Base Load Power Hub (BLPH)

SITE ACCEPTANCE TEST (SAT) PROCEDURE

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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.

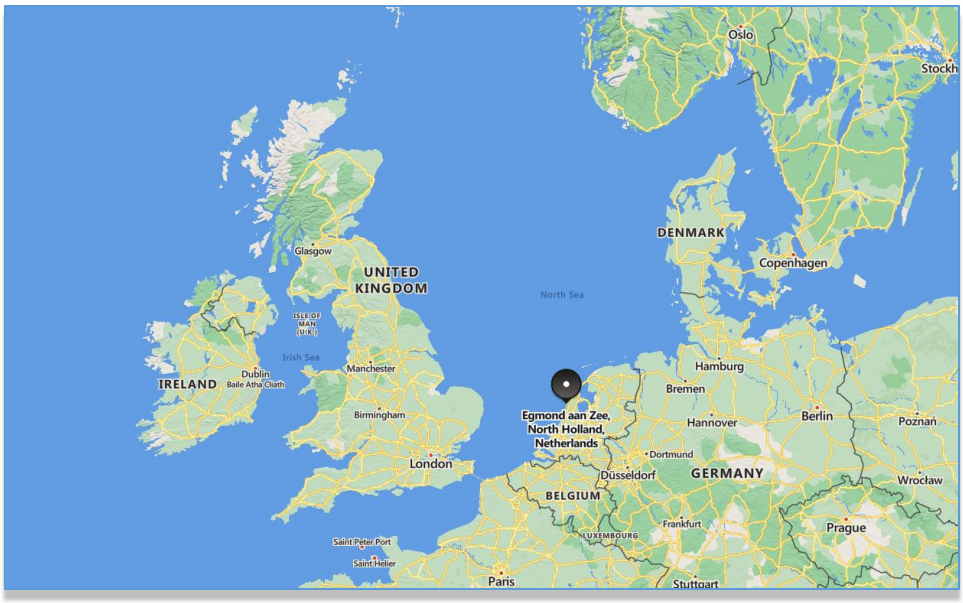


Figure 1 HOLLANDSE KUST NOORD WIND PARK Location Map

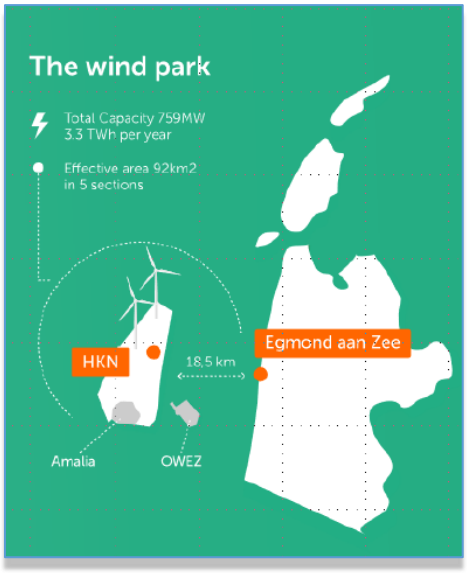


Figure 2 - Wind Park Details

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.

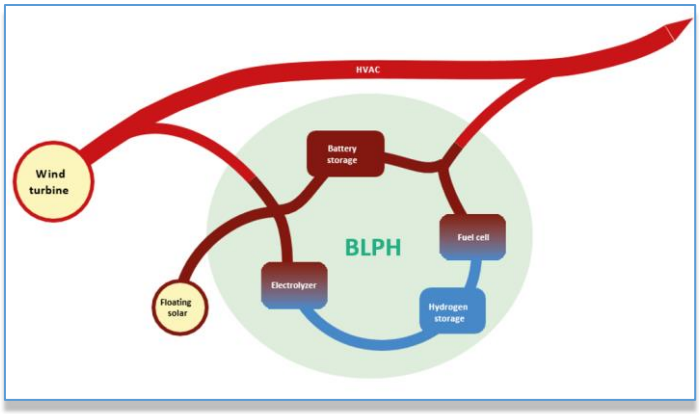


Figure 3 – BLPH Concept

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.

2 DOCUMENT SCOPE

The purpose of this document is to describe the test and checks to perform when the transformers for this project will arrive on site.

2.1 REFERENCES

- IEC 60076-1 – Power transformers - General
- IEC 60076-2 – Power transformers – Temperature rise
- IEC 60076-3 – Power transformers – Insulation level, dielectric tests
- IEC 60076-5 – Power transformers – Ability to withstand short circuit
- IEC 60076-10 - Power transformers – Determination of sound level
- Technical Specification IDS and DDS for Power Transformer – 123A90-DDL-EL-SP-20001
- Data sheet - 1723001697-EL-TDS-00005
- TR-100AD1 General arrangement drawing - 1723001697-EL-DA-00006
- TR-200DE1 General arrangement drawing - 1723001697-EL-DA-00007
- TR-200ED1 General arrangement drawing - 1723001697-EL-DA-00008
- TR-100AD1 Termination and Wiring Diagram - 1723001697-EL-DG-00010
- TR-200DE1 Termination and Wiring Diagram - 1723001697-EL-DG-00011
- TR-200ED1 Termination and Wiring Diagram - 1723001697-EL-DG-00012

2.2 DEFINITIONS AND ABBREVIATIONS

Table 1 - Definitions and Abbreviations

3 DESCRIPTION TEST

3.1 VISUAL INSPECTION, CONFIRM CLEANLINESS AND CHECK OF THE CONFORMITY OF THE INSTALLATION ACCORDING TO THE ENGINEERING DOCUMENTATION

Check the integrity of the transformer, the presence of all the accessories and correct installation in accordance with documents:

- TR-100AD1 General arrangement drawing - 1723001697-EL-DA-00006
- TR-200DE1 General arrangement drawing - 1723001697-EL-DA-00007
- TR-200ED1 General arrangement drawing - 1723001697-EL-DA-00008

3.2 CHECKS OF PAINTING AND, IF NECESSARY, RETOUCH

Check the integrity of paint of transformer. In case of damage retouch in according with painting specification supplied by MF.

3.3 MEASUREMENT OF WINDINGS INSULATION RESISTANCE FROM HV TO LV SIDES, FROM HV SIDE TO GROUND AND FROM LV SIDE TO GROUND

In order to measure the insulation resistance, follow the above procedure:

1) Measurement of insulation resistance between MV and LV connected to ground

- short circuit the MV terminals and connect it to megger

- short circuit the LV terminals and connect them to tank and ground Take the measurement applying 5000Vdc for 1 min

2) Measurement of insulation resistance between LV and MV connected to ground

- short circuit the MV terminals and connect them to tank and ground

- short circuit the LV terminals and connect to megger. Take the measurement applying 1000Vdc for 1 min for transformers TR-200DE1 and TR-200ED1. Take the measurement applying 5000Vdc for 1 min for transformers TR-100AD1.

MV – LV+ground: _____KV ____min Result: _____

LV – MV+ground: _____KV ____min Result: _____

The results obtained during the test must be compared with the results obtained during the FAT.

If the values are very different it will be necessary to contact the manufacturer.

3.4 CHECK OF THE VOLTAGE RATIO AT EACH TAPPING OF THE TAP CHANGER

The voltage ratio of a transformer is the ratio between the line voltage of one winding and the line voltage of another winding (at no load). The phase voltage ratio is also equal to the turn's ratio:

This measurement is usually performed with some instruments called "ratiometer"

The voltage ratio is performed on all the taps of the tap changer (if present); tolerance for voltage ratio are indicated in IEC 60076-1.

Also, you can measure ratio with the measurement of secondary voltage.

In the table below mark the position of tap changer ++, +, 0, - or – and measure the no load secondary voltage between each phase and neutral.

Divide the value of nominal primary voltage with value measured of secondary voltage and mark the results in the table below.

When you have made the measure on each positions compare the results with the test reports of the FAT.

The acceptance criteria of results is the tolerance of 0.5% of rated values as per according of the standard.

Note: see the test report

Position	Phase U	Phase V	Phase W	Risult

Acceptance criteria (tolerance accordance with IEC 60076-1 and Project data sheet.

3.5 CHECK OIL LEVEL

Verify the oil level with the indication of oil level indicator.

This indication must be similar at the indication of temperature of oil thermometer.

In case the indication is much lower of indication of oil temperature provide to refill the transformer in accordance with indication into Installation and Maintenance manual.

3.6 MEASUREMENTS OF THE DIELECTRIC FEATURES OF INSULATING OIL

This test is described into the Standard IEC 60156.

This test wants to verify the breakdown voltage of sample of oil used to fill transformer.

Acceptance criteria:

- Voltage discharge > 55kV

3.7 CHECK OF THE SILICAGEL AIR BREATHER

Colored, non-poisonous silica gel; the color changes from orange to green when absorbing humidity.

3.8 CHECK OF THE POSITION (OPEN) OF ALL VALVES ON THE OIL CIRCUIT

Verify the arrow on the handle valve indicate the direction of radiator.

3.9 CHECK OF THE AIR/GAS ESCAPE ON THE BUSHING AND PIPE ON OIL CIRCUIT

Open the vent valve on upper part of all radiators to verify to vent eventually residual air into them.

Open the vent valve on upper part of Buchholz relay to verify to vent eventually residual air into it.

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3.10 CHECK OF EARTHING OF THE POWER TRANSFORMER AND RELEVANT BONDING OF EACH PART COMPOSING IT

Check the presence of all earthing connection between each part of transformer (cover-tank, cover-conservator, tank-radiators, ecc..).

3.11 CHECK OF CORRECT OPERATING OF ALARM AND TRIP CIRCUIT ON ALL ACCESSORIES

Connection and functionality of accessories will be performed by simulation of alarms, trips etc. basing on approved schematic diagram and accessories data sheets / catalogue.

3.12 TESTS ON FUNCTIONALITY OF TAP CHANGER

This test is performed during the voltage ratio measurement.

Customer:_____

Transformer Nr.:_____

Rated power:_____

Voltage ratio:_____

Date:_____

1. Visual inspection

- Tank: _____
- Radiators:_____
- Bushings:_____
- Accessories:_____
- Painting:_____

2. Insulation resistance measurement

MV – LV+ground: _____KV ____min Result_____

LV – MV+ground: _____KV ____min Result_____

3. Measurement of voltage ratio

Position	Phase U	Phase V	Phase W	Risult

4. Check oil level

Oil level OK ☐

Oil level NO OK ☐

5. Measurement of the dielectric features of insulating oil

Value:_____kV

6. Check of silicagel air breather

Visual check OK ☐

Visual check NO OK ☐

7. Check of position of all valves on the oil circuit

Radiators valves OPEN ☐

Buchholz relay valves OPEN ☐

OLTC relay valves OPEN ☐

Conservator valve CLOSED ☐

8. Check of the air/gas escape on the bushings and pipe on oil circuit

Radiators vented ☐

Buchholz relay vented ☐

L.V. bushings vented ☐

9. Check of earthing of power transformer and relevant bonding of each part composing it

Earthing connection between cover / tank ☐

Earthing connection between cover / conservator ☐

10. Check of correct operating of alarm and tripo circuit on all accessories

Alarm contacts OK ☐

Trip contacts OK ☐

NOTES: _____

_____

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