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THOR OFFSHORE WIND FARM

RADAR AND RADIO INTERFERENCE

RAMBØLL

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1. SUMMARY

The presence of offshore wind turbines can affect radar systems through shadow effect and/or reflections. In addition, offshore wind turbines, if placed in sight lines for radio links, may block or degrade the signals for telecommunication and data transmission of, for example, radio and TV signals.

The purpose of this background document is to map and describe existing radar systems (used for civil or military purposes) and radio links as well as assess potential impacts caused by the presence of wind turbines and possible mitigation measures.

1.1 Radar systems

The closest radars in relation to the plan for the Thor Offshore Wind Farm are the radars in Thyborøn, Hanstholm and Oksbøl used by the Danish Defence. The radars are used for water monitoring and flight registration and are approx. 30 km, 80 km and 75 km from the project area, respectively.

Establishment of Thor Offshore Wind Farm will impact the radar in Thyborøn and possibly the radars in Hanstholm and Oksbøl. It is assessed that the impacts on the Danish Defence's radars as a result of the establishment of Thor Offshore Wind Farm are moderate and the need of mitigation measures must be anticipated.

Mobile radar systems on ships in the vicinity of an offshore windfarm will be affected similar to the surveillance radars on land. The impact is however assessed to be smaller. Sailing safety in the area as a result of a possible offshore wind farm is described in the background report on Maritime Traffic and Safety of Navigation /13/.

Once the final layout of Thor Offshore Wind Farm has been determined, a concrete assessment of the offshore wind farm's impact on the radars must be prepared, as well as measures to ensure water and aircraft monitoring.

1.2 Radio links

There are no point-to-point permits for radio links established over the project area for Thor Offshore Wind Farm, and there is no knowledge of radio chains established according to a surface permit over the area, i.e. where the permit covers an area and the actual positions of the radio antennas are unknown. The establishment of Thor Offshore Wind Farm will therefore not have an impact on existing radio links.

2. INTRODUCTION

2.1 Background

In June 2018, as part of the Energy Agreement 2018, the Danish Parliament decided to build three new offshore wind farms in Denmark before 2030.

Based on a screening study the DEA made the decision in February 2019 for the project development of an area in the North Sea approx. 20 km off the coast of Jutland for the new Thor Offshore Wind Farm with a minimum capacity of 800 MW.

In February 2019 the DEA instructed Energinet to initiate site investigations, environmental and metocean studies and analysis for grid connection for this area. Energinet is therefore carrying out environmental surveys and a Strategic Environment Assessment (SEA) of the plan for Thor Offshore Wind Farm.

The purpose of this background document is to map and describe existing radar systems (used for civil or military purposes) and radio links as well as assess potential impacts on these caused by the potential construction, operation and decommissioning of Thor Offshore Wind Farm. Furthermore, relevant mitigation measures will be proposed as part of the work.

The presence of offshore wind turbines can thus affect radar systems through shadow effect and/or reflections. In addition, offshore wind turbines, if placed in sight lines for radio links, may block or degrade the signals for telecommunication and data transmission of, for example, radio and TV signals.

3. PROJECT PLAN

The plan for Thor Offshore Wind Farm sets out the overall framework for designing an offshore wind farm approx. 20 km from the coast off Thorsminde on the west coast of Jutland, refer to Figure 3-1. The offshore windfarm planned for must be able to provide a minimum of 800 MW and a maximum of 1,000 MW to the national Danish power grid. The decision on the location for the possible offshore windfarm is based on a fine screening of possible installation areas carried out by COWI for the Danish Energy Agency in December 2018.

The plan establishes a framework for a future offshore windfarm with associated onshore facilities, but only at an overall level. At this stage there is thus no knowledge of the offshore wind farm's specific design, including the number, size and location of offshore wind turbines.

Figure 3-1 Area covered by the plan for the Thor Offshore Wind Farm

Wind turbines with a capacity in the range of 8 - 15 MW are expected. The minimum turbine capacity of 8 MW corresponds to the installation of up to 125 turbines, and that the maximum turbine capacity of 15 MW corresponds to the installation of up to 66 turbines. In order to take into account the possible technological development, the starting point for this study is therefore the turbine sizes below (Table 3-1).

Table 3-1 Examples of wind turbine dimensions

	8 MW turbine	15 MW turbine
Rotor diameter, m	170	260
Hub height, m	105	150
Tip height, m	190	280

As described, the park layout and turbine design is not decided at this stage, and the assessments in this study are therefore performed on a general level taking into account various possible variations in park size, variations in turbine design and the resulting variation in the number of turbines, as well as variation in park-layout. There several different park layouts, that can lead to the final, concrete project. The specific project including park layout will therefore have to undergo an EIA at a later stage.

4. EXISTING CONDITIONS

4.1 Methodology

For the mapping of radar systems data have been collected from relevant publicly available registers, authorities as well as through communication with relevant stakeholders. A meeting was held with the Royal Danish Navy (Marinestaben) on 8th of January 2020 /1/ to obtain information on the location and type of military radar systems in a radius of influence of the location of the offshore wind farm and to discuss possible impact on the radar systems and relevant mitigation measures.

Mapping existing and planned radio links near the offshore wind farm area has been carried out based on data collection from relevant public available registers (Frekvensregisteret /14/) and authorities. Based on the mapping of radio links, an assessment is performed of the potential impacts caused by the wind farm.

4.2 Radar systems

Radar is an abbreviation for RAdio Detection And Ranging. A radar works by emitting a pulse of radio waves in a given direction. If the wave strikes an object, it will be reflected as an echo. The radar receiver records the time it takes the radio wave to return and, on this basis, it is calculated how far the registered object is from the radar. Rotating radars make it possible to look in several directions.

Several radar system types exist in Denmark covering meteorological radar systems, civil radar systems for the surveillance of air traffic (airport radars), defence radar systems (including maritime traffic radars) as well as radar systems on ships.

The following sections describes the different types of radar systems that could potentially be affected by the Thor Offshore Wind Farm.

4.2.1 Meteorological radars

The Danish Meteorological Institute (DMI) has set up five radars in Denmark for registration of precipitation. The radars are located on the ground surface and scan the atmosphere with a range of up to 240 km. Within a range of 120 km (of each radar), the whole of Denmark's atmosphere is covered up to 1 km's height. The radars are located at Stevns, in Sindal, in Virring, on Rømø and on Bornholm and can be seen in Figure 4-1.

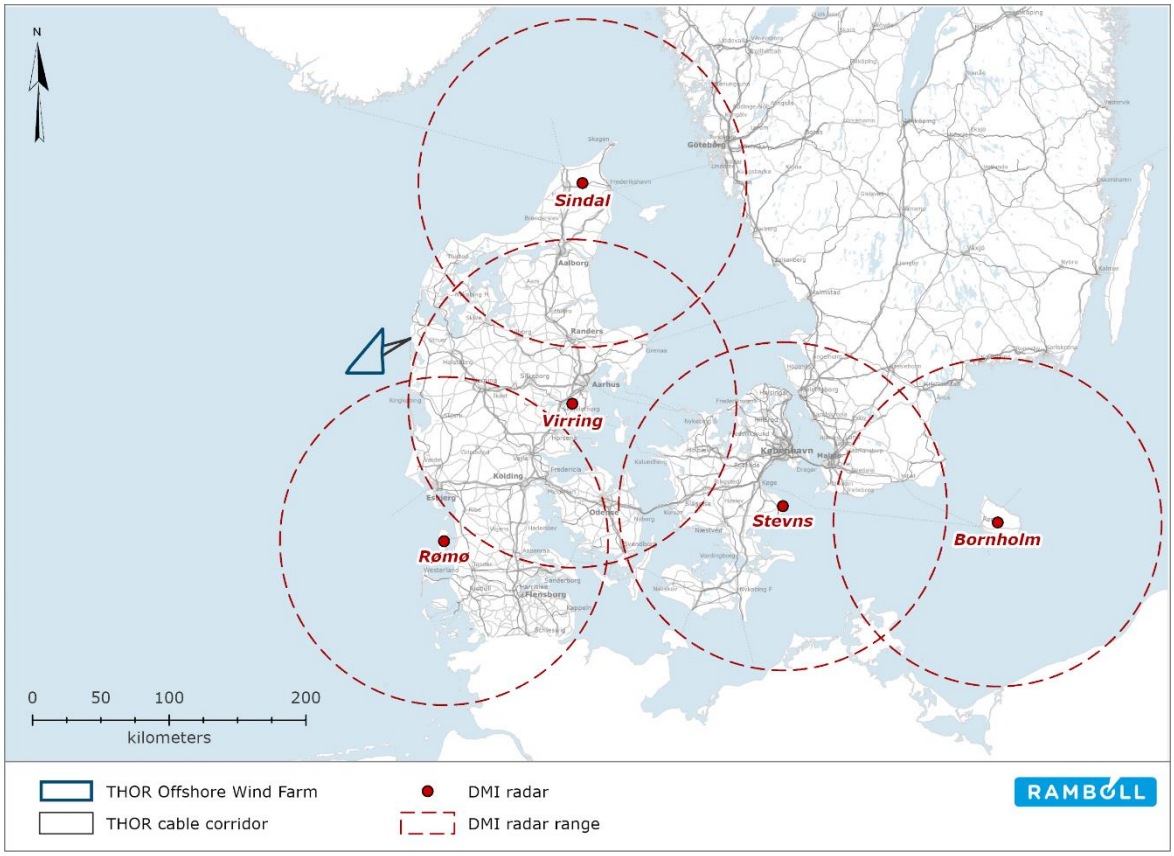

Figure 4-1 Location of meteorological radars in Denmark, with indication of 120 km range.

4.2.2 Civil aviation surveillance radar

To monitor air traffic in Denmark, airports use two different types of radar systems; a primary radar and a secondary radar.

A primary radar is a conventional radar that emits a pulse of radio waves as described initially in the section. Thus, a primary radar cannot see what is captured by the radar, simply that there is an object.

The major Danish airports have primary radars, but in practice use their secondary radars (see below) to monitor air traffic. In general, primary radars have a range of 60 nautical miles, corresponding to 111 km.

The secondary radar has a substantially longer range (250 nautical miles/463 km) and works by sending out a signal that is received by a transponder, which is currently mounted on all major aircraft. The transponder returns the flight position and a code, and by means of the code each aircraft is identified, /2//3/.

At Ramme town there is a navigation facility with a respect zone of 15 km in radius for wind turbines /4/, see Figure 4-2. The purpose of the navigation system is to send out radar signals so that aircrafts can calculate their exact position. The facility is owned by Naviair, which is an independent public company owned by the Danish state at the Ministry of Transport. Their purpose is, among other things, to provide infrastructure for civil aviation.

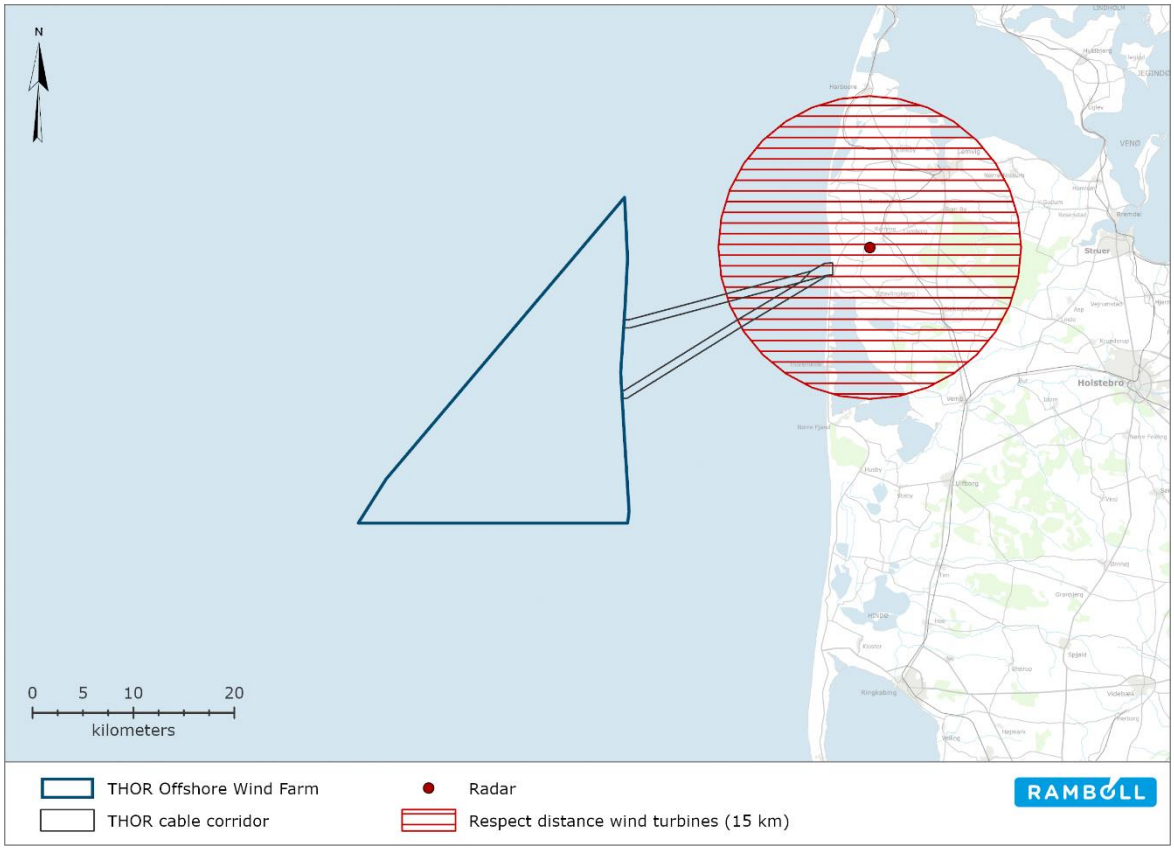

Figure 4-2 Location of navigation radar in Ramme and surrounding 15 km respect zone for wind turbines

4.2.3 Surveillance radars of the Danish Defence

In Denmark, the Royal Danish Navy and Royal Danish Air Force (Flyverstaben) carry out maritime surveillance and flight registration using radars. The maritime surveillance is supported by two maritime surveillance centres located in Frederikshavn and Bornholm, as well as coastal observation stations, patrol vessels, and Vessel Traffic Service (VTS) at the Great Belt and the Sound. Figure 4-3 shows where the Royal Danish Navy have set up primary radars for maritime surveillance in Denmark.

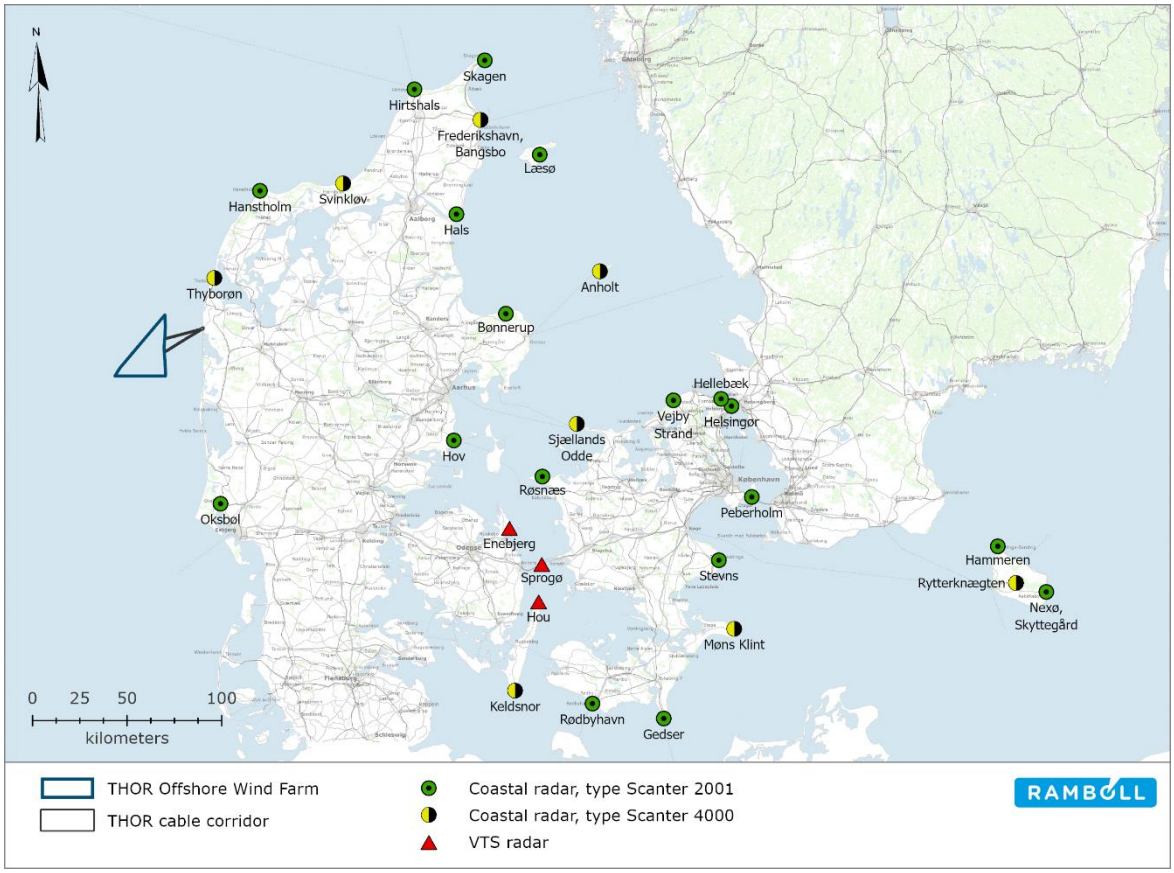

Figure 4-3 Location of radars in Denmark used for maritime surveillance

The closest radars in relation to the project area for the planned Thor Offshore Wind Farm are the radars in Thyborøn, Hanstholm and Oksbøl.

In Thyborøn, a Scanter 4000 type radar has been set up, which is a combined surface and low air warning radar that can detect and follow ships as well as low-altitude aircrafts. A Scanter 4000 radar consists of two rotating antennas and associated radar equipment typically located in a building on ground. The radar in Thyborøn is located at the harbour in an altitude of 36 m and approx. 30 km northeast of the Thor Offshore Wind Farm area /5/. Figure 4-4 shows an image of a Scanter 4000 radar.

In Hanstholm and Oksbøl radars of the type Scanter 2001 have been set up, which is a surface warning radar that can detect and track ships. The Scanter 2001 radar consists of a rotating antenna, as well as associated radar equipment, typically located in a building on ground. In Hanstholm the radar is located approx. 80 km northeast of the project area at Hjertebjerg approx. 60 m above sea level in a 60 m high mast. The radar in Oksbøl is located approx. 75 km southeast of the project area close to shore in a 60 m high mast /5/. Figure 4-4 also shows an image of a Scanter 2001 radar.

Figure 4-4 To the left is a Scanter 4000 radar, which is the type established in Thyborøn. To the right is a Scanter 2001 radar, which is established in Hanstholm and Oksbøl.

4.2.4 Mobile radar systems on ships

Mobile radar systems are used on many ships, especially commercial shipping, but also on ships for pleasure sailing, for navigation in order to avoid collisions. Especially in conditions with low visibility (night, fog, precipitation, etc.) or in stormy situations, ship radars are used as an important navigation tool.

Studies of ship traffic in the area around the project area for Thor Offshore Wind Farm show that the majority of commercial sailing occurs west of the area. These are larger tankers and container vessels. Fishermen and other smaller boats sail from the ports of Hvide Sande, Thorsminde and Thyborøn. Finally, there is a lot of yachting in the area. Please refer to the separate background report Maritime Traffic and Safety of Navigation /13/ for further details on sailing in the area.

4.3 Radio links

A radio link is a data connection between two positions. The connection is established by means of radio waves of very high frequency. Directional antennas are used, and a radio link is thus a wireless alternative to e.g. a cable connection.

Data collection from relevant publicly available registers (Frekvensregisteret /14/) have been used to investigate whether radio links are present near the offshore wind farm. Potential impacts on radio links consist of:

- Blocking of radio signal by the wind turbines.
- Reflection of radio signal by the wind turbines/wings that may interfere with main signal.

For a radio link connection to function optimally, there must be a direct view between two antennas. It is generally considered that a minimum distance of 200 m from a wind turbine or other obstruction to a sight line for a radio link is needed to avoid impact on the radio link /6/.

There are no point-to-point permits for radio links established over the project area for Thor Offshore Wind Farm, and there is no knowledge of radio chains established according to a surface permit over the area, i.e. where the permit covers an area and the actual positions of the radio antennas are unknown. This is because a radio link generally does not reach more than 75 km,

and there are no land or oil platforms within 75 km west of the study area. Thor Offshore Wind Farm will therefore not have an impact on existing radio links and will not be discussed further in the following.

5. ASSESSMENT OF POTENTIAL IMPACTS

Identification and assessment of potential impacts of radars is carried out on the basis of the activities defined in the plan for Thor Offshore Wind Farm setting out the overall framework for the design of the wind farm.

The impacts on radars and radio chains are assessed with a focus on the following factors:

- Intensity
- Spatial extent
- Duration
- Sensitivity of receptor
- Overall significance

5.1 Potential impacts

The distance between a radar and an offshore wind farm is an important property when estimating the extend of the impact from an offshore wind farm. In general, when significant parts of an offshore turbine, e.g. the rotor, are above the radar horizon, impacts will occur. The closer an offshore wind turbine is to a radar, the more likely it is to have an impact on the radar.

Whether an offshore wind farm will impact a radar also depends on factors such as; radar type and the layout of the offshore wind farm. The geographical distribution and set-up pattern as well as the number and dimensions of turbines are thus defining in relation to how much an offshore wind farm will impact the radar in question.

The general impacts of offshore wind farms on radar systems are given below:

- Formation of radar shadow behind wind turbines, which means that underlying targets are either not detected or can only be poorly followed.
- Reflection of radar rays in wind turbine towers and wings, which can give rise to false radar targets (false echoes).

Below is a general description of the potential impacts on different types of radar.

5.1.1 Meteorological radars

Offshore wind farms located near meteorological radars can give rise to false echoes that can be misinterpreted as weather phenomena such as rain/snow or thunderstorms. Weather radars are equipped with software that omits signals from objects that are completely stationary, such as a hillsides or tall buildings. Echoes from the turbine tower on a wind turbine that has no speed can also be reduced/removed. However, echoes from the rotating wings of wind turbines are somewhat more difficult to deal with on weather radars, as they can be easily confused with precipitation (particles at a velocity). Echoes coming from the rotating blades of an offshore wind farm can therefore lead to misinterpretation of weather conditions.

An offshore wind farm located close to a weather radar can also have the effect that part of the meteorological radar's measuring area is blocked, so that weather phenomena behind the offshore wind farm are not registered correctly (shadow area).

Weather radars are oriented towards the sky, in order to observe weather conditions. This means that only nearby wind turbines (or other tall installations) give rise to disturbances. According to guidelines from the English Meteorological Institute, it is recommended that no wind turbines be

placed closer than 5 km from weather radars and for wind turbines located closer than 20 km, it is recommended to carry out a study of impacts. Wind turbines located further away than 20 km can have an impact but will, if any, be significantly smaller /7/.

5.1.2 Civil aviation surveillance radar

Offshore wind farms located within the radar horizon of an airport's primary radar can cause reflection of radar beams in offshore wind towers and in the rotating wings, which can give rise to misinterpretation of echoes (false echoes). The misinterpretation may result in the determination of the distance or direction of an aircraft being incorrect.

In addition, offshore wind farms can give rise to the formation of radar shadows behind the offshore turbines so that flying aircraft behind them are either not detected or can only be poorly followed on the airport's primary radar.

For the secondary radars of the airports, which in practice are those used for air traffic monitoring, the possible impact will generally be less. However, if an offshore wind farm is located close to a secondary radar, as with the primary radar, reflections and blocking of signal may occur, which may cause airborne surveillance to deteriorate.

5.1.3 Surveillance radars of the Danish Defence

Offshore wind farms located within the radar horizon of the Danish Defence's radars used for maritime surveillance and flight registration on Danish territory can also give rise to the formation of radar shadow behind the wind turbines and reflections with false echoes as a result.

The Danish Defence's radars can thus - similar to civilian surveillance radars - misinterpret echoes so that the distance or direction to ships or aircraft is misjudged and / or experience impaired coverage behind the offshore wind farm. This can lead to aircrafts or ships not being detected or only poorly followed on the radar.

As previously described, radar shadow and false echoes could occur if significant parts of the offshore wind turbine are above the radar horizon. Basic geometrical considerations, taking the Earth’s curvature, atmospheric refraction, and a radar antenna height of 35 m into account, suggests that a turbine with a tip height of 280 m may be visible within 94 km from the radar. It is therefore reasonable to assume that impacts will arise on the radar in Thyborøn. The radars in Hanstholm and Oksbøl may also be impacted, however to a lesser degree.

The radar type Scanter 4000 (at Thyborøn) is used for monitoring airspace and surface, while the radar type Scanter 2001 (at Hanstholm and Oksbøl) is primarily used for surface monitoring. These types of radar will all potentially be affected by the Thor offshore wind farm.

Terma, the manufacturer of the Scanter coastal radars, has performed various tests to investigate whether upgrading/replacement of radar systems can optimize the detection of aircraft in wind turbine areas. Tests were performed on Horns Rev I and II with the Scanter 4002 radar system. A small test aircraft (Grumman GA-7) made flights over the two offshore wind farms from different directions, at different altitudes, at varying speeds and in different weather conditions. The tests showed that with the Scanter 4002 radar system, the aircraft could be registered and tracked on flights over the two offshore wind farms /8/,/9/.

The study with Scanter 4002 and other similar studies indicates that the impact of ship and aircraft monitoring caused by offshore wind farms can be reduced by establishing the right mitigation measures /8/,/9/,/10/,/11/. By request from the Danish Defence, this should be investigated

more thoroughly when the design and layout of the Thor Offshore Wind Farm is known /1/. The investigation could consist in simulations of the effect of wind turbines on radar signals, following the Eurocontrol Guidelines (see section 9 below).

Anholt Offshore Wind Farm, which was commissioned in 2013, has been shown to affect the Scanter 4000 radar on Anholt. The radar monitors both airspace and surface, but the impact has primarily been shown on maritime surveillance. The rotating blades of the offshore turbines give rise to false echoes on the radar system, which makes it difficult to monitor the area within the offshore wind farm /15/.

5.1.4 Mobile radar systems on ships

The mobile radar systems (ship radars), which are primarily used for navigation, are affected in the same way as the stationary systems, i.e. by potential radar shadows and false echoes, and can thus disturb navigation in the area.

A separate sailing safety report is prepared, including risk assessments in relation to, for example, ship collisions, as part of the planning for Thor Offshore Wind Farm. The location of the wind turbines, marking on charts and distribution of information material are relevant risk-reducing measures in relation to ship traffic in the area. Please refer to Maritime Traffic and Safety of Navigation report /13/ for further details regarding assessments in relation to sailing safety in the area.

5.2 Construction phase

5.2.1 Meteorological radars

The closest of DMI's weather radars in relation to the project area are the radars in Virring and Rømø (see Figure 4-1) which are both located more than 120 km from the project area. Due to the large distance it is evaluated that the overall effect on meteorological radars as a result of the construction phase of Thor Offshore Wind Farm is insignificant.

5.2.2 Civil Aviation Surveillance Radar

Impact on the airport radars in e.g. Midtjylland, Aalborg and Aarhus in the form of reflections and the formation of radar shadow behind wind turbines is considered to be insignificant during the construction phase. The airports use primarily secondary radars, where reflections and shadows at the given distances from the offshore wind farm will not have an impact.

5.2.3 Surveillance radars of the Danish Defence

During the construction phase, the impact on the radars in Thyborøn, and potentially in Hanstholm and Oksbøl, will consist of blocking / reflection of signal as well as shadow formation from cranes, installation vessels and wind turbines. The impact of the radars during the construction phase will gradually go from being non-existent when the construction work begins, to being equal to the impacts during the operational phase, as the construction work progresses, and more and more offshore turbines are installed. However, due to the relatively short duration, it has been assessed that the impact on the Danish Defence's coastal surveillance radars during the construction phase is small.

5.2.4 Mobile radar systems on ships

The mobile radar systems are affected similarly to the stationary systems (Danish Defence’s radars). However, the impact is primarily relevant for ships located locally in the area around the project area. However, due to the relatively short duration and local distribution, it has been estimated that the impact is small. The significance for sailing safety as a result of the construction

phase of the offshore wind farm is described in the background report on Maritime Traffic and Safety of Navigation /13/.

5.3 Operations phase

5.3.1 Meteorological radars

It is evaluated that the impacts on DMI's weather radars in the operational phase correspond to the impacts in the construction phase. The impacts in the operational phase continue throughout the life of the offshore wind farm, which is approx. 30 years.

The overall effect on meteorological radars as a result of the operation phase of Thor Offshore Wind Farm is estimated to be insignificant.

5.3.2 Civil Aviation Surveillance Radar

It is evaluated that the potential impacts on airport radars in the operational phase correspond to the impacts in the construction phase. The impacts in the operational phase continue throughout the life of the offshore wind farm, which is approx. 30 years.

The overall evaluation is that potential impacts on the airport radars are insignificant during the operational phase.

5.3.3 Surveillance radars of the Danish Defence

During the operations phase, the impact on the radars in Thyborøn and potentially in Hanstholm and Oksbøl will consist of blocking / reflection of signal as well as shadow formation from the presence of wind turbines.

It is evaluated that the future offshore wind farm will impact the ability of radars to detect and track ships in and around the offshore wind farm, as well as affect the Thyborøn radar's ability to detect aircraft over the offshore wind farm.

Therefore, based on the distance to the Thor Offshore Wind Farm, it is evaluated that there will be a moderate impact on radars during the operational phase.

5.3.4 Mobile radar systems on ships

The mobile radar systems are affected similarly to the stationary systems (Danish Defence’s radars). However, the impact is primarily relevant for ships located locally in the area around the planned wind farm. Due to the local distribution, it is estimated that the impact is small. The significance for sailing safety as a result of the operation of the offshore wind farm is described in the background report on Maritime Traffic and Safety of Navigation /13/.

5.4 Decommissioning phase

It has been assessed that the type and intensity of the impacts on radars during the decommissioning phase correspond to the impacts in the construction phase. No further evaluation is made in this section.

6. CUMULATIVE IMPACTS

As Denmark builds more and more wind turbines (e.g. the offshore wind farms Vesterhav Nord and Vesterhav Syd), the overall radar monitoring of both the maritime territory and the airspace over Danish territory could potentially deteriorate to a level, which is critical for the Danish Defence. However, the Danish Defence is expected to require mitigation measures, which will reduce or eliminate potential effects. This is e.g. the case for Vesterhav Syd /16/ and is expected to also be the case for Thor Offshore Wind Farm, pending a detailed analysis of the impact of the specific park layout.

Due to mitigation measures, cumulative effects on radar are expected to be negligible.

7. MITIGATION MEASURES

Establishment of Thor Offshore Wind Farm will potentially impact the Danish Defence's radars in Thyborøn, Hanstholm and Oksbøl. With the right mitigation measures, however, it is assessed that impacts can be significantly minimized. It may therefore be necessary to implement mitigation measures in order to reduce the impacts as much as possible. The scope and type of mitigation measures can only be described in more detail when a decision has been made regarding the establishment of Thor Offshore Wind Farm, and when the design is fixed.

Mitigation measures for coastal radars may include:

- The design of the offshore wind farm's layout so that the radar image is disturbed as little as possible. For example, the number and dimensions of turbines will have an impact on how radar systems are affected.
- Possible establishment of 'gap fill' radars could potentially cover the areas affected.
- Possible upgrade / conversion of the radar systems, which will make monitoring close to and above wind turbines better. However, the Danish Defence has stated that monitoring of particularly low-flying aircraft can be difficult despite upgrading / rebuilding Scanter 4000, for example.

However, the extent of the impacts and the need for and the type of mitigation measures cannot be described on the available basis, as the layout of the offshore wind farm is not known. Mitigation measures in relation to the radars in Frederikshavn, Læsø and Skagen must be defined when the final project is known, i.e. during the design of the offshore wind farm itself. It is thus necessary to have determined turbine locations, height, number and mutual distance before a concrete assessment of the possible impact can be made and mitigation measures can be decided. It is necessary to involve the Royal Danish Navy in the deliberations regarding mitigation measures. The Royal Danish Navy has stated that they have no plans to update / replace their existing radar systems.

8. MONITORING

Monitoring is not considered relevant in relation to radars and radio chains.

9. TECHNICAL GAPS AND UNCERTAINTIES

It will be necessary to carry out a study of potential impacts as well as possible mitigation measures in relation to radars in a later phase of the project. The study should be performed when the final design and layout for Thor Offshore Wind Farm has been determined, as the full extent of the impact on the radars as well as the need for and type of mitigation measures cannot be assessed on the current basis. The study should be according to the Eurocontrol Guidelines on how to assess the potential impact of wind turbines surveillance sensors /12/.

Energinet has initiated the study according to the Eurocontrol Guidelines concurrent to the preparation of this background report. The results of the study will be available at a later stage of the project.

10. CONCLUSION

10.1 Radar systems

The closest radars in relation to the plan for the Thor Offshore Wind Farm are the radars in Thyborøn, Hanstholm and Oksbøl used by the Danish Defence. The radars are used for monitoring of the maritime traffic and flight registration and are approx. 30 km, 80 km and 75 km from the project area, respectively.

Establishment of Thor Offshore Wind Farm is expected to impact the radar in Thyborøn and possibly the radars in Hanstholm and Oksbøl. It is assessed that the impacts on the Danish Defense's radars as a result of the establishment of Thor Offshore Wind Farm are moderate and the need of mitigation measures must be anticipated.

Mobile radar systems on ships in the area around the project area for Thor Offshore Wind Farm will be affected by an offshore wind farm similar to the surveillance radars on land. The impact is however assessed to be smaller. Maritime safety in the area as a result of a possible offshore wind farm is described in the background report on Maritime Traffic and Safety of Navigation /13/.

DMI has set up five weather radars in Denmark for registration of precipitation. The nearest weather radar in relation to the plan for Thor Offshore Wind Farm is the weather radar in Virring, which is located approx. 150 km east of the project area for Thor Offshore Wind Farm. In the given distances from the project area to DMI’s weather radars, the radars will not be affected.

Overall, the impact on radar systems used by the Danish Defence is assessed to be moderate and the need for mitigation measures must be anticipated. Mobile radar systems and weather radars are assessed to be affected to a lesser degree with an insignificant impact.

Once the final layout of Thor Offshore Wind Farm has been determined, a concrete assessment of the offshore wind farm's impact on the radars must be prepared, as well as measures to ensure water and aircraft monitoring.

10.2 Radio links

There are no point-to-point permits for radio links established over the project area for Thor Offshore Wind Farm, and there is no knowledge of radio chains established after a surface permit over the area. The plan for Thor Offshore Wind Farm will therefore not have an impact on existing radio links.

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