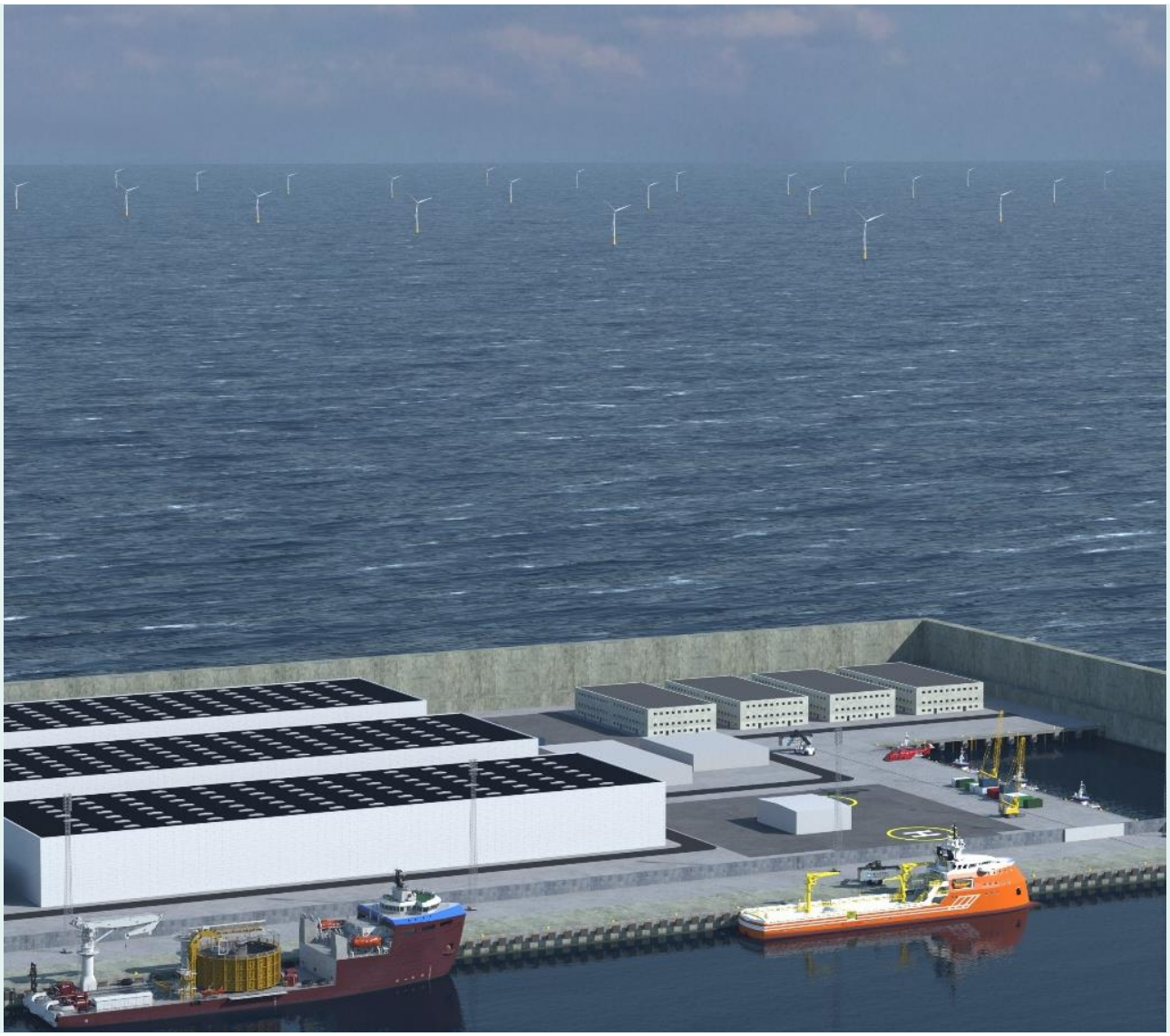

Energy Island North Sea

Scope Report – Underwater Noise

Energinet

Date: 1. December 2021

Contents

1 Project introduction and background

With the Climate Agreement for Energy and Industry of the 22nd of June 2020, the majority of the Danish Parliament decided that Denmark will become the first country in the world to develop two energy islands. One of the islands will be located in the North Sea ("Energioe Nordsoen") with a capacity of 3 GW offshore wind surrounding the island. This island can be further scaled up to allow for grid connection of up to 10 GW offshore wind on the island. It is expected that Energioe Nordsoen will be in full operation by 2033.

The Danish Energy Agency (DEA) has initiated the Strategical Environmental Assessment (SEA) and associated technical reports for all relevant fields. This note includes a detailed description for the scope of works for underwater noise in relation to construction of the Energioe Nordsoen.

This report includes a detailed description of the baseline underwater noise investigations and of underwater sound propagation modelling for the installation of the energy island and wind turbine foundations, as well as assessing the underwater noise during operation of the wind farm.

2 Baseline Underwater Noise in Investigation Area

Underwater noise measurements using two Soundtrap ST600 (OceanInstruments, New Zealand) will be undertaken, to provide baseline information on the underwater soundscape (biological underwater noise as well as abiotic underwater noise from e.g ship traffic) in the investigation area before construction work is initiated. The Soundtraps can obtain continuous recordings of underwater noise up to 20 kHz for extended periods of time, or higher frequencies for shorter periods, thereby also providing information about the baseline underwater noise level in the wind farm areas, as well as provide invaluable information on sound propagation loss in the area. The two sound traps will be deployed together with the PAM stations from the marine mammal field work and detailed information on equipment, deployment and service is provided in the scoping report for marine mammals, work package F.

3 Underwater Noise during Installation Phase

Modelling of underwater noise from offshore wind turbine foundation installation through pile-driving or vibration, related to the establishment of Energioe Nordsoen offshore wind farm as well as piledriving or vibration related to the establishment of the Energy Island will be conducted. The underwater noise modelling will follow the newest scientific knowledge and the recommendations by Southall et al. 2019 and the guideline for assessing the effects of anthropogenic sounds on marine mammal hearing developed by NOAA (National Marine Fisheries Service) in 2018, as outlined in the background note to the DEA (Tougaard, 2021). The DEA is currently updating the existing danish guidelines for underwater noise emission from pile driving, and it is expected that the updated guideline will be based on the newest scientific knowledge as listed above. In particular, it is expected that the revised guidelines will include frequency weighting of the pile driving noise, taking the hearing abilities of the different marine mammal species into account in modeling of impact ranges.

A 3D environmental sound propagation model using the underwater noise modelling tool "dBsea" (developed by Marshall Day Acoustics, newest available version at project start date will be used) will be created. "dBsea" is a state-of-

the-art underwater sound propagation and noise modelling program. It is ideal for investigations of underwater acoustic issues involving single or multiple sources using solvers covering a wide frequency range and in a variety of environments, including shallow water environments.

Extensive modelling of the underwater sound propagation of the noise related to pile driving will be conducted for the three agreed scenarios, where one scenario refers to installation of a specific pile size at a specific time of year, for up to three locations for each of the three offshore wind farms. If any pile driving/vibration activities are required for the construction of the Energy Island, two additional foundation scenarios are also included. If the construction includes any other significant noise sources, those will be included in the model to the possible and relevant extent. The model will be qualified using any obtained data during sound recordings described in section 2. The input parameters for the sound propagation modelling will be based on best available knowledge, however it is recognized that final installation specific details will not be available until later procurement process. The input parameters used must therefore be conservative where necessary. The following input parameters will be provided by Energinet, and will feed into the underwater noise modeling:

- Design assumptions, including layout, specification of possible pile types, sizes of piles, maximum hammer energy (kJ) and pile driving scenario (frequency of strikes) along with specification of hammer type (impact driver/vibratory hammer).
- Specifications of intended equipment types, work schedule (time and location) for construction activities for the energy island.
- Layout of the park – locations for the pile installations.
- Time schedule for installation (which months to be considered for modelling).
- Choice of noise abatement technology and other mitigation measures.

In addition to the information provided by Energinet, NIRAS/DCE will obtain the following underwater noise modelling-relevant information from available literature and other sources:

- Realistic underwater source spectrum and level for the foundation installation based on best available data.
- Sediment composition for the relevant area.
- Bathymetry for the relevant area.

Sound speed profiles (temperature and salinity) for the relevant area for the months/seasons Energinet specifies for modelling.

The calculations will by default include an evaluation of the most suitable source mitigation, by examining existing data on noise abatement systems, and comparing the effect thereof with the assessed impact on the marine mammals and fish. Impact ranges will be assessed in no less than 180 directions from each source location and scenario, and direction specific impact ranges will be documented. Estimates of ranges that will induce either behavioral responses, temporary (TTS) or permanent (PTS) hearing loss in marine mammals will be calculated in accordance with Danish Energy Agency's guidelines for underwater noise – installation of impact-driven piles, in the newest available version at the time of calculations. It is expected that impact ranges for the following marine mammal species are calculated:

- Harbour porpoise
- Minke whales
- White beaked dolphins
- Seals (harbour and grey seals)

Unlike for marine mammals, there are at present no Danish guidelines for assessment of disturbance, injury or hearing impairment of fish, fish eggs and fish larvae and little international consensus on these issues. In general, studies in this field of the few studies that address how different fish species are affected by underwater noise lack both in quantity as well as quality. Despite this gap in the current knowledge, we will use the best available guidelines developed by Popper et al. 2014 (Sound exposure guidelines for fish and sea turtles. ASA S3/SC1.4 TR-2014. Springer and ASA Press, Cham, Switzerland) and Anderson et al. 2017 (A framework for regulating underwater noise during pile driving. A technical Vindval report, ISBN 978-91-620-6775-5, Swedish Environmental Protection Agency, Stockholm, Sweden) to estimate ranges that will induce either temporary hearing loss (TTS) or internal/fatal injury in fish, fish eggs and larvae. The guideline developed by Anderson et al. 2017 build on Popper et. 2104, however the guideline is focused on fish species found in Scandinavian waters e.g. cod and herring. Both species play an important role in the marine ecosystem as well as an important role for the commercial fishery.

4 Underwater Noise during Operation Phase

The underwater soundscape during operation phase, as a result of turbine noise and service vessels, will be briefly assessed based on available literature on the topic.

5 Technical report

The technical report on underwater noise will follow the guidelines of the Danish Energy Agency, and will comprise the following information:

- A thorough method description including a description of all relevant model assumptions.
- A detailed description of project assumptions (specification of materials, hammer energy, frequency of strikes and other relevant parameters). Also contains descriptions, where relevant, of underwater noise resulting from construction of the energy island.
- Records of underwater noise calculations for included scenarios.
- Description and analysis of baseline soundscape based on available existing information and on the results of the underwater noise recordings from Soundtraps.
- Assessment of underwater noise from pile-driving for each included scenario, including at least: spectrum of transmitted sound, noise source strength, sound propagation loss, 'noise maps' showing spatial variation of single strike SEL and cumulative SEL, with appropriate and required frequency weightings and noise abatement systems. Cumulative SEL metrics will include fleeing behaviour of marine mammals and fish where applicable.
- Comparison of results with thresholds for marine mammals (harbour porpoise, minke whales, white beaked dolphins harbour seals and grey seals) and fish (e.g. cod and herring). Estimates of potential impact ranges and impacted areas for marine mammals and fish.
- Proposals for measures to mitigate adverse impacts of underwater noise on marine mammals and fish, as appropriate, including estimated effects on the frequency spectrum of the radiated noise.
- Brief assessment of underwater noise during operation phase based on available literature.
  Identification of possible data and knowledge gaps of importance for the future environmental assessment to be conducted by the future concession holder.