clients at every phase of wind, solar, energy storage, and system integration projects



A leading player in The Netherlands, sought after for its unique expertise and way of working, Ventolines has successfully entered major foreign markets across the globe.

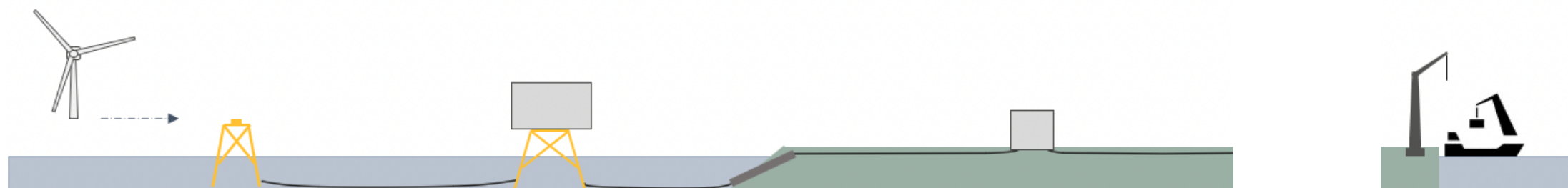
**We aim for a world in which
renewable energy projects
are valuable for everyone**

- 1 USA Block Island
- 2 USA NYSERDA
- 3 USA Clear Water Wind
- 4 Canada The Great Lakes
- 5 Canada Nova Scotia
- 6 Latvia and Estonia Elwind
- 7 Estonia Saare Liivi
- 8 Latvia Technical Due Diligence and Grid Compliance Studies
- 9 Sweden Stenkalles Grund
- 10 Ireland Future Energy Island
- 11 Australia Elanora

Agenda

1. Windfarm general and example / reference
2. Offshore substation functionality
3. What does it look like
4. Electrical set up and redundancy
5. Design and main components
 1. Topside
 2. Jacket
6. Timeline
7. Fabrication and construction strategy
8. Fabrication and installation
 1. Jacket
 2. Topside
9. Post installation works
 1. Cables
 2. Energization and commissioning
10. Summary and take aways
11. Abbreviations

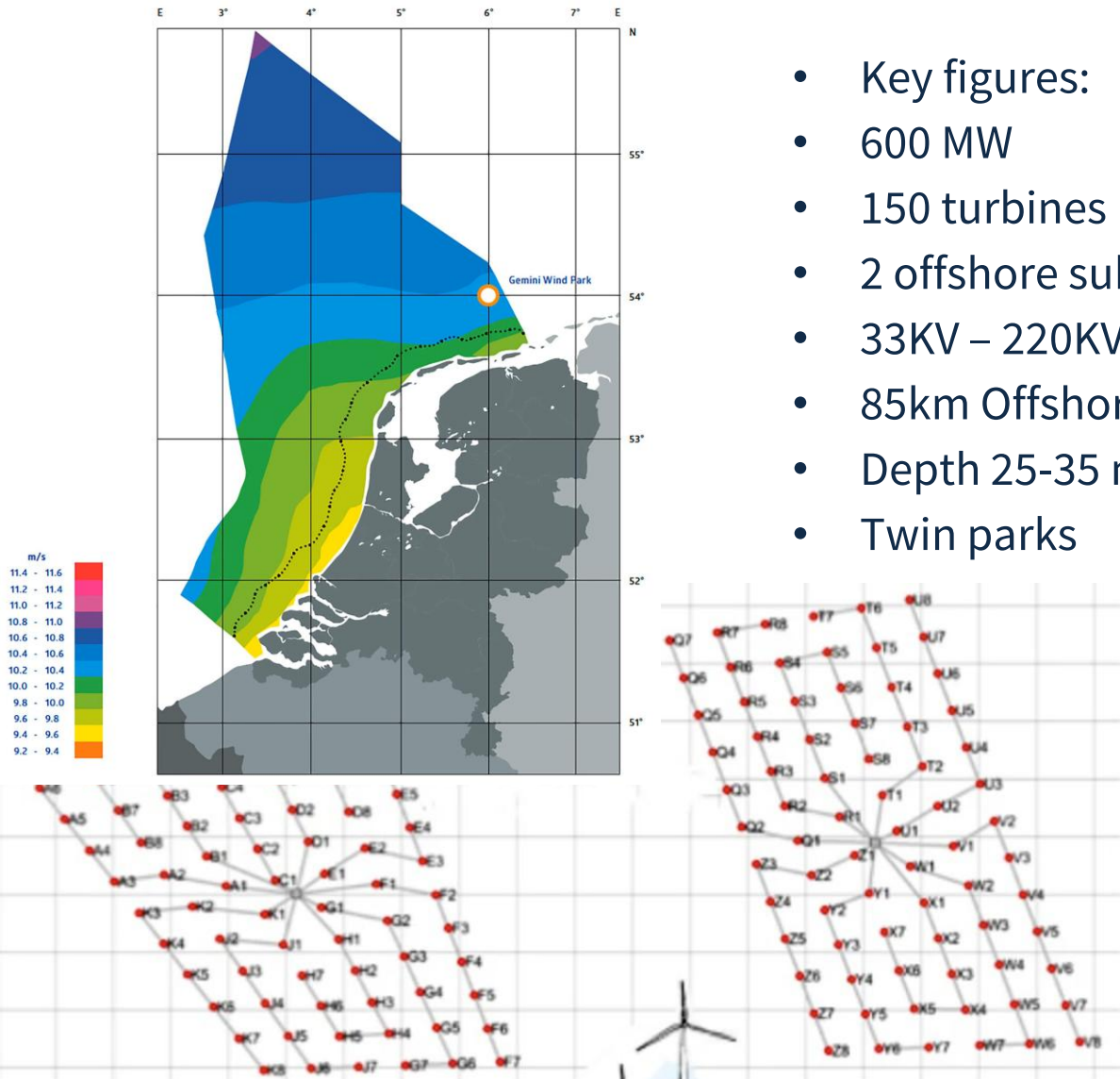
Offshore wind farm



Wind turbines	Foundations • Monopiles • Jackets • Gravity based • Floating	Inter array cabling • 33 / 66 kV • 7 or 8 turbines per string	Offshore Substation • I.e. 33kV - 220 kV • Jacket foundation	Offshore Export cable • I.e. 220 kV • HVAC or HVDC • I.e. 92 km	Onshore export cable • I.e. 220kV	Onshore substation • 220 / Grid voltage	Onshore grid • Grid voltage	• Fabrication locations • Marshalling harbor • Transport & installation
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Example: Gemini Windfarm

- Key figures:
- 600 MW
- 150 turbines (2*75)
- 2 offshore substations
- 33KV – 220KV AC
- 85km Offshore
- Depth 25-35 meters
- Twin parks



Offshore substation functionality

An offshore substation:

- Collects the energy from the wind turbines
- Transforms the power for export
- Sends the power to shore
- Provides switching of cables
- Provides auxiliary power, controls
- Provides access by means of helideck / walk to work / boat landing
- Provides refueling for helicopters
- Provides dayrooms for pilots and crew
- Optionally provides accommodation (often not due to the implications)



Offshore substation



Top side: Housing the functionalities and main components

Helideck: Provides landing opportunity and refueling for the helicopter

Main crane: Provides lifting capacity for supplies and components

Cable deck: Used to store the cable overlength

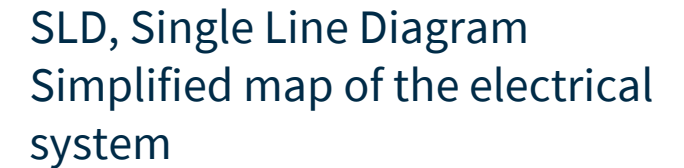
Jacket: Foundation, fixes the substation to the seabed.

Walk to work landing zone: Locations where the walk to work gangway system connects.

J-Tubes: Ducts through which the cables (array and export) are pulled in.

Boatlanding: Push on point for the CTVs

Courtesy: Gemini Windpark



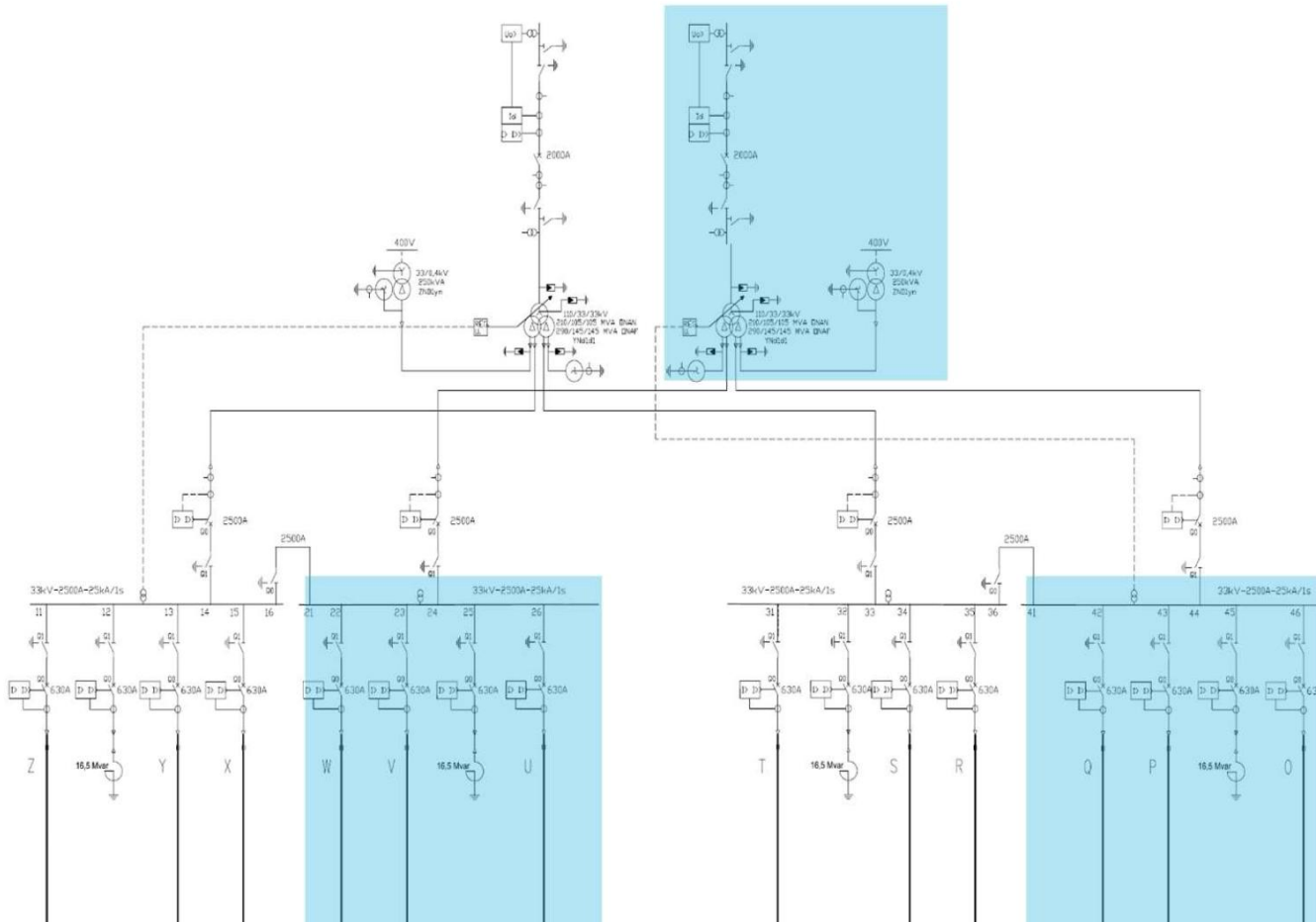
- Main components
- Switches
- Transformers
- Reactors
- Cables

Moving forward with renewable energy

Electrical set up - Redundancy

System A

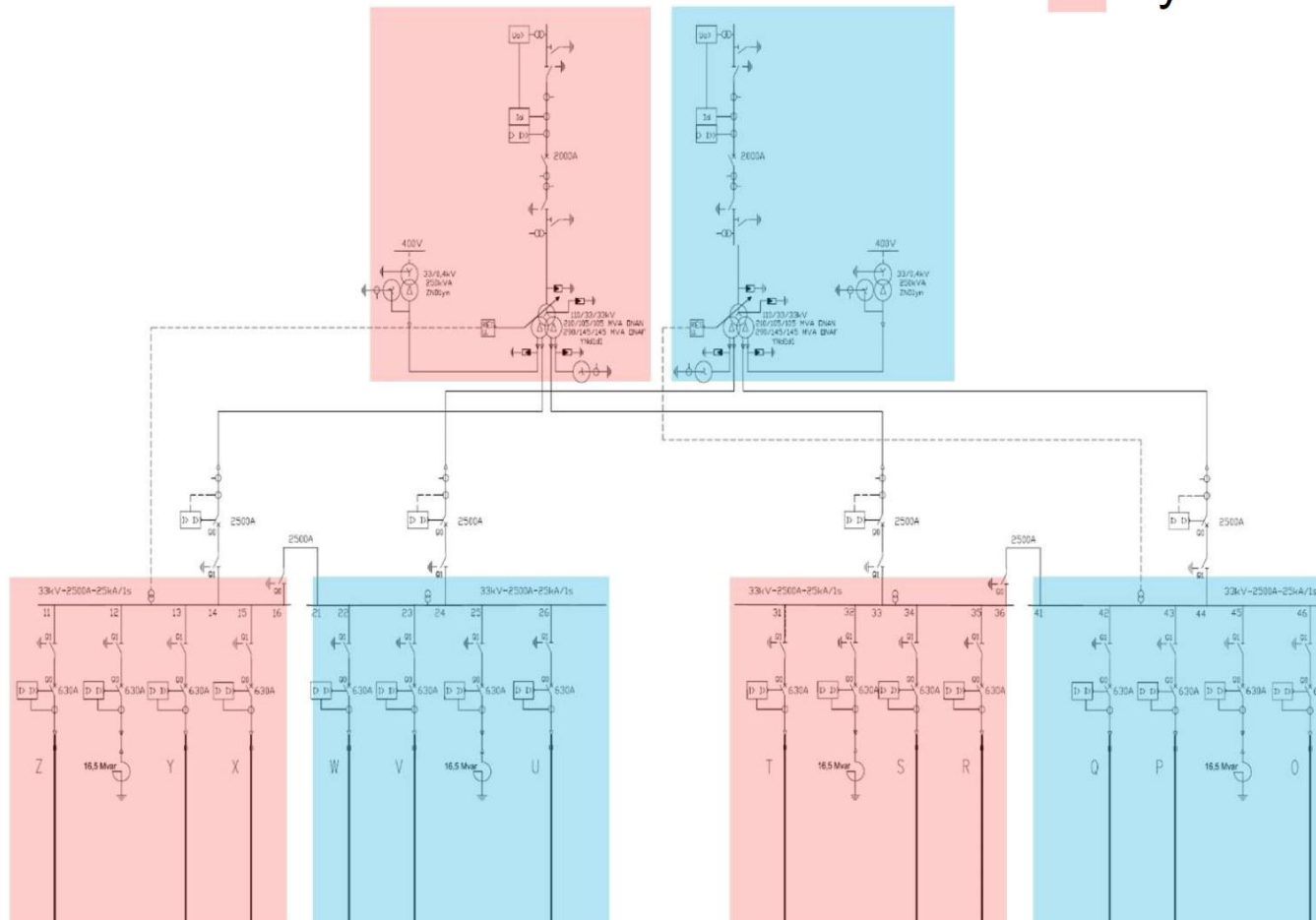
- 1 export cables
- 1 transformers
- 2 switchgear blocks



Courtesy: Bart Ummels – TU Delft / Ventolines

Electrical set up - Redundancy

System A
System B

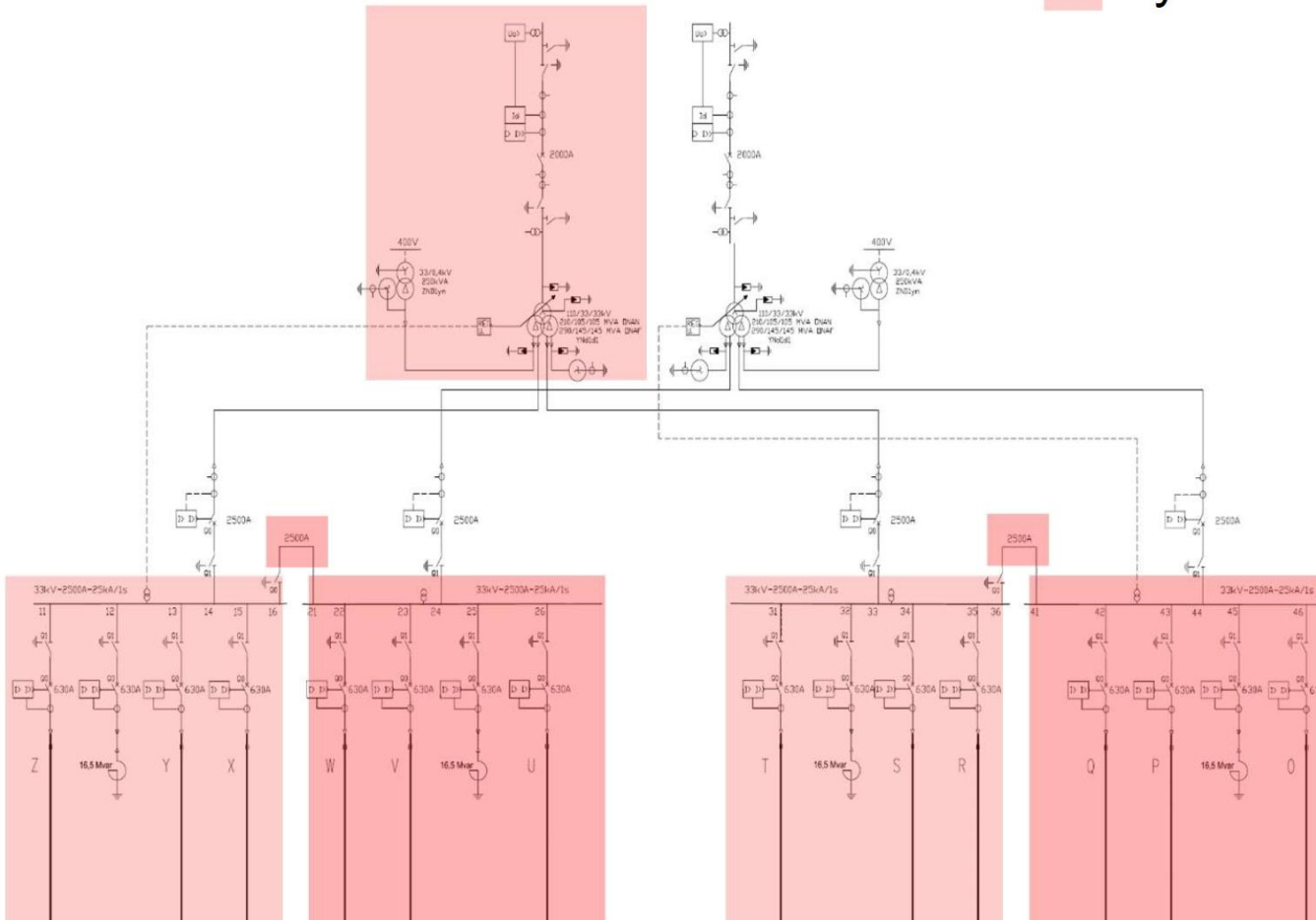


2 export cables
2 transformers
4 switchgear blocks
Normal operation
Each system = 50% windfarm

Courtesy: Bart Ummels – TU Delft / Ventolines

Electrical set up - Redundancy

A → B
 System B

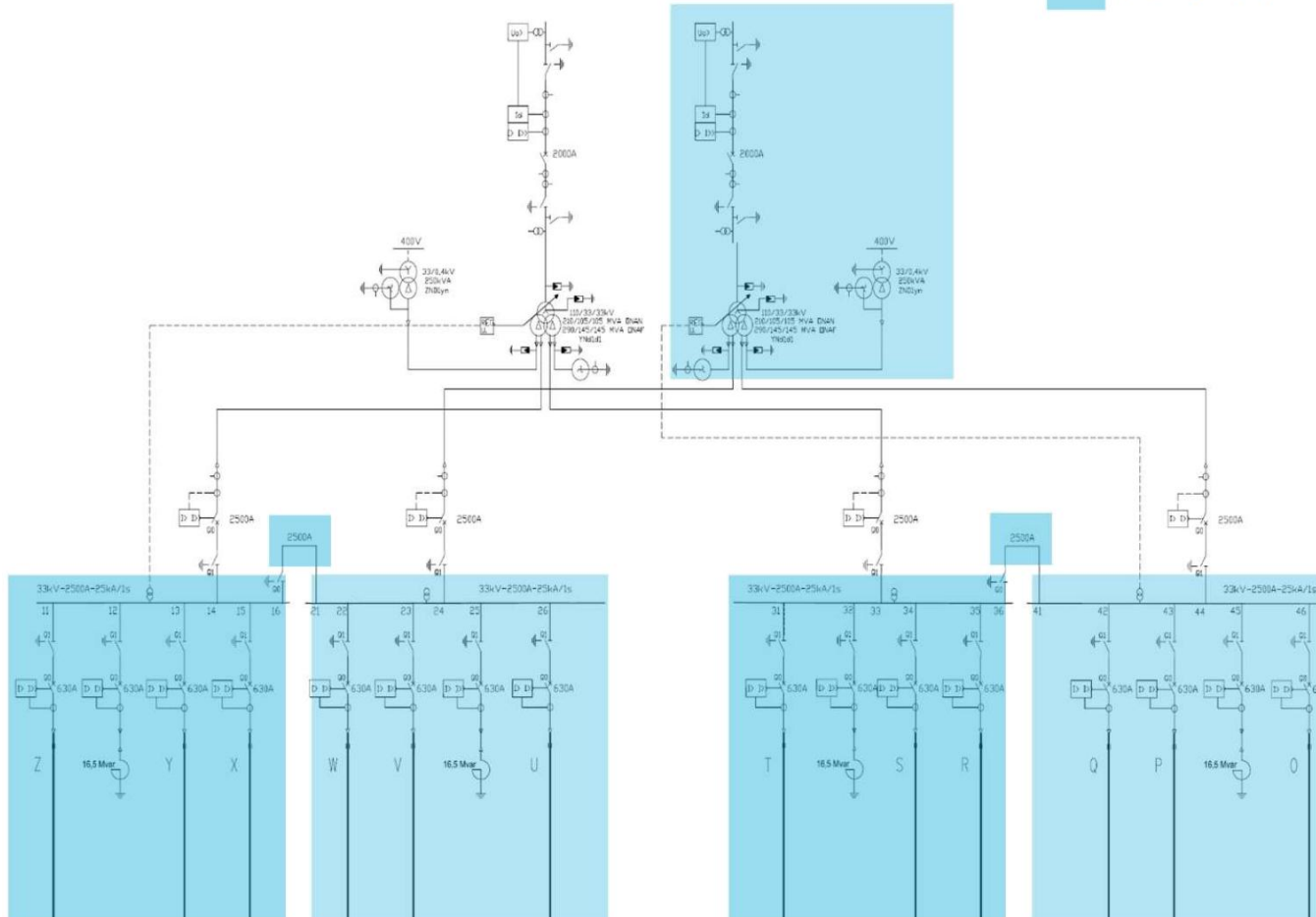


1 export cables
 1 transformers
 4 switchgear blocks
 System A offline
 Switchgear blocks interconnected
 System B = 100% windfarm
 Capacity dependent on capacity
 sizing of transformer and export
 cable

Courtesy: Bart Ummels – TU Delft / Ventolines

Electrical set up - Redundancy

System A
B → A



- 1 export cables
- 1 transformers
- 4 switchgear blocks
- System A offline
- Switchgear blocks interconnected
- System B = 100% windfarm
- Capacity dependent on capacity sizing of transformer and export cable

Courtesy: Bart Ummels – TU Delft / Ventolines

Design (topside)

The design is dictated by i.e. (parameters originating from the desired functionality and environmental requirements)

- Electrical design
- Distance to shore
- Weather and sea state
- Accessibility requirements
- Accommodation and welfare
- Maintenance philosophy
- Redundancy

Figures

- 2500 t (metric tons)
- Length: 52 meters
- Width: 34 meters
- Height: 25 meters
- Decks 4 (Cable, Main (transformers, Aux, weather)

Main components

- Transformers (2*150MVA)
- Switch gear (220&33kV)
- Auxiliary systems
 - HVAC
 - Emergency power generators
 - SCADA & communication
 - Fire
- Emergency systems
- Day and Control rooms
- Main crane
- Helideck



Design (jacket)

Design parameters

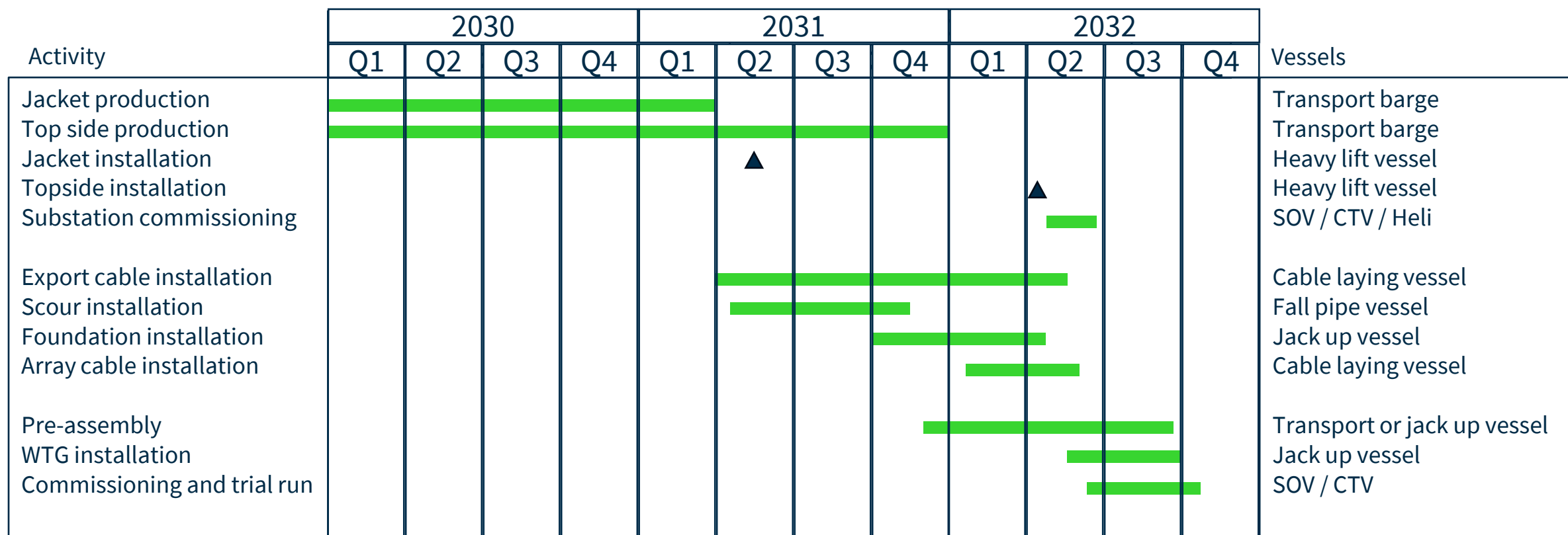
- Water depth
- Met-ocean
 - Wave and tidal
 - Wind and current
- Top side size and weight
- Soil conditions
- Securing method
- Boat landings



Figures

- Footprint 32*32meters
- Height 58 meters
- 1200t
- 4 legs (1,4 m-diam)
- Mud mats
- J-tubes 14

Offshore construction – example timeline



Fabrication and construction philosophy

- Maximize onshore completion
- Modularize where practical
- Parallelize fabrication and equipment installation
- Test and integrate before offshore installation
- Minimize offshore interfaces and duration

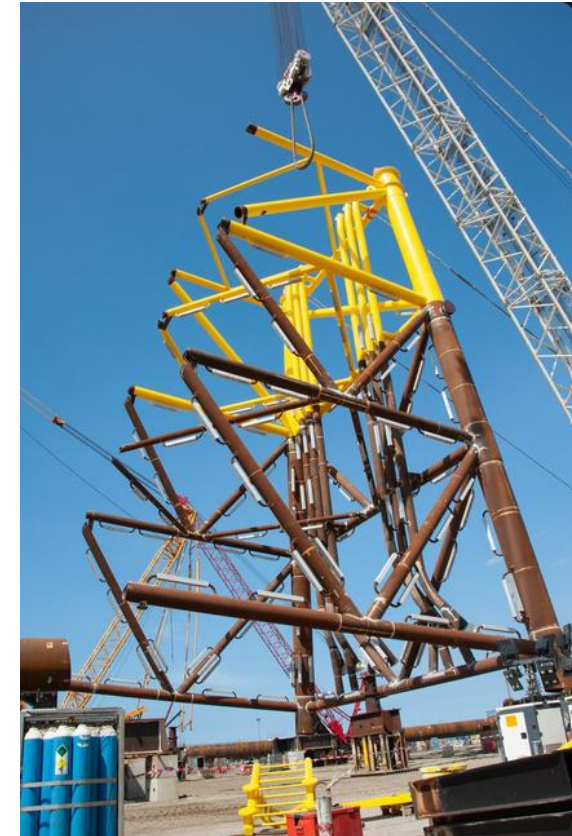
Sufficient contingency in the fabrication planning

- Tension between critical path FID/FC and long lead duration → Critical path
- Delay in FID/FC consumes fabrication and construction contingency
- Parallelize
- Proactive and clear progress monitoring

Onshore fabrication jacket



- Steel fabrication & assembly
- Welding & NDT
- Installation of secondary systems
- Mechanical completion
- Pre-installation checks
- Load-out readiness



Maximize completion onshore — minimize offshore activities.

Jacket sail out



Offshore installation jacket

- Seabed preparation & survey
- Offshore transportation
- Positioning (& upending)
- Jacket landing and installation
- Dimensional verification
- (pin) Pile installation
- Final alignment & grouting
- Offshore completion



Offshore installation jacket



Onshore fabrication Topside

PLATFORM

- Primary steel structure
- Secondary steel
- Buildings & enclosures
- Structural interfaces
- Structural completion

SUBSTATION

- Major electrical equipment
- Mechanical systems
- Electrical installation
- Control & communication
- System integration & testing
- Offshore readiness



Onshore fabrication Topside

PROVE IT WORKS

- Mechanical completion**
- Equipment testing**
- Electrical testing**
- System integration**
- Functional testing**
- Pre-commissioning / readiness**

LOAD-OUT READINESS

- Pre-load-out readiness**
- Load-out preparation**
- Load-out operation**
- Sea fastening**
- Ready for sail-away**



Offshore installation Topside





Substation installed, now what



Installation of export cables (1)

Installation of infield cables (1)

Termination and testing (1)

Cold commissioning (3)

Energization (2)

Hot commissioning (3)

Cable installation

- Export cables
- Infield cables
- Termination and testing
- Optional: Pre-install before topside installation



Energization and hot commissioning

- Energization of HV/MV systems
- Live testing of electrical equipment
- Transformer energization & functional checks
- Protection & control system testing
- SCADA / communication verification
- Interlock, alarm & trip testing
- HV/MV switching sequence verification
- Grid connection & grid compliance tests
- Functional testing under operational conditions
- Progressive energization of systems
- Final punch-list closure
- Ready for commercial operation

Generic take-aways

- Complex one-off process in the project
- On critical path and long lead
- Focus on getting works, preparation and testing done onshore as much as possible
- Create slack in planning between ready for sail out and sail out
- Progress measurement during onshore fabrication and assembly to detect slippage early on and have room to scale up when needed

Q&A



Abbreviations

Abbreviation	Meaning	Explanation
AC	Alternating Current	Electrical current that periodically changes direction
CTV	Crew Transfer Vessel	Small vessel used to transport personnel, tools and equipment between shore and offshore installations.
FC	Financial Close	Point at which the project's financing has been formally agreed and the financial arrangements are in place to proceed with the project.
FID	Final Investment Decision	Formal decision by the project owners/investors to commit to the project and proceed with the investment.
HV	High Voltage	High-voltage electrical system.
HVAC	Heating, Ventilation & Air Conditioning	System controlling temperature, ventilation and air quality inside the offshore substation.
kV	Kilovolt	Unit of electrical voltage.
MV	Medium Voltage	Medium-voltage electrical system.
MVA	Megavolt-ampere	Unit of apparent electrical power. Commonly used to specify the rating/capacity of transformers and other electrical equipment.
MW	Megawatt	Unit of active electrical power. Used to indicate the power output or capacity of an offshore wind farm.
SCADA	Supervisory Control And Data Acquisition	Control and monitoring system used to remotely operate and monitor the offshore substation and connected systems.
SLD	Single Line Diagram	Simplified electrical diagram showing the main electrical equipment, connections and power flow of the substation/wind farm.
SOV	Service Operation Vessel	Large offshore vessel providing accommodation, workshops and long-term access for installation, commissioning or maintenance activities.
t	Metric tonne	Unit of mass equal to 1,000 kg. Commonly used for the weight of offshore structures, topsides, jackets and major equipment.

Presenter



Guido de Groot
– Project Manager

- ~20 years of experience
- Asset Manager Windpark Fryslân
- Construction team OWEZ (108MW), Gemini (600MW), WPF (383MW)

Sources and thanks

Pictures used from

- Windpark Gemini
- Bart Ummels – TU Delft / Ventolines
- Windpark Fryslân
- Scaldis-SMC

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