

REPORT

Offshore Wind Capacity Dogger Bank

Client: TenneT TSO B.V.

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HASKONINGDHV NEDERLAND B.V.

Laan 1914 no.35
3818 EX Amersfoort
Netherlands
Water
Trade register number: 56515154

+31 88 348 20 00 **T**
+31 33 463 36 52 **F**
info@rhdhv.com **E**
royalhaskoningdhv.com **W**

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Author(s): Saskia Mulder

Drafted by: Saskia Mulder, Maarten de Rijk

Checked by: Erik Zigterman

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Approved by: Erik Zigterman

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Table of Contents

| | | |
|----------|---|----------|
| 1 | Introduction | 1 |
| 2 | Current situation Dogger Bank | 1 |
| 3 | Capacity on the Dogger Bank | 3 |
| 3.1 | Wind energy capacity without any other function | 3 |
| 3.2 | Wind energy capacity with current functions (2017) | 3 |
| 3.3 | Wind energy capacity: current functions without O/G (2035-2040) | 4 |
| 4 | Conclusions | 8 |

1 Introduction

TenneT TSO B.V. is developing a long term strategy for an offshore grid after 2023. In the European political declaration of 6 June 2016 on energy cooperation it is stated that ‘the North Sea countries are to enhance their collaboration in order to better utilise the potential of the North Sea as an area for wind farms. Alongside ensuring a secure and affordable energy supply, this will enable a significant contribution to be made to the goal of reducing CO₂ emissions on a European scale by 80 to 95% by 2050’.

TenneT TSO B.V. has asked Royal HaskoningDHV (RHDHV) to give an overview of the capacity of Offshore Wind on the Dogger Bank. The Dogger Bank is an area that is located in Exclusive Economic Zones (EEZ) of different countries and is an interesting location for offshore wind, because:

- It is a relative shallow area on a windy spot;
- Water depth is an important factor in the cost of Offshore Wind. Water depth on the Dogger Bank is between -20 and -40m;
- It may function as a centre for an offshore High Voltage (HV) grid.

This report gives an answer to the following questions:

1. What is the current situation on the Dogger Bank, which functions are present at the moment?
2. What is the available area for offshore wind per country, for the different depths?
3. How many Gigawatt (GW) offshore wind can be placed on the Dogger Bank in the current and the future situation?

The answers to these questions are based on our spatial knowledge of the North Sea and the data from the Noordzeeatlas. In some cases we have made some assumptions; these will be explained where applicable.

2 Current situation Dogger Bank

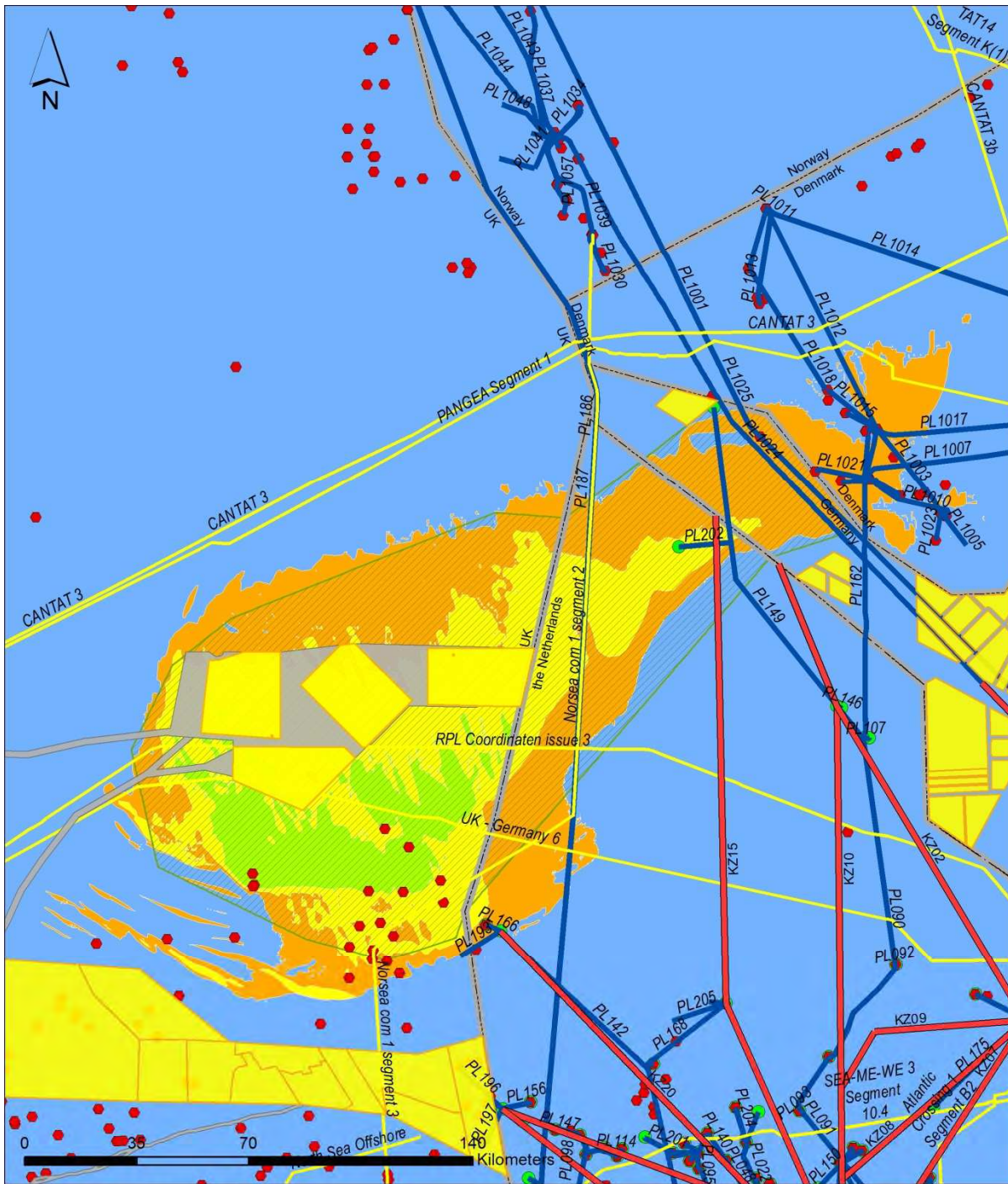
In *Figure 2.1* an overview of all current functions on the Dogger Bank and the water depth is given. It shows that half of the Dogger Bank has a depth < -30 m and half of the area has a depth between -30 m and -40 m. It also shows that there are currently oil & gas platforms mainly located in the United Kingdom (UK) and Denmark (DK) part of the Dogger Bank and several cables and pipelines are crossing the Dogger Bank area. However, compared to the southern North Sea, the Dogger Bank is rather ‘empty’ and compared to the northern North Sea it is rather shallow. This gives good opportunities for future offshore wind.

The Dogger Bank is not designated as a wind energy area in The Netherlands, Germany and Denmark yet, in the United Kingdom part of the area is designated and for 4 offshore wind farms of 1.200 MW per area permits are consented














The Dogger Bank is a Natura 2000-site (in UK, NL and Germany (DE)), which means:

- Nature values are protected;
- No significant impact is allowed;
- An Appropriate Assessment is required before wind farms and the accompanying infrastructure can be built in this area.

We consider the Dogger Bank as a whole (shallow area above -40 m, orange area in figure 2.1) in this report, not only the area within the border of the Natura 2000 site Dogger Bank (green hatched area).



Dogger bank: Overview

- | | |
|---|---|
| Dogger bank Wind Park |  Borders |
|  1m - -20m |  Dogger bank |
|  -20m - -30m |  Helicopter Main Route |
|  -30m - -40m |  Electricity cable |
| Wind Farm Parcels |  Telecom cable |
|  Wind Farm Parcels |  Gas/Olie pipeline |
|  Wind Farm Export Cable Agreements |  Platform with Helideck |
| |  Platform without Helideck |

Figur 2.1 Overview of the functions that are present on the Dogger Bank

3 Capacity on the Dogger Bank

For the analyses we assume that it is possible to build **5 MW/km²** on the Dogger Bank. In the future there will be larger wind turbines available than now, but larger turbines need more space between turbines because of impact of wake. Therefore we assume that the average capacity per km² will not be much higher than it is at the moment.

We have analysed the following scenarios:

1. Wind energy capacity without any other function
2. Wind energy capacity with current the functions in 2017
3. Wind energy capacity with current functions but without oil & gas infrastructure (2035-2040).

3.1 Wind energy capacity without any other function

The available area in km² and corresponding wind energy capacity in GW per depth class and country without any other function on the Dogger Bank is presented in Table 3.1 and Figure 3.1. *Figure 3.1* presents the areas on the map, *Table 3.1* presents the size of the available areas and the calculated potential GW wind energy capacity.

Table 3.1: Available area and corresponding wind energy capacity per depth class and country without other functions

| | UK (km ²) | UK (GW) | NL (km ²) | NL (GW) | DE (km ²) | DE (GW) | DK (km ²) | DK (GW) | Total size | Total GW |
|----------------------|--------------------------|------------|--------------------------|------------|--------------------------|------------|--------------------------|------------|---------------|-------------|
| Between 0 and -20m | 2.567 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 2.567 | 13 |
| Between -20 and -30m | 6.418 | 32 | 1.687 | 8 | 39 | 0,2 | 0 | 0 | 8.143 | 41 |
| Between -30 and -40m | 5.076 | 25 | 3.106 | 16 | 1.440 | 7 | 1.638 | 8 | 11.260 | 56 |
| Total | 14.061 | 70 | 4.793 | 24 | 1.479 | 7 | 1.638 | 8 | 21.971 | 110 |

In total the surface of the Dogger Bank is **21.970 km²** which has a potential offshore wind energy capacity of **110 GW**.

3.2 Wind energy capacity with current functions (2017)

Currently functions like oil & gas, electricity and telecom cables use part of the area of the Dogger Bank, not only with their footprint but also through safety zones where building of turbines is prohibited. In this assessment we use the safety regulations that are used in the Netherlands. For other countries these might be slightly different. For pipelines and cables we use a 500 m safety zone, for helicopter main routes a 2 Nautical Mile (NM) safety zone and for O/G-platforms with a helicopter deck a safety zone of 5 NM. *Figure 3.2* presents these functions with their safety zones and the areas per depth class and country on the map; *Table 3.2* presents the size of the available area and the calculated wind energy capacity in GW.

Table 3.2: Available area and corresponding wind energy capacity per depth class and country with oil-and-gas functions in place (2017)

| | UK (km ²) | UK (GW) | NL (km ²) | NL (GW) | DE (km ²) | DE (GW) | DK (km ²) | DK (GW) | Total Size | Total GW |
|----------------------|--------------------------|------------|--------------------------|------------|--------------------------|------------|--------------------------|------------|---------------|-------------|
| Between 0 and -20m | 1.804 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 1.804 | 9 |
| Between -20 and -30m | 5.314 | 27 | 1.336 | 7 | 36 | 0,2 | 0 | 0 | 6.686 | 33 |
| Between -30 and -40m | 4.433 | 22 | 2.666 | 13 | 974 | 5 | 706 | 4 | 8.779 | 44 |
| Total | 11.551 | 58 | 4.002 | 20 | 1.010 | 5 | 706 | 4 | 17.269 | 86 |

In total the surface that is available respecting the current functions for O/G-infrastructure is **17.269 km²**, which has a potential wind energy capacity of **86 GW**. The O/G functions englobe a total surface of 4.701 km² which account for the difference of 24 GW in offshore wind capacity.

3.3 Wind energy capacity: current functions without O/G (2035-2040)

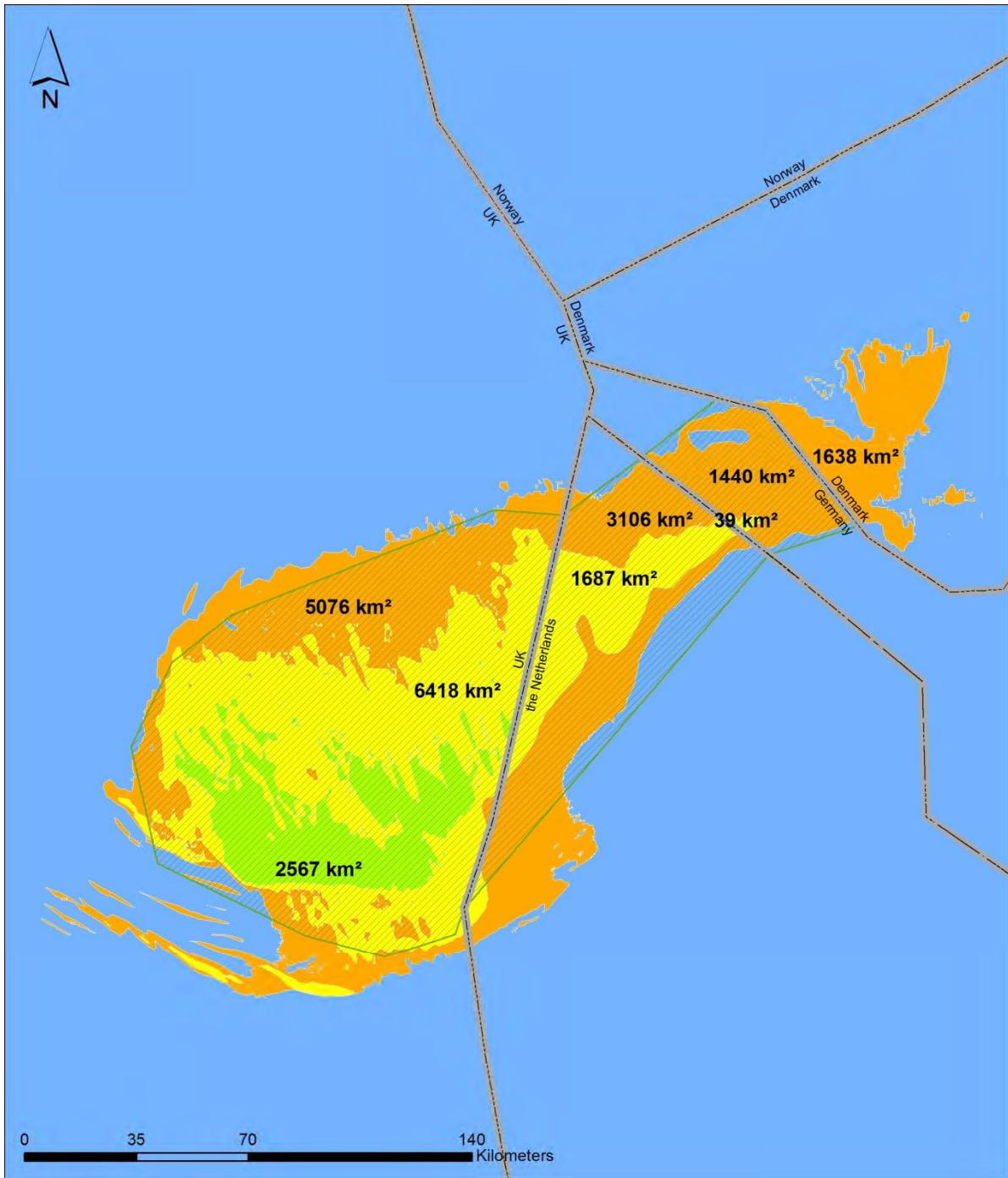
It is expected that a large part of the current oil & gas (O/G) platforms and the related infrastructure will be decommissioned during the coming decades. This has to do with declining level of accessible oil & gas reserves and the reaching of the life span of the platforms and the infrastructure. For this scenario we have assumed that most current platforms will be decommissioned by the time offshore wind farms are planned to be built in the part of the Dogger Bank where this O/G still is available today. Also we presume that most new O/G-platforms will be satellite platforms without helicopter decks or subsea installations.

We presume therefore that 90 % of the space currently used for O/G infrastructure becomes available as from (about) 2035-2040 for wind offshore energy development. *Figure 3.3* presents the cables with their safety zones and the areas per depth class and country on the map; *Table 3.3* presents the sizes of the areas in km² and the wind energy capacity in GW.

Table 3.3 Available area and corresponding wind energy capacity per depth class and country with only 10 % remaining oil & gas infrastructure (unknown where) (2035-2040)

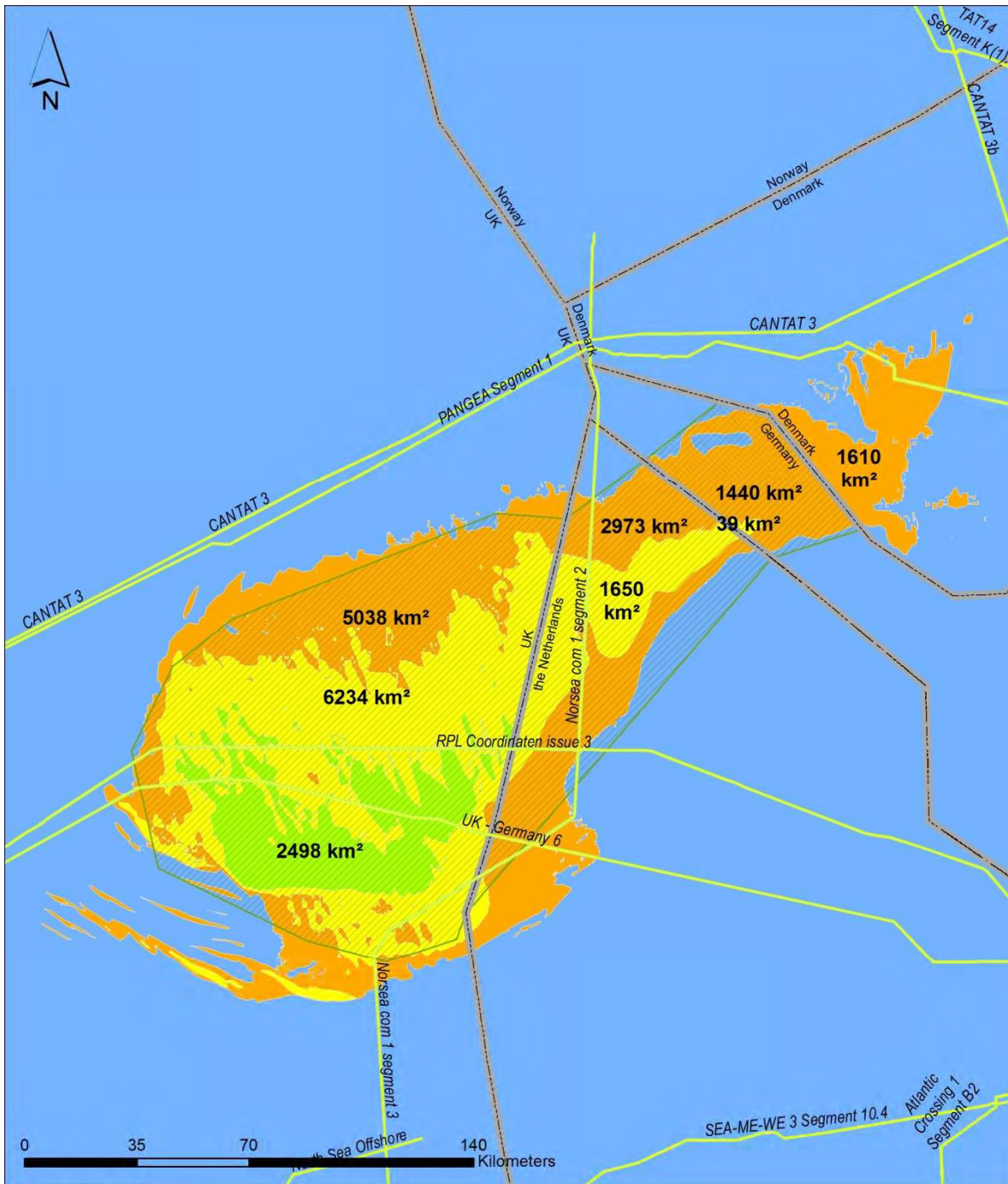
| | UK (km ²) | UK (GW) | NL (km ²) | NL (GW) | DE (km ²) | DE (GW) | DK (km ²) | DK (GW) | Total Size | Total GW |
|----------------------|--------------------------|------------|--------------------------|------------|--------------------------|------------|--------------------------|------------|---------------|-------------|
| Between 0 and -20m | 2.248 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 2.248 | 11 |
| Between -20 and -30m | 5.611 | 28 | 1.485 | 7 | 34 | 0,2 | 0 | 0 | 7.130 | 36 |
| Between -30 and -40m | 4.534 | 23 | 2.676 | 13 | 1.296 | 6 | 1.449 | 7 | 9.955 | 50 |
| Total | 12.393 | 62 | 4.161 | 21 | 1.330 | 7 | 1.449 | 7 | 19.333 | 97 |

In total, the area that is available with only 10 % of the oil & gas in place (in comparison to the current situation in 2017) is **19.333 km²**, which has a potential wind energy capacity of **97 GW**. This means that when oil & gas will be decommissioned an additional area of 2.046 km² becomes available for wind energy development which is equal to an **extra 11 GW** in offshore wind capacity.



Dogger bank
Dogger bank Wind Park S0
 1m - -20m
 -20m - -30m
 -30m - -40m
 Borders
 Dogger bank

Figure 3.1 : Only wind energy in Dogger Bank.



Dogger bank

- | | |
|---|---|
| Dogger bank Wind Park |  Borders |
|  1m - -20m |  Dogger bank |
|  -20m - -30m |  Electricity cable |
|  -30m - -40m |  Telecom cable |
| |  Cables safety zone 500m |

Figure 3.3 – Situation 2035-2040 (all O/G infrastructure decommissioned)

4 Conclusions

In *Table 4.1* the offshore capacity of the different scenario's in the English, Dutch, German and Danish part of the Dogger Bank are given. Obviously the most capacity is available in the English and Dutch parts, as these are much larger areas.

When 90% of the oil & gas infrastructure will be decommissioned in the coming decades, this will provide 11 GW extra capacity. Most of the platforms are situated in the UK part of the Dogger Bank, which means that the most capacity will be gained there.

Table 4.1 Potential offshore wind capacity per scenario and country

| Wind capacity in GW per country and scenario | UK | NL | DE | DK | Total |
|---|----|----|----|----|------------|
| 1. Wind energy capacity without any other function | 70 | 24 | 7 | 8 | 110 |
| 2. Wind energy capacity with current functions (2017) | 58 | 20 | 5 | 4 | 86 |
| 3. Wind energy capacity with 10% of oil & gas (2035-2040) | 62 | 21 | 7 | 7 | 97 |