Base Load Power Hub (BLPH)

Worksite WEF
(Work Execution Flow Scheme)

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Attachment 1 – Worksite WEF

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.

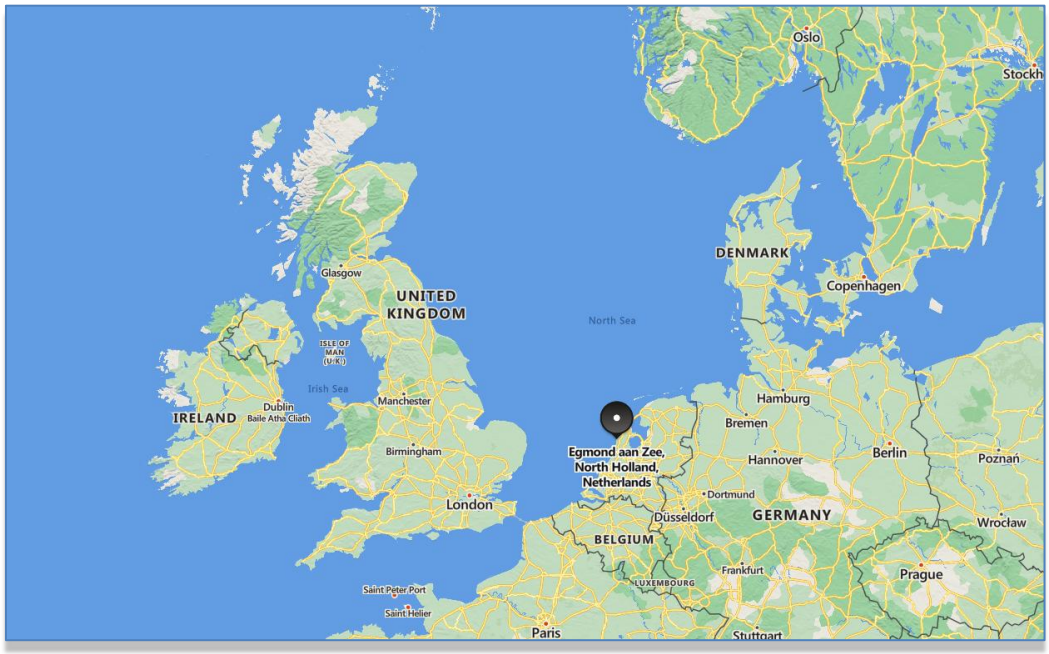


Figure 1 - HOLLANDSE KUST NOORD WIND PARK Location Map

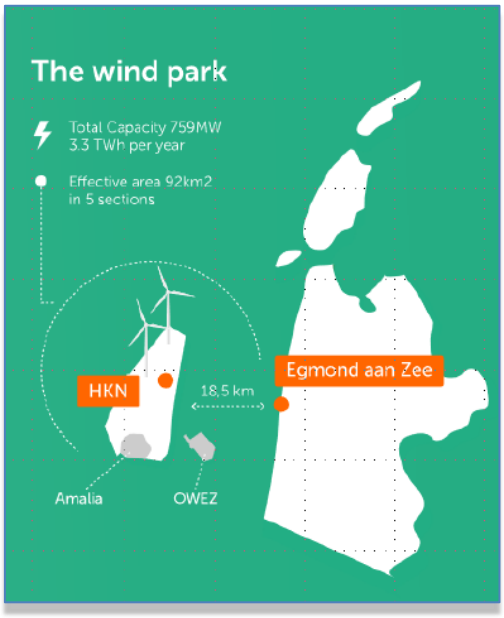


Figure 2 - Wind Park Details

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.

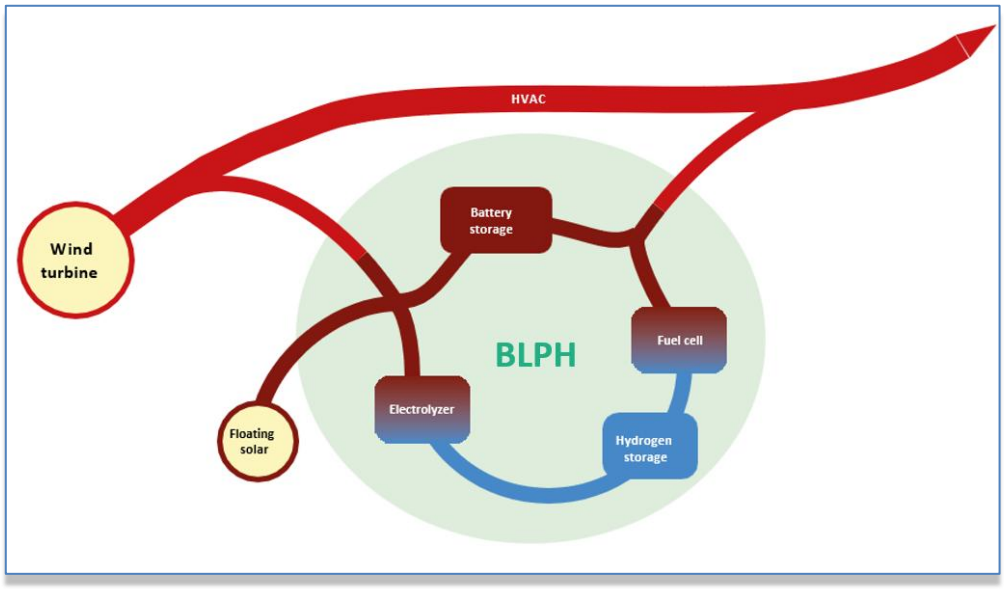


Figure 3 – BLPH Concept

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.

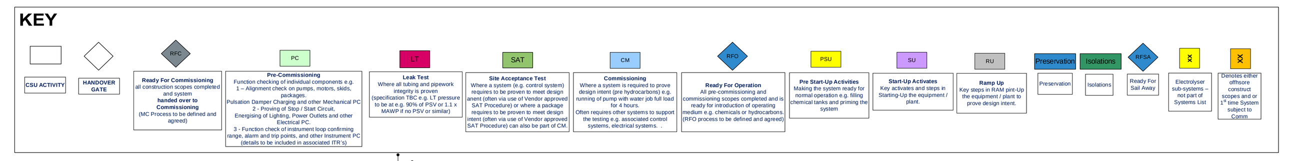
The purpose of the BLPH is to function as a testbed for the integration of energy storage technologies with renewable generation. It is expected that equipment installed on the BLPH will operate as Normally Unmanned Installation for at least two (2) years with no or minimal maintenance and it will have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

It identifies sequence drivers, logic, and interfaces and supports probabilistic contingency analysis of the schedule.

B.L.P.H PROJECT - WORKSITE
WORK EXECUTION FLOW SCHEME (WEF)







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NOTES

1	After discrete system scopes have been completed and tested Interface Testing across the systems to be carried out, as well as trip signal testing to / status signals from consumers such as Switchboards.	MODE 0 = IDLE (Power Import Only)	SU1	SEQUENCE 1 MODE 7 RESEARCH, MODE 8 MAINTENANCE - ELECTROLYSER
2	LT is shown on the respective swim lane where we expect leak testing is required. Details TBC at later date to confirm exactly how many Leak Test Packs will be required to be produced by the specialist contractor have been appointed and are able to review the P&IDs for system / spec breaks.	MODE 1A = IMPORT MODE (Able to Charge)	SU2	SEQUENCE 1 - MODE 7 RESEARCH, MODE 8 MAINTENANCE - BESS
		MODE 1B = IMPORT MODE (Not Able to Charge)	SU3	SEQUENCE 1 - MODE 7 RESEARCH, MODE 8 MAINTENANCE – FUEL CELL
		MODE 2 = HOT STANDBY (Ready to Discharge)	SU4	SEQUENCE 1 - MODE 3 EXPORT BESS OK, FC INHIBITED, MODE 2 HOT STANDBY
3	These systems combined make up the Water Treatment Package.	MODE 3 = EXPORT MODE (Discharge)	SU5	SEQUENCE 1 - MODE 3 EXPORT BESS OK, FC OK, MODE 2 HOT STANDBY
4	Completion of Cause & Effect Testing required to allow final sections of SAT's and relating RFO's to be signed off.	MODE 4 = COLD STANDBY (Power Import: Not able to Export)	SU6	SEQUENCE 1 - MODE 4 COLD STANDBY, MODE 3 EXPORT, MODE 4 COLD STANDBY
		MODE 4A = EMERGENCY MODE (Island)	SU7	SEQUENCE 1 - MODE 3 EXPORT, NOT GRID TIED, MODE 4A EMERGENCY, MODE 5 POWER OUT
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.	MODE 5 = POWER OUT (Black-Out)	SU8	SEQUENCE 2 - MODE 4 COLD STANDBY, MODE 1B NOT ABLE TO CHARGE, MODE 1A IMPORT
		MODE 6 = MAINTENANCE	SU9	SEQUENCE 2 – MODE 2 HOT STANDBY, HNAS NOT HEALTHY, MODE 0 IDLE, MODE 2 HOIT STANDBY
6	This is the Mode Select Testing, detailed steps will be written in the OTP Onshore Performance & Integrated Test Procedure – estimated duration of 18 days. See also the P6 Plan.	MODE 7 = RESEARCH		
		MODE 8 = NONE MODE		

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CROSSWIND | ROSETTI MARINO

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