Base Load Power Hub (BLPH)

3D MODEL REVIEW PROCEDURE

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1 INTRODUCTION

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.

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.

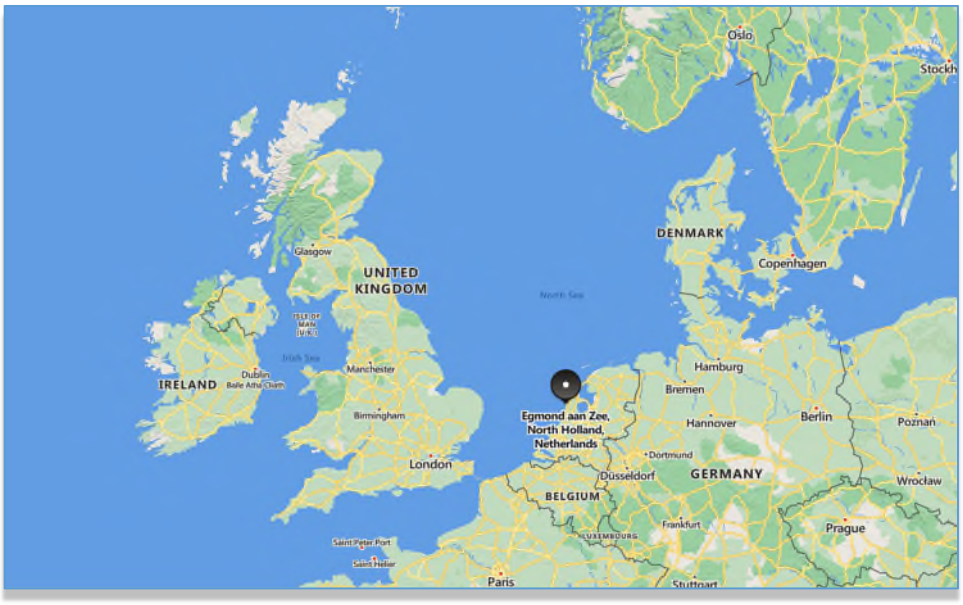


Figure 1 - HOLLANDSE KUST NOORD WIND PARK Location Map

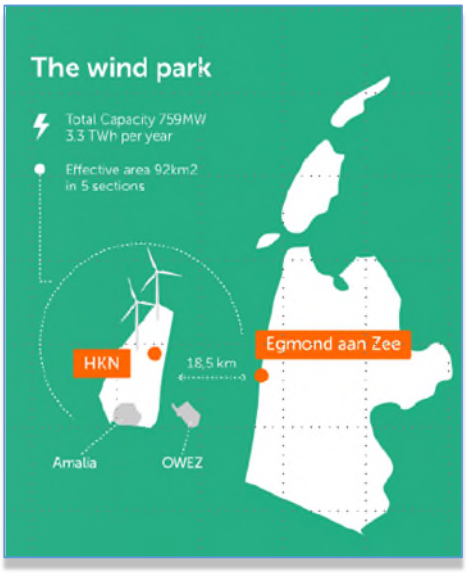


Figure 2 - Wind Park Details

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.

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.

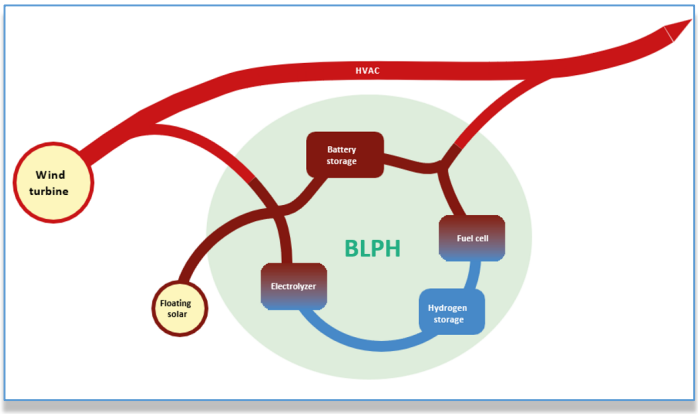


Figure 3 – BLPH Concept

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 DETAIL ENGINEERING 3D MODEL REVIEW

2.1 GENERAL REQUIREMENTS

The purpose of the 3D CAD Model reviews is as a minimum to:

- Confirm compliance of Contractor's design with the Project Specifications and the Company's requirements such as safety, operability, maintainability, constructability, etc.;
- Identify and eliminate at the earliest hazardous elements at the design stage,
- Confirm compliance of model with current P&IDs,
- Confirm that all disciplines requirements are properly integrated in the design,
- Confirm that piping arrangements and routings are consistent with process requirements and stress constraints.

The following types of 3D CAD Model Reviews shall be conducted during the project phases:

- Contractor Internal Model Reviews
- Milestone Contractual Model Reviews

The 3D CAD Model used during the formal reviews shall be a frozen copy of the live engineering database being used for development of the project.

2.2 CONTRACTOR INTERNAL MODEL REVIEWS

It is common engineering practices that the Contractor's Design Teams perform daily reviews of the 3D CAD model as part of its quality procedures. The Contractor's CAD administrator sets-up scheduled automatic export of the 3D CAD Model to allow Lead Disciplines to review and annotate daily the part of the design they are responsible for.

Prior to each Milestone Contractual Model Reviews, dedicated Internal Model Reviews shall be performed by the Contractor to maximize the effectiveness of the Milestone Contractual Model Review. In particular the Contractor shall:

- Ensure the 3D CAD Model is completely consistent with current P&IDs by running data consistency checks using Intelligent P&IDs tools. Verify the 3D CAD Model against the latest revision of vendor drawings, in particular all dimensional information, & equipment locations and nozzle positions.
- Check the automatically produced Material Take Off from the 3D CAD model against the latest revision of the other Project documentation. The weight data source shall be clearly indicated.
- Ensure Line thermal movements, as shown on the stress sketches, do not result in clashes.
- Ensure the 3D CAD Model is clash free, prior to the 60% & 90% formal 3D CAD model reviews.

Based on the results of the Contractor Internal Model Reviews, the Contractor may invite the Company to review specific items prior to the Milestone Contractual Model Reviews such as:

- Confirmation of the design concept around specific items such as piping arrangement around pumps, compressor, control valves, battery block valves, etc.
- Confirmation of the design concept for accessibility, operability, safety and human factors engineering as per existing specifications;
- Areas of concern,
- Confirmation of process requirements.

2.3 MILESTONE CONTRACTUAL MODEL REVIEWS

2.3.1 Generalities

The Milestone Contractual Model Reviews are formal and detailed 3D CAD Model reviews to confirm the state of the engineering design at the milestone point, to review comments addressed by the Company from previous model reviews and to confirm recommended solutions.

Milestone 3D CAD Model Reviews shall be performed at the Contractor's Offices and shall be performed in the following three (3) stages:

2.3.1.1 30% Model Review: The 30% model review mainly concerns, but is not limited to, the review of equipment accessibility, safety evacuation, equipment layout, large diameter piping routing, cable trays routing major Ele/Stru, human factors engineering and constructability. After incorporating the Company's comments, the route of the escape and movement routes will be defined as the basis for further design.

2.3.1.2 60% Model Review: 60% Model Review is conducted to review actions from the 30%

Model Review, and is intended to review, as a minimum, the detailed plant design such as piping systems, underground facilities, cable trays, platforms and ladders, instrumentation, control panels, packaged equipment, etc. The Company approval of all critical piping stress calculation notes of modelled pipes is prerequisite to the validation of the 60% Model review. The results of this review are recommendations for the final design of the plant.

2.3.1.3 90% Model Review – Final 3D CAD Model Review: Final Model Review intended to review the actions from the 60% review to confirm and finalize a detailed plant design.

2.3.2 Organization & Execution

The Contractor shall be responsible to organize and conduct Milestone Contractual Model Review sessions with Company attendance.

In order to maximize the efficiency of the reviews, the Contractor shall conduct the meetings to ensure a proper segregation of the discussions by topic and discipline and shall facilitate the spoken interactions by favouring the minuting of the comments instead of solving them during the review.

The success of the Milestone Contractual Model Reviews will depend on how the discussions are conducted and how logistics are managed by the Contractor.

2.3.3 Supporting information

The Contractor shall make available during the review as a minimum the following documentation in the revision corresponding to the displayed model, and in hard copy:

2.3.3.1 Platform plot plan,

2.3.3.2 Safety layouts (Fire zoning, area classification, escape routing, etc.),

2.3.3.3 Maintenance layouts (Handling way, etc.),

2.3.3.4 Equipment list,

2.3.3.5 Line list,

2.3.3.6 PFDs,

2.3.3.7 P&IDs marked-up with highlights on the reviewed lines,

2.3.3.8 Model review comments sheet from the previous reviews.

2.3.4 Team Composition

The Contractor shall ensure that the key participants from both Contractor and Company will attend the Milestone Contractual Model Reviews, i.e. Project Engineering managers, disciplines PSL, etc.

2.3.5 Comment Review & Follow-up

All outstanding matters and actions shall be individually recorded within a multi-sheet action list providing:

2.3.5.1 A screenshot from the Model review of the matter identified,

2.3.5.2 A succinct description of the matter,

2.3.5.3 A responsible and due date for the action.

Once the action is performed the previous action sheet shall be updated and completed with:

2.3.5.4 A screenshot of the Model review of the corrected design,

2.3.5.5 A succinct description of the actions performed,

2.3.5.6 The date of the action resolution.

3 MILESTONE REVIEWS REQUIREMENTS

The Table 1 provides a guideline of items that should be reviewed during the Milestone Model Review sessions.

The Company and the Contractor shall agree at project start on the applicable items to be reviewed at each stage of the 3D modelling by correcting or completing this table as necessary.

	30% MODEL REVIEW	60% MODEL REVIEW	90% MODEL REVIEW
OBJECTIVE	**Review accessibility, evacuation, layout, construction feasibility**	**Review actions from previous Review.** **Bring the design up to procurement requirements**	**Review actions from previous Review.** **Finalize detailed plant design**
ARC	All buildings modelled and located with estimated outline	All buildings outlines detailed and frozen. All major walls, and floors modelled	All walls, floors, fire doors and stairs modelled.
ELE	Preliminary Routings of main electrical cables trays modelled (> 300 mm). Preliminary Major outdoor electrical equipment (e.g. transformer, ~~motors~~ controllers, etc…) modelled. Preliminary Major Panels Location identified for modelling. (with preliminary vendor detail or supposed preliminary extrusions) Conceptual layout of above-ground main electrical and instrument cable trays. Preliminary Area Lights identified for modelling.	All primary electrical cable trays modelled. (with vendor information) and relative supporting Secondary electrical cable trays started. Container: electrical equipment, lights location and MCTs modelled. Area Classification modelled. Main Tracing items modelled. All local control panels/station modelled. All junction boxes and panels modelled. .	All Primary, Secondary electrical cable trays and field run trays modelled with support points. (inside and outside) All electrical building internals modelled (e.g. switchboards, panels, UPS, etc…). Building/Platform Lights and grounding modelled. Field run cable and tray layout identified and modelled. All local control station for motors modelled. All welding and power outlets modelled. All electrical equipment/system (Navaid, lightning, corrosion system [if necessary], tracing) .
HVA	Routings of main ducts modelled.		

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HSE	Primary escape ways modelled. All main evacuation equipment (Life Boats, helicopter, etc...) modelled. All Muster Areas and Temporary Refuge modelled. Flares, Vents, Exhausts in a Safe Area modelled. Fire Zone, Restricted Area and Impacted Area modelled.	All primary and secondary escape ways modelled. All major access ways for fire fighting modelled. Emergency safety showers and eye wash stations modelled. Main firefighting systems such as hydrants, monitors, isolation valves, fire water pumps modelled.	All firefighting systems such as sprinklers, hydrants, monitors, deluge manifolds, isolation valves, fire water pumps, fire alarms, manual activation call points (MACs) modelled with deluge cones. All Fire and gas detectors modelled with detection cones.
	30% MODEL REVIEW	**60% MODEL REVIEW**	**90% MODEL REVIEW**
OBJECTIVE	**Review accessibility, evacuation, layout, construction feasibility**	**Review actions from previous Review.** **Bring the design up to procurement requirements**	**Review actions from previous Review.** **Finalize detailed plant design**
INS	Routings of main instrumentation cables trays modelled (> 300 mm). Preliminary Instrument Panels/Junction boxes identified for modelling. Control Room Layout evaluated for modelling.	All instrumentation cable trays modelled. Instrument Panels and Junction Boxes location frozen and modelled. Main Off-line instruments located and modelled. Control Room layout and design completed and modelled.	Support points for all modelled trays are allocated. All Off-line Instruments modelled. All instrument valve actuators modelled. All platforms for instruments (e.g. analyzers) modelled.
MEC	All equipment (including packages) modelled according to preliminary vendors' information or with detailed outlines. Main equipment nozzles modelled. Ladders, stairs and platforms on main vessels and columns modelled.	All equipment (including packages) updated based on first vendors' information. All equipment nozzles (process and instruments) modelled. All equipment related ladders, stairs and platforms modelled.	All equipment (including packages) updated with all details based on final vendor information (certified drawings). All equipment information (Weight, CoG, etc…) updated according to final vendor documentation. All nozzles location updated according to final vendor documentation.

MIE	Location and orientation of maintenance spaces and equipment access modelled. Main escape modelled. Primary Lay down areas and Access Hatches modelled. Primary Operating Platforms for Valves, Equipment and Maintenance modelled.	Lifting, withdrawal and material handling volumes for main equipment modelled. Permanent cranes, hoisting beams, pad eyes and davits for maintenance modelled. Maintenance and operation access ways identified and modelled. Monorails and Davits modelled. Equipment Withdrawal and Handling Areas modelled. Secondary Operating Platforms for Valves, Equipment and Maintenance modelled.	Lifting, withdrawal and material handling volumes for all equipment heavier than 20 kg modelled. Additional permanent devices for maintenance and operations modelled.

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	30% MODEL REVIEW	60% MODEL REVIEW	90% MODEL REVIEW
OBJECTIVE	**Review accessibility, evacuation, layout, construction feasibility**	**Review actions from previous Review.** **Bring the design up to procurement requirements**	**Review actions from previous Review.** **Finalize detailed plant design**
PIP	All Large bore piping, fittings and valves above 6" modelled Platforms for major valves for operation and maintenance modelled. All tagged in lines items are named.	All Large bore piping, fittings and valves above 6" modelled and stress checked for critical lines. All other Piping 4” and above including instrumentation modelled. All critical piping lines below 2” modelled. Pipe spacing and access to flanges defined Piping arrangement around equipment defined. Location of control valves, MOVs, manual valves, strainers, filters modelled. All in-line, including valves, instruments and special items, insulation, and on-line instrumentation on the aforementioned pipe sizes modelled to preliminary vendor data or final vendor data. Main platforms for valves, flange joints and others required for operations and maintenance modelled.	All piping, fittings and valves whatever diameter modelled and stress checked for critical lines. All In-line and on-line instrumentation modelled according to final vendor data. All valves modelled according to certified vendor data. All Clash checks (Soft and Hard) resolved and closed. All platforms for valves, flange joints, and others for operations and maintenance modelled.
SUP	All major pipe supports (heavy loads >5t) modelled.	All major and Miscellaneous Pipe Supports frames Located and modelled. All pipe supports for 4" and above pipes located.	All Pipe and General Supports modelled. All Piping support frames and fixings verified and modelled.

	30% MODEL REVIEW	60% MODEL REVIEW	90% MODEL REVIEW
OBJECTIVE	**Review accessibility, evacuation, layout, construction feasibility**	**Review actions from previous Review.** **Bring the design up to procurement requirements**	**Review actions from previous Review.** **Finalize detailed plant design**
STR	Preliminary Deck modelled. Primary steel design for Tanks, Jetty and buildings modelled. Main Pipe racks structures (concrete and primary steel) modelled Fire & Blast walls modelled.	Primary and secondary racks modelled (with secondary steel and bracing). Secondary Structures Steel design completed and modelled. Tertiary steel design started for modelling. Pad Eyes located and modelled. Module, Deck and Piles coordinates checked and verified. All structural analysis completed. Rigging Analysis completed and comments incorporated in model. Cathodic protection design completed and modelled. Major structures clash check resolved.	Tertiary Structures Steel design completed and modelled.

Table 1 – Model Reviews Scope

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