Base Load Power Hub (BLPH)

Site WEF
(Re-Commissioning)
(Work Execution Flow Scheme)

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Revision / Change Log

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No.	Description
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Attachment 1 – Site WEF

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1. INTRODUCTION

1.1 Project Overview

Crosswind, a Shell and Eneco joint venture, was awarded the tender to develop the offshore Hollandse Kust Noord (HKN) wind farm, located 18.5km off the coast of Netherlands near the town of Egmond aan Zee. The consortium plans to have HKN operational in 2023 with an installed capacity of 759MW generating at least 3.3TWh per year. This is sufficient renewable power to supply more than 1 million Dutch households with green electricity.

Offshore wind farms produce intermittent electricity and balancing these dips and peaks and integrating this electricity into the national energy system requires new technologies. For this reason, the offshore wind farm will include several new technologies that could be implemented at full-scale in the future. The new technologies being explored include a floating solar park, a short-duration battery storage as well as long-term storage via green hydrogen produced by water electrolysis and subsequently consumed in a fuel cell. The combination of these individual measures, herein referred to as the Base Load Power Hub (BLPH) will ensure a continuous power supply regardless of the wind situation.

1.2 Project Location

The Hollandse Kust Noord (HKN) wind farm is located 18.5km off the coast of the Netherlands near the town of Egmond aan Zee.

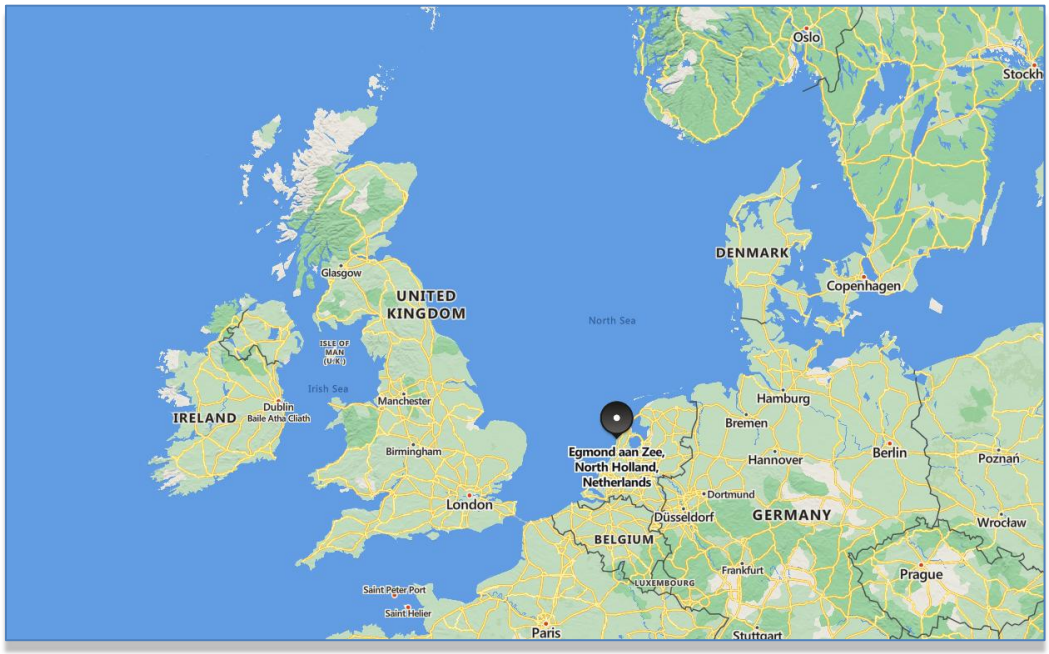


Figure 1 - HOLLANDSE KUST NOORD WIND PARK Location Map

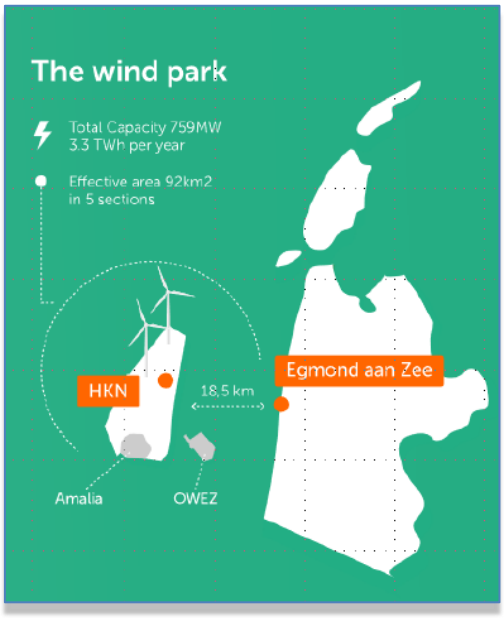


Figure 2 - Wind Park Details

The wind farm will consist of No. 69 x 11.5MW wind turbine generators each to be installed on a dedicated monopile structure. A 70th monopile is located on coordinates E 590719.1, N 5841602.3 and is reserved for installing the platform accommodating the BLPH. The monopile structure was designed and installed by Van Oord Offshore Wind (VooW) and therefore not part of the BLPH scope.

1.3 Project Concept

All components included in the BLPH will be integrated onshore on a topsides and installed in an offshore location within the boundaries of the HKN wind farm. At its simplest, the BLPH will store energy during periods of high electricity generation from renewable sources (a wind turbine generator and the floating solar PV farm) and release it during periods of low generation. In practice. It is expected that the energy stored will supplement generation from renewable sources to ensure that at least 1.0MW of power is exported to the electrical grid regardless of wind/solar availability.

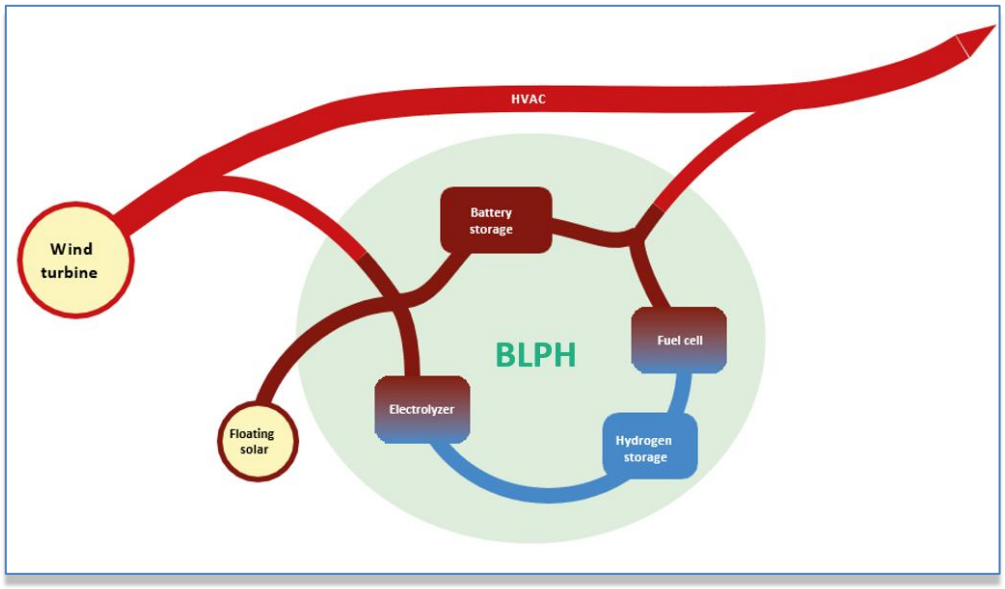


Figure 3 – BLPH Concept

Electricity in the BLPH will be stored in the form of electrons in a battery energy storage system (BESS) as well as converted into green hydrogen via water electrolysis. When the power output from the connecting wind turbine drops to below 1 MWe, the BLPH will return its stored energy to supplement the remaining power output. This will be by discharging the BESS, while stored hydrogen will be converted back into electricity using a fuel cell to extend the discharge duration.

The purpose of the BLPH is to function as a testbed for the integration of energy storage technologies with renewable generation. It is expected that equipment installed on the BLPH will operate as Normally Unmanned Installation for at least two (2) years with no or minimal maintenance and it will have its own independent control room with the ability to communicate with Crosswind's control room.

2. DOCUMENT SCOPE AND PURPOSE

The WEF starts with the "End In Mind" and looks to ensure that the Commissioning and Start Up sequence becomes the backbone of the integrated project plan, ensuring design, logistics, construction and commissioning aligned to meet project goal & milestones.

Due to the change in offshore work scopes, this document now reflects the forecast "Re-Commissioning" activities to be performed at the onshore location at Eemshaven, NL.

B.L.P.H PROJECT – RE-COMMISSIONING
WORK EXECUTION FLOW SCHEME (WEF)

KEY



EXTERNAL OR FLAG

Transmission Owner (TO) Substation Activities (by TO) to be completed and ready for Energisation (with Cable Sealing End Kiosks complete) before Energisation of the Cable. The Cables must be ready for the Cable Pull-through activities. Ref. Cable Pull-through Schedule - TBC

IF TEMPORARY POWER REQUIRED FROM THE GRID, THEN DIESEL GEN SET NEEDS TO BE ON SITE

GD-005 BUYER TO BE MADE AVAILABLE BY PROJECTS 3 MONTHS PRIOR TO COMMISSION AT SITE (ALLOWING FOR LEAD TIMES)

IF GAS TEST TO BE CARRIED OUT, THEN PROJECTS TO ENSURE GAS SUPPLY IS AVAILABLE

Systems under complete prior to Mechanical Completion & Electrical Pre-commissioning begins

Dynamic Sway & Offset mitigation GPS system to be in operation at least 1 week prior to Start-up

Phase

Ready to Start-up

HSE SM (GD01) Activities Starting on the Equipment Start-up

Dynamic
ESD Test 2

Detail TBC

PERFORMANCE TEST OF ELECTROLYSER PACKAGE COMPLETE (72 hour continual run)

OPERATIONAL & ASSURANCE TESTING

CONSTRUCT PHASE (to include removal of sea-fastenings, temporary preservation etc) Safe To Access or similar HSE Checklist to be completed.

Process Control Systems (PCS)
Emergency Shutdown System (ESD)
Fire & Gas Control System (FGS)
Data Networks
Electrical Monitoring & Control System (EMCS)
HSE & CCR OWS/HOS
Marking and Lightning Protection
Cell & UHP Rails
Fuel Cell UCP
Surveillance Systems
HAVAKO & Field Devices
UHP
Water Treatment Package UCP
Instrument Air Package UCP
Nitrogen Generation Package UCP
ELECTRICAL/HER HVDC
ELECTRICAL/HER Water Treatment UCP
ELECTRICAL/HER PSU
Fiber Optic Links
SWBS LOAD NOT ASSIGNED

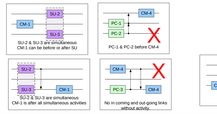
F&G Field Devices
Fire Extinguishers
Life Raft
Escape Provision
Personal Protection
SWBS LOAD NOT ASSIGNED
SWBS LOAD NOT ASSIGNED
SWBS LOAD NOT ASSIGNED

SWBS LOAD NOT ASSIGNED
Fire Detection Open Drain Collection
SWBS LOAD NOT ASSIGNED
Seawater Intake System
SWBS LOAD NOT ASSIGNED
SWBS LOAD NOT ASSIGNED
Non-Ordinant Biocide
SWBS LOAD NOT ASSIGNED
SWBS LOAD NOT ASSIGNED
Instrument Air Package (in ESDS)
Instrument Air Distribution System
Nitrogen Generator Package (in ESDS)
Nitrogen Distribution System
SWBS LOAD NOT ASSIGNED
Water Maker (RO) Disposal
Water Maker Brine Distribution System
Cranes
HVAC HVDC Switchgear Room B-100
HVAC LV Switchgear Room B-101
HVAC UPS Equipment Room B-102
HVAC ACT Equipment Room B-103
ELECTRICAL/HER HVDC Package
ELECTRICAL/HER Water Treatment Package
SWBS LOAD NOT ASSIGNED

Hydrogen from Reefer to Store System
SWBS LOAD NOT ASSIGNED
SWBS LOAD NOT ASSIGNED
SWBS LOAD NOT ASSIGNED
SWBS LOAD NOT ASSIGNED
SWBS LOAD NOT ASSIGNED

Deinventour Package (in ESDS)
SWBS LOAD NOT ASSIGNED
Hydrogen Storage Vessel 1 (in ESDS)
Hydrogen Storage Vessel 2 (in ESDS)
Hydrogen Storage Vessel 3 (in ESDS)
Hydrogen Storage Vessel 4 (in ESDS)
Hydrogen Storage Vessels Header (Deck)
Hydrogen Storage Vessels Header (Hull)
Hydrogen Purification Package
ELECTRICAL/HER Hydrogen Purification Package
ELECTRICAL/HER PSU
SWBS LOAD NOT ASSIGNED
SWBS LOAD NOT ASSIGNED





Key issues

1. Electrolyser cell voltage measurement
2. PCV tuning (H_2 storage >> fuel cell interface)
3. H_2 vent liquid seal
4. Fuel Cell ramp grid sensitivity

Secondary issues:

5. Electrolyser H_2 purification package (HPP) endurance testing (as per OEM SAT procedure)
6. Electrolyser HVAC repeat of set up and rebalancing for (Semi)warm) ambient conditions
7. Rectifier AFE fault during O&E testing >> procedure change to restart after plant safety stops
8. BESS extended tested in grid following/forming switchover
9. Fuel cell transitions between island mode/grid connected mode
10. Climate control/system performance at low temperatures (not tested due to prevailing ambient conditions in Ravenna)
11. Recalibration of Acoustic detection >> change in site / different background noise conditions
12. Water purification package interface (PSC<>Ovivo) tuning for local conditions
13. EMCS (Yokogawa) verification testing post-closure of remaining Punch List Items)

CARRY-OVER SCOPES

- Accomodated within WEF
- To be considered but not incorporated in WEF

NOTES

1. After discrete Control system scopes Tower Weir Tests (TWT) completed and tested (TWT Interface Testing across the systems to be carried out (20% sample check), as well as TWT ing signal testing to / status signals from consumers (20% sample check) such as Switchboards.
2. Although this system / Sub-System will have been fully tested in YARD, due to its nature of operation, the full functionality of this system / Sub-System (i.e. Uninterruptible power supplies) will be tested at various level of testing as sub-phase in YARD will be required.
3. There is required to be Leak Testing to prove integrity of the system and that refrigerant has moved / been damaged in transit. This should be planned post Vent System modification works being complete. This will also cover Witness Joints that require to be checked on – see flange register for details e.g where PSVs were removed, reset and refitted.
4. During this time the hydrogen will be routed to each vessel in turn (to fill) displacing the N2 and proving vessels each operate as expected.
5. NOTE - During YARD commissioning a temporary analyser was used to measure H2 quality which also acted to confirm N2 displacement.
6. This is the Mode Select Testing, this was fully tested at the YARD in Ravenna, and is not required to be fully tested again here. Hydrogen / oxygen in vent lines are detailed in the Start-Up Procedure, and demonstrated here.
7. IECSS can be operated as stand-alone, as long as 400V & 6.6kV made available. A full check would require to be done to confirm if any overvalues would be required to be put in place with no Yokogawa interface available. Once Yokogawa would be made available further test would be required.
8. Only Cable Pull-through activities, i.e. removal of sea fastening and any temporary preservation, where initial power up checks of equipment / systems will be carried out.

Doc. No.	Revision	Description	Prep.	Chk'd	Appr'd
123-SS-0015	A	Issue for Information - AFI COMMISSIONING	A. Iovane	D.Venable	R.Scarfiti

Doc. No.	Description	Rev.	Date
123-SS-0001	Sheet 1 - Changing PC / HV Parts	A1	31-Mar-22
123-SS-0002	Sheet 2 - Ready to Start-Up	A1	31-Mar-22
123-SS-0003	Sheet 3 - Start-Up Activities	A1	31-Mar-22
123-SS-0004	Sheet 4 - Energy, Oil Refill & Ongoing Tests	A1	31-Mar-22
123-SS-0005	Sheet 5 - Ramp Up Activities	A1	31-Mar-22
123-SS-0006	Sheet 6 - Personnel Safety Tests	A1	31-Mar-22
123-SS-0007	Sheet 7 - Emergency Shut Down Tests	A1	31-Mar-22
123-SS-0008	Sheet 8 - Performance Testing Activities	A1	31-Mar-22
123-SS-0009	Sheet 9 - Integrated Performance Testing Activities	A1	31-Mar-22
123-SS-0010	Sheet 10 - Shut Down Activities	A1	31-Mar-22
123-SS-0011	Sheet 11 - Post Commissioning Activities	A1	31-Mar-22
123-SS-0012	Sheet 12 - Hydrocarbon Activities	A1	31-Mar-22

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BLPH Project – Re-Commissioning
WEF (Work Execution Flow Scheme)
Document Number: 123-SS-PHL_COM_GP-53058

CROSSWIND | ROSETTI MARINO

NOTES / GUIDANCE RE OFFHSORE WEF

instrumentality, or unincorporated venture.

PRESERVATION MODE
the condition of the OBJECT in which a party can safely conduct preservation activity. The OBJECT is placed on foundation at destination, has transportation equipment removed, is connected to generator or other temporary supply of low voltage power, a supply of demi-water is available, and safe access/egress from the OBJECT is enabled.

RFC is ONLY shown where there is known construct works for a system / sub-system e.g if equipment removed prior to sail away and needs to be re-fitted.
To align with outstanding B ITR list and PLs

If there are known scopes then PC or COM will be shown e.g we know that instruments were removed and sent to the vendor for the IA & N2 packages.

RFC is shown ONLY for systems where there is known construction scopes to be carried out e.g VENT

1	Basis assumes Temporary 6.6KV power supply required. If 66KV would be available upstream of 82-00 MV 6.6KV Switchboard would be the only change.
2	Travel Well Test added (from Yard WEF) to denote that the system was proven in the YARD and a Travel Well Test required only e.g switchobards and transformers. This will not be the case for all e.g the Instrument Air and Nitrogen Systems will have to be re commissioned (but less than was required in the YARD)
3	
4	Completion of Cause & Effect Testing required to allow final sections of SAT's and relating RFO's to be signed off.
5	During this time the hydrogen will be routed to each vessel in turn (to fill) displacing the N2 and proving vessels each operate as expected.
6	This is the Mode Select Testing, detailed steps will be written in the OTP Onshore Performance & Integrated Test Procedure – estimated duration of 28 days. See plan excerpt with information that was available at the time – to be revised and updated once engineering complete.