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# Recommendations for Additional Wind Resource Measurement Sites in the North Sea to Support Wind Energy Developments Beyond 2030

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# Recommendations for Additional Wind Resource Measurement Sites in the North Sea to Support Wind Energy Developments Beyond 2030

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# Summary

To support the Netherlands' goals of achieving ca. 21 gigawatts of wind energy by 2030[1] and approximately 72 gigawatts by 2050, precise mapping of wind resources in the Dutch North Sea region is crucial. Long-term wind measurements near proposed wind farm sites are essential for accurate wind resource assessments, supporting wind farm developers in designing wind farms and reducing financial risks. Currently, TNO monitors the wind resource at four offshore locations; however, the northern part of the Dutch Exclusive Economic Zone (EEZ), designated for wind farm development beyond 2030, remains still uncovered. This study aims to identify a suitable offshore platform to expand the measurement campaign towards search areas 6/7 in the north.

To identify candidate platforms, a visualisation of wind farm zones and existing offshore platforms, used in oil and gas exploration, was made, and a qualitative trade-off was performed based on a number of criteria:

- Proximity to the area of interest
- Distance from neighbouring Dutch or foreign wind farms
- Alignment with prevailing wind direction
- Distance to the existing TNO measurement locations
- Presence of KNMI meteorological measurement station on the platform

An important criterion is the expected cessation of production (COP) date of the platforms, as the value of wind resource measurements increases with longer measurement periods. However, this data was unavailable, so a shortlist of preferred options was created without it.

The recommended platforms, in order of preference, are:

1. F3-FB-1
2. F2-A-Hanze
3. D15-FA-1

Before a final decision is made, it is necessary to confirm the expected COP date with the platform operators.

If none of these platforms represent acceptable options or if there is a future expansion of the TNO measurement campaign, it is recommended to consider platforms A18 and A12-CPP as new measurement locations. The former provides an excellent opportunity to conduct wind farm wake analysis, while the latter is strategically located in the northernmost sector of the Dutch EEZ. This positioning could facilitate long-term measurements should the Netherlands decide to explore wind farm development north of search area 6/7.

[1] On May 14$^{th}$ 2024, an updated planning was published indicating a new end date to 2032.

# Contents

# Abbreviations

| | |
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| COP | Cessation Of Production |
| EEZ | Exclusive Economic Zone |
| EPL | Europlatform |
| LEG | Lichteiland Goeree |
| WRA | Wind Resource Assessment |

# 1 Introduction

Offshore wind energy plays a central role in the Netherlands' transition to a carbon-neutral energy supply. In the short-term, the Netherlands aims to realise ca. 21 gigawatts of offshore wind around 2030 [1] [2]. In the long-term, the goal is to further expand this number to around 72 gigawatts by 2050 [3]. Consequently, a vast area of the Dutch Exclusive Economic Zone (EEZ) in the North Sea will be exploited to generate renewable energy. Figure 1.1 provides an overview of the designated areas for wind farm development, up to and after 2030.

To support the rollout of offshore wind energy, TNO undertakes a comprehensive campaign for monitoring the offshore wind resource across various platforms in the North Sea, commissioned by the Ministry of Economic Affairs and Climate. Since 2014, significant advancements have been achieved in accurately mapping wind conditions in the North Sea through the utilisation of lidar systems for meteorological measurements on existing offshore platforms [4]. The measurement data is shared with the public, serving as an important information source for wind resource assessments.

Accurate wind resource assessments (WRA) are crucial to wind farm developers for making informed decisions, wind farm design, and ensuring the long-term success and profitability of a wind farm. These WRAs are commonly performed by correlating short-term wind measurements on site with long-term measurement data from a meteorological station at a greater distance, or alternatively with long term hindcast data. The value and certainty of measurements are improved when they are performed for a longer period of time. The importance and need for long term wind measurements is further justified in [5].

Currently, TNO is conducting measurements on four offshore platforms: Lichteiland Goeree (LEG), Europlatform (EPL), K13A and L2-FA-1. As is apparent from figure 2.1, all platforms are located in the middle or southern part of the Dutch EEZ, and therefore cover a confined area. Since towards 2030 and beyond, further development of offshore wind energy is expected in the northern sector of the Dutch EEZ, it is advised to perform wind resource measurements in this area as well. Hence, there is a need to explore potential new measurement locations.

The aim of this study is to identify potential locations, offshore oil and gas exploration platforms, for wind resource measurements for wind farm development after 2030. A similar study has been conducted previously, which led to the selection of platform L2-FA-1. The approach in this study will follow a similar trajectory compared with the previous one.

The structure of this report is set out as follows: first, chapter 2 discusses the methodology and criteria for platform selection. Following a qualititave trade-off, a final list of recommended platforms is presented. Subsequently, chapter 3 concludes the findings of this study.

[2] The offshore wind roadmap was recently modified with an end date to 2032 [2]

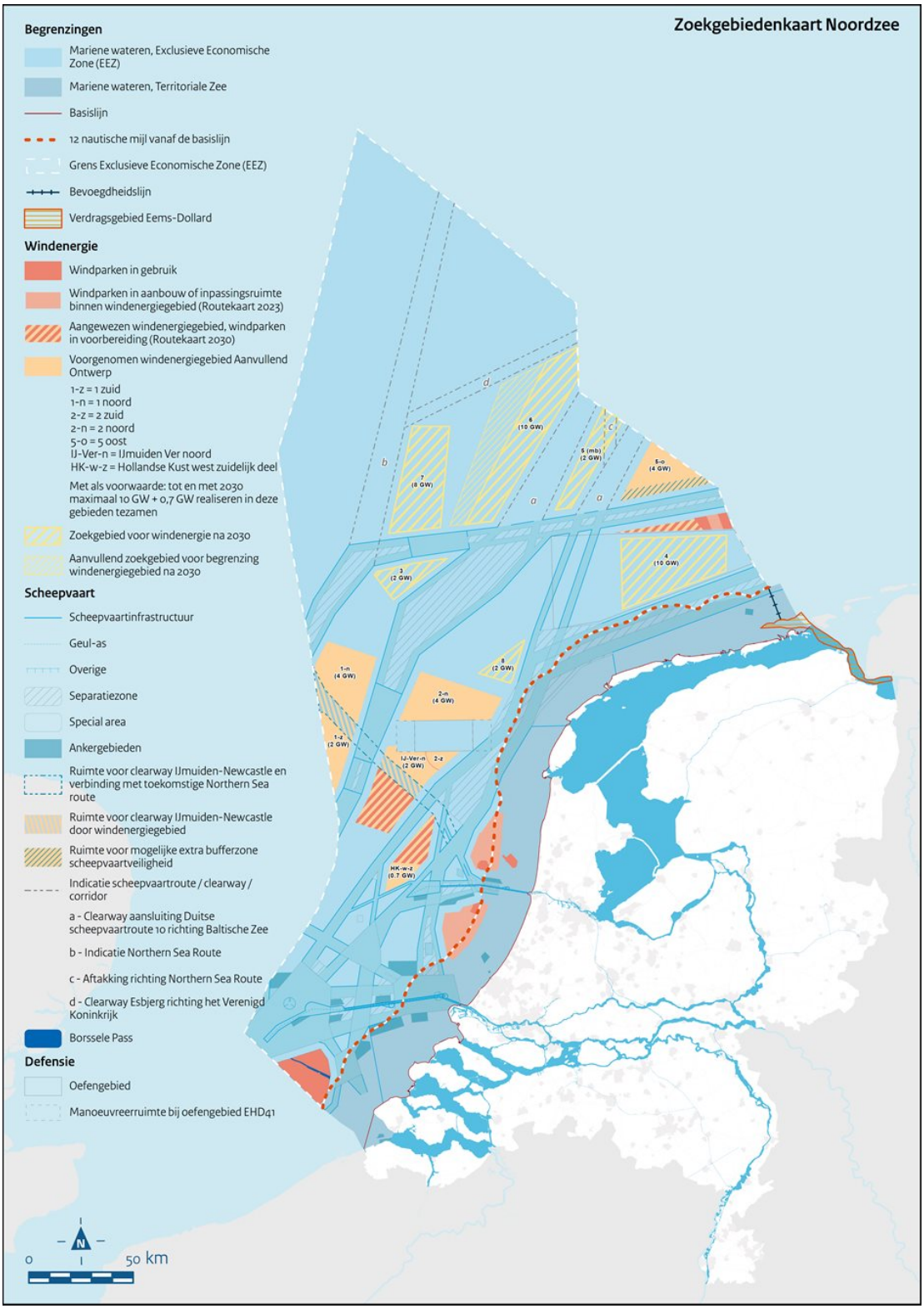


Figure 1.1: Designated wind farm zones up to 2030 and search areas after 2030 in the Dutch EEZ [3].

# 2 Site Selection

The value and quality of wind measurements depend on several factors, with the geographical location of the measurement site being arguably the most influential. In the introductory chapter, the need for an additional measurement location has been established. In this chapter, the methodology and criteria for selecting the new site will be outlined. Furthermore, a qualitative trade-off will be presented. Finally, a list of recommended platforms will be provided, in order of preference.

## 2.1 Methodology

Wind condition monitoring in the North Sea is currently being performed by both TNO and KNMI. Figure 2.1 maps the current long-term measurement locations in the Dutch EEZ, and their respective position to wind farm zones up to and beyond 2030. As can be seen from this figure, KNMI has a good coverage across the Dutch North Sea. Nonetheless, these measurements are performed at relatively low altitude for meteorology purposes. For accurate wind resource measurements for wind energy application, wind speeds at hub height (around 150 meters) and above are needed for modern wind turbines. Exploiting various offshore platforms, TNO collects data on wind speed and direction specifically for wind energy applications. Measurements are taken at several altitudes using lidar systems, reaching heights up to 300 meters.

The most recent addition to the TNO measurement campaign has been the platform L02-FA-1, based on the recommendation for an additional location from a previous study [6]. In this study, a new measurement location has been selected specifically for the north eastern sector of the Dutch EEZ, in the proximity of wind farm development zone “Ten Noorden van de Waddeneilanden”. With this additional TNO measurement location, a significant increase in coverage is achieved with respect to wind condition monitoring in the North Sea. However, as becomes clear from the figure, there is still a large area in the northernmost part of the Dutch EEZ that remains uncovered in TNO’s measurement campaign.

Thus, given this study’s objective to recommend additional locations for long-term wind measurements beyond 2030, the analysis will be focused within the northern sector of the Dutch EEZ, with particular emphasis on locations in the proximity of search area 6/7.

For the site selection, a qualitative trade-off will be performed to select a number of existing offshore oil and gas platforms that would be suitable for this purpose. These platforms will be listed in order of preference, and evaluated against the following criteria:

1. Proximity to the search area of interest. The quality of WRAs is increased when lidar measurements are performed close to the location of interest, providing greater accuracy compared to the wind atlases [8].
2. Distance to existing- and future planned offshore wind farms. The quality of wind measurements is increased when the wind is undisturbed, eliminating the need for corrections due to wind farm wakes or upstream installation activities.
3. Relative direction w.r.t. existing- and future offshore wind farms. Similar to the previous criterion, it is important to consider the relative position of a measurement location with respect to the surrounding wind farms and the prevailing wind speed. The measurement

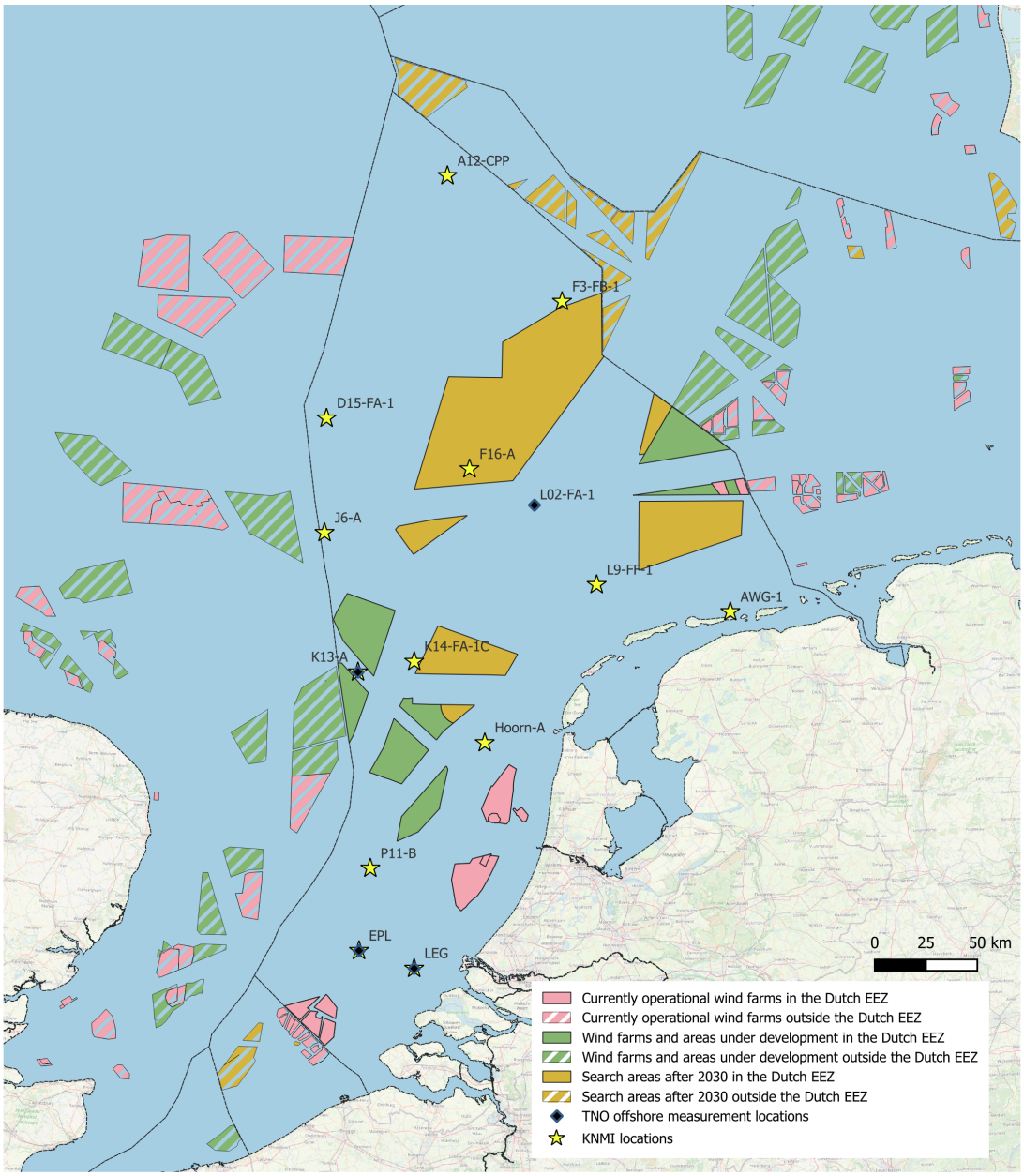


Figure 2.1: Wind farm zones in the North Sea up to and beyond 2030, together with existing measurement locations in the Dutch EEZ. Geospatial data of the wind farm zones is sourced from the North Sea Energy database [7].

location will lose its value if the wind is disturbed by the wake of existing- or future offshore wind farms.

4. Distance to existing TNO measurement locations. Platforms that are at a greater distance w.r.t. existing measurement locations are preferred, because the wind conditions will be mapped over a larger area in the North Sea, increasing the value of the measurements.

5. Existing KNMI measurement locations. Platforms that already include a KNMI measurement station are preferred, because data transmission infrastructure is already in place and may be shared. Furthermore, the wind direction measurements from KNMI could be used to verify and correct the wind directions measured by the lidar systems.

6. Operational status of the production platform, and expected Cessation Of Production (COP) date. Platforms with a later COP-date provide the opportunity to perform wind measurements for a longer time period, thereby increasing their value [5].

For this study, it was not possible to include the expected COP-date as this data was not available, and will therefore, not be part of the trade-off. Instead, a shortlist of preferred platforms will be presented in the conclusions that is based on the remaining criteria. Subsequently, the operators of these platforms will be contacted to ascertain the likelihood of the platforms remaining operational until 2030. Only after obtaining confirmation from the operators regarding the operational status can a final decision on the selected platform be made.

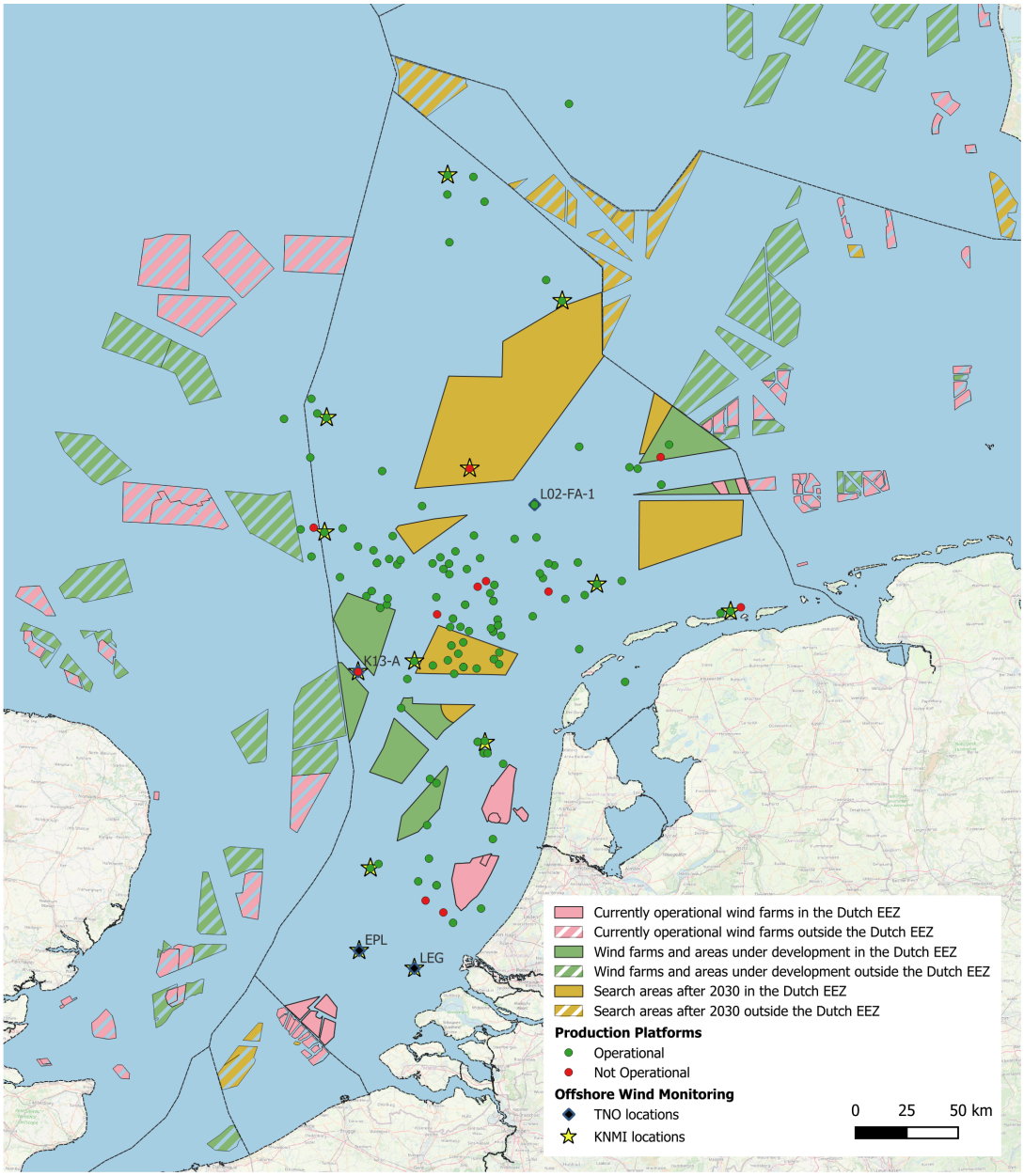


Figure 2.2: Existing offshore oil- and gas platforms in the Dutch EEZ. Data sourced from NLOG [9].

## 2.2 Trade-Off

Many offshore oil and gas production platforms are currently operational in the Dutch EEZ, with a particularly high density in the area between measurement locations K13-A and L02-FA-1. Figure 2.2 provides an overview of all production platforms, based on data from [9]. Figure 2.3 offers a closer look at the wind farm search areas. It is worth noting that there are numerous non-Dutch wind farms either operational or under development in the vicinity of the Dutch wind farm search areas. The influence of these international wind farm areas must also be considered in the platform selection.

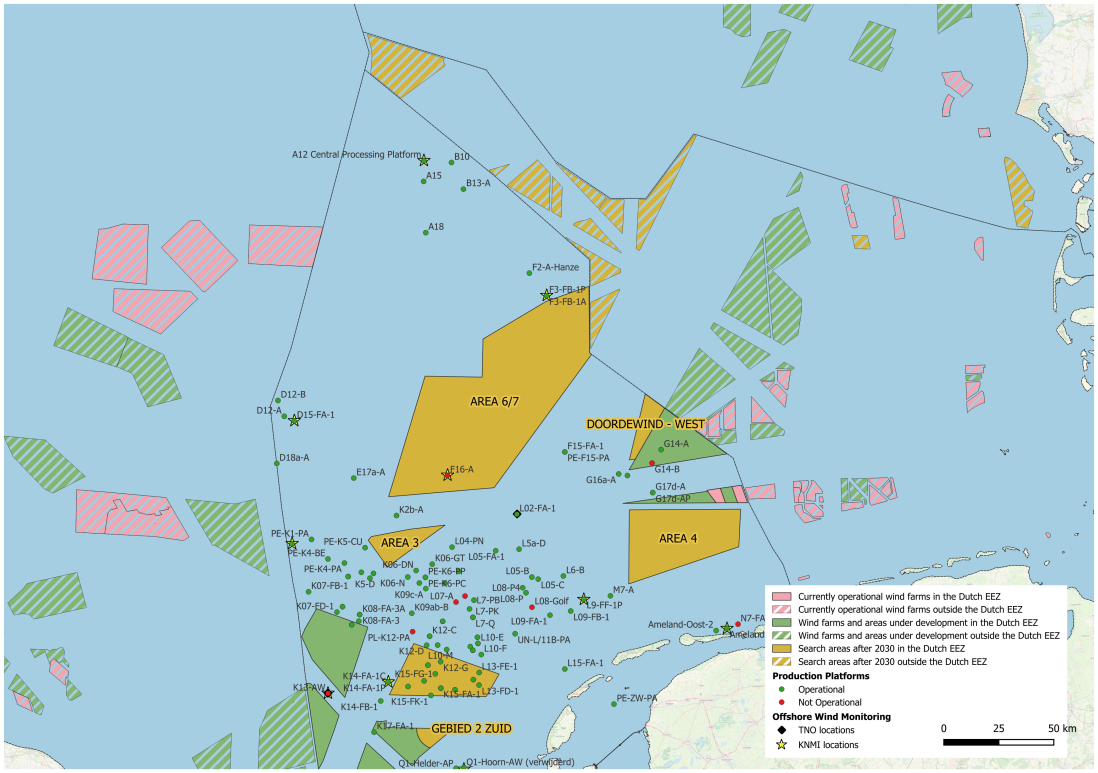


Figure 2.3: Production platforms in the neighbourhood of wind farm search areas after 2030.

Since the analysis is centered around search area 6/7, we limit ourselves to those platforms that are in the northernmost part of the Dutch EEZ. The platforms of interest are the ones shown in figure 2.4. In a previous study [6], platforms F3-FB, F3-FB-LT and A12-CPP had been identified as recommended platforms for this sector, being strategically located for monitoring the wind conditions of future wind farms after 2030. Nevertheless, other platforms in the northern sector of the Dutch North Sea, which were previously not considered, could potentially also be of interest.

In order to further narrow down the list of platforms to consider for the selection procedure, it can be argued that platforms F15-FA and F15-FA-1 are too close to the existing TNO measurement location L2-FA-1, as they are within 50 km radius of the platform. Platform F16-A also falls within this range. And although KNMI platforms are favored, it has already been announced that the latter platform will be decommissioned by the end of 2028 [10].

Platform D18a-A is located west of search area 6/7 and could be considered a strategically suitable location. However, it is within 30 km of UK wind farms and areas under development. Considering the effect of wind farm wakes on wind measurements, it is important to account

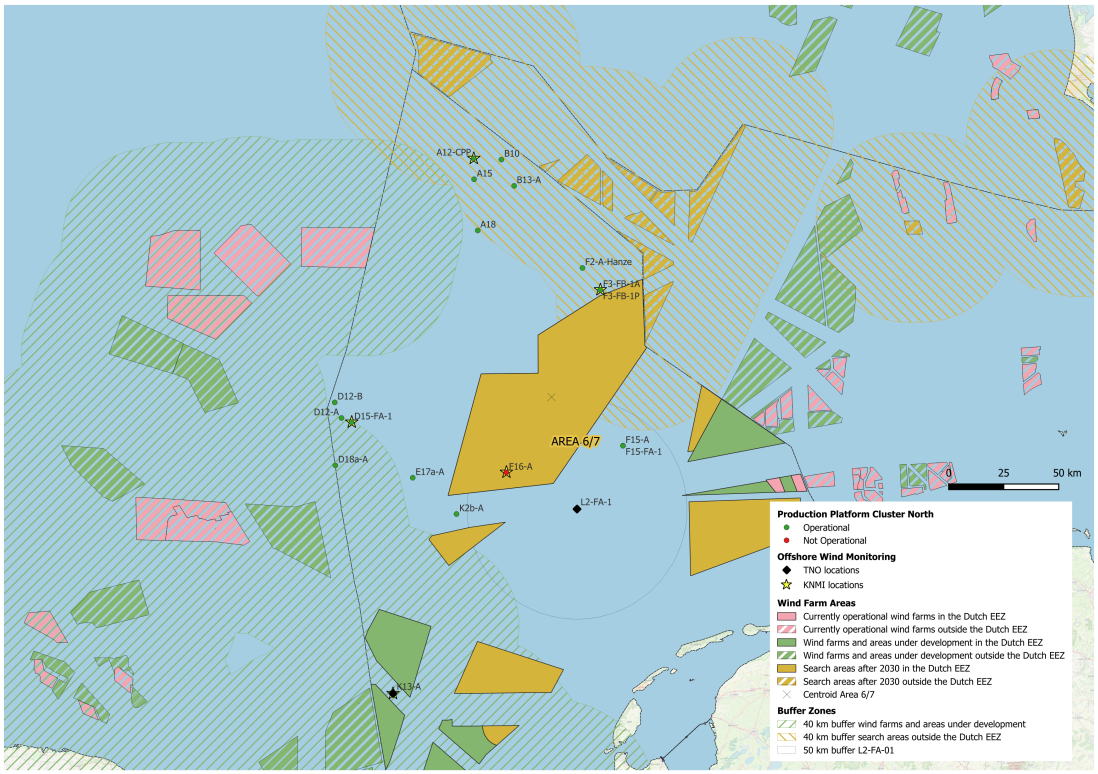


Figure 2.4: Production platforms of interest in the proximity of area 6/7, and buffer zones around wind farm areas up to and beyond 2030.

for the prevailing wind direction in the North Sea. Figure 2.5 illustrates the wind roses of TNO's four measurement locations. Because of the alignment between platform D18a-A and the UK wind farm in the prevailing wind direction, the platform is expected to be situated in the wind farm's wake roughly 30% of the time, considering the wind roses. Consequently, the wind will likely be too disturbed to obtain high-quality wind measurements at this location.

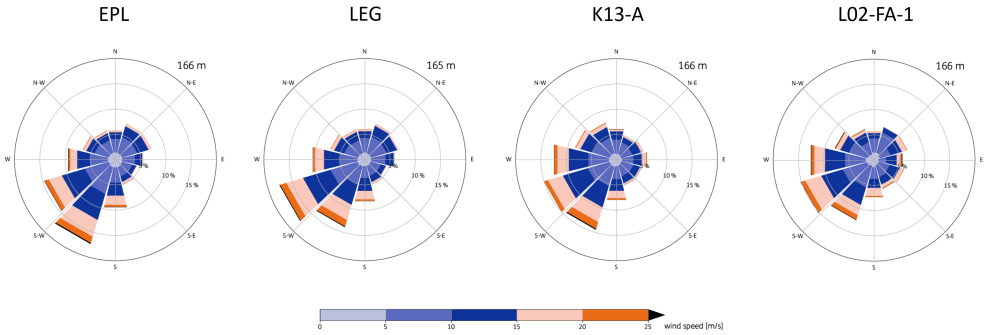


Figure 2.5: Wind rose at approximate hub height of the four TNO measurement locations.

Platforms D12-A, D12-B and D15-FA-1, are located further away from the aforementioned wind farms, as they are located just outside the 40 km buffer zone. Because they are clustered together, platforms D12-A and D12-B will be discarded from the selection procedure in favor of D15-FA-1 because the latter is also a KNMI location. However, it has been demonstrated in a previous study that the wind speed deficit in the wake of a wind farm can still be in the order of 10% at a distance of 40 km downstream of the wind farm [8]. Furthermore, platform D15-FA-1 is located further away from the centroid of search area 6/7 compared to L2-FA-01.

Platforms E17a-A and K2b-A are situated outside of this 40 km buffer zone and rather close to search area 6/7. However, E17a-A will likely still register disturbed wind data from the WSW wind direction sector. K2b-A could be a better option but is relatively close to both the existing measurement stations L2-FA-1 and K13-A, making it less useful.

North of Area 6/7, there is a cluster of four platforms in the northernmost area: A12-CPP, A15, B10, and B13-A. Their positions relative to the search area of interest and surrounding wind farm areas are similar. However, platform A12-CPP is also a KNMI location, making it the preferred option from this cluster. Nonetheless, it is located about 85 km away from the search area boundary, which might limit its value.

Platform A18 is relatively isolated in the northern sector and presents a promising option. It might experience some wind speed disturbance from the W-WNW direction due to the wake of the UK wind farms. However, this platform presents an excellent opportunity to conduct wind farm wake analysis, as measurements taken here can be compared with data from the KNMI measurement station at platform A12-CPP. Positioned approximately 30 km from A12-CPP, the wind measurements at A18 are likely to show a high correlation with those at A12-CPP. When one platform experiences undisturbed wind, the other might be within the wake of the UK wind farms, and vice versa, particularly during westerly or south-westerly winds. This positioning makes A18 an excellent candidate for a wind farm wake analysis study. It must be noted though, that a wake analysis is not the main goal of this study. And like the northern cluster of platforms, platform A18 is also still relatively far from search area 6/7.

Lastly, platforms F3-FB-1 and F2-A-Hanze seem like excellent options. They are located far from any wind farm currently in operation or development and are in the direct vicinity of the search area of interest. It is highly unlikely that wind farm development in the areas around search area 6/7 will commence before 2030, making these platforms excellent candidates for long-term wind resource measurement. Of these platforms, F3-FB-1 is the preferred option because it also houses a KNMI meteorological measurement station.

## 2.3 Recommended Platforms

The final list of recommended platforms is, in order of preference:

1. **F3-FB-1**: Located near the border of search area 6/7, without any surrounding wind farms in operation or development, and being a KNMI measurement station, this platform would be the preferred option, provided it is expected to remain operational until at least 2030.
2. **F2-A-Hanze**: Similarly located as the first option, this would be the second choice. However, the downside is that there is no KNMI measurement station present on this platform.
3. **D15-FA-1**: Although situated at the 40 km buffer boundary of a UK wind farm in development, this platform is strategically located with respect to existing TNO measurement locations L2-FA-1 and K13-A. Additionally, it is a KNMI measurement location. Therefore, this platform could be a good alternative if the platforms in the first two options are expected to be decommissioned within the next five years.

Alternatively, platforms A18 and A12-CPP could be considered if the Netherlands decides to explore the possibility of developing wind farms north of search area 6/7. Furthermore, platform A18 presents a unique opportunity to conduct a wind farm wake study.

# 3 Conclusions

To support further rollout of offshore wind energy in the Netherlands beyond 2030, this study aimed to identify a suitable offshore platform to expand the measurement campaign towards search area 6/7 in the northern part of the Dutch EEZ. Candidate platforms were identified through a visualisation of wind farm zones and existing offshore platforms, followed by a qualitative trade-off based on a number of criteria: distance to the area of interest, distance from neighbouring wind farm zones, alignment with prevailing wind speed, distance w.r.t. existing TNO measurement locations, and whether the platform also houses a KNMI meteorological measurement station. The expected cessation of production (COP) date is an important criterion as well, as the value of wind resource measurements is increased if measurements are conducted for a longer period of time. Unfortunately, this data was unavailable, and a shortlist with preferred options was made without this information.

The recommended platforms, in order of preference, are F3-FB-1, F2-A-Hanze, and D15-FA-1. It should be noted that it is necessary to confirm with the platform operators when the expected COP date is foreseen before making a final decision. If none of these platforms represent acceptable options or if there is a future expansion of the TNO measurement campaign, it is recommended to consider platforms A18 and A12-CPP as new measurement locations. The former provides an excellent opportunity to conduct wind farm wake analysis, while the latter is strategically located in the northernmost sector of the Dutch EEZ. This positioning could facilitate long-term measurements should the Netherlands decide to explore wind farm development north of search area 6/7.

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