Base Load Power Hub (BLPH)

Electrical System Study Report - Vital Supply Recovery

Document Number: 123A90-DDL-EL-RE-20174

Document Class: 2

01	14/08/2024	Accepted for construction (AFC)	FMO	LMA/AMA	MDO
00	28/05/2024	Issue for Review (IFR)	FMO	LMA/AMA	MDO
Rev.	Date	Description	Prepared	Reviewed	Approved

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Revision / Change Log

Rev.	Description
00	Issue for Review (IFR)
01	Accepted for Construction (AFC)

HOLDS LIST

No.	Description

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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.

1.1.1 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.

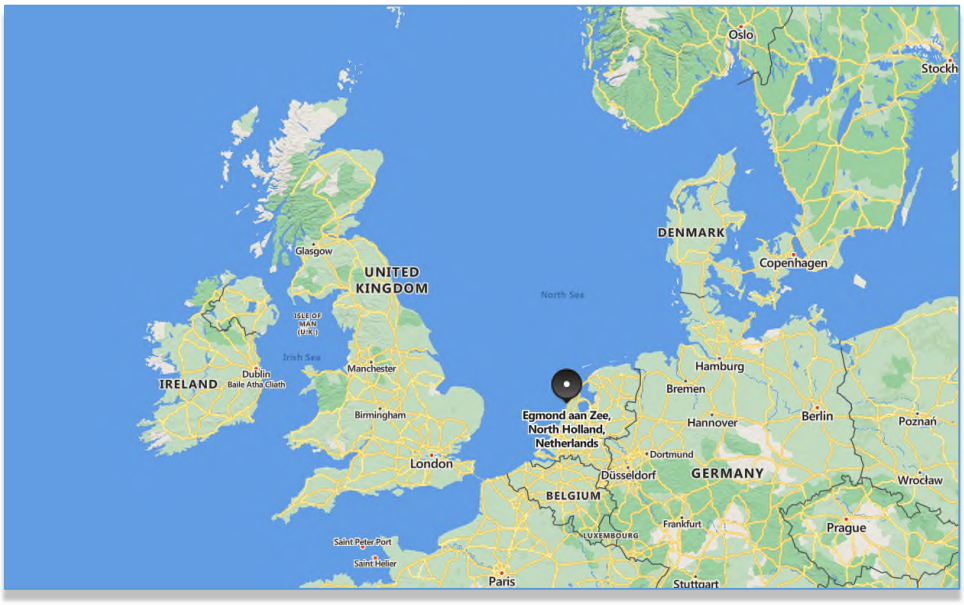


Figure 1 HOLLANDSE KUST NOORD WIND PARK Location Map

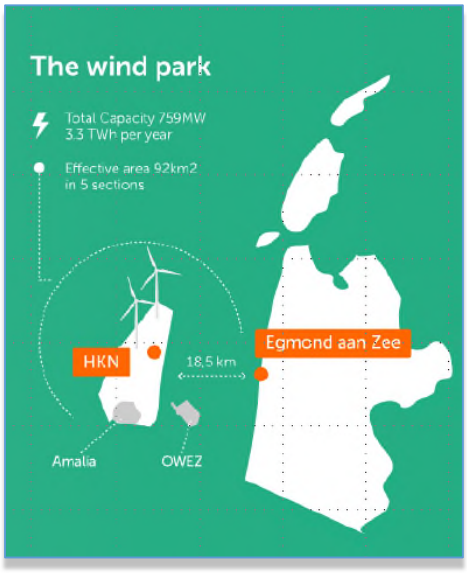


Figure 2 - Wind Park Details

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 located on coordinates E 590719.1, N 5841602.3 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.

1.1.2 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.

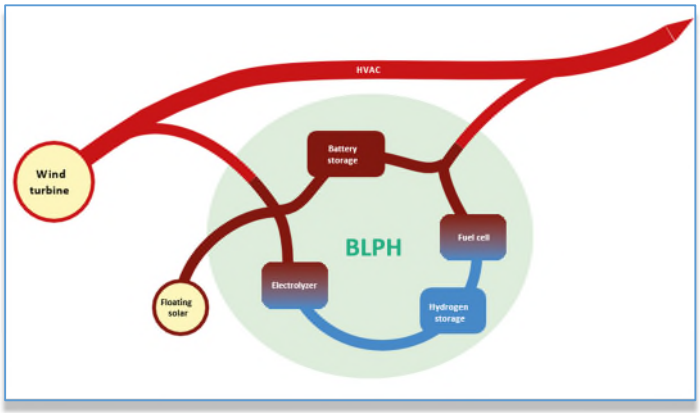


Figure 3 – BLPH Concept

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 s 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.

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2 DOCUMENT SCOPE

This document provides a description of the functionality for the black start of the BLPH and provides the minimum sizing criteria for the temporary power supply for the black start of the platform.

2.1 REFERENCES

Doc. No.	Description
123A90-DDL-EL-DG-20158	Overall-Key Single Line Diagram
123A90-DDL-EL-DG-20159	Electrical Single Line Diagrams LV System
123A90-DDL-EL-DS-20036	Technical Data Sheet – DC UPS System
123A90-DDL-EL-DS-20032	Technical Data Sheet – AC UPS Systems
123A90-DDL-EL-DS-20088	Technical Data Sheet – Navigation Aid System
123A90-DDL-EL-LIS-20016	Electrical Load List and Balance -CCS MODE CHARGING

Table 1 - Reference Documents

2.2 DEFINITIONS AND ABBREVIATIONS

BLPH	Base Load Power Hub
CCS	Central Control System
COMPANY or Client (CPY):	Crosswind
CONTRACTOR (CTR):	ROSETTI MARINO S.p.A.
FGS	Fire and Gas System
GIS	Gas Insulated Switchgear
HVAC	Heating Ventillation and Air Conditioning
PAS	Process Automation System
PROJECT:	HOLLANDSE KUST NOORD WIND PARK Project
SIS	Safety Instrumented System
UCP	Unit Control Panel
UPS	Uninterrupted Power Supply

Table 2 - Definitions and Abbreviations

3 FUNCTIONALITY DESCRIPTION

When the BLPH is disconnected from the grid (windfarm) and there is no power supply from solar, BESS and fuel cell, BLPH enters the power out mode of operation. This is an electrical blackout condition, and the vital loads will be maintained solely by the DC, AC UPS systems and Navigation System.

Batteries in DC UPS system are located within the B-100 HV equipment room on the lower deck.

Batteries in AC UPS systems and Navigation System are located within the B-300 UPS equipment room on the lower deck.

If the blackout condition lasts long such that the batteries are close to full discharge and hence, no longer available, then BLPH suffers a total loss of power.

In this case a black start of the platform via an offshore mobile power source will be needed to supply the platform's 'essential' loads simultaneously.

3.1 DC, AC UPS AND NAVIGATION SYSTEM

There is one DC UPS system (*Refer to 123A90-DDL-EL-DS-20036 TDS – DC UPS System*). It is:

- UP-200F1 – a 10 kVA DC UPS system

There are two AC UPS systems (*Refer to 123A90-DDL-EL-DS-20032 TDS – AC UPS Systems*). They are:

- UP-200F3 – a 35 kVA AC UPS system for PAS
- UP-200F4 – a 15 kVA AC UPS system for F&G

There is one AC UPS system in Navigation Aid system (*Refer to 123A90-DDL-EL-DS-20088 TDS – Navigation Aid System*). It is:

- UP-200F2 – a 3 kVA AC UPS system

Full discharge of batteries in 10 kVA DC UPS system (UP-200F1) leads to following:

- Power interruption to DC control of 66 kV GIS and DC control of 6.6 kV switchgear

Full discharge of batteries in UP-200F3 leads to following:

- Power interruption to CCS
- Power interruption to SIS
- Power interruption to synchronization system
- Power interruption to UCP packages
- Power interruption to UCP HVAC

Full discharge of batteries in UP-200F4 leads to following:

- Power interruption to FGS
- Power interruption to system server and network cabinet

Full discharge of batteries in UP-200F2 included in the Navigational Aid system leads to the shutdown of the Navigational Aid System.

3.2 PROCEDURE

A black start, where totally unavoidable, will utilize an offshore mobile power source in BLPH platform to recover the supply to vital loads by charging the batteries in DC and AC UPS systems, and to feed the vital loads under the main LV switchgear SG-200N1 until the network is recovered so that it is possible to reconnect the BLPH platform to the grid (windfarm).

3.2.1 STEP 0

Before starting any black start the following preliminary checks and operations must be completed:

1. Complete power blackout condition exists in the BLPH platform.
   - All the switchgears are disconnected.
   - Batteries in DC and AC UPS systems are fully discharged.
2. All the feeders of the main LV switchgear SG-200N1 shall be manually opened. Feeders that are, if not already disconnected, shall be opened manually, in order to have a controlled restart.
3. The offshore mobile power source shall be connected to the junction box JB-200E2, outside the B-200 room.

3.2.2 STEP 1

This step is fundamental for platform reinstatement (a manual delay in black start procedure will be considered between start of each item, due to transformers in-rush currents):

4. The back-up incomer on the main LV switchgear SG-200N1 shall be manually closed, following the relevant procedureaccording to the switchgear schematic drawing 1723002197-EL-DG-00031 and manual 1723002197-EL-MAN-00054.
   - The 400 V busbar on SG-200N1 becomes live.
5. Feeder to the AC PAS UPS system (UP-200F3) is switched on manually on SG-200N1.
   - According to Vendor procedureoperating manual 1724000372-EL-MAN-00025, the system is live and able to supply energy to CCS and UCPs HVAC
   - Batteries in AC PAS UPS system (UP-200F3) start to be recharged.
6. Feeder to the AC F&G UPS system (UP-200F4) is switched on manually on SG-200N1.

- According to Vendor operating manual 1724000372-EL-MAN-00025procedure, the system is live and able to supply energy to F&G and Network panel.
- Batteries in AC F&G UPS system (UP-200F4) start to be recharged.

7. Feeder to DC UPS system (UP-200F1) is switched on manually on SG-200N1.
   - According to operating manual 1724000372-EL-MAN-00024Vendor procedure, the system is live and able to supply energy to GIS's Local control panel and auxiliary of SG-100D1 (6.6kV switchgear)
   - Batteries in DC UPS system (UP-200F1) start to be recharged.
8. Feeder to the AC UPS system (UP-200F2) in the Navigational Aid System is switched on manually on SG-200N1.
   - After Vendor black start procedureaccording to operating manual 1724000775-EL-MAN-00019, the system is live and able to supply NavAid items.
   - Batteries in AC UPS system (UP-200F2) start to be recharged.

3.2.3 STEP 2

This step is needed to keep the platform safe.

9. Container's HVAC systems feeders are switched on manually on SG-200N1.
   - The system has power to start the ventilation
10. Emergency lighting from BoP distribution board
    - The system has power to re-charge the internal batteries of lamps and in case of night, to work properly
11. Lighting circuits from container's internal distribution boards
    - The system has power to work properly the lamps inside the container (B-100/B-200/B-300 and B-400)

3.2.4 STEP 3 –

12. GIS connection to grid by closing from EMCS the 66 kV line switches and circuit breaker and the 6.6 kV breakers/contactors.
    - BLPH electrical restart
    - BLPH can restart with all power necessary to re do the platform.

3.2.5 STEP 4

13. Start-up of the IA Package and N2 generator package
    - systems can purge the H2 tanks.

4 REQUIREMENTS FOR SIZING OF VITAL SUPPLY RECOVERY SOURCE

Based on 123A90-DDL-EL-LIS-20016 - Electrical Load List and Balance -CCS MODE CHARGING, following loads are listed which should be fed by the offshore mobile power source, according to the previous procedure.

In in order to maintain the size of generator as smaller as possible, Air and N2 packages are considered to be fed directly from the grid instead of from the temporary power supply.

ITEM	Description	Load (kW)
UP-200F1	DC UPS system (DC control of 66 kV and 6.6 kV switchgear)	10
UP-200F3	AC UPS system (CCS, SIS, synchronization system, UCP packages and UCP HVAC)	35
UP-200F4	AC UPS system (FGS, Network cabinet)	15
UP-200F2	AC UPS system (Navigational Aid System)	3
CN-200N1	Impressed Current Cathodic Protection (ICCP) System	11
B100-HSB-001	HV Room – B-100 – HVAC + lighting	14.74 + 0.74
B200-HSB-001	LV Room – B-200 – HVAC + lighting	14.74 + 0.74
B300-HSB-001	UPS Room – B-300 – HVAC + lighting	14.74 + 0.74
B400-HSB-001	ITER – B-400 – HVAC + lighting	15.79 + 0.74
DP-200N1	DB - Lighting & Small Power - BoP	1.53
TOTAL LOAD		138.5 kW

With respect to AC and DC UPS the rated power has been listed since they will require the power to feed the loads and to charge the batteries at the same time.

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5 CONCLUSION

The offshore mobile power source for vital supply recovery shall be sized based on chapter 3 and chapter 4. The minimum rating of the offshore mobile power source shall be 138.5 kW.

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