Base Load Power Hub (BLPH)

Insulation and Winterisation Philosophy

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Table of contents

1 INTRODUCTION 5

1.1 PROJECT OVERVIEW 5

1.1.1 Project Location 5

1.1.2 Project Concept 6

1.2 DOCUMENT SCOPE 7

1.3 REFERENCES 7

1.4 DEFINITIONS AND ABBREVIATIONS 8

2 Introduction 9

2.1 Winterisation Temperature 9

2.2 INSULATION CLASSES 10

2.2.1 Heat Conservation 10

2.2.2 Personnel Protection 10

2.2.3 Electrically Heat Traced 10

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List of Figures

Figure 1 HOLLANDSE KUST NOORD WIND PARK Location Map 5
Figure 2 - Wind Park Details 6
Figure 3 – BLPH Concept 6

List of Tables

Table 1 - Definitions 8
Table 2 - Abbreviations 8
Table 3 - Insulation and heat tracing requirements 11

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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.

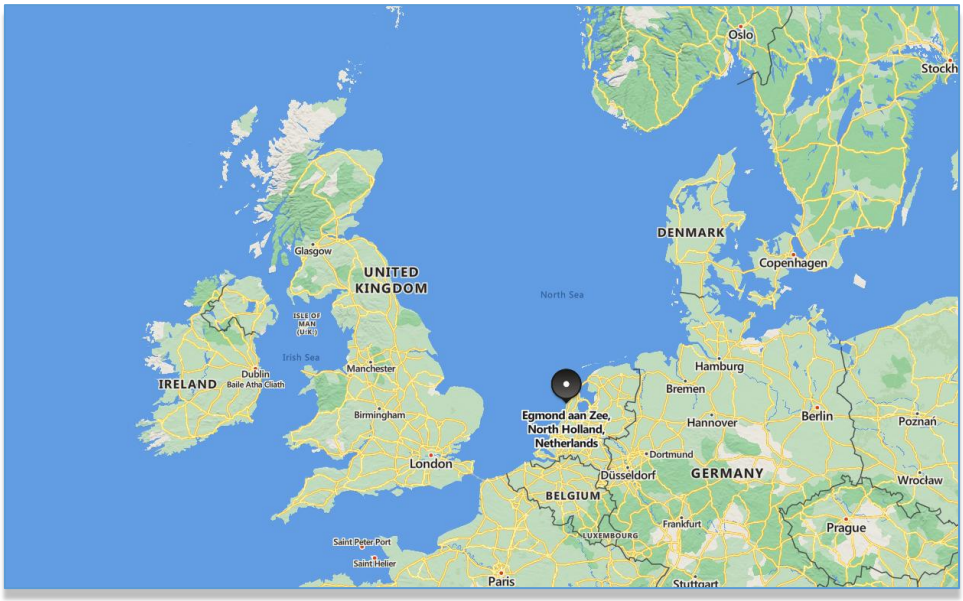


Figure 1 HOLLANDSE KUST NOORD WIND PARK Location Map

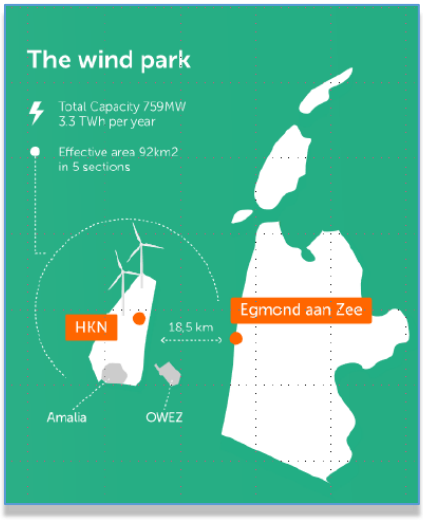


Figure 2 - Wind Park Details

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.

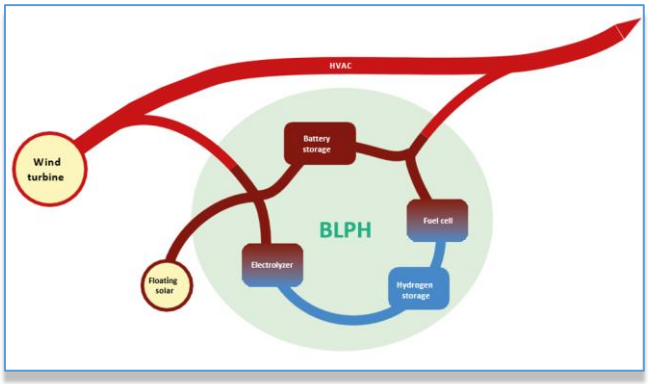


Figure 3 – BLPH Concept

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.

1.2 DOCUMENT SCOPE

The purpose of this document is to present the project winterisation philosophy to be applied to CROSSWIND BLPH project. The philosophy shall define the minimum requirements for insulation and winterisation, to prevent operational upsets and to ensure personnel and operational safety.

1.3 REFERENCES

Project Documents

Ref. [1] Basic Design Engineering Package_Rev2 - Document No: K559-2254-PM-PLN-003

Ref. [2] BLPH PLATFORM SITE AND ENGINEERING DATA_Rev1 - Document No: CWHKN-INN-BPH-DTS-00005

Ref. [3] Heat And Mass Balance - Document No: 123A90-DDL-PR-BL-80002

Ref. [4] BLPH PROCESS FLOW SCHEME ELECTROLYSER AND HYDROGEN DRYING PACKAGE – Document No: 123A90-DDL-PR-DG-80003

Ref. [5] BLPH PROCESS FLOW SCHEME HYDROGEN STORAGE – Document No: 123A90-DDL-PR-DG-80004

Ref. [6] BLPH PROCESS FLOW SCHEME FUEL CELL PACKAGE – Document No: 123A90-DDL-PR-DG-80005

Ref. [7] BLPH UTILITY FLOW DIAGRAM WATER TREATMENT PLANT – Document No: 123A90-DDL-PR-UFD-80006

Ref. [8] BLPH UTILITY FLOW DIAGRAM INSTRUMENT AIR AND NITROGEN SYSTEMS – Document No: 123A90-DDL-PR-UFD-80007

Ref. [9] BLPH UTILITY FLOW DIAGRAM VENT SYSTEMS – Document No: 123A90-DDL-PR-UFD-80008

Ref. [10] Materials Selection Report – Document No: 123A90-DDL-MAT-RE-60011

Ref. [11] Set of P&ID from 123A90-DDL-PR-PID-80011 to 80029, 80041 and 80042

International Codes and Standards

For a list of external, Industry and/or Vendor Standards as well as for a list of Shell DEPs that shall be applied to the project, reference shall be made to Section 10 of Ref. [1].

1.4 DEFINITIONS AND ABBREVIATIONS

DEFINITIONS

COMPANY or Client (CPY):	Crosswind
CONTRACTOR (CTR):	ROSETTI MARINO S.p.A.
PROJECT:	HOLLANDSE KUST NOORD WIND PARK Project

Table 1 - Definitions

ABBREVIATIONS

BESS	BATTERY ENERGY STORAGE SYSTEM
BLPH	BASE LOAD POWER HUB
DEP	DESIGN ENGINEERING PRACTICES
HKN	HOLLANDSE KUST NOORD
P&iD	PIPING AND INSTRUMENT DIAGRAM
PP	PERSONAL PROTECTION
PV	PHOTOVOLTAIC
UFD	UTILITY FLOW DIAGRAM

Table 2 - Abbreviations

Note: for fluid code see table 3 of this report.

2 INTRODUCTION

Winterization is a general term that encompasses insulation and heat tracing. Winterization covers all aspects of operation including heat conservation, cold conservation, personnel protection, frost proofing, seasonal ambient condition changes such as solar heat gain in the summer, external condensation in the winter and ice protection and extreme weather conditions.

The extreme weather design conditions and other design components for winterization will follow the site conditions as per Ref. [2].

As a general guideline, the application of insulation should be minimized to avoid potential corrosion beneath the insulation and to simplify access for maintenance.

This philosophy applies for the following equipment and associated piping / instrumentations:

- Hydrogen Storage Vessel V-25001 A/B/C/D/E/F;
- Sea Water Lift Pumps P-50001 A/B;
- Water Treatment Package A-50000;
- Wastewater Tank T-55001 (Note 1);
- Hydrogen Vent Ko Drum V-43001;
- Hydrogen Vent Q-43004;
- Connected piping to Electrolyser and Fuel cell.

Moreover, it also applies for piping and associated instrumentation that are externally connected with the following packages:

- Instrument Air Package A-63000;
- Nitrogen Generation Package A-64000.

Note 1
Winterization of the Wastewater Tank T-55001 is not required, since the tank is partially filled with 100% MEG (3.5 m^3 of MEG on a total tank volume of 16 m^3) to avoid freezing the content between six-month maintenance periods.
The 3.5 m^3 of 100% MEG guarantees that when the water from upstream sources is discharged toward the tank over a period of six months, the aqueous MEG-water solution does not freeze.
Assuming 10 m^3 of drained water, in fact, the MEG-water solution has a freezing point of -11°C, lower than the minimum ambient temperature (e.g. -8.4°C).

2.1 WINTERISATION TEMPERATURE

The winterization temperature is the minimum maintained temperature and depends on the physical properties of the fluid, such as pour point, freezing point, cloud point and maximum tolerable viscosity, whichever gives the higher temperature. In general 5°C shall be used.

2.2 INSULATION CLASSES

For the above indicated systems, the following insulation classes apply:

- H – Heat Conservation.
- P – Personnel Protection.
- E – Electrically Heat Traced.
- N – Not Insulated (Painted)

2.2.1 Heat Conservation

Heat conservation insulation shall be used where heat losses from the piping and/or equipment to the surroundings are to be minimised. Insulation for heat conservation shall be used when the process fluid is above minimum ambient temperature (-8.4°C) and it is desirable to minimise heat loss, to avoid a process upset.

2.2.2 Personnel Protection

Insulation for personnel protection shall be used on all lines not otherwise insulated, where the process fluid normally operates at or above +70°C or below -10°C, and in areas where personnel could potentially be present and would otherwise be at risk of heat/cold burns.

It is noted that the maximum temperature of the hydrogen line from the Electrolyser Package A-20000 is 65°C, but this only for few meters, after which the temperature will drop as the outside ambient temperature is well below 65°C (from -8.4 to 25 °C). In any case it worth to remember that the platform is unmanned, therefore during operation of the Electrolyser Package there should be no people on board, thus there is not any risk to put people in direct contact with a pipe having a temperature close to 65°C. Personal protection is then not required for BLPH CROSSWIND Project.

2.2.3 Electrically Heat Traced

All heat tracing shall be electrical. Tracing may be employed where isolated items of piping, equipment and instrumentation require protection and shall always be used in conjunction with insulation. It shall be used as a method for temperature conservation and not as a method for raising equipment temperature. Where practicable, the extent and use of heat tracing should be minimised by:

- Selection of appropriate operating conditions
- Use of chemical/diaphragm seals for process instruments
- Minimization of pockets or situations where ice/hydrate formation propensity isincreased.
- Minimization of stagnant lines
- Minimization of distances of small bore branch lines to points of positive isolation
- Free draining lines with suitable slopes (default - 1:100)

- Infrequently used systems, should preferably be drained down after use during winter periods rather than be maintained full.

Seal legs, seal drums, and overflow lines when used in safety-critical service shall be heat traced and insulated to prevent freezing of the water seal.

The insulation and heat tracing requirements are as shown in Table 1:

Fluid Code	System	Piping
DM	Demineralized Water	H, E, N
HY	Hydrogen	N
AV	Atmospheric Vent	N
WW	Waste Water	H, E, N
SWR	Water Return	H, N
IA	Instrument Air	N
N	Nitrogen Gas	N
VL	LP Vent	N
DI	Deionised Water	H
CB	Concentrated Brine	H
CI	Chemical Injection	E
SWS	Water Supply	E

Table 3 - Insulation and heat tracing requirements