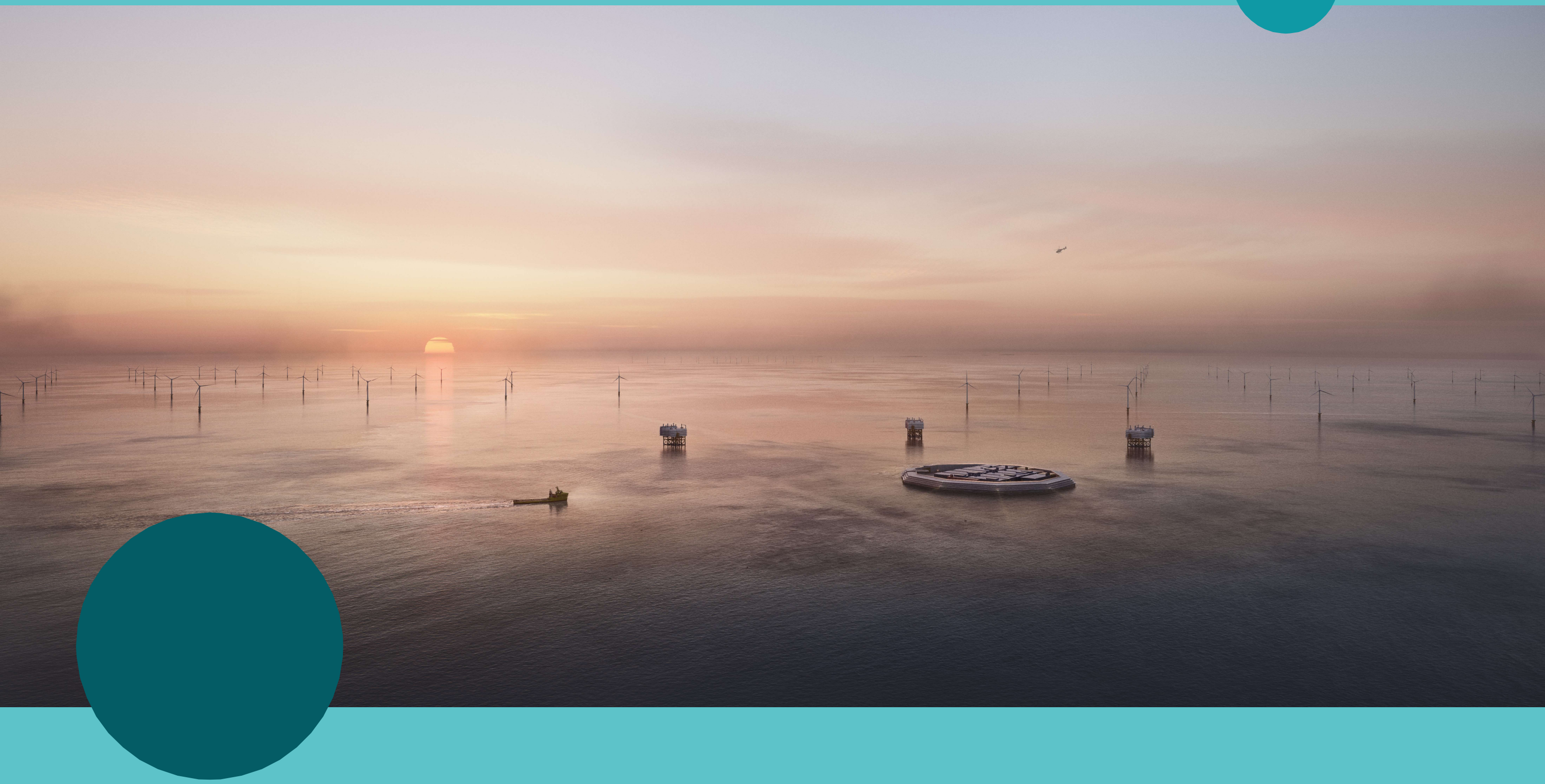
Danish Energy Agency

# Summary results from Offshore Wind Market Dialogue for the Energy Island in the North Sea

## Regarding the technical concept and the procurement process of the Energy Island in the North Sea



May 2023, v1.0

Danish Energy Agency

# Contents

# 1. Introduction

In the period March 31 to May 7, 2023, The Danish Energy Agency (DEA) have held a written technical market dialogue with stakeholders in the Offshore Wind industry with an interest in providing input to the procurement process and technical framework conditions of the Energy Island in the North Sea.

The electronic material in relation to this market dialogue has been published online on EU Supply/TED.europa.eu website. Furthermore, the material has been uploaded on DEA website (link). This current anonymized summary of the answers to this market dialogue will be uploaded to the DEA website as well.

The result of the market dialogue will support DEA in defining the offshore wind farm (OWF) developer's technical specifications of the interfaces to, and land use on the Energy Island.
The outcome will be included in the optimization of the tender material for the Energy Island and later used in future offshore wind tenders related to the North Sea Energy Island.

The published invitation and questions are located on ENS web site (link).
An online information meeting was held on April 21, 2023 (link to presentation).

# 2. Purpose of the market dialogue

The purpose of the written technical market dialogue was to consult with central offshore wind market stakeholders about the technological challenges and solutions that are imagined to affect the Energy Island technical concept.
In the market dialogue, questions were posed about technical elements as well as requirements for access to common service areas (including e.g. harbour and helipad) and O&M conditions.

The offshore wind market has thereby had the opportunity to provide valuable input to the future framework for the procurement process of the North Sea Energy Island and the integration of offshore wind equipment and facilities on the Island.

# 3. Background

A broad political majority in the Danish parliament has agreed that an energy hub in the North Sea shall be located on an artificially constructed island located 80-100 km west of the coast of Jutland. The Energy Island will in a first phase have the capacity to facilitate and transmit 3-4 GW offshore wind power by 2033 with a target to increase the capacity to 10 GW by 2040.

The Energy Island will contribute to utilize the large amount of wind resources in the North Sea and act as an energy hub that collects electricity from the surrounding offshore wind farms and distributes the electricity between countries and other hubs connected via the electricity grid.
It should be noted here that further marked dialogue(s) related to the OWF procurement process is planned in the future after the publication of the Energy Island tender.

## 4. Results of the market dialogue

We have received answers and feedback from four major industrial stakeholders: Ørsted, CIP, NIRAS and Vattenfall. We highly appreciate the feedback and will take the valuable input into consideration for the further development of the Energy Island tender material.

An anonymized summary of the key market feedback on the questionnaire is enclosed in section 5 below.

Further information on Denmark's Energy Islands can be found here (link).

Thank you for your feedback.

**Danish Energy Agency**
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*Disclaimer and use of inputs from the dialogue*
*The information, including the written Q&A's, provided by the DEA during the market dialogue in the spring of 2023 is non-binding to the DEA. The binding information will be the published Energy Island tender material. The Q&A's from this market dialogue, are therefore without any legal status during the Energy Island procurement process.*

## 5. Offshore Wind Farm Market Dialogue, April, 2023

From the respondents the following general comments were provided:

- It was recommended that the DEA should focus on functional requirements rather than specific technical solutions. The DEA takes note of this and confirms that the Energy Island tender material will be based on functional requirements wherever possible.

- It was recommended that the DEA should reserve space for equipment related to hydrogen and Power-to-X technologies. As per the political agreement the bidders for the energy island tender are allowed to include an additional area for innovative activities, however such additional area will not be evaluated as part of the Energy Island bid. Due to this, the DEA is not specifying or requiring areas for innovative activities on the island.

The main feedback from the respondents on the questionnaire can be summarized as follows.

| **1. Electrical equipment requirements** | | | Summary of answers, anonymized. |
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| 1.01 | Equipment: Please list the electrical equipment (incl. Estimated footprint and weights) expected to be located on the island per 1 GW? | High | The general electrical equipment for offshore wind on the Island is as expected. (GIS bays (incl. cable bays, bus couplers, transformer bays), LV earthing transformers, neutral earthing resistors, 3 winding transformers, etc.)<br>The total amount of electrical equipment is dependent on the grid code as defined by the TSO, Energinet.<br>The electrical equipment is expected to be modularized, prefabricated and commissioned onshore |
| 1.02 | Substation - General. Can you distinguish any other considerations (Electrical), which have been overlooked and needs to be taken into account to accommodate a robust and safe GIS switching station? | High | In case filters, reactors, STATCOMs and synchronous condensers are needed, it would add to the amount of switchgear needed and thereby to the space required. |
| 1.03 | Substation: Is it likely that the OWF-substation will include harmonic filters and power compensation equipment (shunt reactors)? If so, which sizes are expected? | High | Reactor compensation is to be defined from cable length and numbers of cables. |
| 1.04 | Transformers: Do you expect Three phase or Single phase power transformers for stepping up the transmission voltage to 400 kV? | High | Three-phase power transformers is to be expected. |

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| 1.05 | Transformer replacement: Is there a procedure for transformer replacement (plug-in terminations, installation flexibility etc.)? | High | It is expected that transformer manufacturers will prepare a replacement procedure |
| 1.06 | Voltage level: Do you expect the voltage level, from the OWF to Energy Island, to be 66 kV or 132 kV (or something else)? | High | 66 kV is Todays standard, 132 kV will most likely be ready by the time of installation. For long distance, 275kV is expected but an OSS will be required. |
| 1.07 | Grid code: Do you expect the OWF to transmit harmonic distortions to the Point of Connection (PoC) on the island? Reactive Power Compensation: How many MVAR do you expect the OWF cables to generate during normal operation? Do turbines include controllers to limit the MVAR exchange (unity power factor at point of connection)? | High | Expected very low level of harmonic distortion and filters might be needed. Reactive power generated by the offshore wind farm cables depends on the voltage level and the length of cables. Reactors is required for static compensation. |
| 1.08 | Any other recommendations or suggestions? | High | Suggest focus should be on maintenance and potential replacement, requirements for grid code and stability related to HVDC connections. |
| 1.09 | Emergency power: Could a battery bank, installed on the island, replace the need for EMD (Emergency Diesel Generators)? What is the estimated footprint/physical size? | Lower | A battery system should be considered for emergency power. However, a diesel-based system might not be avoided due to that the risk of a battery system supersedes the benefits from replacing an EMD, due to challenges of recharging without grid, weather etc. |
| 1.10 | Earthing system: Which are the dimensioning factors to limit excessive touch voltages and transferred potential to a minimum? | Lower | An overall Energy Island earthing system should be based on a study and is envisaged to incorporate island structures |
| 1.11 | GIS room: Is it likely that the OWF-substation will be a Double Bus - Double Breaker arrangement or do you foresee other configurations in the OWF-substation? | Lower | Depends on the specific case/voltage level. |

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| 1.12 | GIS room: What extra space is required in the GIS-room (apart from required bays) for service, maintenance and storage? | Lower | A few (2-5) extra meters should be expected. |
| 1.13 | GIS: How many busbars do you estimate per 1 GW to be required for the OWF GIS switching station (based on degree of redundancy and available technologies, rated current)? | Lower | Number of busbars will depend on the connection agreement with the TSO. |
| 1.14 | Transformer spares: Do you assume spare transformer units to be located on the artificial island? If so, number of spare transformer units | Lower | Not spare transformers, but critical spare parts for transformers, which can be stored in warehouse facilities |
| 1.15 | Transients: Do you expect any transients/oscillations to be generated during switching of the OWF cables?<br>Do you expect that the GIS-breakers connected to OWF cables require any particular equipment to minimize transients etc. (point on wave switching or pre-insertion resistors etc.)? | Lower | Point On Wave (POW) relays may be necessary on outgoing feeders to reduce transients |
| 1.16 | Voltage fluctuations: In what range (+-%UN) do you expect the operating voltage to vary during normal operation? | Lower | Depends on definition of Grid Code as defined by the TSO, Energinet. |
| **2. Cable requirements** | | | |
| 2.01 | Cable joints: Do you expect any cable joints between submarine-cables and land-cables on the island? If so where will they be located? | High | Depends on Energy Island design (cable management plan and cable landing concept). |
| 2.02 | Cables, Fiber: Assuming 1 GW offshore wind capacity, how many fiber cables do you expect to have access to on the island? How many fiber cables do you expect to install? | High | Export cables normally have 48 - 96 optical fibers per cable. |
| 2.03 | Cable design: Do you expect cables to be of 3-core or 3 x single core design? What | High | The offshore export cable is expected to be a 3-core design with a weight between 50kg and |

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| | is expected weight, diameter, minimum bend radius and maximum permissible side wall pressure? | | 150kg per meter dependent on voltage level.<br>Diameter = 20 - 30 cm.<br>Minimum Bending Radius (MBR) is expected to be between 3 - 4 m dependent on voltage level.<br>Permissible side wall pressure = 30 - 50 kN/m. |
| 2.04 | Cable design: How big a minimum bending radius do you expect for the cables from the OWF when entering the Energy Island? | High | See previous comment. |
| 2.05 | Cables, Submarine: Will the submarine cables be buried/trenched into the seabed? (At what depth?) | High | Yes, a Cable Burial Risk Assessment (CBRA) will be required. A target depth of at least ~1 m is expected. |
| 2.06 | Any other recommendations or suggestions? | High | - |
| 2.07 | Cable design: Will the design of the submarine cables from the OWF plant be of the same type all the way from OWF Plant to GIS switching station at the island (change to submarine to land, armoring, bending radius etc.)? | Lower | Will depend on physical conditions, installation setup and distance to cable entry point. |
| 2.08 | Cable terminations: How do you expect cables to be terminated in the GIS on the energy island? (plug-in?) | Lower | Plug-in is expected on terminations. |
| 2.09 | Cable monitoring: Will the OWF cables be monitored in any way? | Lower | Most likely by Distributed Temperature Sensing (DTS) and maybe also acoustic and vibration monitoring |
| 2.10 | Cable design: Kindly elaborate on difference (prevent water intrusion) on how armoring, lead-sheath etc. have an impact on bending radius, J-tubes etc. - comparing land-cables vs submarine-cables. | Lower | - |
| 2.11 | Cable design: What would be the thermal conductivity requirements for the cable guiding tubes? | Lower | Thermal conditions are expected to be the main challenge and a thermal analysis is required to assess/improve thermal conditions |

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| **3. Cable Entry System requirements** | | | |
| 3.01 | Distances: How big a distance between the cables do you think you need when the cables reach the scour protection and when the cables reach the front of a caisson solution?<br>Should the cable guide tubes be positioned perpendicular to a caisson solution?<br>How much free space do you need around the cable when it is placed in a guide tube? | High | Focus on functional requirements for the energy island tender rather than a specific design.<br>Guide tubes should be around 2.5 times the diameter of the three-phase cable diameter<br>A distance between 5-10 m distance between cables for 66 kV cables is expected. |
| 3.02 | Distribution: Should the cable entries at the Energy Island be evenly distributed along the perimeter of the Energy Island? | High | Not necessarily evenly distributed, but depends on the cable management plan and Energy Island size. |
| 3.03 | Seabed interface: What is the best practice to bring the cable from the seabed to the island perimeter, assuming that around the entire perimeter, an area will be covered with scour protection? The cables need to cross this area. Which technical solution is preferred and seen as best practice taking into account not only installation, but also O&M? How does this technical solution look like and what are the main elements to be used? | High | Focus on functional requirements for the energy island tender rather than a specific design.In case of utilizing scour protection, preinstalled guide tubes under the scour protection would most likely be the best solution. However, applying protection to the cable on top of the scour protection using for example bend restrictors coupled with rock berms or horizontal direct drilling (HDD) should be assessed. |
| 3.04 | Spares: Do you require spare cable entry places, e.g. J-tubes, to replace cables? How many? | High | Will depend on cable entry system. |
| 3.05 | Any other recommendations or suggestions? | High | - |
| 3.06 | Seabed interface and guide tubes: How do you assume cables can be placed through the scour protection that will have to be placed in front of a caisson solution? | Lower | Focus on functional requirements for the energy island tender rather than a specific design.<br>Depends on Energy Island design |

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| | What would be the minimum thickness, the inner and outer diameter of a guide tube enabling the cable to cross the scour protection area (guide tube installed underneath the scour protection) and to deal with the impact of the installation of the scour protection and potential corrosion of the guide tubes during its lifetime?<br>Do you think that a charnier solution in the cable tube close to the front of the caisson will be necessary (risk of differential settlements etc.)?<br>Do you think that the cable guide tubes will have to be protected with some kind of mattresses in order not to get in direct contact with armor stones on top of the scour protection? Do you believe that cable guide tubes should be coated on the inner side in order to minimize friction forces when cables are being pulled in/out? | | |
| 3.07 | Responsibilities related to guide tubes: For a caisson solution, the erosion protection in front of the caisson will have to be placed as soon as possible when the caisson has been put in place in order to prevent scour in front/below the caisson due to wave action. Do you believe that the laying of armor stones in the scour protection should wait until the cable guide tubes have been put in place? Do you believe that you will have to excavate a trench through the scour protection for the cable tubes at a later stage when the cable pull in is planned to take place? Do you believe that a temporary mattress will have to be placed at the foot of the scour protection in order not to damage a guide tube that has already been installed in the erosion protection when cables are going to be | Lower | Focus on functional requirements for the energy island tender rather than a specific design.Depends on Energy Island design |

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| | pulled in? Who do you believe should be responsible for the functionality of the scour protection if a trench is excavated through the scour protection for installation of a cable guide tube? | | |
| **4. Cable installation design** | | | |
| 4.01 | Cable routes: If a caisson solution is chosen as perimeter structure for the Energy Island, would you then prefer to have the cable routes in guide tubes through the caisson and into the Island, cables routes in guide tubes below the caissons and into the Island, cable routes in guide tubes on the outside of the caisson mounted to the vertical concrete wall? Or another system? | High | Focus on functional requirements for the energy island tender rather than a specific design. Depends on Energy Island design |
| 4.02 | Pull-in/Pull-out system: How do you assume a pull-in system could be arranged on a caisson solution for cables? How do you assume a pull-in system could be arranged in case of an artificial Island made with stone/concrete block protection? How do you believe a pull out system for replacement of cables could be arranged through previously installed cable guide tubes? How big a pulling force do you think will be necessary? | High | Focus on functional requirements for the energy island tender rather than a specific design. Depends on Energy Island design - for pulling in of cables preinstalled pull wires in guide tubes are expected. |
| 4.03 | Settlements: Which kind of solution is possible to deal with the differential settlements between the island perimeter (e.g. caisson) and the surrounding seabed? | High | Focus on functional requirements for the energy island tender rather than a specific design. Depends on Energy Island design and cable entry system. Limited settlements are expected. |
| 4.04 | Cable crossings: What cable-crossing methodology is envisaged? How is future cable repairs envisaged? | High | Focus on functional requirements for the energy island tender rather than a specific design. Number of cable crossings should be minimized |
| 4.05 | Any other recommendations or suggestions? | High | - |

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| 4.06 | Cable Installation proximity: How close to a caisson solution do you believe you will have to operate with a cable installation vessel?<br>Are you able to work safely close to the scour protection and how close can you come? | Lower | Should be provided by the cable installation contractor during the design phase. |
| 4.07 | Cable Protection: Which kind of protection (e.g. mattresses) will be needed? | Lower | Should be provided by the cable manufacturer during the design phase. |
| 4.08 | Responsibilities: Who do you assume should be responsible for laying of cable tubes for cables from OWF to the Energy Island - the Energy Island Contractor? The OWF developer? | Lower | The Energy Island Contractor will be responsible for enabling cost-effective and reliable passing of the perimeter structure with cable guide tubes. |
| **5. Structural interface and construction** | | | |
| 5.01 | Access: Which is the expected availability for access on the island during installation and during the O&M period, expressed in % of time during the month/year (e.g. 95% of the time)?<br>Which are the expected conditions for accessing to the island, expressed in allowable Hs, Tp, and wind speed for safe access? | High | Will depend on season and weather variations and conditions.<br>Service accessibility is expected to be similar to what you see on offshore substations meaning access depends on seasonal variations in visibility and wind and wave conditions. Helipad access will be very weather independent and for larger services good weather days are expected to be used. |
| 5.02 | Manning: How many workers do you believe you need to be working on the Island during the construction and installation phases? And do you believe that the workers should be staying on a - "hotel" jack up or - on a "hotel" ship or- on the Energy Island - or a combination? Other solutions? | High | Cannot be specified at this point. The construction and commissioning team can optional be working from a hotel vessel or from facilities on land. |
| 5.03 | Marine environment: Do you think that the marine environment will be a problem for the electrical equipment placed on the Island (overtopping etc.)?<br>And if so how do you assume that you will be able to mitigate this problem? - | High | The electrical equipment should be protected from the environment. |

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| | Should the equipment at the lay-down area and the permanent position be raised above the ground? And do you need the equipment to be protected from rain, overtopping etc.? | | |
| 5.04 | Port: Do you need a port at the Energy Island in order to install and construct the electrical facilities on the Island for the transmission system/OWF system? And if needed, what kind of vessels do you believe will be necessary - free floating vessel, jack ups etc.? | High | Port facilities/sheltered key side is expected. It is expected that these facilities can be a shared access and that the requirements will be within the envelope required by the TSO. Heavy load transport vessels, semisubmersibles, barge, Ro-Ro cargo and sheerleg's area the expected type of vessels. |
| 5.05 | Transport: How do you expect to transport the equipment that you intend to install on the Island (SPMT's, mobile crane etc.) | High | Will depend on size of modules. For larger modules SPMTs (Multi-wheelers) will most likely be used. |
| 5.06 | Vessels: How big a ship do you assume that you need for loading/unloading electrical equipment to the Island? Will a "good weather" quay for larger ships be a possibility?<br>And if so how often do you believe that you will have to use this quay during the execution phase?<br>How large weather windows for such an operation do you need? And what will be the maximum wave height that you can tolerate for this operation?<br>* A "good weather" quay is assumed to be placed on the eastern side of the Energy Island - without any protection/shelter effect besides the extension of the Energy Island | High | A sheltered key side/a good weather quay is considered feasible/sufficient during the summer season. The quay side should be able to handle a North Sea barge with a length above 120 m |
| 5.07 | Laydown areas: How large is the expected minimum required laydown area during installation and commissioning. | High | Up to 10.000 m2 might be required, but the size depends on the level of modularization. |
| 5.08 | Weights: How big (heavy) electrical items do you think you will have to | High | Expected to be based on modular design either craned or rolled into place. |

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| | transport on the Island and how do you assume you will get the equipment unloaded to the Energy Island? Unloading/loading with a crane - Ro-Ro operation - other? Area needed for temporary storage at the Island? | | Up to 3000 tonnes in case of prefabricated modules<br>Up to 500 tonnes for largest individual replacement components.<br>Expect Ro-Ro operation and SPMT (multi-wheelers). |
| 5.09 | Any other recommendations or suggestions? | High | - |
| 5.10 | Vibrations: Do you have a vibration limit ("m/s2" and/or "mm/s") for electrical equipment placed on the Island / the perimeter structure? | High | It is expected that vibrations will be lower compared to components on an offshore structure and therefore it is not expected to be design driving. Vibration limits potentially during transport and installation |
| **6. Environmental Impact Assessment** | | | |
| 6.01 | EIA timing: The OWF EIA will be completed after the EIA for the Energy Island / Electrical infrastructure. Does this timing pose any challenges for the development of the OWF layout or the design of the OWF equipment required on the island? | High | The timing of the OWF EIA and the EIA for the Energy Island is not necessarily important, if it is ensured that the necessary technical details concerning the actual project are aligned |
| 6.02 | Any other recommendations or suggestions? | High | - |
| 6.03 | Ecosystem: How will you assure net positive impact on the epifauna and marine ecosystem of the accumulated effect of the island and the OWF? Which nature enhancing components are you able to integrate in the design and operations of the OWF? | Lower | Will depend on Energy Island design. |
| **7. OWF Areas and Layout** | | | |
| 7.01 | Footprint and height: Estimated OWF substation footprint and height of <u>all</u> buildings and area needed on the island (cable pulling area, GIS, control-building etc.) - See also Q 1.01. | High | The OWF 1 GW substation footprint is estimated to be at least ~2.000 m2 in case filters are required. Space for cable routing should be assured. |

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| 7.02 | Safety: How will you protect the OWF equipment against fire? Would you assume a specific distance between OWF electrical equipment modules? | High | Adequate measures will be taken to protect against fire damage. |
| 7.03 | Any other recommendations or suggestions? | High | - |
| 7.04 | Configuration: How do you estimate the array cables to be configured in the wind farm (radial, branched, closed loop)? | Lower | Both radial and branched should be expected. |
| 7.05 | Layout: Given the marine traffic and marine archaeology in the area, does this have any significant effect in the wind farm layout? | Lower | Windfarm layouts should be built outside the shipping lanes. |
| 7.06 | Layout: Given the scenario that sand for the Energy Island will be extracted from the offshore windfarm sites in the vicinity to the Energy Island, does this have any effect on the development of the layout of the offshore wind farms? | Lower | It is not expected that sand extraction has a significant effect on the development of the OWF layout. However, It is perceived beneficial to review the dredging plans, e.g. to ensure retainment of cable route corridors and minimize spatial impacts.<br>It is recommended to keep the dredging outside the areas for the phase 1 projects allowing the seabed level to settle before the windfarms are built in these areas |
| **8. Operation & Maintenance** | | | |
| 8.01 | Access: Which access will the offshore wind farm developers need when conducting O&M of transformers and associated equipment? | High | The logistic setup will have to be developed. |
| 8.02 | Manning: Expected personnel on Island during maintenance campaigns (no permanent staff expected) | High | The logistic setup will have to be developed. |
| 8.03 | O&M rooms: Do you expect to have operation & control rooms on the artificial island?<br>And if so, what are the assumed footprint of such rooms? | High | The logistic setup will have to be developed. |

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| 8.04 | Facilities: Which facilities will the off-shore wind farm developers require on the island to operate and maintain trans-formers and associated equipment? | High | GIS room and warehouse facilities. |
| 8.05 | Planning: Will maintenance activities be performed on a daily basis? Or do you plan to run extended maintenance cam-paigns requiring the maintenance team to dwell/live on the island for multiple days? | High | Will be limited as much as possible. |
| 8.06 | Services: Which services will you require from the Energy Island Operator to maintain OWF transformers and other equipment on the island? | High | Crane facilities in the harbor that can handle mi-nor lifts and small containers |
| 8.07 | Transportation: What will be your pri-mary means of transportation to and from the island? | High | Vessels and helicopter |
| 8.08 | Utilities: What kind of utilities would you need to use during maintenance activi-ties?<br>If so, is there any particular requirement the Energy Island Operator should be aware of? | High | No special requirements from Energy Island Op-erator |
| 8.09 | Any other recommendations or sugges-tions? | High | - |
| 8.10 | Contractors: Will you require assis-tance in performing O&M activities from external contractors? | Lower | Yes |
| 8.11 | Waste: Would you handle waste (e.g. cooling oil for transformers, substituted parts, any other component) from maintenance operations? Would you need waste management service from the Energy Island Operator? | Lower | Yes, waste management service is needed from the Energy Island Operator.Alternatively OWFs would handle it themselves. |
| 8.12 | Services: Will you need the Energy Island Operator staff to conduct tasks on your | Lower | No staff expected. |

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| | behalf, e.g. routine inspections or rounds? | | |
| **9. Other** | | | |
| 9.01 | Construction time schedule: When and what activities are foreseen for the equipment delivery on island, installation, testing and commissioning? | High | For a modular approach the construction time could be done within one summer season |
| 9.02 | Readiness on Island for installation: What are the main pre-requisite for start the installation activities on the Island (i.e. power, utilities etc.)? | High | The island needs to be safe and work has to be safe to conduct.<br>The island has to be completed to a level where Energinet can execute their work so the wind developer can interact with Energinet´s system.<br>Main utility systems should be operational and a good weather quay operational. |
| 9.03 | Duration: What is the expected installation time for 1 GW equipment | High | Expected to be realized within one summer installation period |
| 9.04 | Duration: What is the expected commissioning time for 1GW (on Island) | High | Completed within 6-12 months. |
| 9.05 | Duration: What is the expected de-commissioning time for OWF related electrical equipment (on island)? | High | Decommissioned within 3-12 months. |
| 9.06 | Any other recommendations or suggestions? | High | Focus on functional requirements for the energy island tender. |