Netherlands Enterprise Agency

Measuring and Modelling Strategy Wind and Water Additional Offshore Wind Energy Roadmap 2030

11 October 2022

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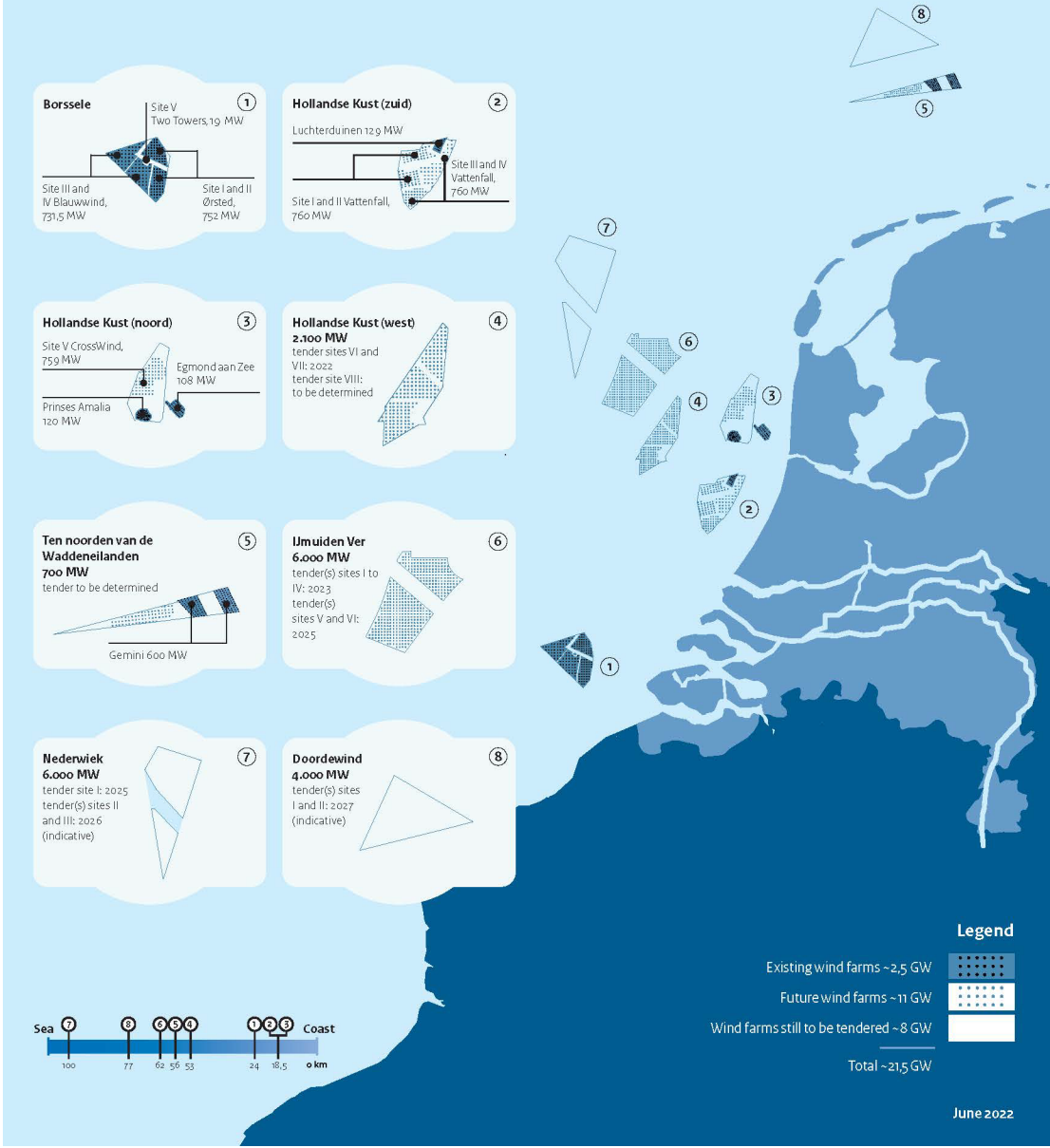
Additional Roadmap

Capacity (GW)	Wind farm zone, site(s)	Tender for sites	(Anticipated) commissioning date of wind farm
approx. 1,0	IJmuiden Ver, Site III	Fourth Quarter of 2023	(2028)
approx. 1,0	IJmuiden Ver, Site IV		(2028)
approx. 1,0	IJmuiden Ver, Site I		(2029)
approx. 1,0	IJmuiden Ver, Site II		(2029)
approx. 1,0	IJmuiden Ver (noord), Site V	Second Quarter of 2025	(2029)
approx. 1,0	IJmuiden Ver (noord), Site VI		(2029)
approx. 2,0	Nederwiek (zuid), Site I		(2030)
approx. 2,0	Nederwiek (noord), Site II	2026*	(2030)
approx. 2,0	Nederwiek (noord), Site III		(2031)
approx. 0,7	Hollandse Kust (west), Site VIII	2026/2027**	TBD **
approx. 0,7	Ten noorden van de Waddeneilanden, Site I	2026/2027*	(2031)
approx. 2,0	Doordewind, Site I	2027*	(2031)
approx. 2,0	Doordewind, Site II	2027*	(2031)



End User Consultation

2021 PROJECT MANAGERS

- Usage of data
  - Contributes to level playing field and goal achievement
  - Entire dataset is used, developments of added value
  - Certification supports financing and reduces discussions about data quality
- Proposed further developments
  - Models for larger areas and longer term measurements
  - Wind gradient determination

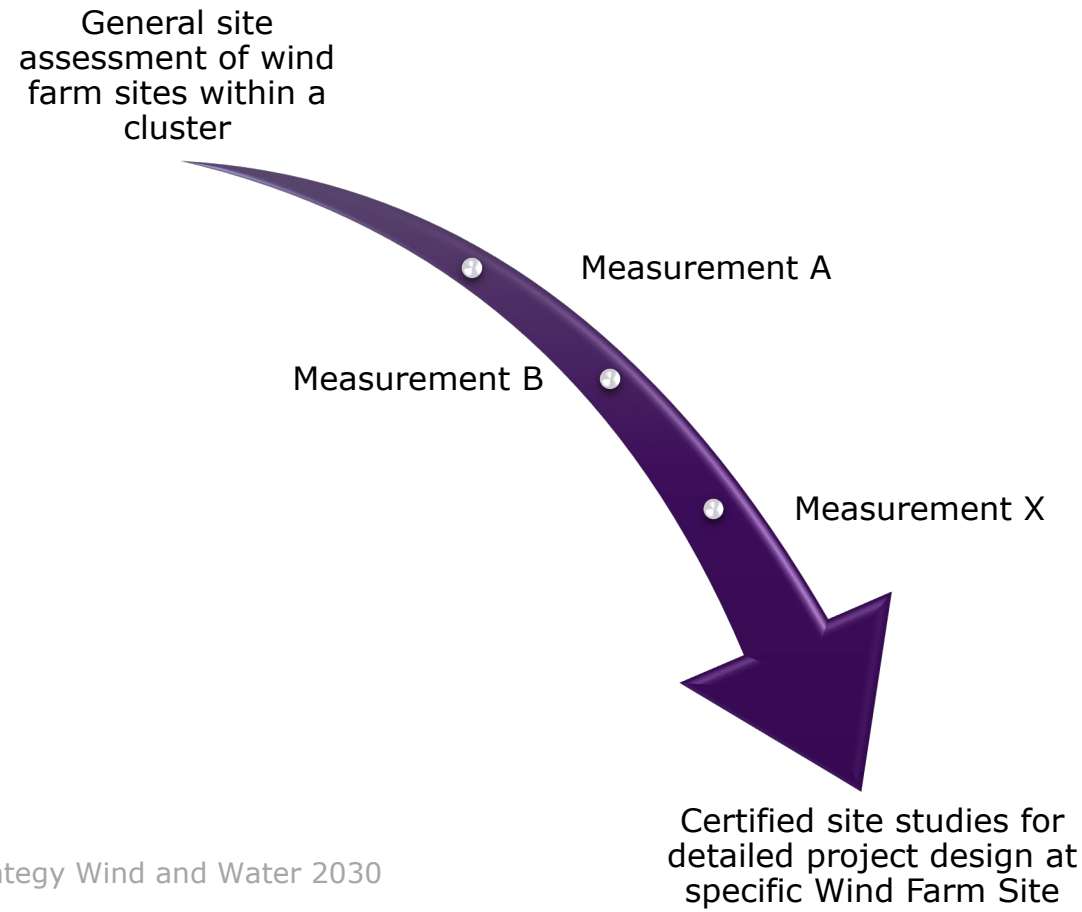
2022 WIND AND WATER EXPERTS

- Measurement data needs:
  - Wakes
  - Blockage
  - Turbulence Intensity
  - Gradients
- Suggestions for measurements
  - (Relocation of campaigns) to determine wakes
  - Scanning Lidar as addition to portfolio
- Proposed deliverables IJmuiden Ver
  - Proposal IJmuiden Ver in line with needs

Strategy and Execution

- General
- Metocean Assessment
- Metocean Campaigns
- Measuring Locations
- Turbulence Intensity, Wakes and Gradients

General Strategy: From Feasibility Level to Detailed Design Level in a Phased Approach



Metocean Assessment

- Feasibility level and detailed design level
  - Example feasibility level: Metocean Desk Study IJV)
  - Example detailed design Metocean Desk Study and WRA TNW
- Detailed design level Metocean Assessment: Combination of Wind Resource Assessment and Metocean Desk Study
  - Same assessments of datasets from measurement stations
  - Alignment between data for yield assessment and for design
  - Better (motivation and understanding in the) usage of models
  - Database also for WRA output
  - Driving metocean measurements to further reduce uncertainties

Detailed Design Metocean Assessment (incl. Database)

- Contractor: DHI
- Deliverables
  - Dates as disclosed by RVO
  - All deliverables are based on measured bathymetry
  - All deliverables to be certified
- Details: Aankondigingen (tenderned.nl)

WFZ	Months of local floating lidar measurement data incorporated	Date of last MC measurement in period	Measurement bathymetry	Date of disclosure MA to end users	Permit tender
IJmuiden Ver	6	Q4 2022	Q3 2022	Q3 2023	Q4 2023 (WFS IJV I-IV)
	12	Q2 2023	Q3 2022	Q1 2024	Q2 2025 (WFS IJV V-VI)
	24	Q2 2024	Q3 2022	Q3 2024	Q2 2025 (WFS IJV V-VI)
Nederwiek	12	Q2 2023	Q4 2023	Q3 2024	Q2 2025 (WFS NW I)
	24	Q2 2024	Q4 2023	Q4 2025	2026 (WFS NW II-III)
Doordewind	24	Q2 2025	Q4 2025	Q4 2026	2027 (WFS DW I-II)

Metocean Measurement Campaigns

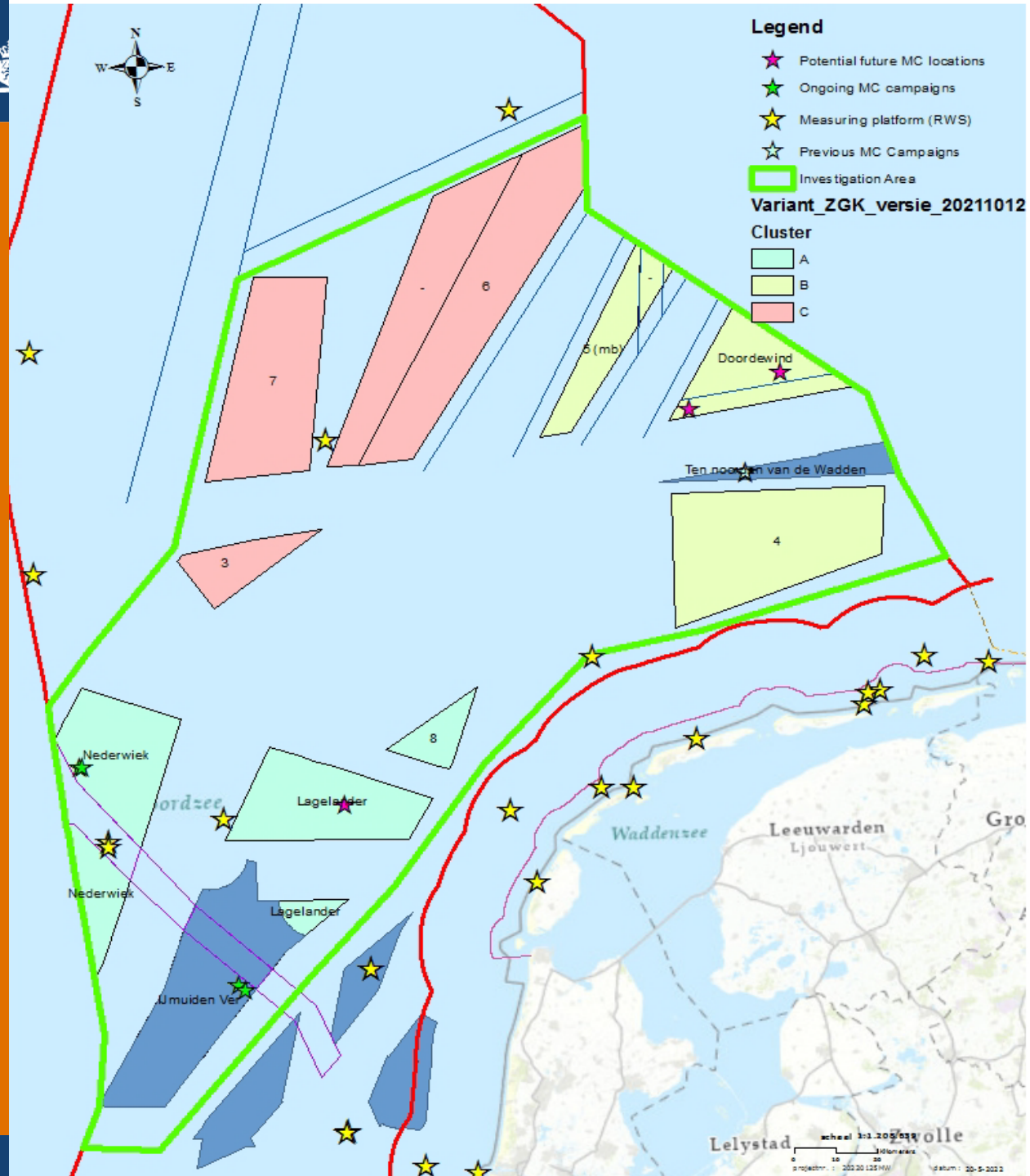
- Determine local metocean climate
- Determining wind gradients and enhanced understanding of water measurements
- Parallel/overlapping measurements through all the sites
- To explore: portfolio of measurements with specific characteristics (metocean buoy, mounted vertical lidar, scanning lidar?)
- Measurements for locations beyond Roadmap 2030 not in this strategy (except for Lagelander).

General Characteristics Metocean Campaigns

- 2 measuring systems and 1 spare system
- Wind, Wave, Current measurements
- Deliverables;
  - 24 x monthly reports and datasets
  - Full dataset for first year
  - Full dataset and report for two years of measurements
- Flexibility in location and campaign duration

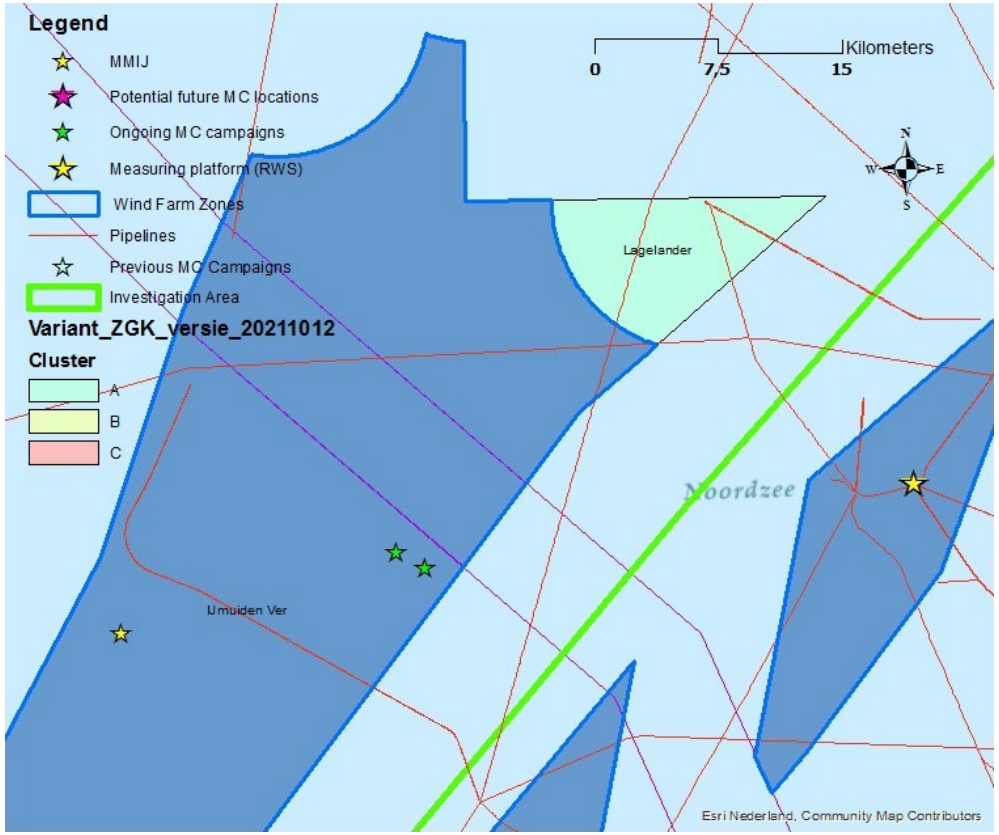
- IJmuiden Ver and Nederwiek operational
- Three other Metocean Campaigns (to be located in Lagelander and Doordewind) contracted
- Details: Aankondigingen (tenderned.nl)

Measuring Locations



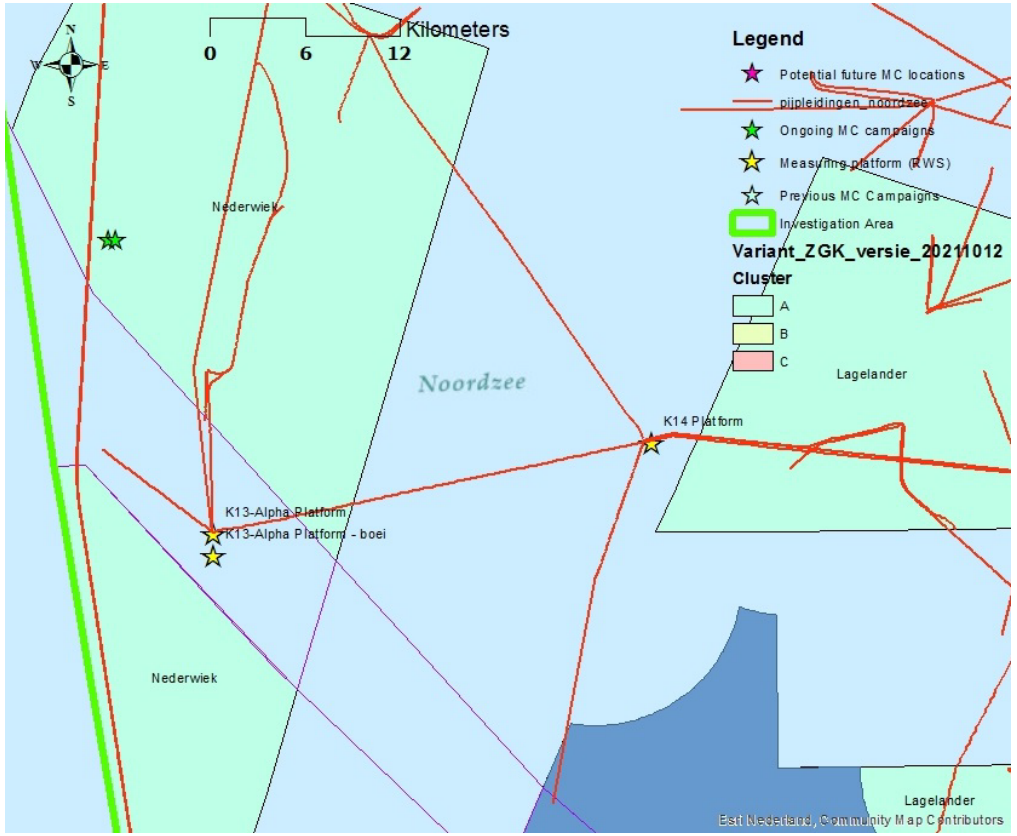
Metocean Measurements IJmuiden Ver

- TNO Metocean Campaign Meteomast IJmuiden
  - 4 year campaign (completed)
- RVO Metocean Campaign
  - Contractor: RPS
  - Period of measurements: May 2022-May 2024
  - Goals:
    - Wind gradient determination
      - Time overlapping measurements in Nederwiek, LageLander, IJmuiden Ver and K13a
      - Measurement at separate location from meteomast IJmuiden
    - Effect of bathymetry on waves and currents (Features in bathymetry at IJV with potential impact on design)
    - Metocean characterisation at IJmuiden Ver
  - Live data



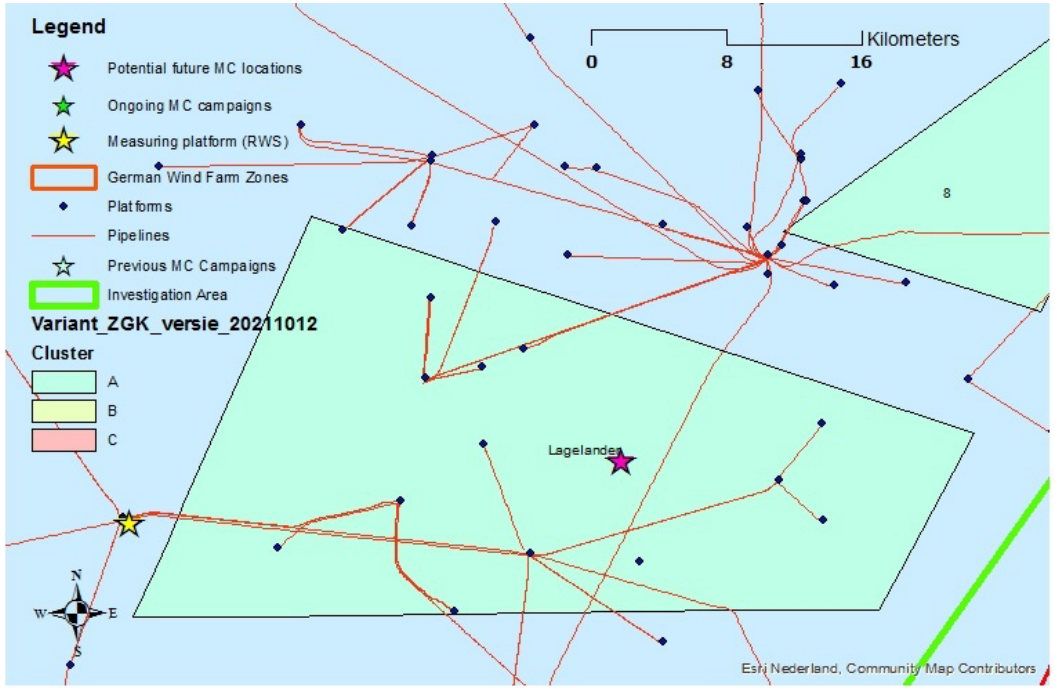
Metocean Measurements Nederwiek

- Ongoing TNO Wind Measurement Campaign at K13Alpha and RWS Wave Measurements
- RVO Campaign
  - Contractor: RPS
  - Period of measurements: June 2022 - June 2024
  - Goals:
    - Wind gradient determination
      - At least one year of overlapping measurements in Nederwiek, LageLander, IJmuiden Ver and K13a
      - Overlapping period with K13a
    - Partly undisturbed wind measurements before construction of UK OWF (Norfolk Boreas and Norfolk Vanguard)
    - Metocean characterisation at Nederwiek
  - Live data



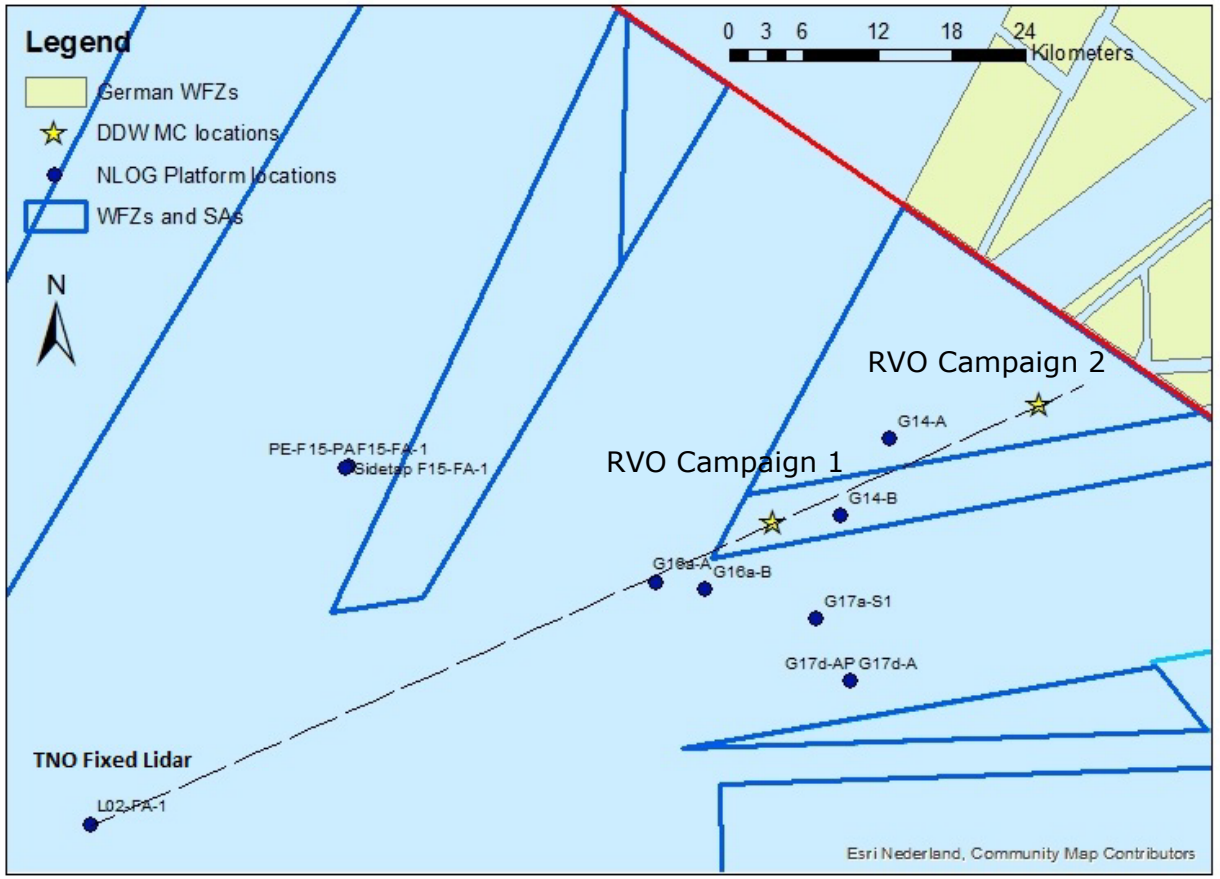
Metocean Measurements Lagelander

- RVO Campaign
  - Contractor: GEOxyz
  - Planned period of measurements:Q4 2022 – Q4 2024
  - Goals:
    - Wind gradient determination
      - At least one year of overlapping measurements in Nederwiek, LageLander, IJmuiden Ver and K13a
    - Metocean characterisation at Lagelander
  - Please note: Lagelander currently not in Additional Roadmap 2030, being reassessed for after 2030



Metocean Measurements Doordewind

- RVO Campaign
  - Contractors
    - GEOxyz (south western campaign; ‘1’)
    - RPS (centre campaign; ‘2’)
  - Planned period of measurements:
    - GEOxyz: Q1 2023 – Q1 2025
    - RPS: Q2 2023 – Q2 2025
  - Goals:
    - Metocean characterisation at Doordewind
    - Wind gradient determination within Doordewind
    - Providing measurement dataset that can be used in the validation of wake and blockage models for far distance wake/blockage effects (relation to operational German OWFs (Deutsche Bucht, Veja Mate)
  - TNO Campaign in preparation: fixed Lidar on platform near northern locations.



IJmuiden Ver

- Until Q3 2023
  - Existing local data: Metmast IJmuiden
  - Feasibility level Metocean Desk Study
  - Monthly Metocean Campaign reports (campaign starting from Q2 2022)
- Q3 2023
  - $6^{(+)}$ monthly reports of Metocean Campaign data
  - Detailed design Metocean Assessment incorporating 6 months of Metocean Campaign data
  - Webinars
    - Metocean Campaign
    - Metocean Assessment
- From Q4 2023
  - Further reduction of uncertainties, creating maximum value for end users
    - World class certified Metocean model
    - > 1 year of additional measurements

Turbulence Intensity (TI), Wakes and Gradients

- Q4 2022
  - Exploring feasibility of horizontal scanning lidar for **wake and gradient** measurements
  - Discuss with Metocean Assessment Contractor further detailing of site specific **turbulence intensity** determination
  - Decision on potential modelling of wakes
- Q2 2023
  - Decision on potential relocation of Metocean measurements IJV and NW to determine **wakes/gradients**, based on:
    - Assessment of measured data by RVO
    - Identified needs and advice from the Metocean Assessment
  - Discussion on needs for measurement campaigns in Search Area 6 and/or 7