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# Neart na Gaoithe — Seabird Interactions Study



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This document presents a **summary** of the two-year **Seabird Monitoring Study** at the Neart na Gaoithe (NnG) wind farm, planned to commence in March 2026.



# STRIX

Rua Sousa Aroso, 556 - 4º DTº - Trás  
4450-287 Matosinhos – Portugal  
Tel: (+351) 220 120 828 • Fax: (+351) 220 165 424

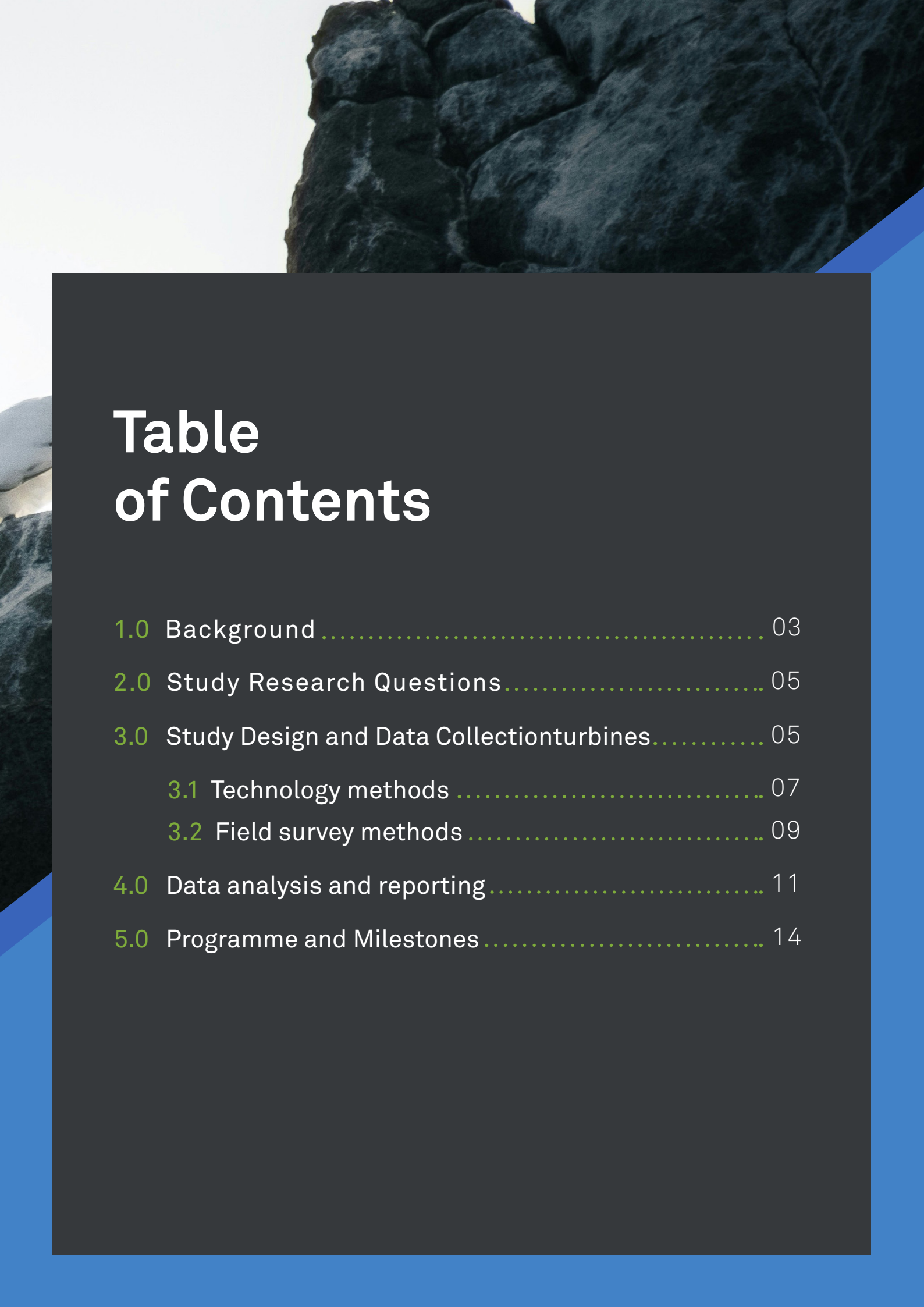
[info@strixinternational.com](mailto:info@strixinternational.com)  
[www.strixinternational.com](http://www.strixinternational.com)

**NnG** OFFSHORE  
WIND



EDF Renewables, United Kingdom, Atria One, 144  
Morrison Street, Edinburgh, EH3 8EX.  
Tel: 0131 376 0900

[info@nngoffshorewind.com](mailto:info@nngoffshorewind.com)



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# 1.0 Background

Neart na Gaoithe (hereafter referred to as 'NnG'), is an offshore wind farm located in the outer Firth of Forth, with a maximum generating capacity of

450 megawatts (MW) (Figure 1). The overall objective of the proposed development is to generate renewable electricity to feed into the Scottish national

grid, to reduce reliance on fossil fuels, thereby reducing future levels of atmospheric CO<sub>2</sub> and other greenhouse gases.

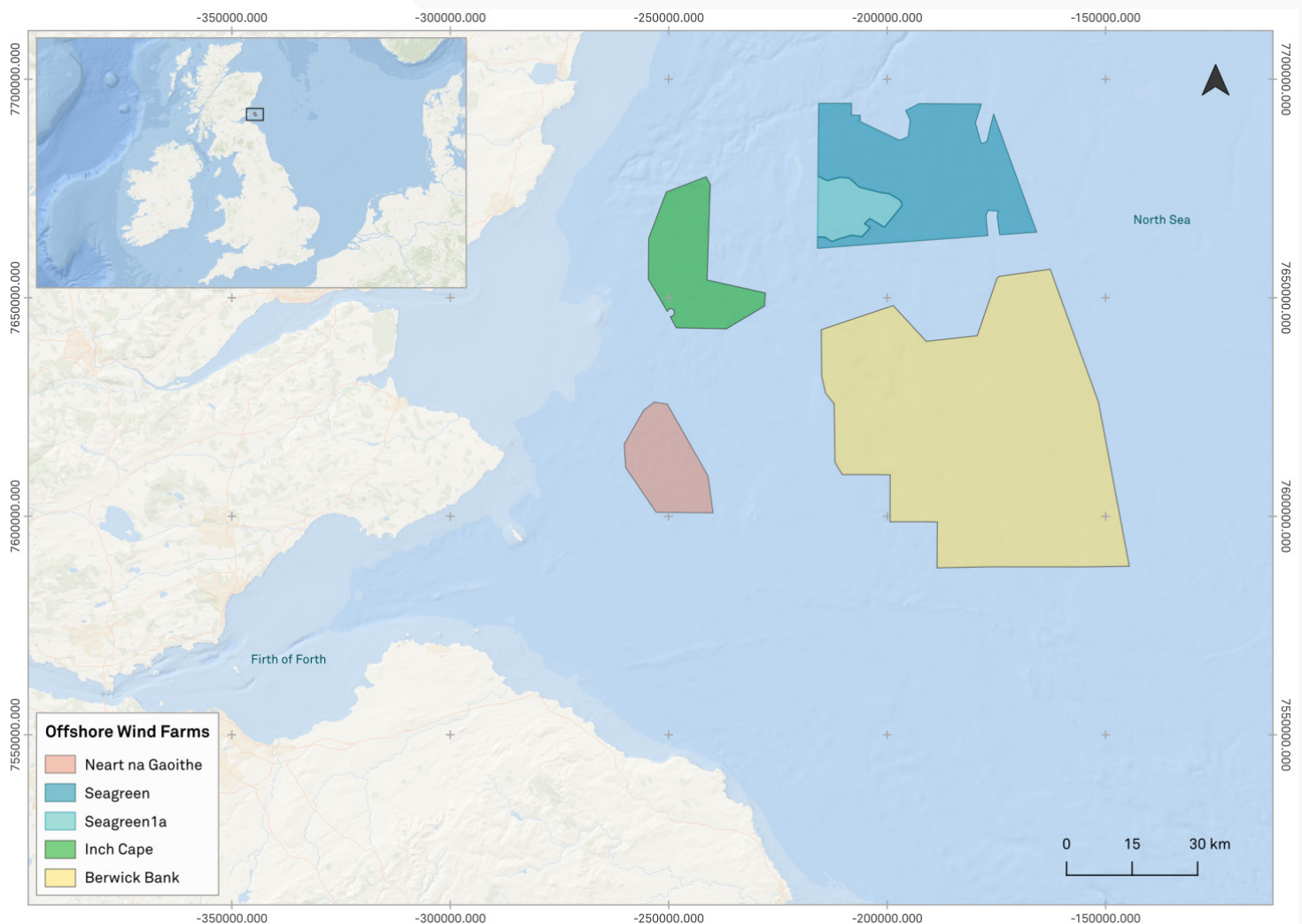


**Figure 1 – Limits and geographical location of the Forth and Tay offshore wind farms**

Consents were granted for the NnG, Seagreen and Inch Cape offshore wind farms (OWFs) in the Forth and Tay region in October 2014. Consent was also granted to a fourth OWF (Berwick Bank) in 2025.

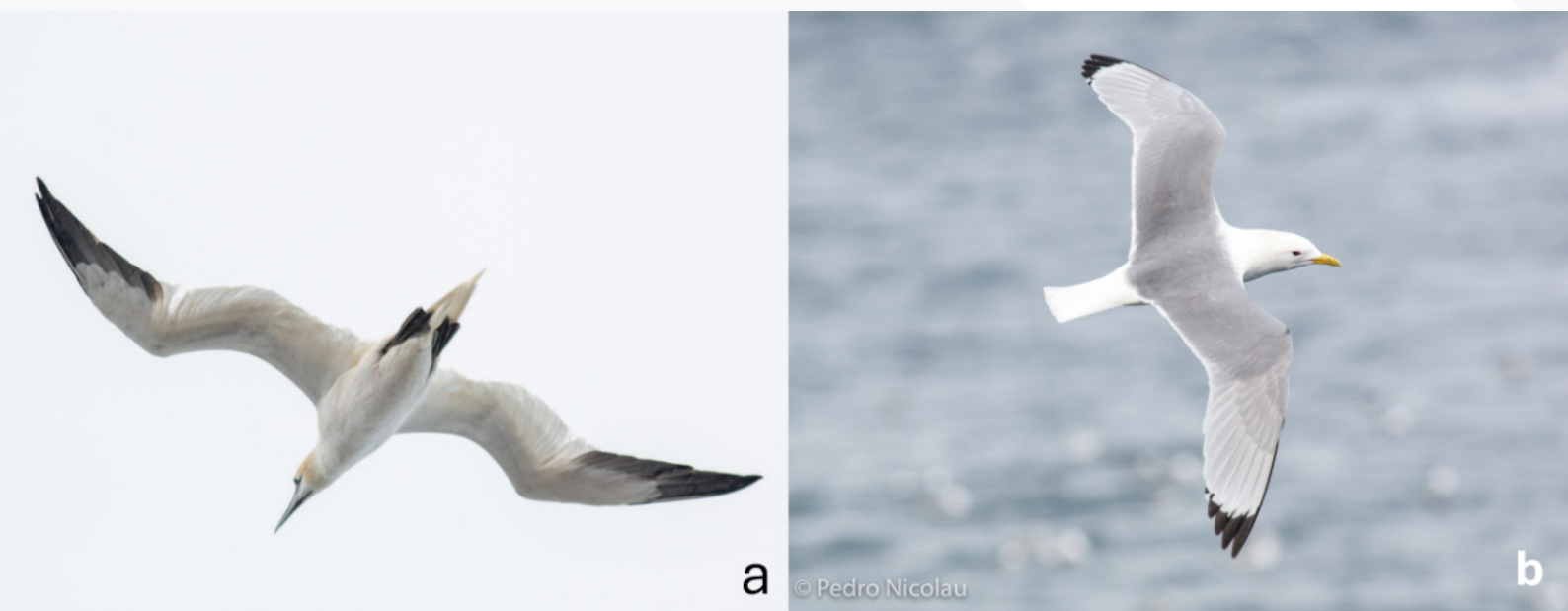
The approved PEMP for two of the Forth and Tay OWFs, NnG and Seagreen Alpha and Bravo (Seagreen 1) focus on the main potential impacts and/or key uncertainties associated with the consented Forth and Tay OWFs as identified in their respective Environmental Impact Assessments (EIAs).



Seabirds were identified as a focus of the PEMP and in a wider context represent a key consenting risk for OWFs. The main negative impacts of these projects on seabirds are potential collision with the wind turbines, displacement and barrier effects. This Study forms part of the NnG and Seagreen

ornithological monitoring programme as set out in the project PEMP and focusses on collision and avoidance behaviour of key seabird species around operational turbines during the breeding season. Additional studies focusing on displacement and barrier and population effects are

being undertaken separately. This study will focus on two key species of interest for the Forth and Tay OWFs: Northern gannet *Morus bassanus* and black-legged kittiwake *Rissa tridactyla* (hereafter gannet and kittiwake) and aims to address key uncertainties in relation to collision risk (Figure 2).



▲  
**Figure 2 – The two key species monitored:**  
**a - Northern gannet and**  
**b - Black-legged kittiwake.**

It is very important to quantify the factors and the mechanisms underlying the risk of seabird collision with wind turbines. This study will record seabird interactions with an operating OWF at multiple scales. In addition to meeting monitoring obligations and validating predicted impacts for the two

OWFs in question, the Study will help to inform the development of future offshore wind projects in assessing potential collision impacts on seabird populations. Infrastructure associated with this Study has been installed on the NnG OWF and is jointly funded by the NnG, Seagreen 1 and Berwick Bank projects.

## 2.0 Study Research Questions

The Study will address the following relevant questions raised both by the members of the Forth and Tay Regional Advisory Group Ornithology sub-group (FTRAG-O) and the Study Advisory Panel. The research questions are as follows:

- 1 Does collision occur and are there empirical methods to record seabird collisions at OWFs?
- 2 What are the collision rates?
- 3 What are the reactive behaviours of seabirds around turbines?
- 4 How can we accurately record reactive seabird behaviour close to operational offshore wind turbines?
- 5 At what distance does any behaviour change such as avoidance or reactive behaviour occur and is this the same for each focus species?
- 6 How can that information be used to understand collision risk to seabirds at OWFs?
- 7 How do weather conditions and time of day affect avoidance or reactive behaviour?
- 8 Does behaviour change within and between seasons?

## 3.0 Study Design and Data Collection

The methodology for this study was developed collaboratively and agreed upon with key stakeholders through the FTRAG-O, ensuring alignment with best practices and project objectives. It will rely primarily on advanced technology, complemented by targeted sampling periods conducted by field ornithologists at sea.

**Two main types of data will be collected: (1) information on bird collisions and (2) data on flight activity, patterns, and behavioral responses of birds within and around NnG OWF.** Data acquisition will be continuous (24/7), using a combination of sensor systems—including radars and cameras—installed on turbines. These systems will automatically extract, process, and store relevant information (*Figure 3*).

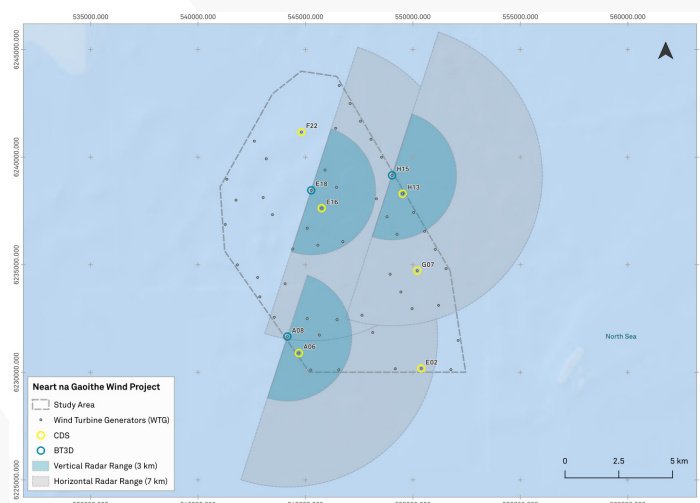


**Figure 3 –  
Layout of the Bird  
Monitoring System  
in NnG OWF.**



The positioning of the sensor systems on turbines has been strategically planned to ensure spatial coverage of key sectors—such as corners, peripheries, and interior turbine clusters—where variations in seabird movement patterns, wind exposure, and collision risk (e.g. corner effects, headwinds, tailwinds) are expected to be most pronounced.

Periodic visual surveys by expert ornithologists will also be conducted to validate and calibrate the automated data and to gather complementary insights, such as species identification and flight height distributions of key seabird species.

# 3.1 Technology methods

## Birdtrack-Radar3D (BT3D)

The main purposes of the BT3D system are the detection, tracking and classification of birds at medium to long range (0.6-5.0 km), combining both radars and cameras. The radar component is comprised by a horizontal radar (primary radar) and a vertical radar (secondary radar) (Figure 4). When birds are detected by the primary radar, the secondary radar is automatically orientated

to detect the same birds. An algorithm matches targets from secondary to primary radar, obtaining 3D data for these targets.

The cameras used in BT3D have powerful magnification and resolution, and because of near infrared sensitivity and powerful illuminators, can detect and track 24h/7d.

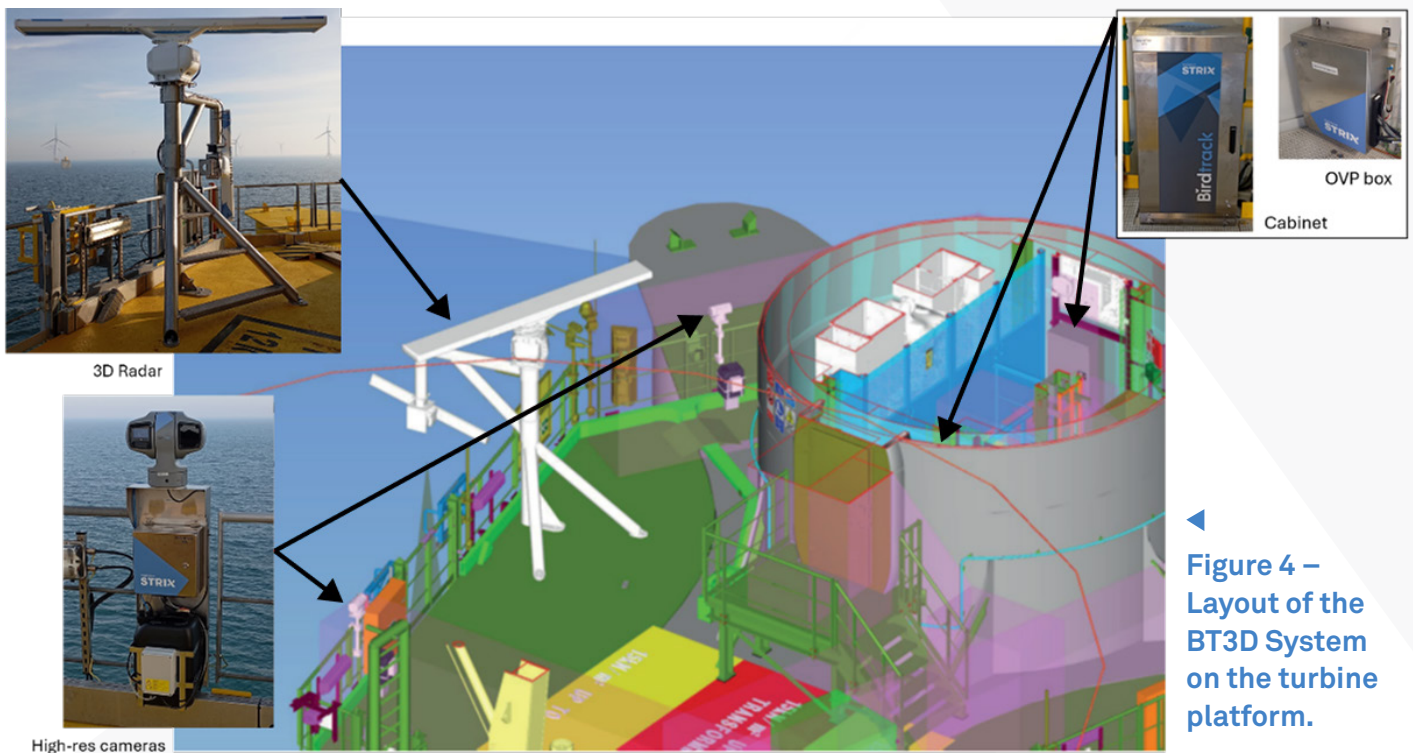
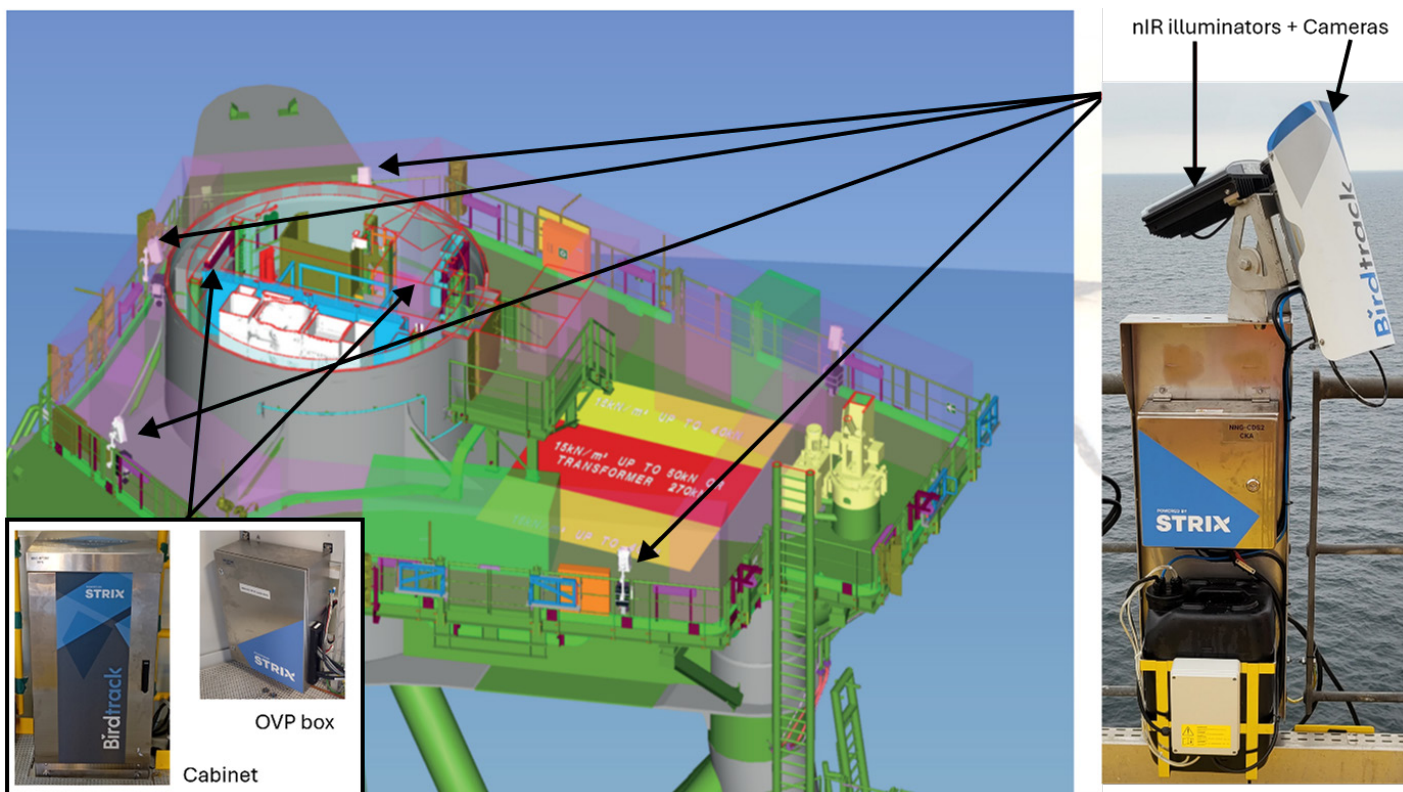


Figure 4 –  
Layout of the  
BT3D System  
on the turbine  
platform.



▲  
**Figure 5 – Layout  
of the CDS System  
on the turbine  
platform.**

### Collision Detection System (CDS)

The CDS is a video solution, designed to work 24h/7d in offshore environments.

Multiple cameras and near infra-red illuminators are used around the wind turbine tower pointing upwards, to observe area around the rotating blades and an additional buffer of 10 metres (Figure 5). The system uses computer vision algorithms to detect birds in the frames. When a bird is detected in the observed area, a video snippet is created, stored and labelled, so that it can be later evaluated regarding the occurrence of a collision or near collision event, as well as inform on micro-avoidance behaviour. These video snippets contain a few seconds before detection as well as a few seconds after bird detection stopped.

**For the Collision Detection System, the main components are as follows:**

- 5 units of AxisQ1647 5MPixel Camera
- Cabinet with Servers, Storage and Communication IT



## 3.2

# Field survey methods

### Assessment of bird collisions and micro-avoidance behaviour

Six CDS have been installed on turbines in the NnG OWF (Figure 3). After commissioning, all the CDS will be operating and continuously recording data 24h/7d throughout the whole 2-year duration of the study. However, for this project, only data collected in the breeding season (March to October inclusive) and during daylight hours will be analysed. Video snippets recorded by the CDS will be scrutinized by expert ornithologists in an office environment. As well as identifying species present in the snippets, the ornithologists will catalogue and produce annotations describing the observed collisions, crossings or other type of behaviours visible, specifically micro-avoidance behaviour. A snippet inspection protocol will be established to reduce errors, bias and cross-check variations.

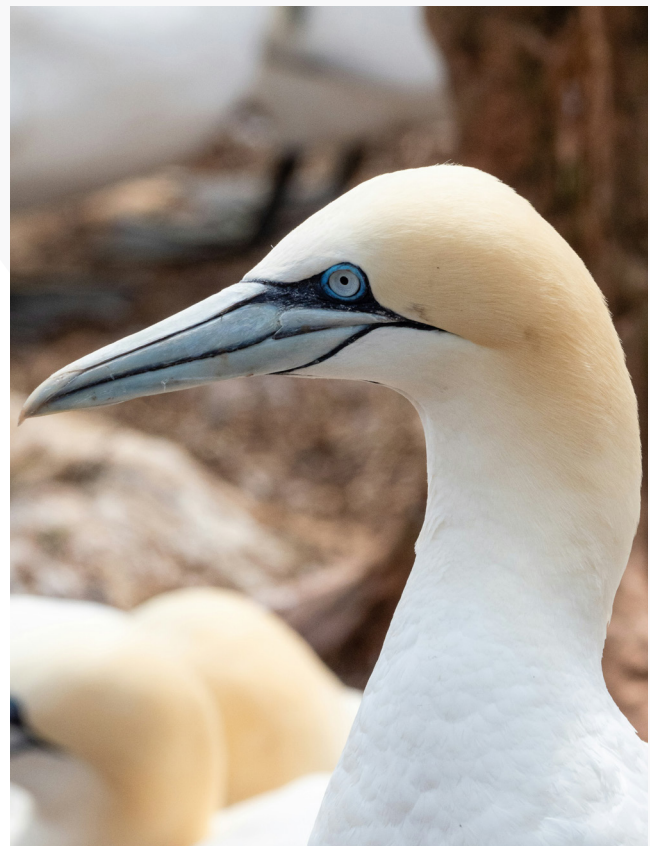
Weather data will be collected from local weather stations. Visibility data will be obtained regularly in the OWF using the cameras in BT3D systems and objects at known distance from the turbines.

During the periods of sampling visual campaigns, observers' teams will be located on two or three vessels at the proximity of some of the turbine platforms with the installed CDS. These observers will also record and catalogue any event (collision or crossing) involving birds at the proximity of the turbine tower or swept area.

BT3D systems installed will also cover in their range one to two turbines where CDS will have been installed and will also be able to detect collisions or swept area crossings as they will be programmed to direct and zoom their long-distance high-resolution cameras to any bird target approaching the proximity of a turbine. In the case of simultaneous multiple targets in that situation priority will be given to targets approaching a turbine without a CDS.

### Assessment of bird fluxes

The Study will encompass both technological and visual data collection to inform on three-dimensional flight behaviour and on fluxes of seabirds at different distance scales from turbines.



The BT3D solution combines both radars and cameras, with the main purposes of detecting, tracking and classifying birds at medium to long range. The radar component comprises a horizontal radar (primary radar) and a vertical radar (secondary radar), while the video component includes two high-resolution cameras. STRIX in-house developed software BT, will process and combine raw radar data to filter clutter from relevant echoes, tracking the birds frame after frame, to obtain georeferenced positions of each bird path and associated video samples.



A total of three BT3D systems have been installed in turbines A08, H15 and E18 in the NnG OWF. The BT3D systems will be operating and continuously recording data 24/7 throughout the whole 2-year duration of the Study, with data collected during the breeding season (March to October) and during daylight hours being analysed as part of this study. For both kittiwakes and gannets, a near 100% detectability of individuals is likely to be attained at a range of up to 3 kms.

The occurrence of behavioural responses to the presence of wind turbines will be studied based on the seabird trajectories recorded by the BT3D systems distributed throughout the NnG OWF. A big proportion of these birds will be filmed by the BT3D cameras during a part of their path, enabling subsequent allocation of the movement to a given species. The resolution rendered by the systems' high-resolution cameras will allow ornithologists to identify a gannet up to 4 km distant (under very good weather and visibility conditions during daylight) and a kittiwake up to 2 km.

Behavioural responses to the presence of the entire OWF, such as macro-avoidance (active avoidance by birds of the whole OWF) are more effectively studied at a larger scale. Hence, parallel research to the present Study, such as that involving GPS-tracking of gannets and kittiwakes and digital aerial surveys in the OWF areas and a surrounding buffer area, are also being used to investigate this subject, as part of the NnG and Seagreen PEMP. BT3D are fully automated systems that will deliver 24h/7d data collection throughout the whole duration of the Study. To ensure the reliability of this information for data analysis, an intensive schedule of radar data validation and ground truthing by expert seabird observers is planned to be conducted periodically. Validation and ground truthing sessions will be conducted by teams of expert seabird observers from vessels moved purposely to the OWF for this effect. Every team will involve two observers, to ensure a higher efficiency in the planned tasks.

## 4.0

# Data analysis and reporting

Species identification will be provided by expert ornithologists, who will inspect video snippets of birds. Camera and optical specifications of the systems took into consideration the required bird size in pixels for this type of classification and also maximum recorded flight heights for the target species, which is 120 m for gannets, and 100 m for kittiwakes.

The Study will focus on processing and identifying the priority species (Gannet and Kittiwake), with imagery analysis primarily directed to both species, and only secondarily towards large gulls and other species captured on video snippets. Both species imagery and radar tracking will be scrutinized, and only after that (and if time allows) other species will be identified and subsequently analysed.

Collision rates (mortality rates): number of collisions per turbine per time unit will be computed for each species. Video snippets collected by the CDS, located on six turbines, will be examined by expert ornithologists in order to identify the species involved and also the outcome of the interaction with the turbine (collision with mortality, collision with no mortality, avoidance, non-avoidance without collision).

Since the CDS facilities will also provide records of the number of birds entering the blade swept areas, and given that collisions might be rare

events, therefore leading to estimates with limited statistical power, potential collision rate estimates (the number of birds entering the blade swept areas per turbine per time unit) will also be estimated. Monthly and annual collision rate values will be estimated. Estimates considering shorter time units will also be computed to assess the influence of environmental variables (meteorological) that act at finer temporal scales.

Avoidance dramatically alters the probability of occurrence of a collision, so an avoidance rate factor must be applied to take account of the likely degree of successful avoidance. Avoidance is species-specific and is also influenced by external factors such as wind. The concept of avoidance can be considered at three different scales:

**Macro avoidance (maA)** – birds avoid the wind farm altogether (displacement);

**Meso avoidance (meA)** – birds avoid single turbines or turbine arrays (anticipatory and impulsive evasion);

**Micro avoidance (miA)** – birds avoid turbines right before colliding (last second evasion).

The overall avoidance rate is composed of combining the avoidance rates at the three different spatial scales and will be calculated as follows:

Overall avoidance rate =  
 $1 - [(1 - \text{maA}) \times (1 - \text{meA}) \times (1 - \text{miA})]$

Data and evidence to answer the study questions: **Questions 1 and 2** will be answered mainly with collision data obtained by CDS. In question 2, the volume of bird movements on the base of the collision rate calculation will be given by the BT3D system.

**Questions 3, 4 and 5**, relative to the three types of avoidance, will get relevant data from CDS and

BT3D systems, complemented with data from validation and ground truthing by expert seabird observers on vessels.

**Questions 6, 7 and 8** will be addressed by analysing the patterns of avoidance measured against environmental factors and traits of the target species.

**Birdtrack**  
Tracking life





## 5.0 Programme and outputs

Following a long period of planning and preparation, the bird monitoring study in the NnG OWF is planned to last approximately two years, with two data collection windows between March and September 2026 and 2027. Outputs from the study will include:

- A database to provide statistically robust evidence on collision impacts for the two key target species (gannet and kittiwake) over a minimum of two complete breeding seasons.
- Two annual reports
- A final technical report, on the completion of two breeding seasons of monitoring activity, presenting the results on all aspects of the collision impact monitoring for the two key target species.
- Delivery of data collected over two full years (24/7 hrs per day) in a usable/universal format, suitable for use in further studies, such as strategic studies.
- In addition to reporting monitoring collisions and/or avoidance, in both annual and final reports, the study will provide provisional data analysis, interpretation and reporting on a monthly basis.



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