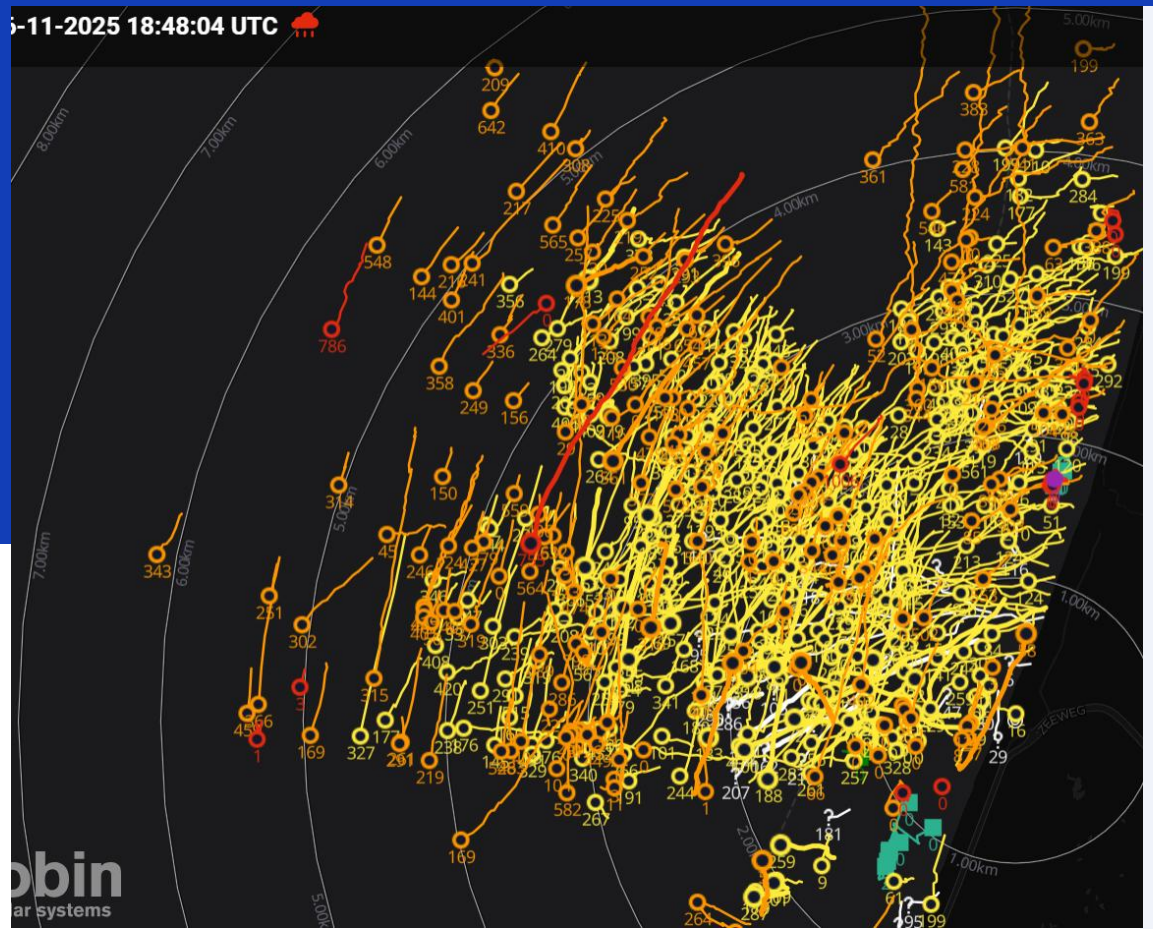
Epoch AICUP Bird Monitoring

Breuer, J.C.M. (Joep) |

TNO innovation for life

Content



- TNO
- Introduction Black Blade project
- Bird Monitoring
- Mitigation techniques
- Hints for analysis
- Who is who
- Vacancy

TNO at a glance

- TNO is an **independent, not-for-profit** research institute founded in 1932
- **T**oegepast **N**atuurwetenschappelijk **O**nderzoek → Applied Physics Research
- TNO's **mission** is to create impactful innovations for the sustainable wellbeing and prosperity of society
- Research is executed in 6 units, at 23 locations throughout the Netherlands and by ~5000 people

Energy & Materials Transition

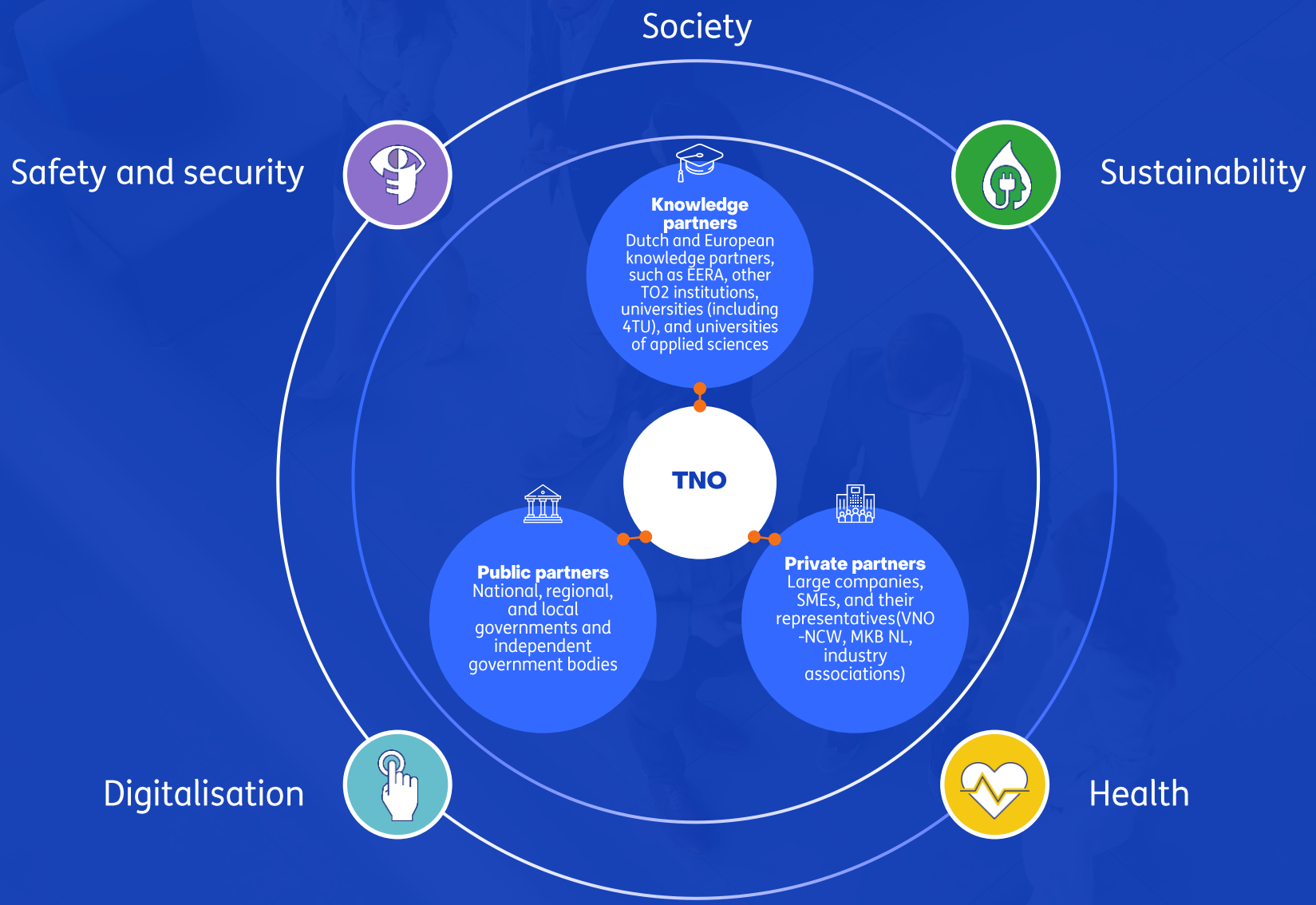
Defence, Safety & Security

Healthy Living & Work

High Tech Industry

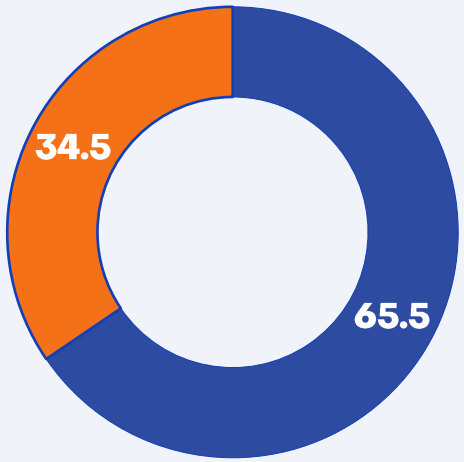
ICT, strategy & policy

Mobility & Built Environment

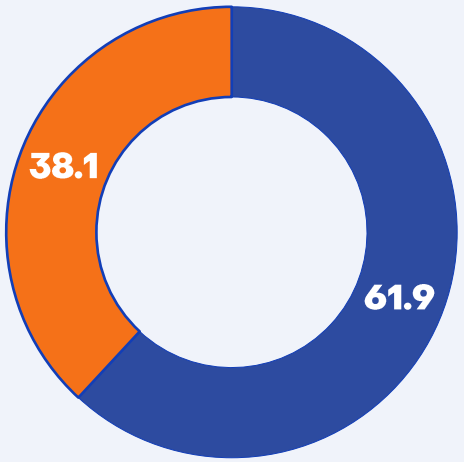

Society
Safety and security
Sustainability
Digitalisation
Health
Knowledge partners
Dutch and European knowledge partners, such as EERA, other TO2 institutions, universities (including 4TU), and universities of applied sciences
TNO
Public partners
National, regional, and local governments and independent government bodies
Private partners
Large companies, SMEs, and their representatives(VNO -NCW, MKB NL, industry associations)

Key figures for employees 2024

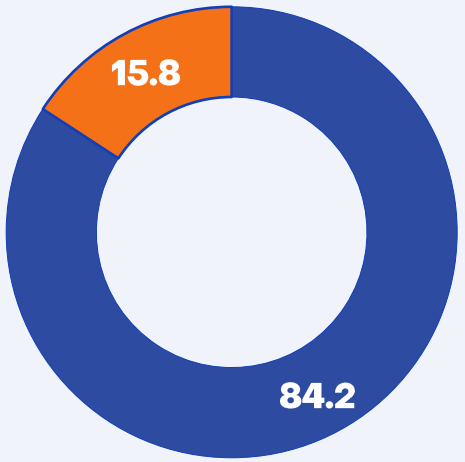
Male/female ratio.
(total) in %



Male/female ratio
top TNO in %
(SB, EB and 1st echelon)



Nationality
(67 nationalities) in %



Number of employees

4,524 Total workforce

4,316 2023

Locations & lab facilities

Some lab facilities highlighted:

- Building Innovation Lab (Delft)
- Solar Lab (Petten & Eindhoven)
- Castel milieulab (Utrecht)
- Nano Lab (Delft)
- Accelerator Mass Spectrometer (Leiden)

TNO's Wind Energy Team

2 locations: Petten & Rijswijk

55 people spread over 4 teams

36% international colleagues

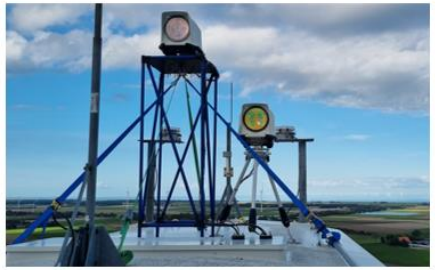
1 professor & 1 PhD student

AeroStructures

- Aerodynamic modeling
- Structural modeling
- Digital twins
- Windfarm modeling

Measurements

- Accredited measurement
- Research measurements
- Sensor innovations
- Ecological measurements

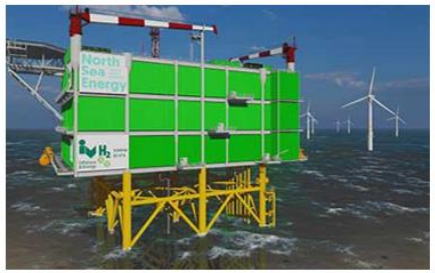


IOMD

- Logistics modeling
- Cost modeling
- Robotics / drones
- Circularity / LCA

System Integration

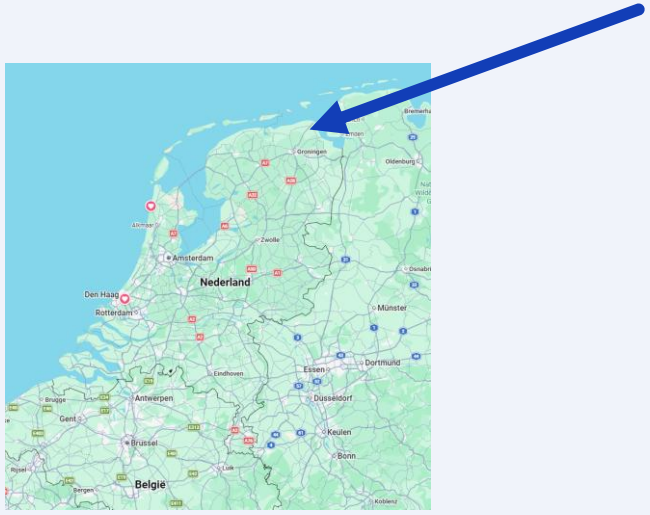
- Hybrid power plant modeling
- Market modeling
- Wind farm control
- Electrical modeling



Robin Radar Black Blade Eemshaven ZWEMT

Location

- **Wind farm**: Eemshaven
- **Turbines:**
  - Turbine 20 (black blade)
  - Turbine 21 (white blade)



Robin Radar

Robin Radar MAX

• Waardenburg	eind August 2023	-	31 Oct 2023
• TNO	1 Nov 2023	–	Dec 2024

13-09-2024 08:00:33 UTC
You are currently in replay mode
Borkumkade
Meeuwenstaartweg
Ranselgatweg
robin
radar systems
© MapTiler © OpenStreetMap contributors

Radar data annotated by bird experts

- Use of radar GUI
- Select birds from a list
- Or manual input

- 18 field visits with in total 5200 tracks validated.

- Report on Waardenburg Ecology site (zwarte wiek onderzoek)
- In Dutch
- Eindrapportage zwarte wiek onderzoek - eindrapport april 2025

Tagged tracks

Tabel 6.1 *Overzicht van de uitgevoerde protocollen en weersomstandigheden tijdens de veldbezoeken*

Datum	Turbines	Tracks valideren	FN-protocol	Start	Eind	Wind	Temp. °C	Bewolking	Zicht (km)	Neerslag	Neerslag %
05-Sep-23	20, 21	x	x	10:30	15:30	2-3 O	28	0/8	>15	geen	0
12-Sep-23	18, 19	x	x	09:00	14:00	2 ZW	19	6/8	1	mist	100
19-Sep-23	20, 21	x*	x	09:30	14:22	5 ZW	16	6/8	10	geen	0
28-Sep-23	18, 19		x**	09:10	13:50	5 ZW	19	7/8	10	geen	0
11-Oct-23***	20, 21	x	x	09:50	14:00	4 ZW	18	8/8	10	miezer	5
12-Oct-23	18, 19	x	x	08:58	13:09	2-3 ZW	19	2/8	10	geen	0
17-Oct-23	20, 21	x	x	10:15	14:40	1-2 Z	10-12	2-4/8	>15	geen	0
18-Oct-23	18, 19	x	x****	11:03	15:04	4 O	7	4/8	10	geen	0
25-Oct-23	20, 21	x	x	08:58	13:12	2 ZO	12	5/8	10	geen	0
25-Oct-23	18, 19	x	x	13:30	17:30	2 O	13	8/8	15	geen	0
13-Dec-23	18, 19, 20, 21	x		08:55	13:04	2 O	6	8/8	0.25	miezer/ mist	90
29-Jan-24	20, 21	x	x	12:38	16:49	2-3 ZW	5	8/8	3	geen	0
13-Feb-24	18, 19	x	x	09:05	13:11	4 ZW	5	7/8	5	geen	0
13-Mar-24	18, 19, 20, 21	x		09:10	13:15	3 ZO	8	8/8	0,5	mist/ motregen	100
28-Mar-24	20, 21	x	x	09:02	13:10	3-4 Z	10	5/8	10	geen	0
09-Apr-24	18, 19	x	x	09:09	13:15	3 ZW	13	8/8	10	geen	0
30-Apr-24	20, 21	x	x	09:10	12:05	3 ZO	16	8/8	10	regen	5
10-May-24	18, 19	x	x	08:00	12:10	2 N	10	8/8	3	geen	0

* Korter tracks gevalideerd, 1,5 uur per windturbine
** Langer FN-protocol uitgevoerd, 2 uur per windturbine
***Tijdens telling installatie WT-Bird® systeem windturbine 21
****FN-protocol alleen bij windturbine 19 uitgevoerd

7 Onderzoek vlieggedrag met vogelradar

7.1 Resultaten gevalideerde tracks

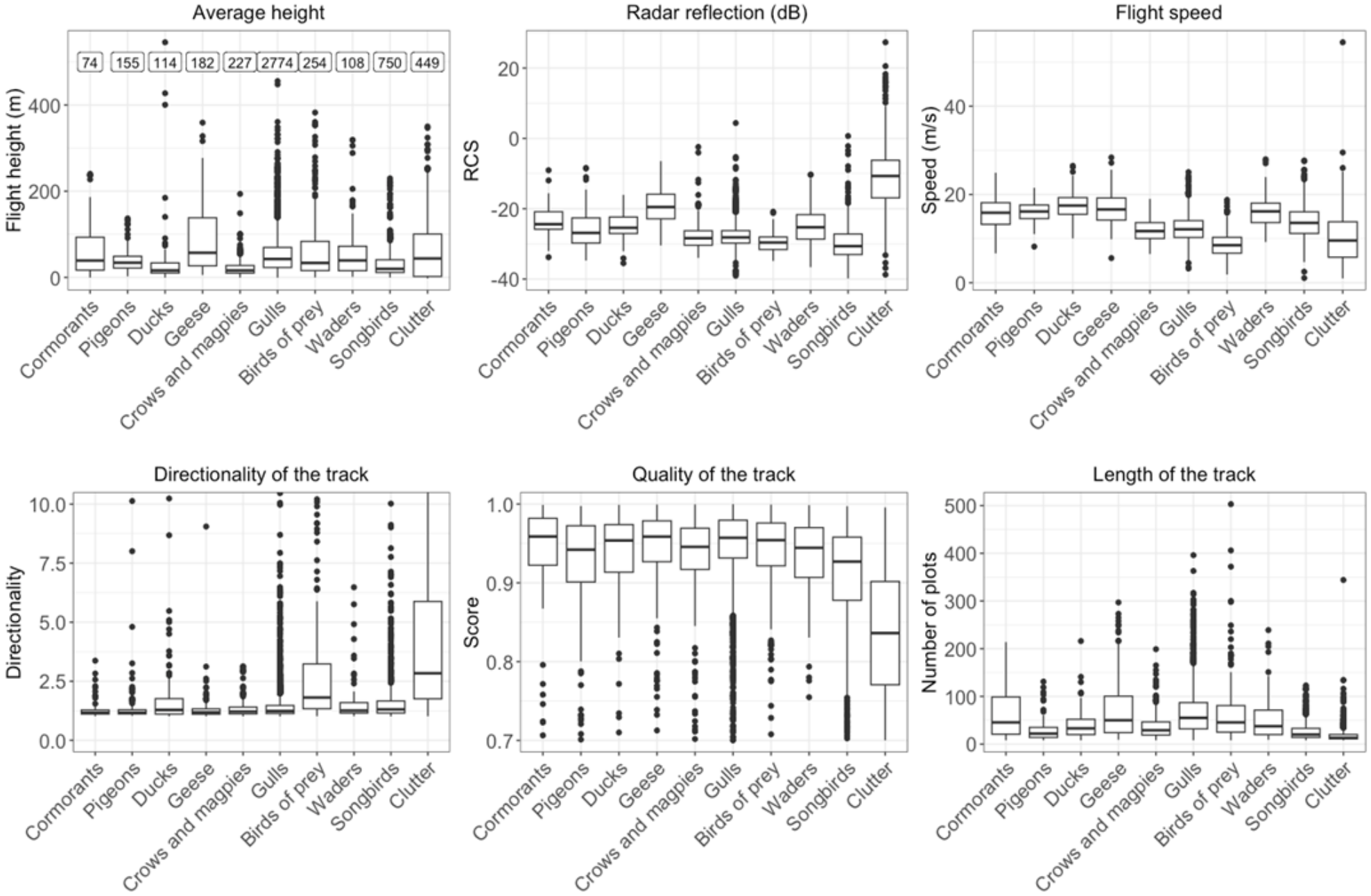
In totaal zijn tijdens de 18 veldbezoeken 5.200 tracks gevalideerd, die samen 16.383 individuen of objecten representeren. Hiervan waren 4.757 tracks vogels en 443 tracks objecten die clutter veroorzaakten (Tabel 7.1).

Tabel 7.1 *Overzicht van de tracks die van september 2023 tot en met mei 2024 zijn gevalideerd. Alleen de soorten en objecten waarvan tien of meer tracks zijn gevalideerd zijn weergegeven.*

Soort/object	Aantal gevalideerde tracks	Aantal individuen	Soort/object	Aantal gevalideerde tracks	Aantal individuen
kokmeeuw	1.389	2.033	kramsvogel	35	299
stormmeeuw	538	704	vink	35	118
zilvermeeuw	370	437	goudplevier	32	1.114
kleine mantelm.	336	380	toendrarietgans	32	184
spreeuw	284	4832	wulp	31	41
boerenzwaluw	126	186	grote mantelm.	26	27
torenvalk	117	118	duif *spec.*	25	35
meeuw *spec.*	115	846	koperwiek	23	59
zwarte kraai	109	120	houtduif	22	121
holenduif	106	721	kolgans	22	497
kauw	103	220	putter	20	101
zangvogel *spec.*	95	167	gans *spec.*	18	282
grauwe gans	88	383	brandgans	18	152
wilde eend	82	165	vogel *spec.*	14	215
kievit	80	242	scholekster	13	20
aalscholver	74	244	bergeend	12	13
graspieper	66	144	clutter *spec.*	372	372
bruine kiekendief	65	65	turbine	36	36
buizerd	54	63	schapen	20	20
veldleeuwerik	39	80	voertuigen	15	15

Verschillen in trackkarakteristieken tussen tracks van vogels en clutter

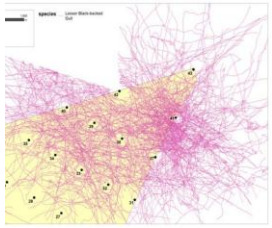
Voor verschillende soortgroepen vogels en voor clutter is een vergelijking gemaakt van een aantal trackkarakteristieken van de gevalideerde tracks (Figuur 7.1). De 'clutter-tracks' wijken duidelijk af van de tracks van de verschillende vogelsoorten voor wat betreft de

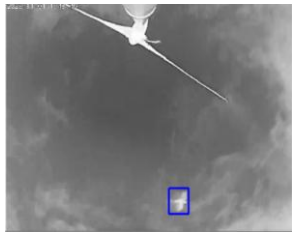
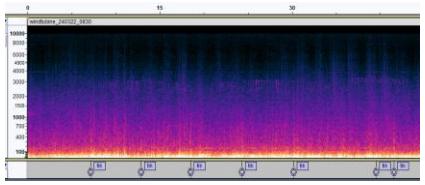

Average height
Flight height (m)
74
155
114
182
227
2774
254
108
750
449
Radar reflection (dB)
RCS
Flight speed
Speed (m/s)
Directionality of the track
Directionality
Quality of the track
Score
Length of the track
Number of plots
Cormorants
Pigeons
Ducks
Geese
Crows and magpies
Gulls
Birds of prey
Waders
Songbirds
Clutter

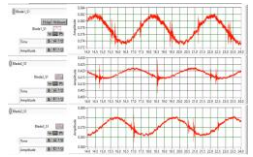
Monitoring

TNO innovation for life

Other ways of Monitoring birds





Telemetry

Radar

eDNA

Radar (automotive)

PTZ cameras

Lidar (automative)

Fixed cameras

Microphones

Microphones Array

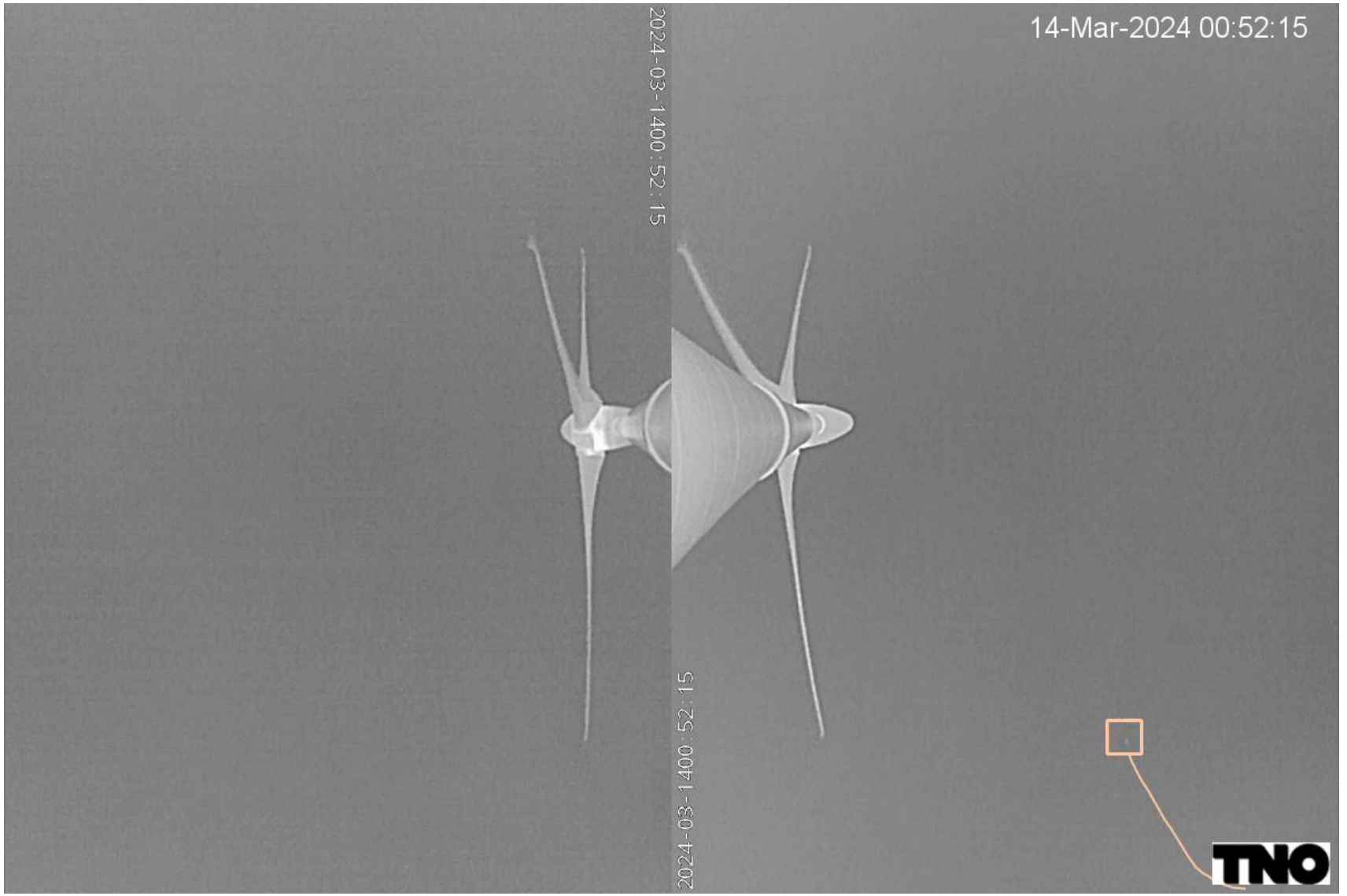
Vibration sensors

Range in m

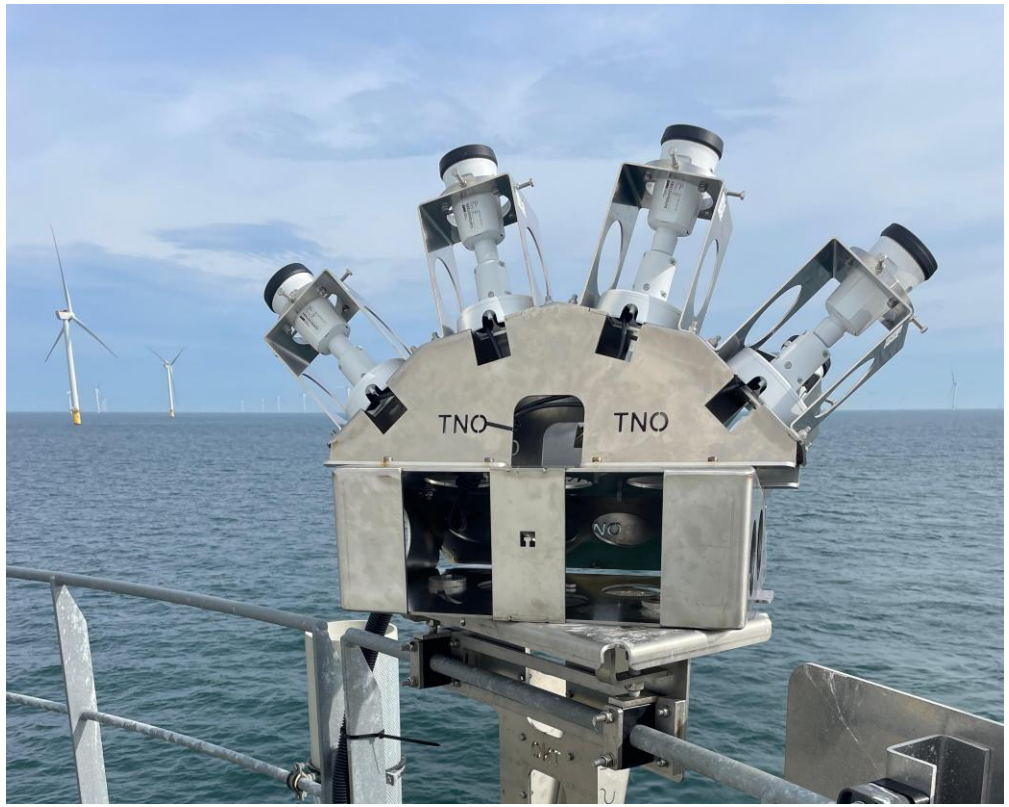
100000 | 10000 | 1000 | 100 | 10 | 1

Sensors WT-Bird Turbine 20 (black blade)

Movies Avoidance

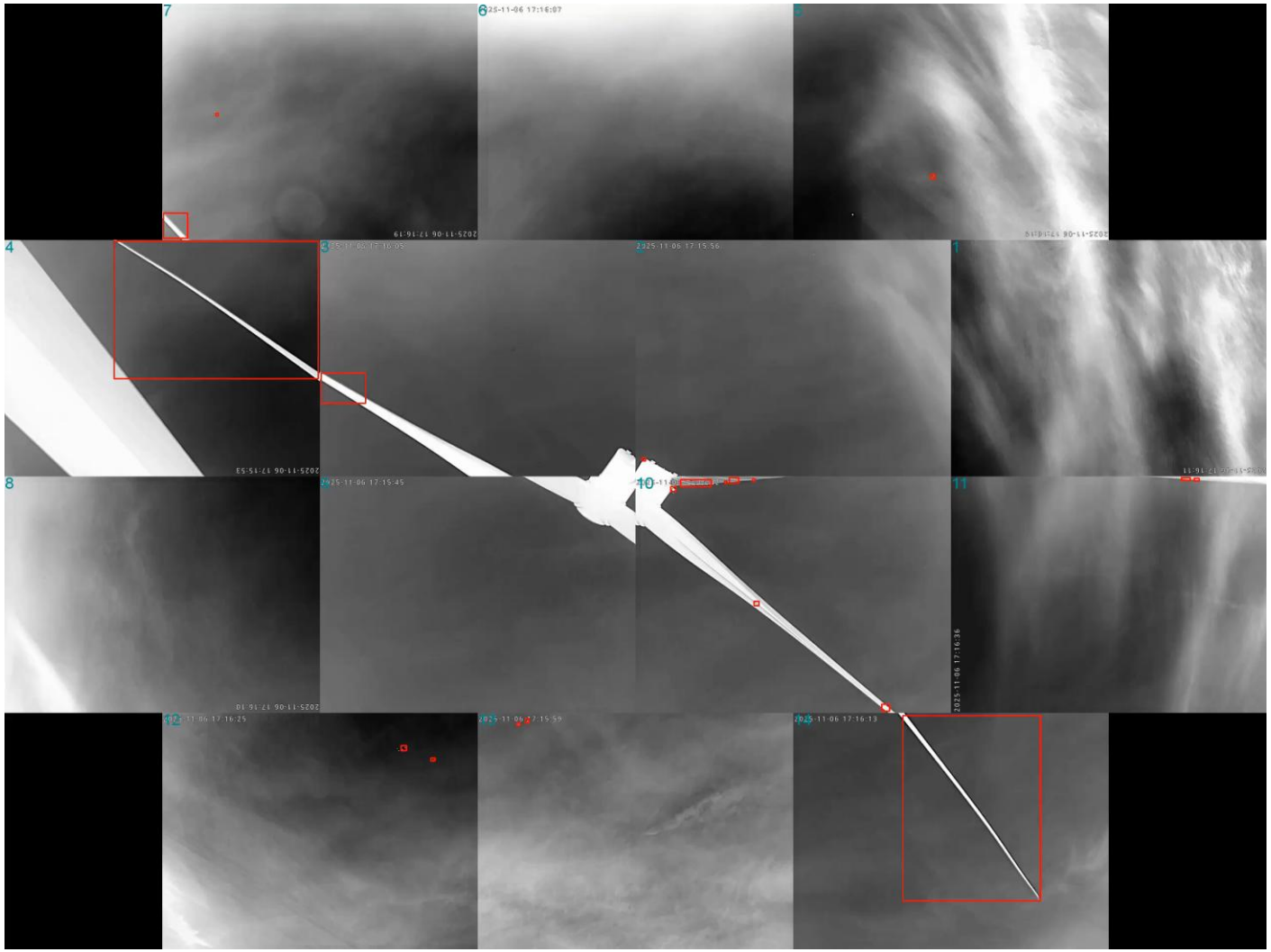


Installation of cameras



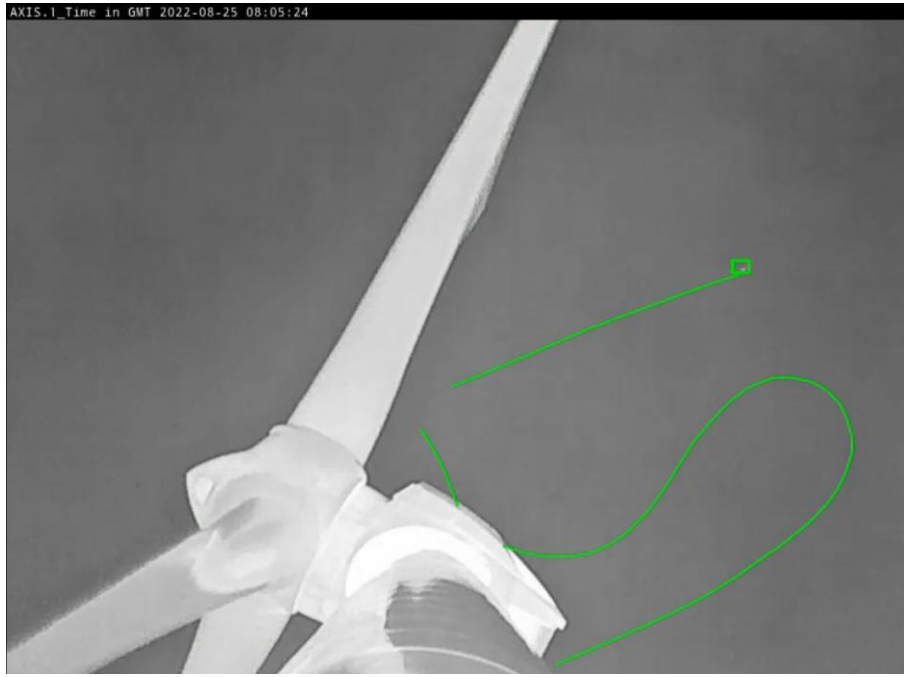
Installation video:
https://grow-offshorewind.nl/files/videos/202511-birdsafe-short.mp4

First results Video turbine W2



Vibration sensors in blades

- To detect collisions



A Multi-Sensor Approach for Measuring Bird and Bat Collisions with Offshore Wind Turbines

Results Comparable Between Methods

GenEst fatality Estimate

	Estimate	90% CI
All Bird and Bat	16.8	9.88 - 27.92
All Bird	1.44	n/a*
Bat	15.67	n/a*

Area correction = Hull & Muir

* Confidence interval not calculated because the observed carcass count <5

Observed ground fatalities

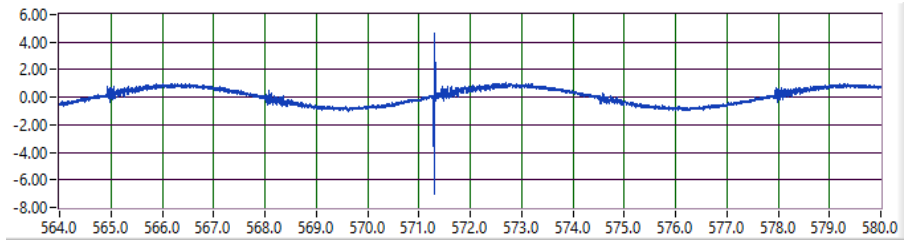
- 14 bats
- 1 bird

WT-Bird® based estimate

detection	Detection Adjusted Fatality Estimate	Uptime Adjusted Fatality Estimate
NREL (0.65)	23.08	29.21
NREL (0.75)	20.00	25.32

WT-Bird® Collisions

- 15 collision events
- 21% downtime on one or more sensors; box beam
- WEST believes the WT-Bird® detection rate was ~0.75
- Amazing because 14/15 known fatalities were bats (8 – 25 g)



[h] Conference on Wind Energy and Wildlife Impacts (CWW), Šibenik, Croatia , September 18-22, 2023

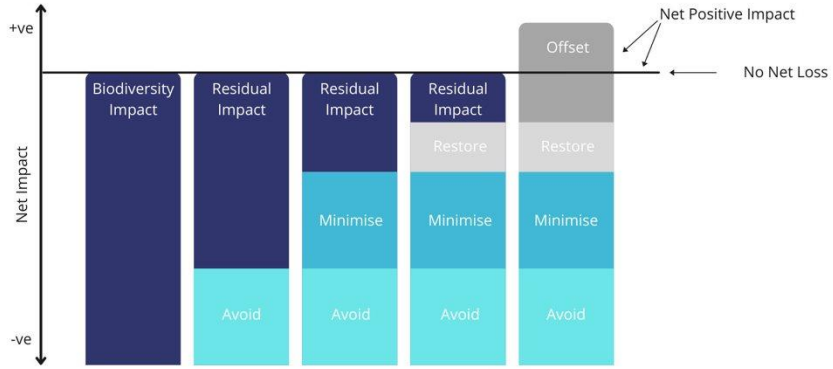
WEST

TNO innovation for life

Mitigation

Effects of Wind Energy on Birds and Bats

- Habitat Loss
  - Loss of Flight Routes
  - Loss of Resting and Foraging grounds
- Avoidance
  - Flight pattern changes
  - Migration route change
  - Barrier Effect
- Collisions
  - Reduced Survival
  - Direct Mortality

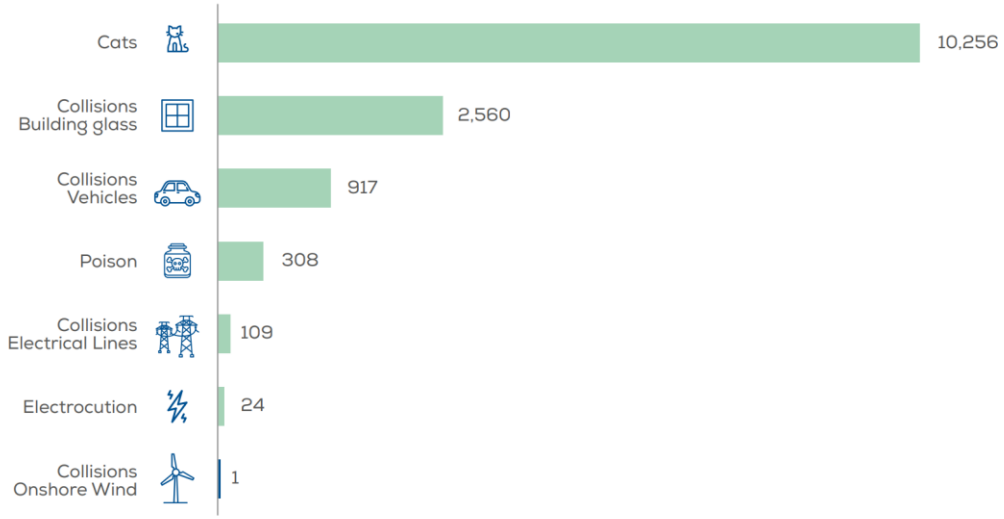


Main focus on Avoid and Minimise Measures

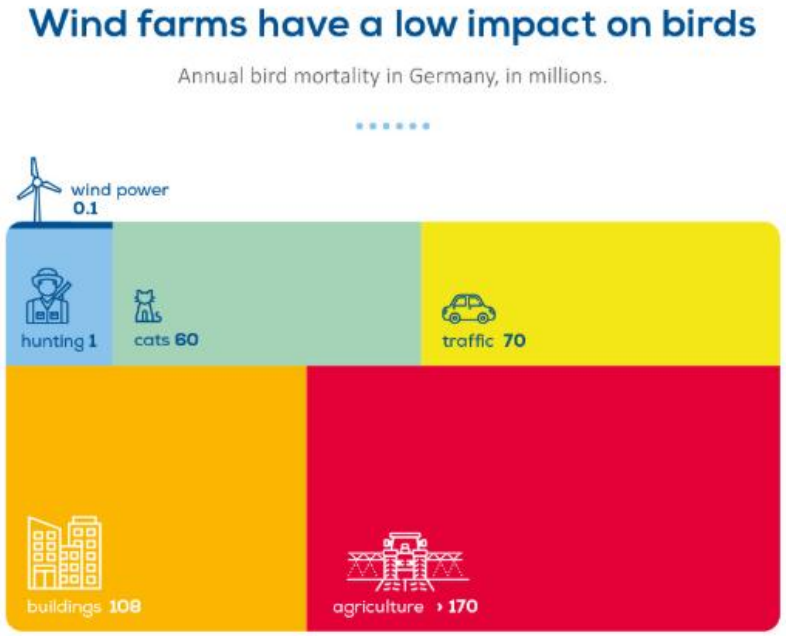
- Restore and Offset outside wind farm areas

Putting things in perspective

- Wind turbines are not the main cause of bird mortality
- Does not mean we do not have to do anything about it
- For some species, wind might be a bigger risk

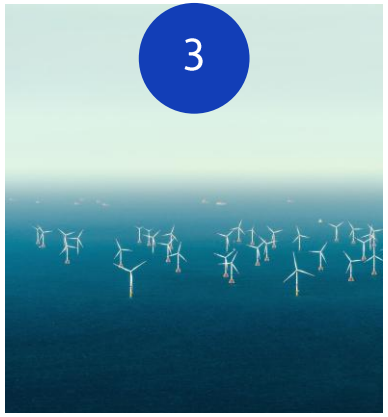


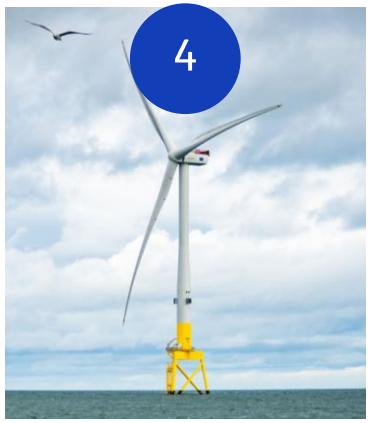
Source: U.S. Fish and Wildlife Services, 2017



Birds and bats: Example of mitigations

European West Coast | Dutch Coast | Windfarm | Wind Turbine



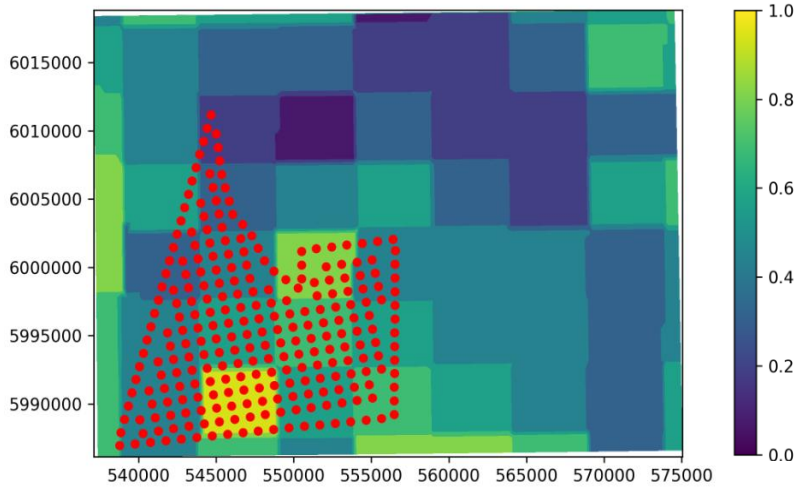


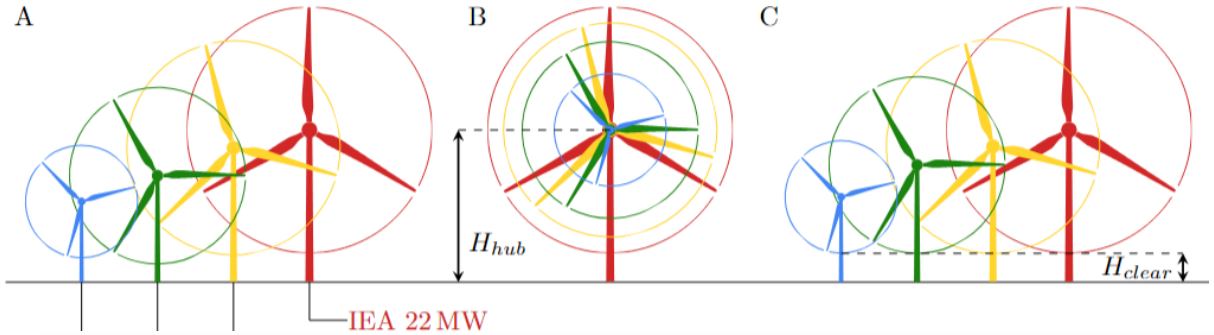
Offset	Location	Design/Operation	Design/Operation

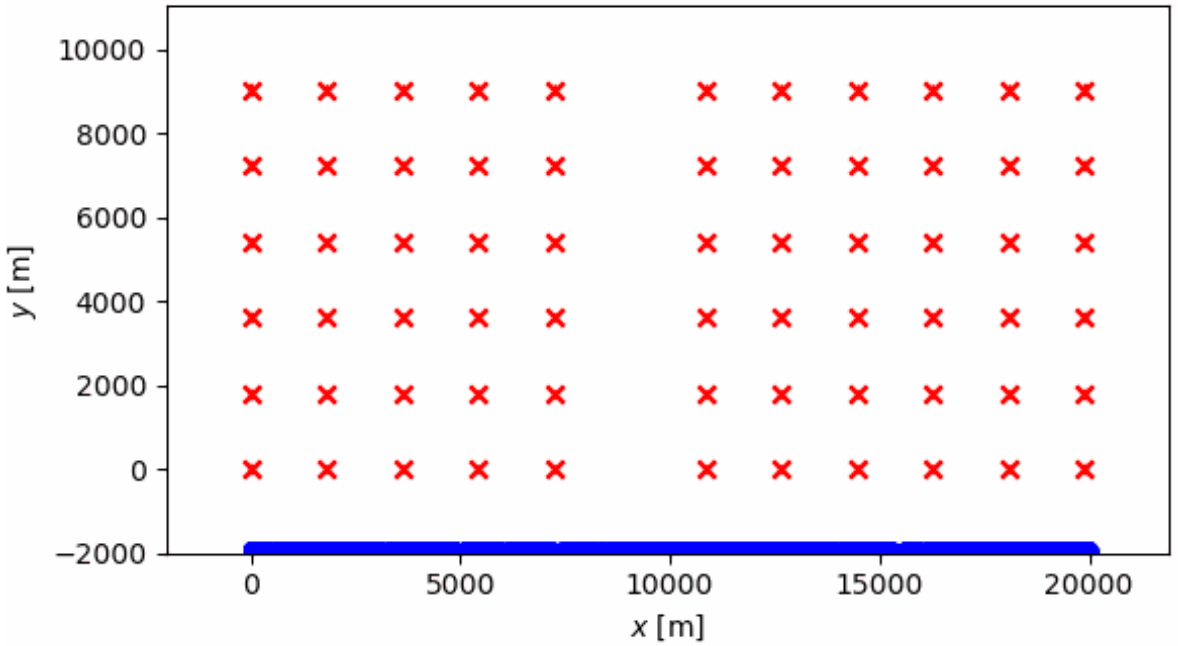
• Reinforce population
  • Corridors
  • Foraging
  • Mortality
	• Spatial planning
	• Protected areas
	• International coordination
		• Spatial layout
		• Sizing
		• Farm curtailment
			• Lower tip height
			• Visibility
			• Deterrence
			• Micro-curtailment

Examples of TNO research on mitigation

- Wind farm location
- Wind farm design
- Wind farm operation
- Turbine sizing
- Black blade

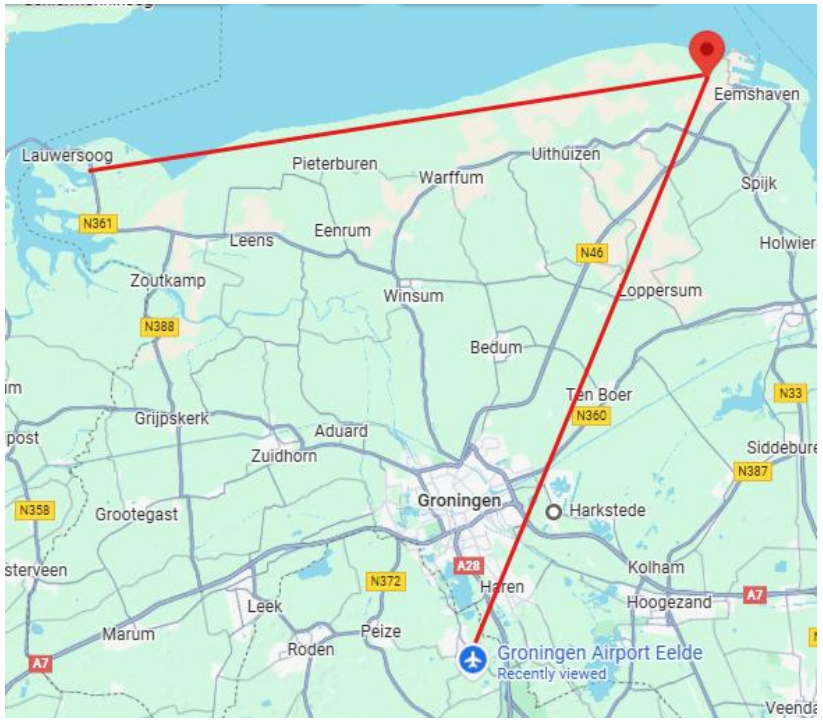


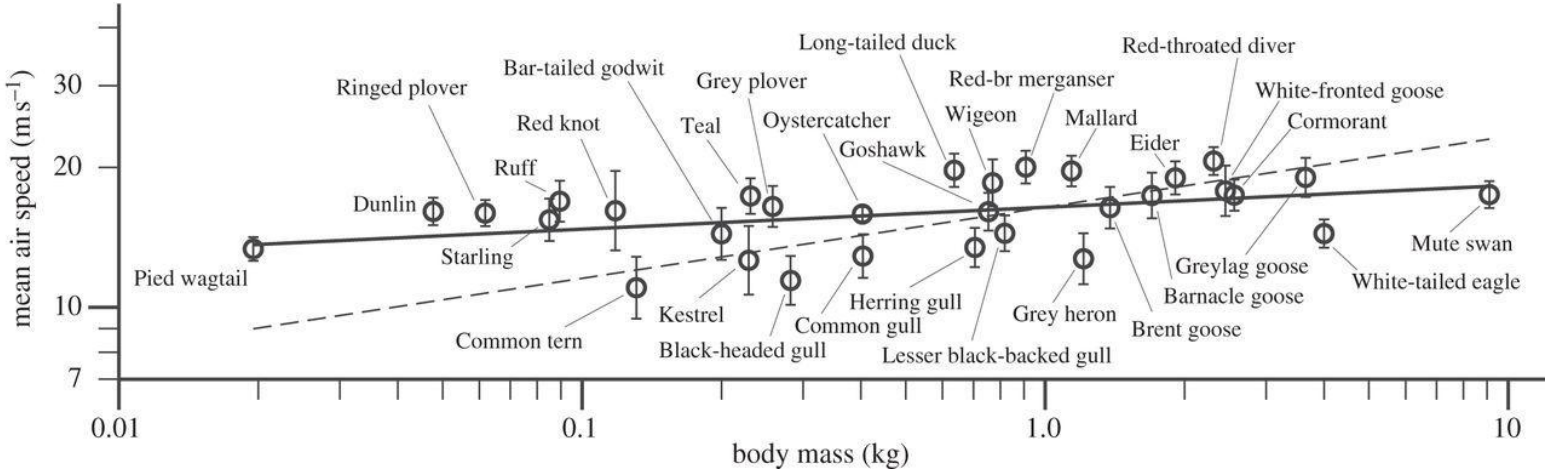




Hints

- Use other data sources
  - Weather data
    - Wind speed
    - Rain
    - Air density
  - Bird information
    - Local species/species list
    - Activity during year/time of day
    - Size
    - Flight speeds
    - Flight patterns
  - Radar in UTC, WE report in CET/CEST





Who is Who

Joep Breuer

Ecology Lead

TNO Wind Energy

Sam Ordeman

Scientist

TNO Wind Energy

Erik Fritz

Scientist

TNO Wind Energy

Vacancy

... / Careers / Vacancies /

Rijswijk Master Fulltime – 40

Intership | Simulating bird flight through offshore wind farms using agent-based modelling

Apply now

[Vacancy Intership | Simulating bird flight through offshore wind farms using agent-based modelling at TNO in Rijswijk]
https://www.tno.nl/en/careers/vacancies/2025/10/intership-simulating-bird-flight-through/

Theme name

Place text here

Place a title here

TNO innovation for life