## Additional Roadmap

<table>
<thead>
<tr>
<th>Capacity (GW)</th>
<th>Wind farm zone, site(s)</th>
<th>Tender for sites</th>
<th>(Anticipated) commissioning date of wind farm</th>
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<tbody>
<tr>
<td>approx. 1.0</td>
<td>IJmuiden Ver, Site III</td>
<td></td>
<td>(2028)</td>
</tr>
<tr>
<td>approx. 1.0</td>
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<td>(2028)</td>
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<td>(2029)</td>
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<td>approx. 1.0</td>
<td>IJmuiden Ver, Site II</td>
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<td>(2029)</td>
</tr>
<tr>
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<td>(2029)</td>
</tr>
<tr>
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<td>IJmuiden Ver (noord), Site VI</td>
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<td>(2029)</td>
</tr>
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<td>Nederwiek (zuid), Site I</td>
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<td>(2030)</td>
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<tr>
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<td>Nederwiek (noord), Site II</td>
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<td>(2030)</td>
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<tr>
<td>approx. 2.0</td>
<td>Nederwiek (noord), Site III</td>
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<td>Hollandse Kust (west), Site VIII</td>
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<td>2026/2027**</td>
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<tr>
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<td>2026/2027**</td>
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<td>Doordewind, Site I</td>
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<td>(2031)</td>
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<tr>
<td>approx. 2.0</td>
<td>Doordewind, Site II</td>
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<td>(2031)</td>
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</table>
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

General site assessment of wind farm sites within a cluster

Measurement A

Measurement B

Measurement X

Certified site studies for detailed project design at specific Wind Farm Site
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)

<table>
<thead>
<tr>
<th>WFZ</th>
<th>Months of local floating lidar measurement data incorporated</th>
<th>Date of last MC measurement in period</th>
<th>Measurement bathymetry</th>
<th>Date of disclosure MA to end users</th>
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<tbody>
<tr>
<td>IJmuiden Ver</td>
<td>6</td>
<td>Q4 2022</td>
<td>Q3 2022</td>
<td>Q3 2023</td>
<td>Q4 2023 (WFS IJV I-IV)</td>
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<td>Q3 2022</td>
<td>Q1 2024</td>
<td>Q2 2025 (WFS IJV V-VI)</td>
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<td>Q2 2024</td>
<td>Q3 2022</td>
<td>Q3 2024</td>
<td>Q2 2025 (WFS IJV V-VI)</td>
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<tr>
<td>Nederwiek</td>
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<td>Q2 2023</td>
<td>Q4 2023</td>
<td>Q3 2024</td>
<td>Q2 2025 (WFS NW I)</td>
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<td>24</td>
<td>Q2 2024</td>
<td>Q4 2023</td>
<td>Q4 2025</td>
<td>2026 (WFS NW II-III)</td>
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<tr>
<td>Doorwind</td>
<td>24</td>
<td>Q2 2025</td>
<td>Q4 2025</td>
<td>Q4 2026</td>
<td>2027 (WFS DW I-II)</td>
</tr>
</tbody>
</table>

Measuring and Modelling Strategy Wind and Water 2030
10/11/2022
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 (tendered.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
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
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.
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