ROSETTI MARINO

1	NO COMMENTS - APPROVED - WORK MAY PROCEED
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Sign	Date
Giuseppe Cavallo	17/02/25

e Load Power Hub (BLPH)

NITROGEN GENERATION PACKAGE
SYSTEM/PACKAGE FUNCTIONAL 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.

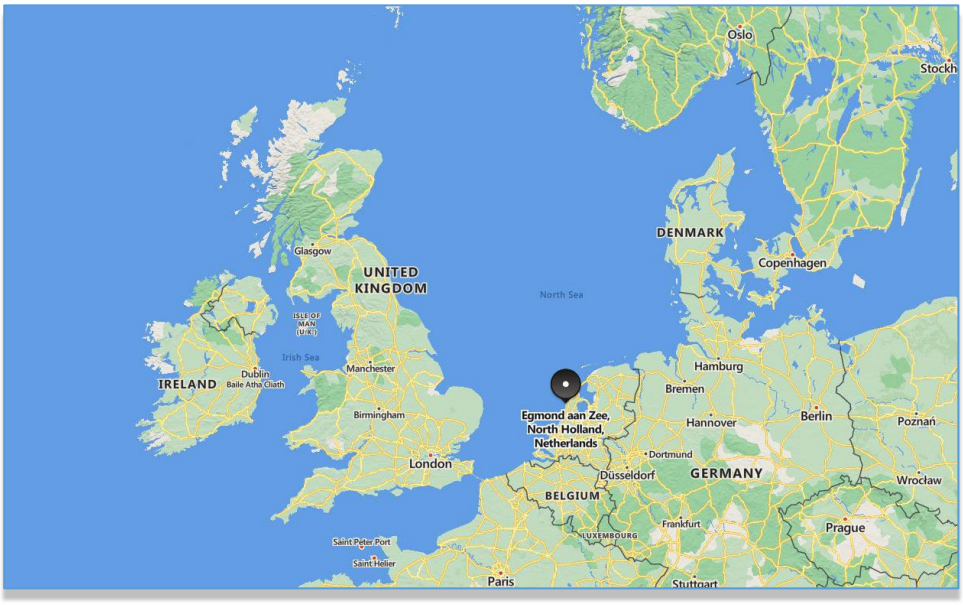


Figure 1 HOLLANDSE KUST NOORD WIND PARK Location Map



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.

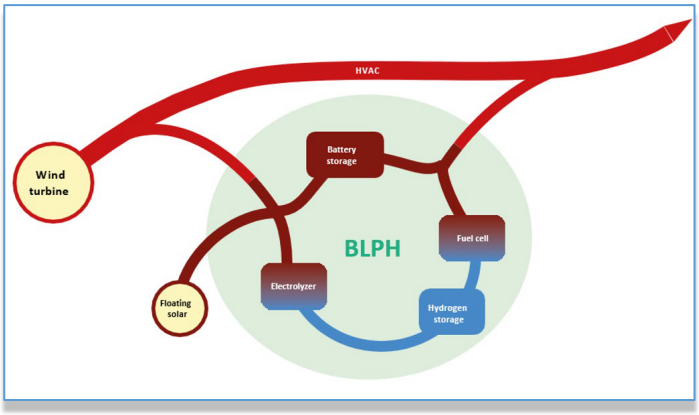


Figure 3 – BLPH Concept

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 identifies any electrical equipment to be fed with its main characteristics.

2.1 REFERENCES

Doc. No.	Description
1724000437-PR-PID-00018	PACKAGE P&ID
1724000437-MAC-DS-00011	EQUIPMENT DATA SHEETS INCLUDING PSA, ETC.
1724000437-IN-LIS-00016	INSTRUMENT LIST WITH SET POINTS/CONTROL/ALARM/SHUTDOWN
1724000437-MAC-MAN-00029	INSTALLATION, OPERATING AND MAINTENANCE MANUAL (INCLUDING SITE ERECTION INSTRUCTIONS AND PROCEDURES)

Table 1 - Reference Documents

2.2 DEFINITIONS AND ABBREVIATIONS

COMPANY or Client (CPY):	Crosswind
CONTRACTOR (CTR):	ROSETTI MARINO S.p.A.
PROJECT:	HOLLANDSE KUST NOORD WIND PARK Project
PSA	Pressure Swing Adsorption
LCP	Local Control Panel
PLC	Programmable Logic Controllers
UCP	User Control Panel
SIS	Safety Instrumented System
L Alarm	Low Alarm
H Alarm	High Alarm

Table 2 - Definitions and Abbreviations

3 FUNCTIONAL DESCRIPTION

3.1 DESCRIPTION OF THE NITROGEN GENERATOR PACKAGE A-64000

The nitrogen generation package is composed by a dual tower nitrogen generator C-64001A/C-64001B, no.1 nitrogen receiver V-64001, no.2 after filters S-64001A/S-64001B.

Dry air enters the system and it is conveyed to generator towers. The Pressure Swing Adsorption (PSA) technology exploits the activated molecular sieve's capacity of adsorbing oxygen to produce nitrogen. Atmosphere is mainly composed by nitrogen and oxygen. PSA generator adsorbs oxygen (but not nitrogen) when the active material is in high pressure conditions. Therefore, if a flow of dry air enters the PSA pressurized vessel, at the outlet flange the percentage of oxygen is drastically reduced resulting in an increased quantity of nitrogen. The regeneration of the material is simply obtained by depressurization: at 0 barg the oxygen is not more trapped.

The oxygen analyzer installed dowstream the PSA generator monitor the purity of the gas: in case of low purity, the off-spec gas is automatically vented to atmosphere by mean of an on-off valve, while in case of proper purity the produced gas arrives into the nitrogen receiver that acts as a buffer tank.

At the skid outlet a post-filter group (one filter operating, the second on in stand-by) is installed to remove the dust from the nitrogen.

3.2 NITROGEN GENERATOR PACKAGE A-64000 MAIN DATA

POSITION	PRESSURE (operating / design)	FLOW RATE	TEMPERATURE (operating / design)	PROCESS DATA
DRY AIR INLET	9 / 12 barg	150 Nm^3/h	40 / 80°C	Dew point ≤ -40°C
NITROGEN OUTLET	8 / 12 barg	60 Nm^3/h	40 / 80°C	PURITY ≥ 97%

3.3 DESCRIPTION OF THE PSA NITROGEN GENERATOR OPERATING CYCLE

Tower C-64001A is in the generation phase, while tower C-64001B is regenerating.

Inlet air enters the adsorption tower C-64001A through the 64-XV-051 inlet pneumatic valve, it passes through carbon molecular sieve bed where oxygen is trapped. Oxygen is then removed and nitrogen is released through the 64-XV-056 outlet valve.

The regenerating tower C-64001B is depressurized to atmospheric pressure, opening the discharge valve 64-XV-054, to strip oxygen from carbon molecular sieve.

After the complete regeneration of tower C-64001B, the discharge valve 64-XV-054 is closed, inlet and outlet valves 64-XV-051 and 64-XV-056 are closed, while equalizing valve 64-XV-055 is opened to let both towers reach the same pressure, in order to avoid possible shocks of the active bed during the subsequent change-over phase.

Both towers C-64001A and C-64001B are equipped with pressure transmitter to monitor the pressure. In case of high/low alarm, refer to the installation, operating and maintenance manual for the following actions to be taken by the operator.

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3.4 DIFFERENTIAL PRESSURE TRANSMITTER LOOP

The nitrogen generator package A-64000 is provided with no.2 after filter.

Differential pressure transmitters 64-PDIT-056 is provided to measure the pressure drop across the on-line filter.

In case of high pressure drop, the after-filter in stand-by condition shall be put on-line and the filteriing element of the after-filter which was in operating condition when the alarm condition has been reached shall be replaced with a new one.

Instrument tag	Alarm set value
64-PDIT-056	0.5 bar

High differential pressure drop alarm (set: 0.5 bar) [FAULT]

- Generates a dedicated alarm via Profinet (retentive alarm).
- Switch on the "General alarm" lamp on LCP.
- Activates the switch of the two filters (slave in line and subsequent exclusion of the master filter), by means of actuated valves 64-XV-060 and 64-XV-061.

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3.5 OXYGEN ANALYZER LOOP

The PSA nitrogen generator system is provided with no.1 oxygen analyzer 64-AT-051 on the outlet nitrogen line, which has an active role in the logic of the package.

If measured oxygen concentration is higher than the set value, an alarm condition is generated to inform the operator (general alarm lamp on local control panel 64-LP-001 and in addition the alarm is sent to onshore via modbus communication to alert remotly the operator); automatically the valve 64-XV-058 is closed and the valve 64-XV-059 is open, to vent the out of spec nitrogen to the atmosphere.

Instrument tag	Alarm set value
64-AT-051	3%

3.6 ANALYTICAL DESCRIPTION OF THE OPERATING CYCLE PHASES

PHASE	TOWER C-64001A	TOWER C-64001B	DURATION
1	Generation	Depressurization (Regeneration)	50 sec
2	Equalization	Equalization	10 sec
3	Depressurization (Regeneration)	Generation	50 sec
4	Equalization	Equalization	10 sec

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3.7 ACTUATED VALVES CONTROL LOOP

During the different operating phases, every valve is in a stated position: if PLC detects that real position of one valve does not comply with requested position, the sequence is interrupted, with all valves frozen in the current position, and an alarm condition is generated to inform the operator (general alarm lamp on local control panel 64-LP-001 and in addition the alarm is sent to onshore via modbus communication to alert remotly the operator).

Possible situations for alarm activation are:

- failure of solenoid valve, which does not allow instrument air flow to pneumatic actuated valve
- failure of solenoid valve, which wrongly sends instrument air flow to pneumatic actuated valve
- failure of pneumatic actuated valve
- failure of PLC
- missed signal from PLC
- failure of limit switches.

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3.8 DESCRIPTION OF LOGIC SEQUENCE

PHASE 1: TOWER C-64001A GENERATION - TOWER C-64001B DEPRESSURIZATION

Solenoid valves			Pneumatic valves	
Tag	**Status**		**Tag**	**Status**
64-XY-051	Energized		64-XV-051	Open
64-XY-052	Not energized		64-XV-052	Closed
64-XY-053	Not energized		64-XV-053	Closed
64-XY-054	Energized		64-XV-054	Open
64-XY-055	Not energized		64-XV-055	Closed
64-XY-056	Energized		64-XV-056	Open
64-XY-057	Not energized		64-XV-057	Closed

PHASE 2: TOWER C-64001A EQUALIZATION - TOWER C-64001B EQUALIZATION

Solenoid valves			Pneumatic valves	
Tag	**Status**		**Tag**	**Status**
64-XY-051	Not energized		64-XV-051	Closed
64-XY-052	Not energized		64-XV-052	Closed
64-XY-053	Not energized		64-XV-053	Closed
64-XY-054	Not energized		64-XV-054	Closed
64-XY-055	Energized		64-XV-055	Open
64-XY-056	Not energized		64-XV-056	Closed
64-XY-057	Not energized		64-XV-057	Closed

PHASE 3: TOWER C-64001A DEPRESSURIZATION - TOWER C-64001B GENERATION

Solenoid valves			Pneumatic valves	
Tag	**Status**		**Tag**	**Status**
64-XY-051	Not energized		64-XV-051	Closed
64-XY-052	Energized		64-XV-052	Open
64-XY-053	Energized		64-XV-053	Open
64-XY-054	Not energized		64-XV-054	Closed
64-XY-055	Not energized		64-XV-055	Closed
64-XY-056	Not energized		64-XV-056	Closed
64-XY-057	Energized		64-XV-057	Open

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PHASE 4: TOWER C-64001A EQUALIZATION - TOWER C-64001B EQUALIZATION

Solenoid valves			Pneumatic valves	
Tag	**Status**		**Tag**	**Status**
64-XY-051	Not energized		64-XV-051	Closed
64-XY-052	Not energized		64-XV-052	Closed
64-XY-053	Not energized		64-XV-053	Closed
64-XY-054	Not energized		64-XV-054	Closed
64-XY-055	Energized		64-XV-055	Open
64-XY-056	Not energized		64-XV-056	Closed
64-XY-057	Not energized		64-XV-057	Closed

Remarks:

- The local control panel 64-LP-001 is equipped with a local/remote selector (software type) to have the possibility to remotly start/stop the package.
- The safety instrumented system (SIS) will send the shutdown command 64-XS-001 to nitrogen UCP 64-LP-001 in case of emergency condition. The nitrogen package will act the shutdown sequence. Refer to the installation, operating and maintenance manual for the following actions to be taken by the operator.
- In case of Critical Faults the signal 64-XA-003 will be sent from UCP to safety system SIS. This signal is a cumulative of all critical fault inside the Nitrogen package. The SIS will send the command 64-XS-001 as soon as it will receive the signal 64-XA-003. Refer to the installation, operating and maintenance manual for the following actions to be taken by the operator.
- The package is equipped with a pressure transmitter 64-PT-057 installed downstream the after-filter group: in case of low pressure alarm, refer to installation, operating and maintenance manual for the following actions to be taken by the operator.
- The nitrogen receiver is equipped with a pressure transmitter 64-PT-059: in case of low pressure alarm, refer to installation, operating and maintenance manual for the following actions to be taken by the operator.
- Pressure transmitter 64-PT 052
    - L Alarm SET <8 barg. Active only during PHASE 1: delay10s.
    - H Alarm SET >0.5barg. Active only during PHASE 3: delay 30s.
- Pressure transmitter 64-PT 053
    - L Alarm SET <8 barg. Active only during PHASE 3: delay10s.
    - H Alarm SET >0.5barg. Active only during PHASE 1: delay 30s.

  Both alarms generate a dedicated alarm via Profinet (retentive alarm) and switch on the "General alarm" lamp on LCP.