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ENERGY ISLAND BORNHOLM
TECHNICAL REPORT – HAZID WORKSHOP

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TECHNICAL REPORT – HAZID WORKSHOP

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ABBREVIATIONS

AIS	Automatic Identification System
SEA	Strategic Environmental Assessment
HAZID	Hazard Identification
TSS	Traffic Separation Scheme
OWF	Offshore Windfarm
EEZ	Exclusive Economic Zone
MSL	Mean Sea Level

1. INTRODUCTION

The energy islands mark the beginning of a new era for the generation of energy from offshore wind, aimed at creating a green energy supply for Danish and foreign electricity grids. Operating as green power plants at sea, the islands are expected to play a major role in the phasing-out of fossil fuel energy sources in Denmark and Europe.

After political agreement on the energy islands have been reached, the Danish Energy Agency plays a key role in leading the project that will transform the two energy islands from a vision to reality. The islands are pioneer projects that will necessitate the deployment of existing knowledge into an entirely new context.

In the Baltic Sea, the electrotechnical equipment will be placed on the island of Bornholm, where electricity from offshore wind farms will be routed to electricity grids on Zealand and neighboring countries. The offshore wind farms will be established approximately 15 km south-southwest of the coast and will be visible to the naked eye, but not dominate the horizon. The turbines off the coast of Bornholm will have a capacity of 3 GW, corresponding to the electricity consumption of two million households.

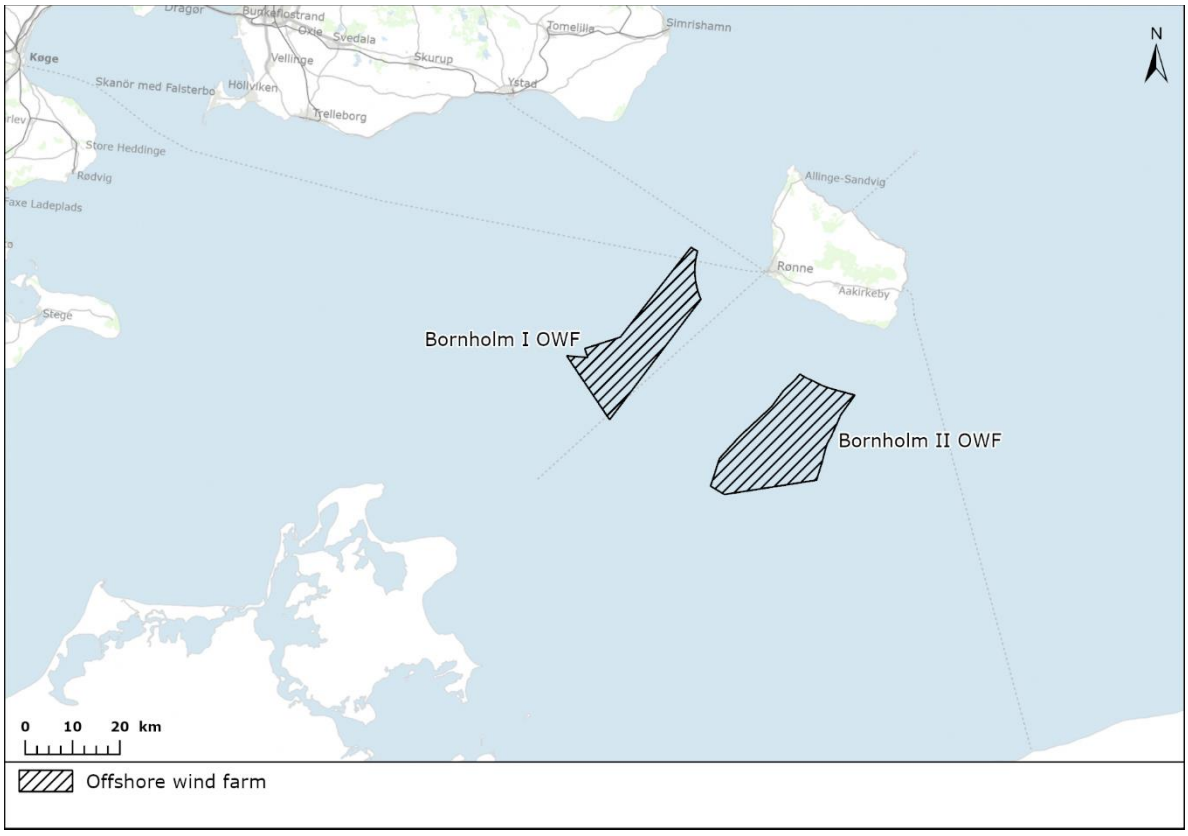


Figure 1-1 Energy Island Bornholm in the Baltic Sea with the marked areas for the offshore wind farms (OWF) southwest of Bornholm.

1.1 Scope

As background for an early assessment of the implications for the ship traffic and input to a Strategic Environmental Assessment (SEA) for the establishment of Energy Island Bornholm, the offshore wind farms in the Baltic Sea southwest of Bornholm, a workshop was held on December 15, 2021. The workshop purpose was to consult the marine users on hazard identification (HAZID), to address the effect on the marine safety in relation to the Energy Island Bornholm.

The participants at the workshop all had local knowledge of the navigational and maritime situation and could therefore contribute with input about impacts, hazards and suggestions on how to minimize both. At the workshop, both the project's construction phase and the operational phase, i.e., when the wind farm is completed, was discussed. Moreover, a decommissioning phase with activities in the area is assumed to be comparable to the construction phase with respect to activities in and near the area.

This report documents the outcome of the HAZID workshop. The results are based on preliminary plans. The purpose of carrying out the hazard identification process is to identify hazards related to the maritime safety during construction and operation of Energy Island Bornholm. The input given at the workshop is included as a basis for the strategic environmental assessment and the maritime risk assessment, a technical background for future project phases. Details on construction activities, layout of windfarms, etc., are subject to future planning, and additional HAZID work and risk assessments are foreseen.

2. BACKGROUND INFORMATION

The hazard identification is based on a set of background information:

- The geographical area
- Investigation area including possible wind turbine pattern
- Ship traffic in the area (based on AIS data)

The above-mentioned items are detailed in the following.

2.1 Geographical area

The Baltic Sea south of Sweden is an active site for the commercial ship traffic with several traffic separation systems (TSS). Figure 2-1 shows the investigation area and offshore windfarm (OWF) areas of the Energy Island Bornholm as well as the proposed alignment for a High-Voltage DC cable between Bornholm and Zealand. The project is currently planned with two OWF areas located with the nearest wind turbine approximately 15 km from the shore of Bornholm.

The wind farms will be planned within the Danish exclusive economic zone (EEZ) and have HVDC cables between the coast of Bornholm and near Køge. The cable crosses TSS Bornholmsgat and the precautionary area close to Bornholm and passes southwest of TSS Falsterbo near Zealand. The cable follows the Baltic Pipe at the seabed from Bornholm to Zealand.

The water depth between the OWF varies between 10 m and 20 m at Mean Sea Level (MSL). The area between the OWF is also known as "Rønne Banke", with less depth than the surrounding area. At the OWF areas are the water depth approximately 25 m - 45 m MSL. An overview of the area is shown with a nautical chart in Figure 2-1 and a detailed chart for the water depth for Rønne Banke is shown in Figure 2-2.

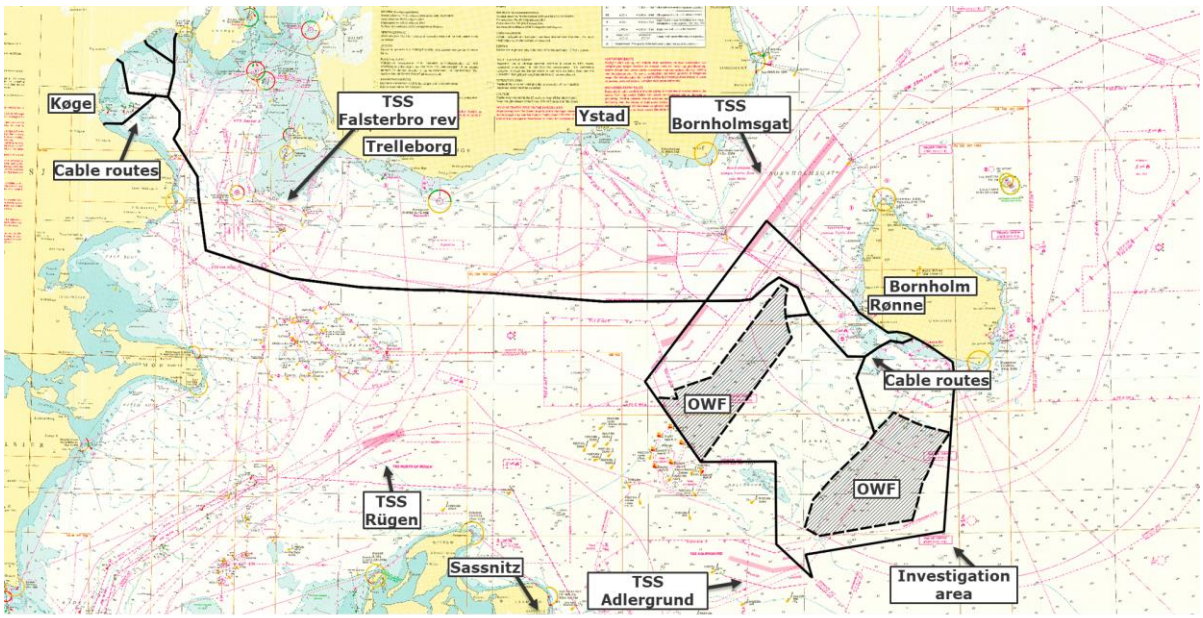


Figure 2-1 Location of cables, investigation area and the offshore wind farms for Energy Island Bornholm on the nautical chart.

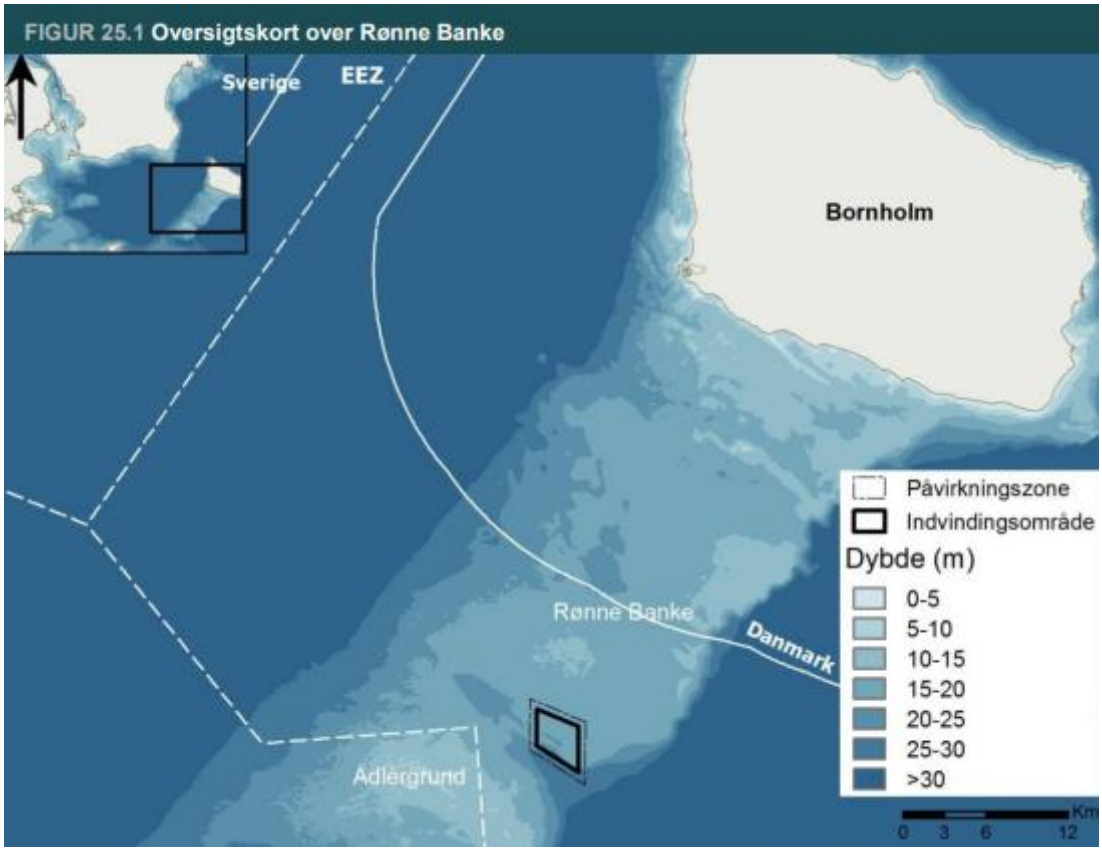


Figure 2-2 Overview of the water depth at Rønne Banke southwest of Bornholm, Source: https://www.trm.dk/media/2626/25-sandindvinding-paa-roenne-banke.pdf.

The Energy Island Bornholm north-western edge and southern corner of the investigation area shown in Figure 2-1 are crossing the traffic separation scheme; TSS Bornholmsgat and TSS Adlergrund. The investigation area has dense vessel traffic navigating next to the Bornholm I OWF at the TSS Bornholmsgat through the precautionary area but also ferries are navigating on a daily basis from Køge and Ystad to Rønne and back. Ships also take on pilot west and north of Bornholm and ships entering or leaving the TSS to take up a pilot adds to the traffic density outside the TSS between TSS Bornholmsgat and Bornholm.

In the water southwest of Bornholm is a commercial ship corridor through the OWF areas from west to east, mainly used by the DFDS ferries and other cargo ships. Bornholmslinjen ferries also has a route between Rønne and Sassnitz sailing along the eastern side of the Bornholm I OWF, and it also passes next to the German OWF.

An indicative layout is shown in Figure 2-3 illustrating the pattern with 153 wind turbines of 20 MW size. The number of turbines is lower if larger turbines are installed. For the HAZID workshop, it was assumed that turbines could be placed in any part of the OWF areas, so the total proposed area was used as basis. However, the final layout of the wind farm has not yet been decided and it is acknowledged by the Energinet that aspects such as passing ship traffic result in need for detailed planning of the wind turbine layouts in later phases of the project.

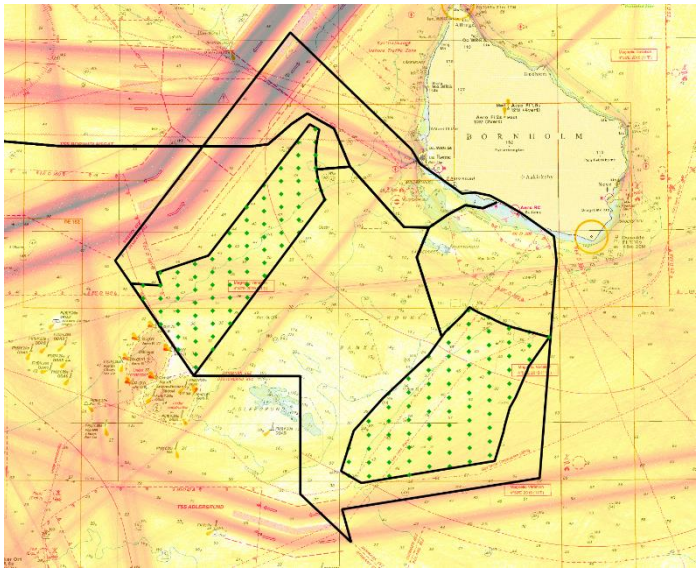


Figure 2-3 Indicative layout of the wind turbine locations (153 green dots, respectively 77 west and 76 east).

2.2 Ship traffic in the area

Historical ship traffic data for the area was analyzed prior to the workshop. All analyses were based on AIS data covering the whole year from January 1st to December 31st, 2019. It should be noted that not all vessels are registered in AIS data.

All vessels above 300 gross tonnage are obliged to have AIS installed (class A transponders), all passenger ships as well, and all fishing vessels over 15 meters in length (EU rules). Smaller vessels where there is no equipment requirement with AIS are, for example, pleasure boats and other smaller boats. However, some of these have chosen to have AIS installed (class A or B transponders) to be more visible at sea and will therefore also be found in the data used. Due to the distance from shore in open water, traffic with smaller pleasure boats is assumed to be limited within the OWF areas, and pleasure boat traffic is therefore not addressed further than the outcome of these with AIS-transponder.

The data, which contained both vessels with class A and B transponders, was used to generate a ship traffic density plot for all ship types as shown in Figure 2-4.

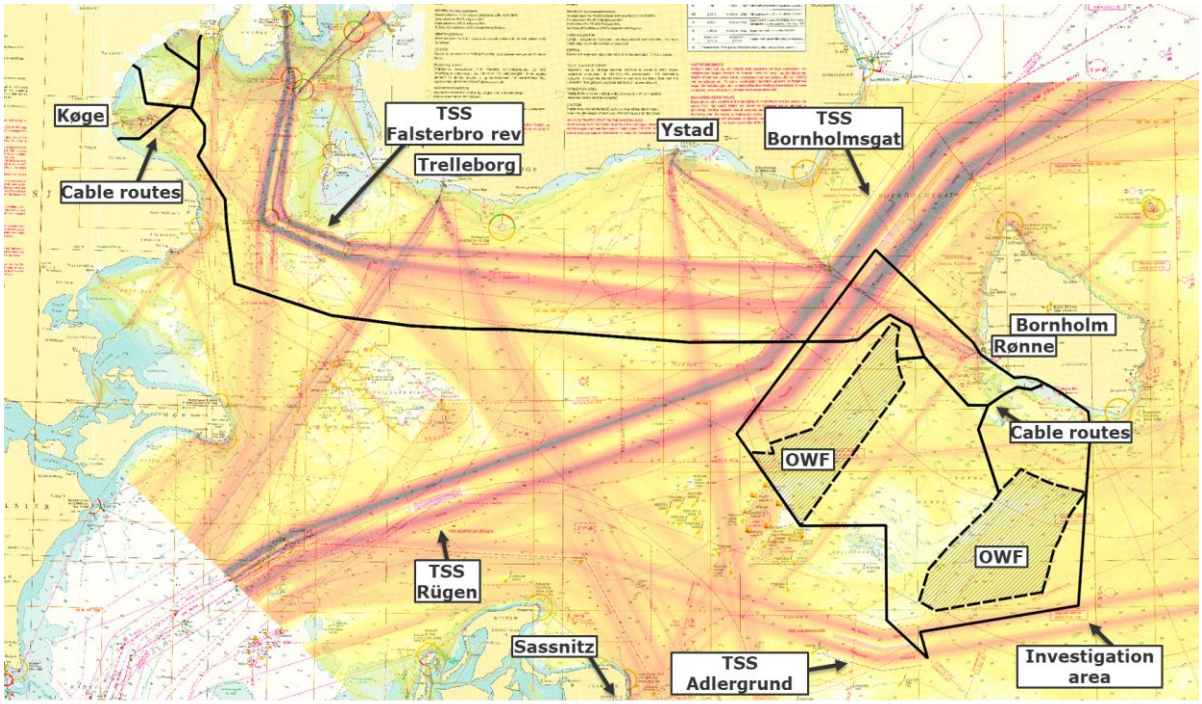


Figure 2-4 Ship traffic density plot for all types of ships, based on AIS data from a one-year period (January 2019 to December 2019).

Two specific intensity maps are visualized in Figure 2-5 to get a better understanding of the ship traffic and the routes for some of the ship types.

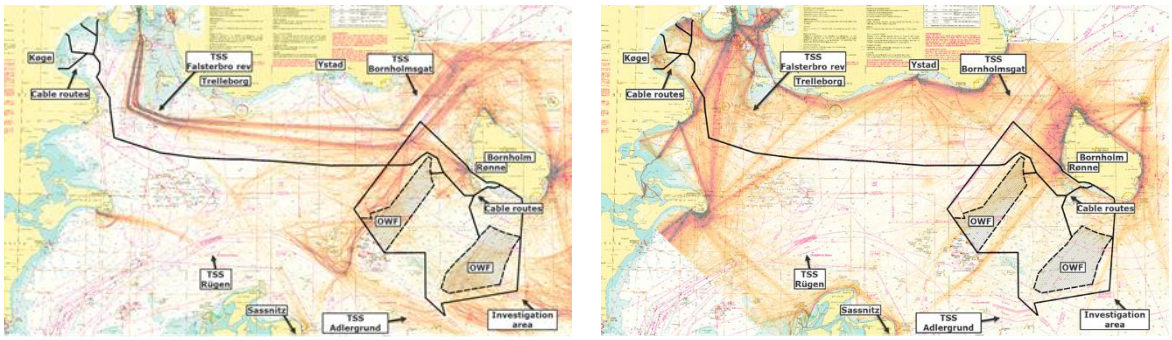


Figure 2-5 Ship traffic density plots for fishing ships (left) and pleasure boats (right), based on AIS data from a one year period (January to December 2019).

A total of 14 routes were identified from Figure 2-4 and Figure 2-5. The identified routes are presented in Figure 2-6 with arrows for each route colored based on their characteristics. A green route is passing a TSS, whereas the red routes cross the OWF areas, and the blues are sailing from and to Rønne harbor at Bornholm.

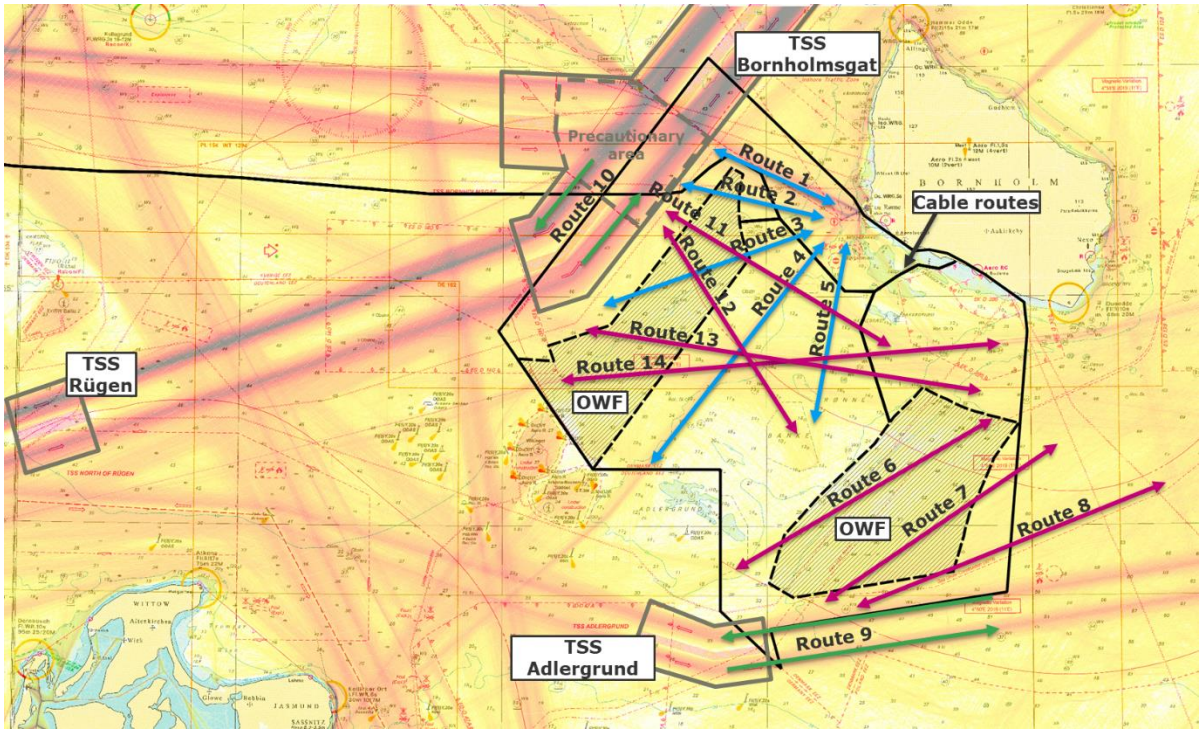


Figure 2-6 Identified ship traffic routes colored based on route characteristics.

Route 1-5 are representing ship traffic from and to Rønne harbor at Bornholm.

- Route 1: Mainly the fast ferry between Rønne and Ystad but also ships heading out of Rønne into precautionary area and further west to the TSS Falsterbo.
- Route 2: Traffic from TSS Falsterbo and precautionary area towards Rønne but also traffic heading out to TSS Rügen.
- Route 3: Traffic between TSS Rügen and Rønne sailing in a straight line south of the precautionary area.
- Route 4: Mainly passenger ferries sailing between Rønne and Sassnitz along the Bornholm I OWF proposed area and nearby German OWF.
- Route 5: Ship traffic between a natural resource extraction area and Rønne.

Route 6-8 are representing ship traffic crossing the Bornholm II OWF proposed area.

- Route 6-8: Ship traffic merging/leaving main Route 9 before and after TSS Adlergrund depending on the sailing direction.

Route 9-10 represent ship traffic passing through the TSS Bornholmsgat and precautionary area

- Route 9: Ship traffic passing through the TSS Adlergrund south of the Bornholm II OWF proposed area.
- Route 10: Ship traffic passing through the TSS Bornholmsgat and precautionary area west of the Bornholm I OWF proposed area.

Route 11-14 represent ship traffic crossing the proposed area for the Bornholm I OWF.

- Route 11: Ship traffic passing south of Bornholm between the precautionary area and south-east of Bornholm.
- Route 12: Ship traffic between a natural resource extraction area and precautionary area.
- Route 13: Ship traffic between the TSS Falsterbo heading directly south of Bornholm and the precautionary area at the TSS Bornholmsgat.
- Route 14: Traffic south of TSS Rügen and south-east of Bornholm sailing in a straight line.

The annual number of ships registered on each of the 14 routes for both directions are shown in Figure 2-7. Routes 9 and 10 have the most vessel traffic due to the traffic through each of the TSS'es together with the ferry traffic at Rønne from route 1. Route 8, 13 and 14 have medium intensity and the remaining routes have lower intensity.

Route	North/West	South/East	Total
1	2075	1724	3799
2	119	560	679
3	100	182	282
4	359	354	713
5	112	124	236
6	85	80	165
7	289	251	540
8	504	285	789
9	2631	2623	5254
10	11248	13575	24823
11	160	173	333
12	124	121	245
13	556	559	1115
14	519	542	1061

Figure 2-7 Identified ship routes and counted vessel passages along each of them.

A review of the traffic was presented in bar charts for each ship type and vessels lengths for each identified route. These charts can be found in Figure 2-8 but also in Appendix 2 as part of the slides presented at the HAZID workshop.

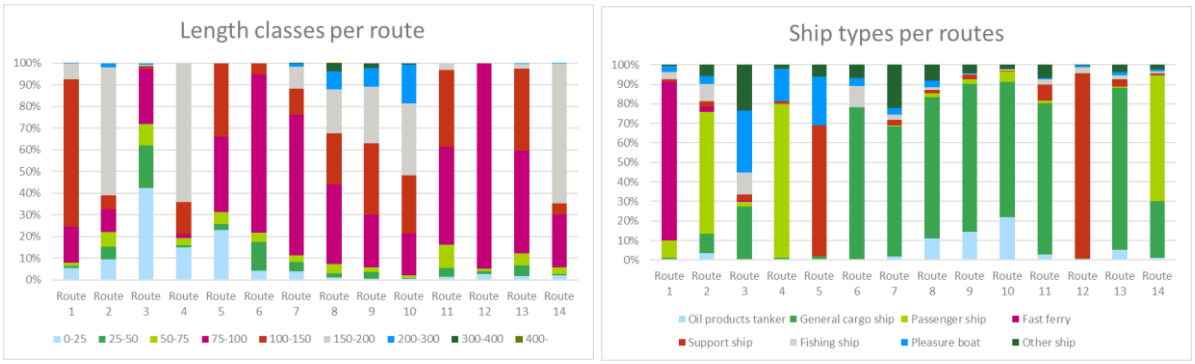


Figure 2-8 Ship length and ship types for the identified ship routes.

3. METHODOLOGY

A HAZID workshop is a systematic team-based process with the purpose of identifying the hazards for a given system. In the current context the purpose was to identify hazards related to maritime safety during the construction and operation of the offshore wind farm. Focus was on the impact from the offshore wind farm on maritime safety. The result of the HAZID forms the basis for the subsequent risk analysis.

In this section, we present the scope and execution of the workshop, the participants, and the basis for documenting the identified hazards.

3.1 Scope of workshop

A full risk assessment involves a number of tasks in order to assess whether the resulting overall risk is acceptable. Parts of the risk assessment may be quantitative or qualitative estimates of frequency of accident occurrences, consequences in case accidents occur, and cost/benefit assessments related to risk reducing measures.

A HAZID workshop constitutes a first important step by identifying in a structured way the hazards that form the basis for the subsequent risk assessments. The scope of the workshop is marked by orange in Figure 3-1, where the hazards in relation to possible accidents will be identified.

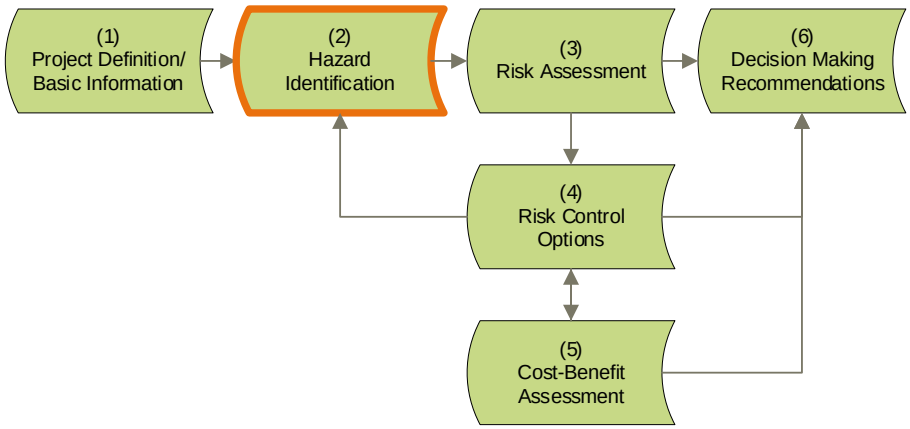


Figure 3-1 Scope of workshop.

A hazard can lead to an accident or a near miss incident. The accident is either collision or grounding. For this specific workshop, groundings were only addressed for ships diverting from the route and grounding on Bornholm due to the large depth in the area. The nearest distance to shallow waters is at Rønne Banke, which still have at least 10 m water depth. The following accident types are considered:

- Ship-ship collision
- Collision with foundation/turbine

The accident types 'ship-ship collision' and 'ship-turbine collision' are only considered in relation to changes in ship traffic patterns due to the presence of the offshore wind farm.

The actual risk related to the various hazards will be assessed in the subsequent risk analysis.

3.2 Workshop setup and participants

The HAZID workshop took place on Wednesday December 15, 2021 from 12.00 to 16.00 at a digital Microsoft Teams meeting and the workshop was conducted in Danish as there were no international participants. A total of 21 people attended the workshop. The organization they represented are shown in Table 3-1.

Table 3-1 Organizations represented.

Organization:		
Søfartsstyrelsen	Danske Rederier	Danmarks Fiskeriforening
Energistyrelsen	Bornholmslinjen	Dansk Sejlunion
Geodatastyrelsen	DFDS Seaways	Energinet
Søværnskommandoen	DanPilot	Ramboll
Rønne Havn		

The following invited organizations did not attend the workshop: Fiskeristyrelsen, Miljøstyrelsen, Naturstyrelsen, Foreningen for skånsomt kystfiskeri, Danmarks Havfiskerforund, Søsportens sikkerhedsråd, Sjöräddningssällskapet, Sjöfartsverket and Danske Tursejlere.

Few other organizations declined the invitation because they could not attend or had no comments to the navigational safety wrt. the project. These organizations are Kystdirektoratet, Dansk søredningsselskab, Marine hjemmeværn and Bornholms Trollingklub. The last two organizations sent their comments to the project. The Marine hjemmeværn wrote that they had no comments and Bornholms Trollingklub with an elaborate input which can be found in Appendix 3.

The workshop was divided into three parts. In the first part, the participants were introduced to the project and Energinet's company profile. This was followed by a review of the vessel traffic analysis for the proposed area and the surrounding vessel traffic lanes. The participant had several questions and concerns during the presentation which were discussed ongoing. The slides shown at the workshop can be found in Appendix 2.

The second part of the workshop was a consultation with the marine users. Based on the first part, the participants continued questioned and discussed concerns about the project. The concerns included both the construction phase and the changes the operational phase entails for the marine users including the HVDC cable.

The third part of the workshop consisted of a HAZID session where the participants had the opportunity to point out special situations or locations that pose a danger to third parties. The HAZID session was structured around a number of relevant geographical areas and aspects. The input given from the participants in the workshop is incorporated in this report, and the participants have had opportunity to comment on its content before it is completed.

3.3 Workshop methodology and procedures

- The workshop was conducted according to the following, overall plan:
- 12:00: Welcome and short presentation of participants (All)
- 12:15: Introduction to the workshop – HAZID and process (Rambøll)
- 12:25: Presentation of Energy Island Bornholm and the ship traffic conditions in the area (Energinet/Rambøll)
- 12:50: Questions, comments, concerns

- 13:05: Coffee break
- 13:15: Hazard identification – operational phase with wind farm present in the area
- 14:30: Coffee break
- 14:45: Continued hazard identification operational phase
- 15:15: Hazard identification – hazards relevant for construction or decommissioning phase
- 15:45: Review of hazards, summary and final questions
- 16:00: Workshop ends

The focus of the hazard identification was primarily on the operational phase with the wind farm present in the area. However, hazards were identified also for the construction phase, the HVDC cable, and any additional concerns were thereby addressed in relation to having construction activities in the area. The workshop ended at "15:45" with no further comments.

3.4 Documentation of identified hazards

During the HAZID workshop, all hazards were documented in a hazard log (Excel sheet) together with possible risk reducing measures and further comments. At the end of the workshop, an oral review of the findings was given, and the summary was commented.

The hazard log was developed in English at the workshop and has been further elaborated and structured for inclusion in this HAZID report. The hazard log from the workshop is attached in Appendix 1.

4. RESULTS

A total of 19 hazards were identified. The hazards were distributed as follows:

- Construction: 3 hazards
- Operation: 16 hazards

Each of the 19 hazards are described in detail in Appendix 1 along with possible risk reducing measures. The hazards will be analyzed in the risk analysis to assess the collision frequency and possible consequences. A summary of the hazards is given in this section.

4.1 Construction phase

Three potential hazards were identified specifically in relation to the construction phase. Several hazards identified for the operational phase are also relevant for the construction phase. An overview of these hazards including hazard description and causes is seen in Table 4-2.

Table 4-1 Overview of identified potential hazards related to the construction phase.

ID	Potential Hazard	Cause(es)	Route ID
1	Pleasure boat collides with construction ships	Pleasure boats sailing through the Bornholm I or II OWF area	All
2	Pleasure boats sail closer to the commercial traffic	Prohibition areas around construction activities	All
3	Collision with part of wind turbines or work vessels	Ship traffic sailing towards construction area	All

During the construction phase it is important to plan the work in due time and set up marine coordination. The aspect on the navigation safety focused on the markings of the wind turbines, the potential disturbances of the ship radars, and the hazards this could give. Further the need of informing passing ships sailing in the area on the ongoing work, to reduce the potential impact on vessels in the area, was mentioned.

Additional comments were stated in connection with planning and marking in the construction phase and use experiences from the Fehmarnbelt. Also, the Danish Sailing Union are willing to share information via newsletters to their members (pleasure boat sailors).

4.2 Operational phase

Sixteen hazards were identified in relation to the operational phase. An overview of these hazards including hazard description and causes is seen in Table 4-2.

It should be noted that most of the hazards identified for the operational phase are also relevant for the construction phase.

Table 4-2 Overview of identified potential hazards related to the operational phase.

ID	Potential Hazard	Cause(es)	Route ID
4	Pleasure boats increase traffic at other routes	Pleasure boat might stay clear of wind farms for safety	All
5	Pleasure boat can sail within the wind farm and be difficult to model.	Pleasure boat sail pattern are diffuse compare to commercial traffic	All
6	Traffic around wind farm areas get denser	Pleasure boat will search around the areas	All

7	Ship collision or near-miss due to reduced overview	Turbines causing radar shadows affecting land-based surveillance radars and ship radars	All
8	Ships collide with turbines with full or drifting speed	Ships may experience a human error and machine failure	All
9	Cruise ship collides with a wind farm	Terror occurring at cruise ships	All
10	Reduced ability to perform helicopter rescue operations within the area	Challenging to operate helicopters between wind turbines, especially in certain wind and weather conditions	All
11	Ships will merge into the main traffic in a southerly direction at the Precautionary Area	Ships getting a pilot at the northern tip of Bornholm	Route 10,1, 2
12	Ship traffic through the area will be squeezed out and the routes around will be denser; both TSS Adlergrund, but possibly also up through the Bornholm I OWF area via the route used by DFDS	Ship traffic might avoid sailing in between the Bornholm II OWF area	Route 6, 7, 8
13	Safety is reduced due to merging action will take place closer to the busy Precautionary Area	Ship traffic rerouted further north navigate into an alternative corridor south of Bornholm	Route 13, 14
14	Dense traffic at northern area of the Bornholm I OWF	Ferry traffic sails through the area between Rønne and Precautionary Area	Route 1, 2
15	Additional dangers when sailing across the sailing corridor as well as limited opportunities to identify maintenance traffic due to radar shadow	Maintenance traffic to / from the wind farms crosses other routes	All
16	Ship collision due to complex situations between Rønne and Precautionary area	The presented corridor is perceived to be narrow and there is a lot of varied ship traffic from fast ferries to cargo and cruise ships	Route 1, 2
17	The traffic in this area is pushed north and thus towards the corridor between Rønne and the Precautionary Area	The presence of the Bornholm I OWF area	Route 1, 2
18	Eastbound ship traffic grounding at Bornholm or collides with Bornholm I OWF area	Captain not reacting at the bend before the turn to TSS Bornholmsgat	Route 10
19	Anchor may damage cable at seabed	Ship drops or loses its anchor	All

During the workshop the criticality of the navigational safety with regards to the proposed area for the Energy Island Bornholm were discussed. Especially the northern part of the Bornholm I OWF next to the TSS Bornholmsgat were noted as a busy area for ships with routes crossing, merging, and splitting together with a nearby ferry lane crossing. The Bornholm I OWF also has a navigational corridor going through which the DFDS company generally uses. It was discussed how the corridor could be established making it feasible and safe to navigate through the park. An alternative corridor rerouting the traffic where also discussed given a suggestion from DMA.

The Bornholm II OWF was discussed at the workshop wrt. the routes passing or crossing the area. Several hazards were identified in relation to interactions between ship traffic routes, radar disturbances and visual disturbances due to the presence of the wind farm, and relevant mitigations including marking of the wind turbines and the area were discussed.

Furthermore, the proposed area for the Energy Island Bornholm has been and is still an area used for fisheries, which is seen on the intensity map in Figure 2-5 generated from the AIS data. Also, the reply from the danish trolling fisheries describes that the proposed area is used by them (see Appendix 3). The Bornholmslinjen passenger ferry between Rønne and Sassnitz (German) use a route through the area in between the proposed location for the OWF on Route 4. The captain sailing Bornholmslinjen stated that he has experience of sailing past the German wind farms right

inside the German EEZ which shows that there have been no problems – neither during construction nor in the operational phase.

4.3 Additional comments and input from the participants

- Danish Sailing Union: Pleasure sailing is generally increasing.
- Danish Sailing Union: There should be a focus on limitations in relation to anchoring at the cables.
- Danish Fisheries Association: No comments in connection with the workshop.
- Danish shipping has members interested in raw material extraction. It is suggested to further investigate potential raw material extraction in the area in connection with the planning of Energy Island Bornholm.
- The Port of Rønne has a request for exemption from the area with a 5 nautical mile radius around Rønne for all obstacles incl. submarine cables to accommodate possible anchoring and handling of larger cruise ships, etc. Rønne also has plans to be the Baltic Sea's green filling station, so that bunkering operations can also take place in the future. There is an "inshore traffic zone" north of Rønne between Bornholm and TSS Bornholmsgat. Rønne harbor wants this zone to be maintained.
- Danpilot: Agrees with the comment from the Port of Rønne that the "inshore traffic zone" between Bornholm and TSS Bornholmsgat should be maintained.
- DanPilot: There are no general problems with pleasure boats in the TSS.
- DMA: Safety zones around shipping corridors are based on international guidelines and as a starting point there is a two nm safety zone at TSS Bornholmsgat. The safety zones depend on the amount of traffic and the possibilities for evasive manoeuvres. The exact design will be based on a risk assessment. In relation to proposed sailing corridors through the Bornholm I OWF , German plans have been considered in the German EEZ. The German plans could affect the current traffic, which has thus been considered. In connection with cables, the cable executive order must be complied with and anchoring within 200 m of a cable is not permitted in Danish waters. In Sweden, there are not the same regulations and the export cable between Bornholm and Zealand will run over large stretches in Swedish waters.

The Danish Geodata Agency has a number of navigational surveys, which can be used by Energinet now, or in the future process.

The Danish Energy Agency stated also about the project that: 2 GW has been politically decided at present, but the possibility of expansion to 3 GW. This affects the size of the areas, which have not been finally decided at present. Going as close to the coast as indicated in the material for the workshop thus requires a political decision.

APPENDIX 1
HAZID LOG (ENGLISH)

ID	Hazard	Cause(es)	Route ID	Ship type(s)	Type of accident	Project phase	Risk reduction measures	Comments
1	Pleasure boat collides with construction ships	Pleasure boats sailing through the Bornholm I or II OWF area	All	Pleasure boat	Ship-ship collision	Construction		Pleasure boats do not always follow markings, especially critical in construction
2	Pleasure boats sail closer to the commercial traffic	Prohibition areas around construction activities	All	Pleasure boat	Ship-ship collision	Construction		Danish Sailing Union: Important with phase division both geographically and in time. Possibly, plan some work for the winter period when there are fewer pleasure boats sailing.
3	Collision with part of wind turbines or work vessels	Ship traffic sailing towards construction area	All	All	Ship-turbine collision	Construction	There are IALA requirements for lighting and marking that must be complied with. Detailing this is too early in the process	DMA: In connection with construction, there were deflector vessels at Kriegers Flak
4	Pleasure boats increase traffic at other routes	Pleasure boat might stay clear of wind farms for safety	All	Pleasure boat	Ship-ship collision	Operation		Danish Sailing Union: Far from all pleasure boats use AIS. The proportion is not known, but it may be as few as 5%.
5	Pleasure boat can sail within the wind farm and be difficult to model.	Pleasure boat sail pattern are diffuse compare to commercial traffic	All	Pleasure boat	Ship-turbine collision	Operation		Danish Sailing Union: It matters a lot how big the turbines are. Fewer and larger wind turbines generally pose a lesser risk than many and small wind turbines.

ID	Hazard	Cause(es)	Route ID	Ship type(s)	Type of accident	Project phase	Risk reduction measures	Comments
6	Traffic around wind farm areas get denser	Pleasure boat will search around the areas	All	Pleasure boat	Ship-ship collision	Operation		Danish Sailing Union: The southern area - Bornholm II OWF - is generally sparsely sailed
7	Ship collision or near-miss due to reduced overview	Turbines causing radar shadows affecting land-based surveillance radars and ship radars	All	Any commercial ship	Other	Operation		Søværnskommandoen: In connection with radar disturbances, there have been problems with false echoes at Sprogø. There are no immediate examples of major radar disturbances, but there may be issues with a detailed project. The Danish Maritime Authority refers to the same problems at Sprogø.
8	Ships collide with turbines with full or drifting speed	Ships may experience a human error and machine failure	All	All	Ship-turbine collision	Operation		
9	Cruise ship collides with a wind farm	Terror occurring at cruise ships	All	Cruise ships	Ship-turbine collision	Operation		
10	Reduced ability to perform helicopter rescue operations within the area	Challenging to operate helicopters between wind turbines, especially in certain wind and weather conditions	All	All	Other	Operation		Søværnskommandoen: During rescue operations, helicopter operations in the area in particular can be hampered by the wind turbines. For larger rescue operations, a wind farm will contribute to the complexity.

ID	Hazard	Cause(es)	Route ID	Ship type(s)	Type of accident	Project phase	Risk reduction measures	Comments
11	Ships will merge into the main traffic in a southerly direction at the Precautionary Area	Ships getting a pilot at the northern tip of Bornholm	Route 10,1, 2	Any commercial ship	Ship-ship collision	Operation	Larger/wider shipping corridor added in northern part or through Bornholm I OWF	DanPilot: In general, the biggest problem is at the northern end of the Bornholm I OWF area between Rønne and Precautionary Area
12	Ship traffic through the area will be squeezed out and the routes around will be denser; both TSS Adlergrund, but possibly also up through the Bornholm I OWF area via the route used by DFDS	Ship traffic might avoid sailing in between the Bornholm II OWF area	Route 6, 7, 8	All	Ship-ship collision	Operation	Larger/wider corridor for ship traffic	DFDS: The increased traffic should be taken into account in determining the width of sailing corridors Danske Rederier: It will e.g. give approx. 20% increase in traffic in TSS Adlergrund based on traffic figures
13	Safety is reduced due to merging action will take place closer to the busy Precautionary Area	Ship traffic rerouted further north navigate into an alternative corridor south of Bornholm	Route 13, 14	Any commercial ship	Ship-ship collision	Operation	Larger/wider shipping corridor added in northern part or through Bornholm I OWF	DFDS: It is necessary for the maintenance of DFDS's route that a corridor be established through the Bornholm I OWF *(where the routes 13 and 14 pass through the OWF on Figure 2-6 page 8)*. Without a corridor - or with a northern corridor - the route will not be profitable Danske Rederier: It is very important that a sailing corridor passes through the Bornholm I OWF *(where the routes 13 and 14 pass through the OWF on Figure 2-6 page 8)*. Both for the sake of increased fuel consumption by sailing a detour, but also for the sake of sailing safety. Without a sailing corridor, there will be more traffic on the already heavily trafficked main routes, and there will be more crossing traffic. In addition, the corridor must be wide enough to accommodate any increased traffic volume as a result of traffic diversion.

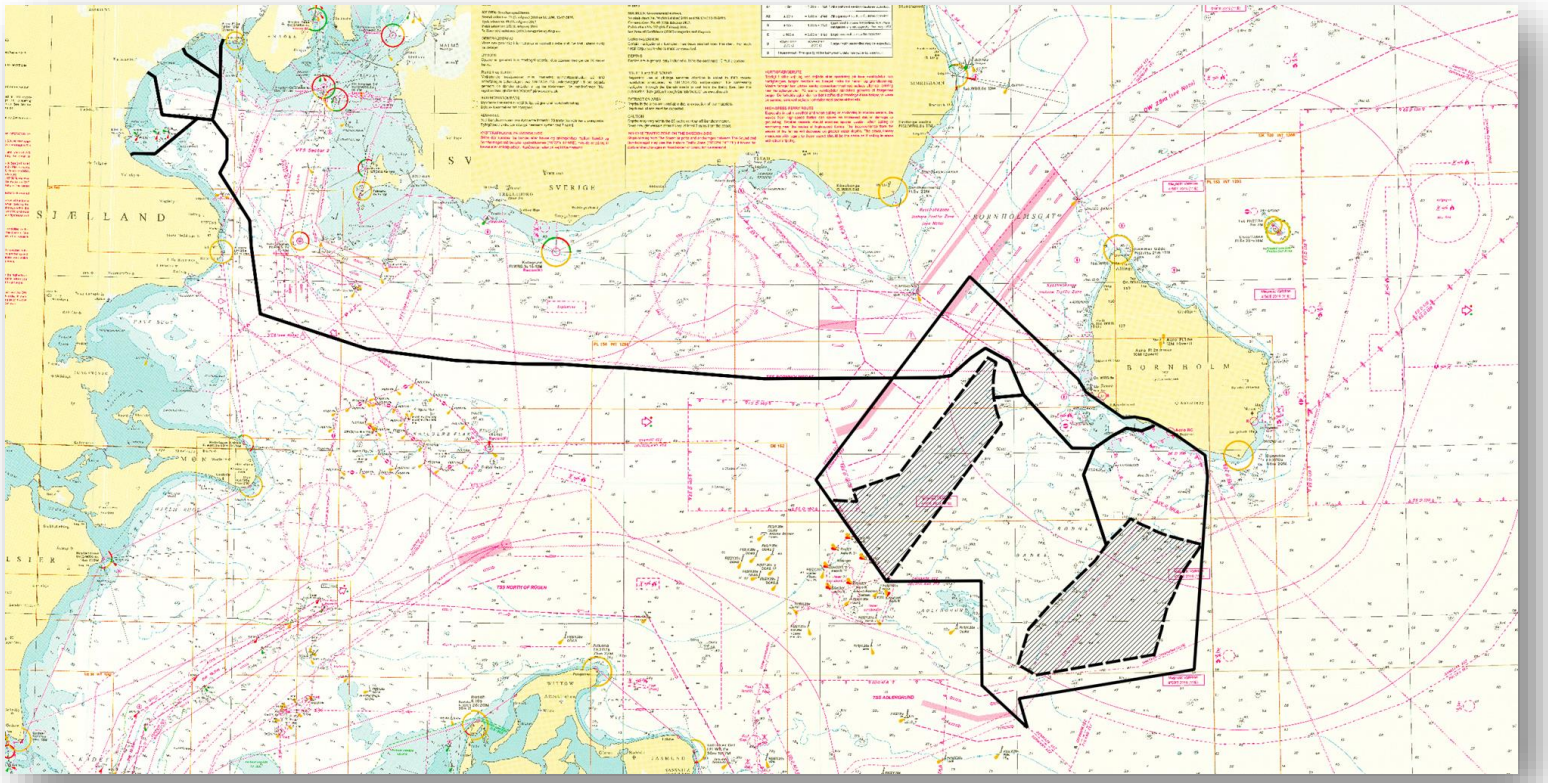
ID	Hazard	Cause(es)	Route ID	Ship type(s)	Type of accident	Project phase	Risk reduction measures	Comments
14	Dense traffic at northern area of the Bornholm I OWF	Ferry traffic sails through the area between Rønne and Precautionary Area	Route 1, 2	Any commercial ship	Ship-turbine collision	Operation	Larger/wider shipping corridor added in northern part or through Bornholm I OWF	Bornholmslinjen: It could be an advantage at some point to establish VTS monitoring in the area and a suggestion for pleasure boats is that they should have AIS equipment on board for visibility
15	Additional dangers when sailing across the sailing corridor as well as limited opportunities to identify maintenance traffic due to radar shadow	Maintenance traffic to / from the wind farms crosses other routes	All	All	Other	Operation	A specific route for maintenance traffic pointed out in navigational charts during establishment phase	DMA: In connection with maintenance activities, the assessment will depend on where the maintenance port is planned. Focus on risk by crossing traffic flows. For example. greater risk at a maintenance port in Sweden or Germany, as the main traffic in resp. Bornholmsgat or at Adlergrund must be passed on the way to the parks
16	Ship collision due to complex situations between Rønne and Precautionary area	The presented corridor is perceived to be narrow and there is a lot of varied ship traffic from fast ferries to cargo and cruise ships	Route 1, 2	All	Ship-ship collision	Operation	There is a radar for traffic monitoring in Almindingen. It generally has a good overview, but there can of course be specific disturbances in connection with a wind farm	Rønne harbor: In the future, larger cruise ships of perhaps 350 m are expected, for which there must also be room for. Therefore, the need for sufficiently wide sailing corridors through the Bornholm I OWF is pointed out.
17	The traffic in this area is pushed north and thus towards the corridor between Rønne and the Precautionary Area	The present of the Bornholm I OWF area	Route 1, 2	All	Ship-ship collision	Operation	Larger/wider shipping corridor added in northern part or through Bornholm I OWF	
18	Eastbound ship traffic grounding at Bornholm or collides with Bornholm I OWF area	Captain not reacting at the bend before the turn to TSS Bornholmsgat	Route 10	All	Ship-turbine collision	Operation	There is an alarm zone in the area west of Bornholm in relation to responding to ships that may get off course from the main route and towards a grounding on Bornholm. The MAS guard responds here to an automatic alarm. If this	

ID	Hazard	Cause(es)	Route ID	Ship type(s)	Type of accident	Project phase	Risk reduction measures	Comments
							alarm zone is moved outside the wind farm, there is not a long reaction time between a deviation from the main route and a possible collision with the wind turbines.	
19	Anchor may damage cable at seabed	Ship drops or loses its anchor	All	Any commercial ship	Other	Operation	Markings in navigational chart prohibit anchoring along marked cables	

APPENDIX 2
SLIDES FROM HAZID WORKSHOP

Energy Island Bornholm
HAZID workshop

Maritime traffic and safety of navigation



RAMBØLL

Bright ideas.
Sustainable change.

Agenda

12:00: Welcome and short presentation of participants (All)

12:15: Introduction to the workshop – HAZID and process (Rambøll)

12:25: Presentation of Energy Island Bornholm and the ship traffic conditions in the area (Energinet/Rambøll)

12:50: Questions, comments, concerns

13:05: Coffee break

13:15: Hazard identification – operational phase with wind farm present in the area

14:30: Coffee break

14:45: Continued hazard identification operational phase

15:15: Hazard identification – hazards relevant for construction or decommissioning phase

15:45: Review of hazards, summary and final questions

16:00: Workshop ends

Who is participating today?

- Søfartsstyrelsen
- Energistyrelsen
- Geodatastyrelsen
- Søværnskommandoen
- Rønne Havn
- Danske Rederier
- Bornholmslinjen
- DFDS Seaways
- DanPilot
- Danmarks Fiskeriforening
- Dansk Sejlunion
- Energinet
- Ramboll

Agenda

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15:45: Review of hazards, summary and final questions

16:00: Workshop ends

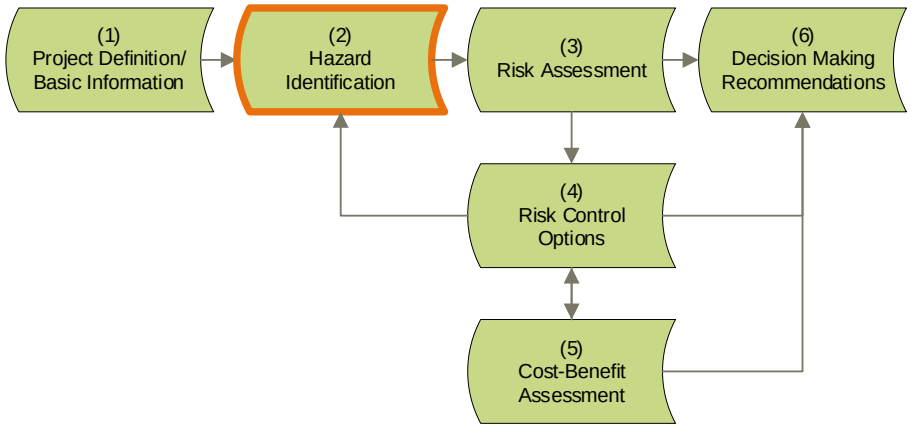
Why are we here?

- Energy Island Bornholm – A change in the waters southwest of Bornholm in the Baltic Sea
- Ramboll is conducting a consultation of the marine users on behalf of Energinet in order to identify risks and hazards from a navigational safety point-of-view

YOU ARE THE EXPERTS!

Introduction to the workshop

- A hazard may lead to an accident in form of a collision or grounding



- Related to changes during the construction, operation and decommissioning of the windfarm, we focus on hazards that may lead to
  - Ship – ship collisions
  - Ship collisions with wind turbines
  - Ship grounding

HAZID Process

- Today you will have the opportunity to influence on identification of risks for future assessment
- We will note your input on hazards and any suggestions to mitigation (impact and risks)
- The HAZID workshop will be documented in a HAZID report

ID	Hazard	Cause(es)	Route ID	Ship type(s)	Type of accident	Project phase	Risk reduction measures	Comments
1								
2								
3								

Risk assessment process

- The HAZID report will be sent to the workshop participants for commenting
- The identified hazards will be considered when assessing
  - Frequency of accidents (ship collisions, groundings, and collisions with wind turbines)
  - Consequence of collisions
  - Possible mitigations
- The risk assessment to be developed will form basis for the impact assessment on marine traffic for the Strategic Environmental Assessment (SEA) and as background for future assessment of a concrete offshore windfarm

- Additional HAZID work and risk assessment to be performed as part of the future work for a concrete project

Agenda

12:00: Welcome and short presentation of participants (All)

12:15: Introduction to the workshop – HAZID and process (Rambøll)

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16:00: Workshop ends

ENERGINET
Eltransmission

ENERGI ISLAND BORNHOLM
and associated offshore wind farms

HAZID WORKSHOP

Maritime Safety and Navigational Risks

POLITICAL BACKGROUND

As a consequence of the climate agreement of 22nd June 2020, the majority of the Danish parliament decided to establish two energy islands with associated offshore wind farms.

With the energy islands, Denmark contributes to the fulfilment of the Paris Agreement and to the EU's ambitions to increase European electrical capacity by 2050 with offshore wind equivalent to 300 GW.
The islands are set to be placed in the Baltic- and in the North Seas respectively.

Energinet has been assigned to commence preliminary geophysical and geotechnical as well as biological studies of the designated marine areas around Bornholm.

In addition, the establishment of the energy islands strengthens the commercial interest of the market leading Danish wind energy sector.

ENERGY ISLAND BORNHOLM

In the Baltic Sea, the island of Bornholm is to constitute the actual island connecting the two associated new offshore wind farms with national and international electrical grids, and hence acting as an electrical hub supplying up to 3 GW of energy.

The offshore wind farms associated with this project is constituted of two areas which together produces the up to 3 GW energy. The offshore wind farms are situated app. 15 km south/southwest of the island of Bornholm.

Energiø Bornholm is planned to be in full operation by 2030.

PLAN, SEA AND MARINE BASELINE STUDIES

Energinet has been assigned to assist the Danish Energy Agency in conducting an overall plan for the project Energiø Bornholm. The plan is the framework of the project and defines the framework within which a later client must design a specific project.

This plan must include a strategic environmental assessment (SEA) of the plan. A SEA assesses the impact of the plan on the environment. Rambøll has been assigned to assist Energinet with the work with the SEA and the associated environmental baseline investigations

In addition to assisting the Danish Energy Agency in carrying out the strategic environmental assessment, Energinet will carry out a number of pre investigation studies of seabed, environmental and biological conditions in the designated marine areas around Bornholm which, according to the plan, have been allocated to the two wind farms and associated cable corridors. In addition, collection of metocean data will also be carried out.
Based on the results of these studies, a number of technical baseline reports will be prepared, to aid in the later work with defining the final and detailed project.

HAZID WORKSHOP

On behalf of the pre investigations a set of environmental and marine baseline report will be made. Within these reports, a report regarding marine traffic will be made to address navigational safety and risk assessment as a consequence of the establishment of the wind farms.
A remedy to assess risks is to invite all relevant stakeholders to a HAZID workshop, which will result in a risk assessment of the impact of the project.

The main objective of the HAZID Workshop is to qualitatively evaluate the maritime traffic safety in relation to Energy Island Bornholm and associated offshore windfarms, hereby:

- To identify navigational hazards associated with the operation, construction and decommissioning

- Review the effectiveness of existing/planned safety measures and, where required, to expand the safety measures (i.e., propose recommendations and follow-up actions).

The Danish Maritime Authority will be the competent authority approving the Navigational Risk Assessment and will attend the workshop as observer.

ENERGINET

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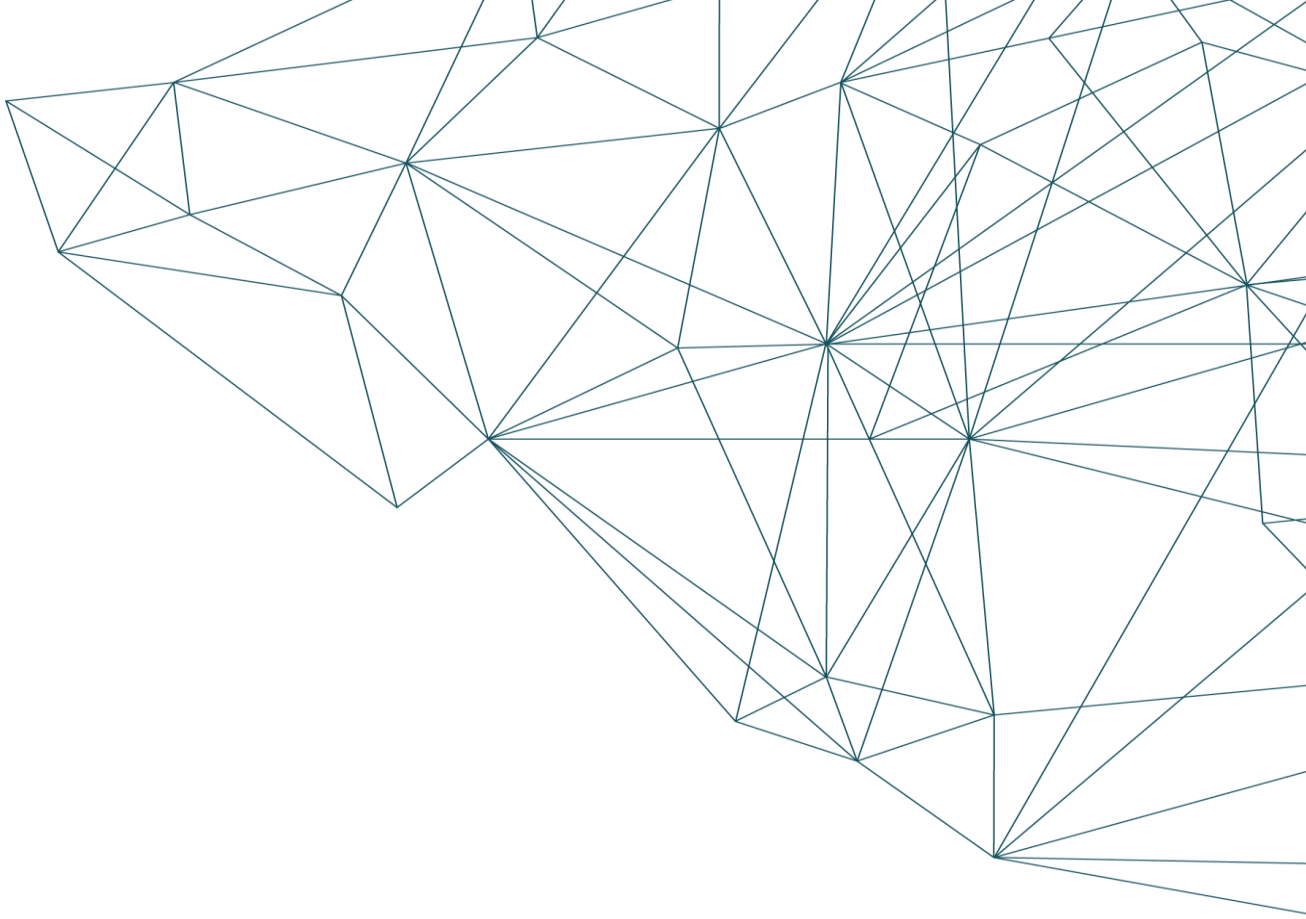
7000 Fredericia
Tlf 70 10 22 44

info@energinet.dk
www.energinet.dk

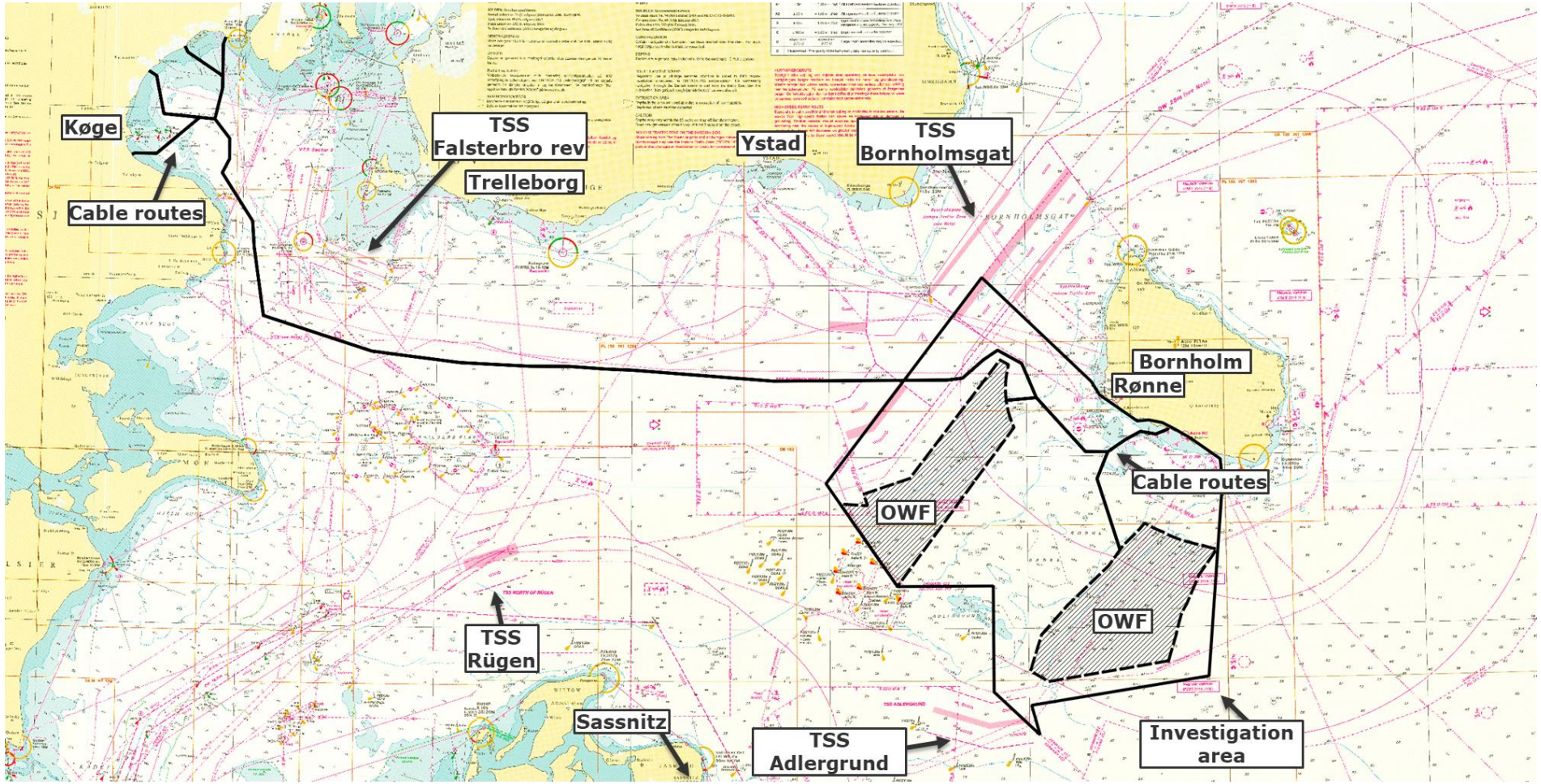


Energinet er en selvstændig offentlig virksomhed ejet af staten.

Det betyder, at de publikationer m.v., som Energinet udgiver, alene er udtryk for Energinets faglige vurderinger. Disse vurderinger deles ikke nødvendigvis af klima-, energi- og forsyningsministeren, der varetager ejerskabet af Energinet på statens vegne.

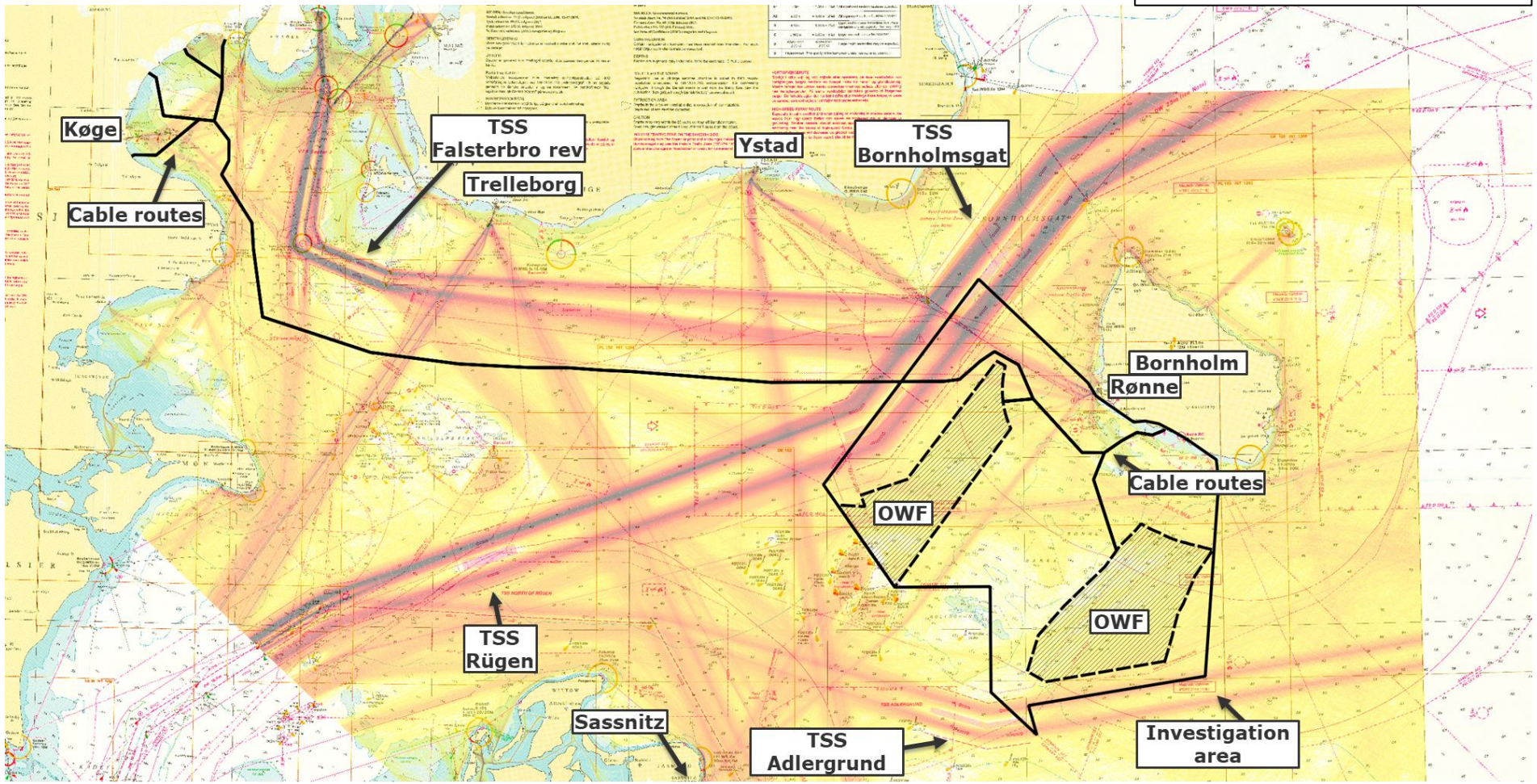
Energinet bestræber sig på at være en åben og transparent virksomhed, hvor vurderinger og analyser gøres tilgængelige for alle.

Overview

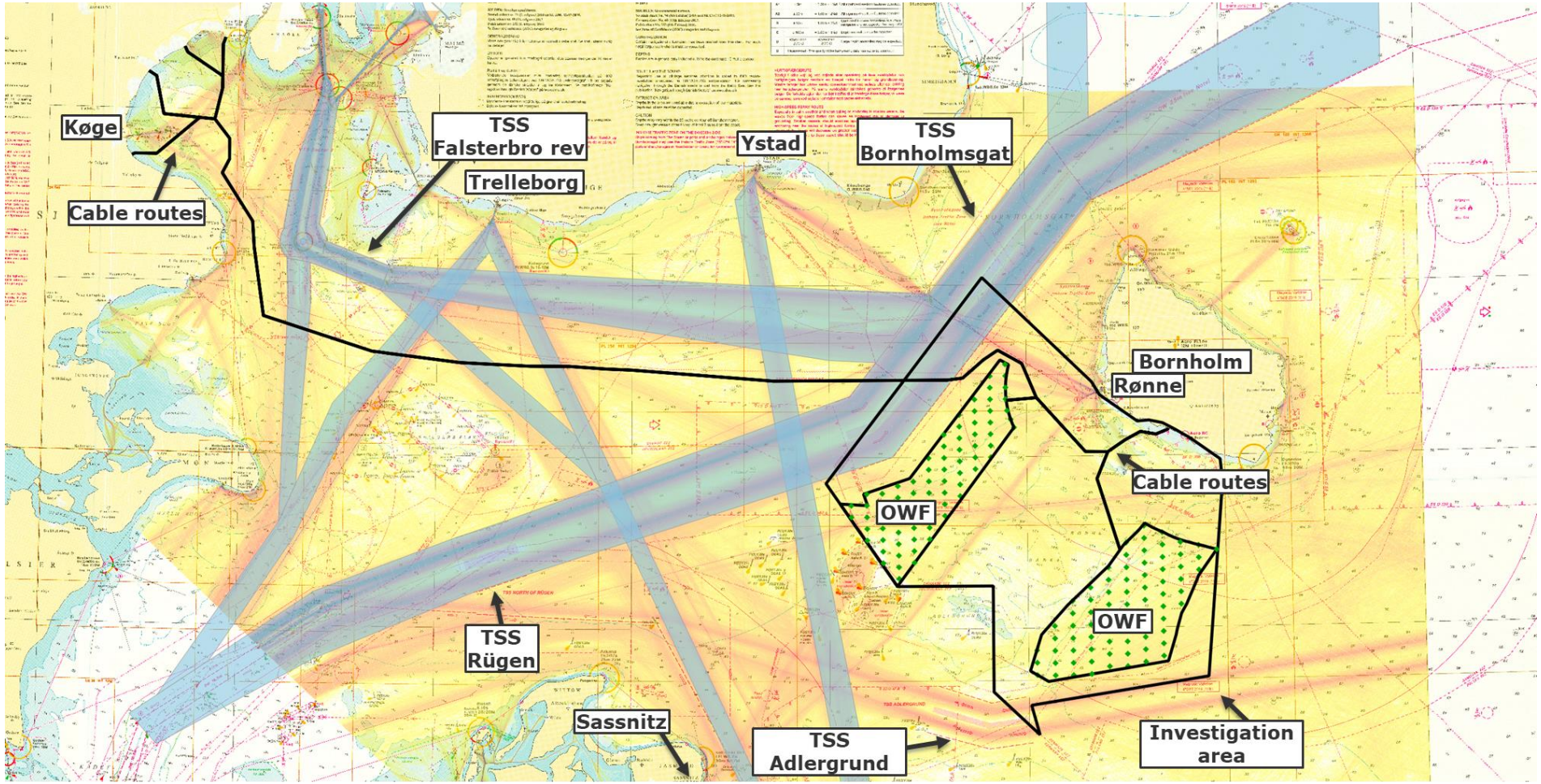

Køge
Cable routes
TSS
Falsterbro rev
Trelleborg
Ystad
TSS
Bornholmsgat
Bornholm
Rønne
Cable routes
OWF
OWF
TSS
Rügen
Sassnitz
TSS
Adlergrund
Investigation
area

Ship traffic intensity in the Baltic Sea between Zealand and Bornholm

AIS data for 2019 pre-covid

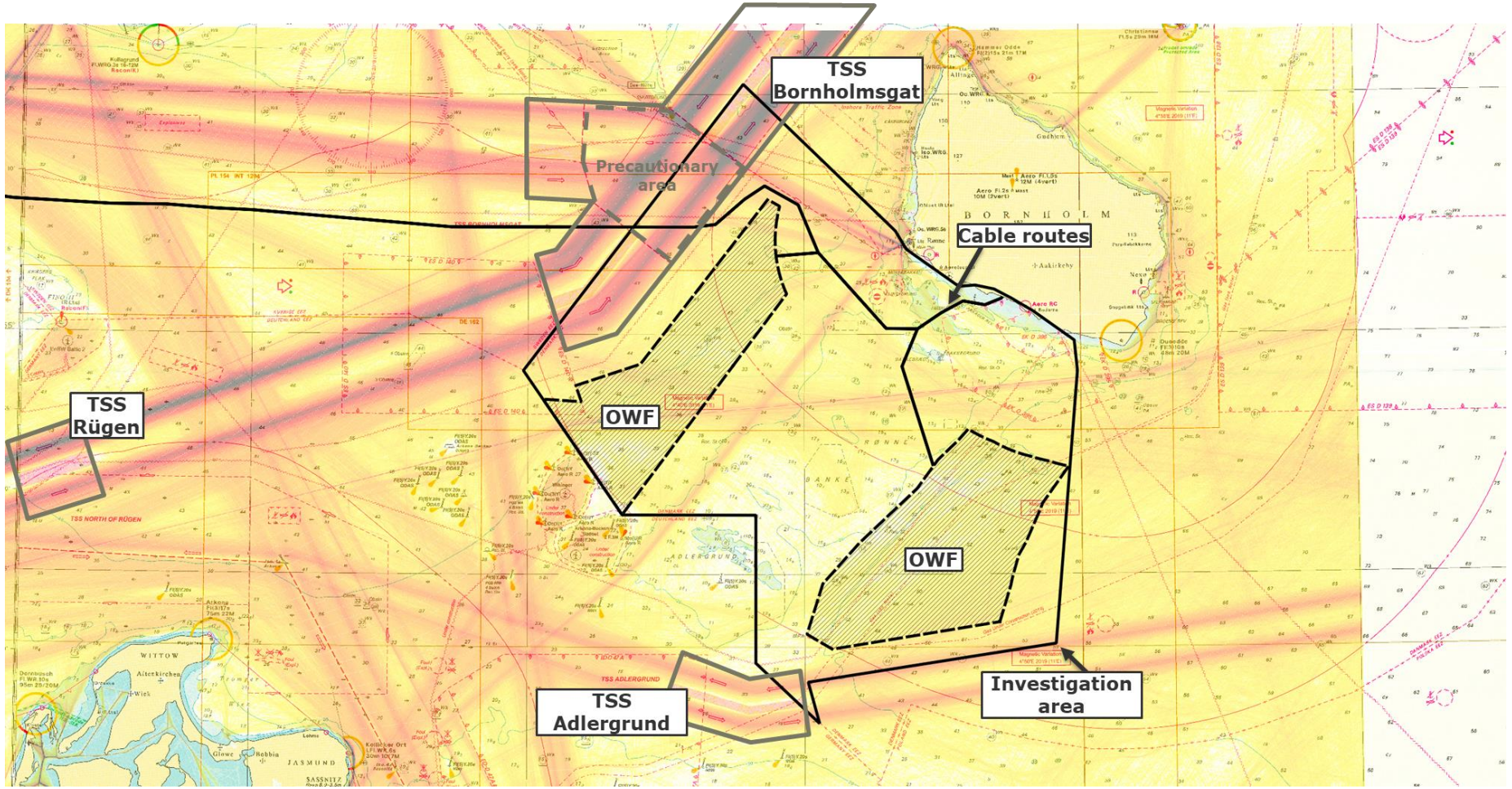


The Swedish maritime corridors

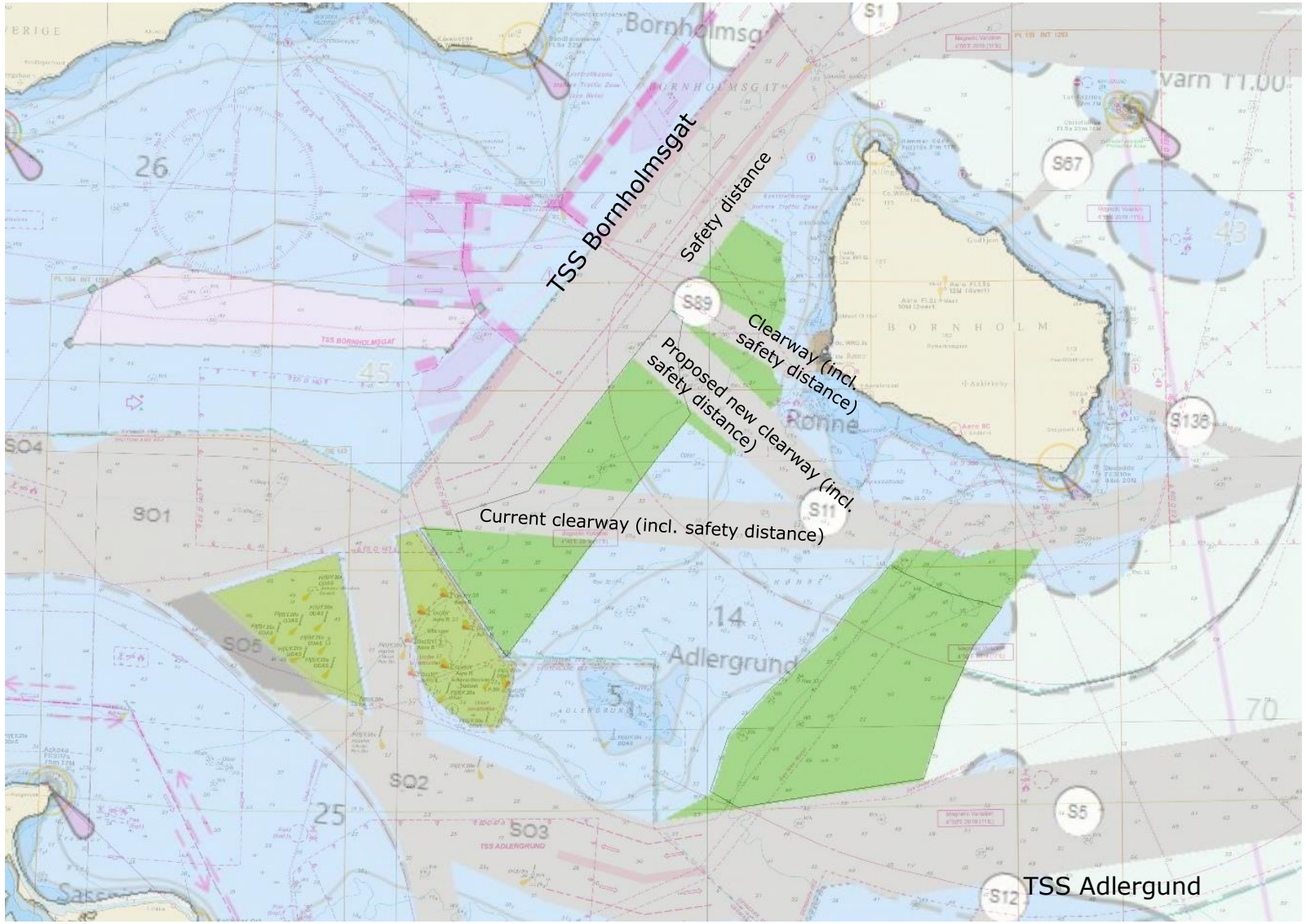


Ship traffic intensity around and in the area

AIS data for 2019 pre-covid



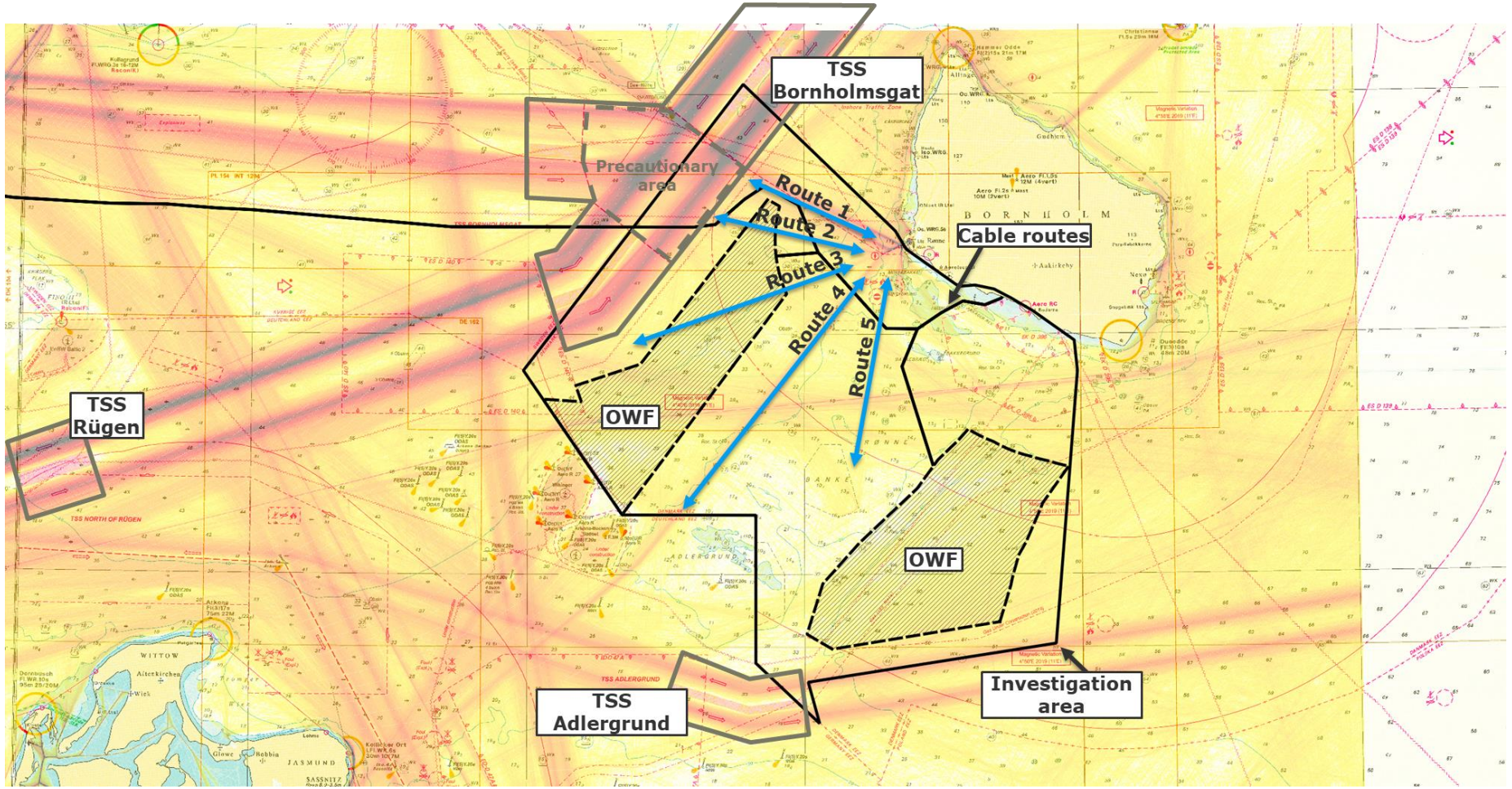
Ship traffic corridors near Energiø Bornholm



- Possible rerouting of corridor south of Bornholm – alternative. DMA working on changing the corridor.

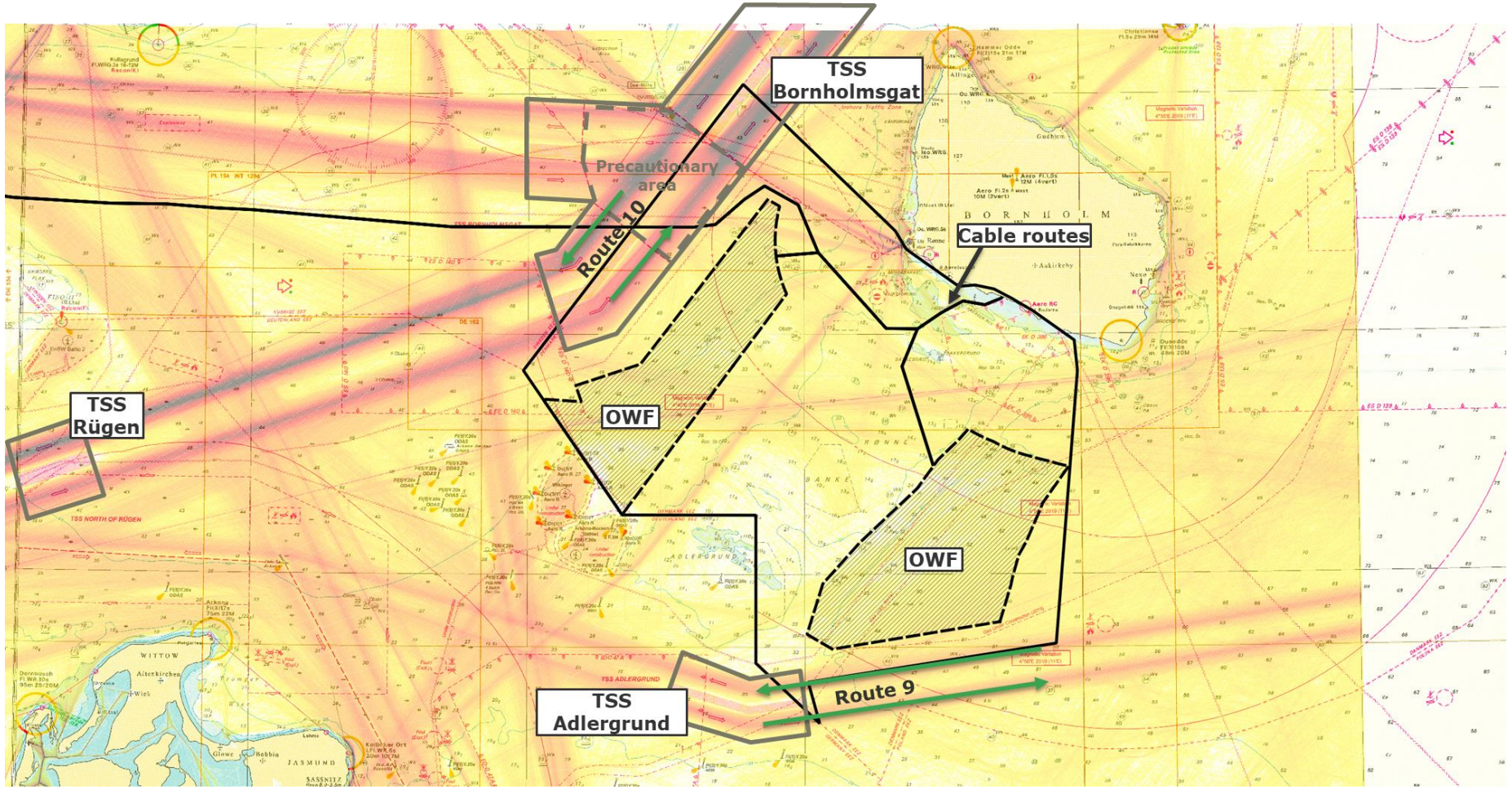
Identified routes from Rønne habour

AIS data for 2019 pre-covid



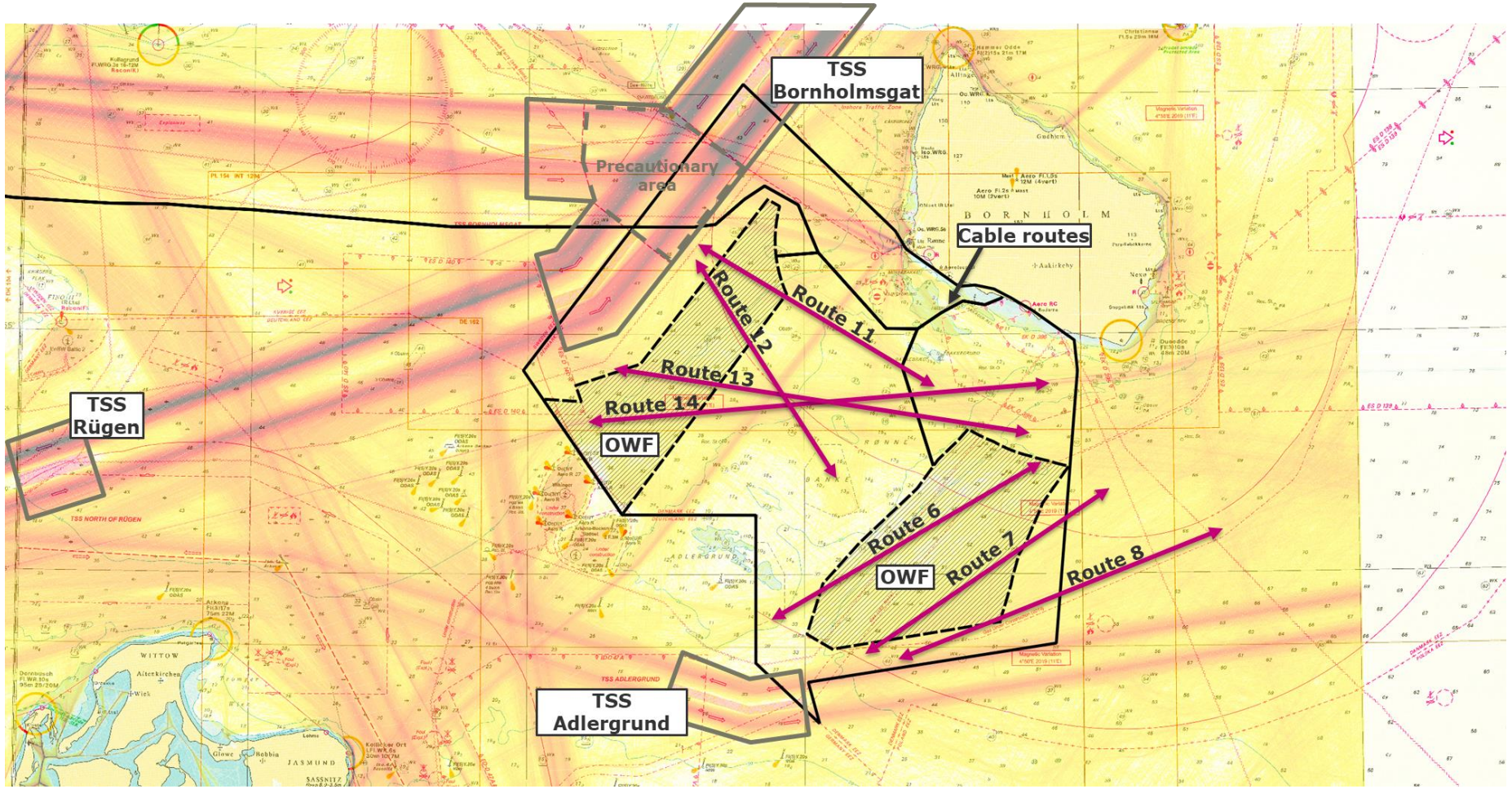
Identified routes through the TSS

AIS data for 2019 pre-covid



Identified routes through the OWF areas

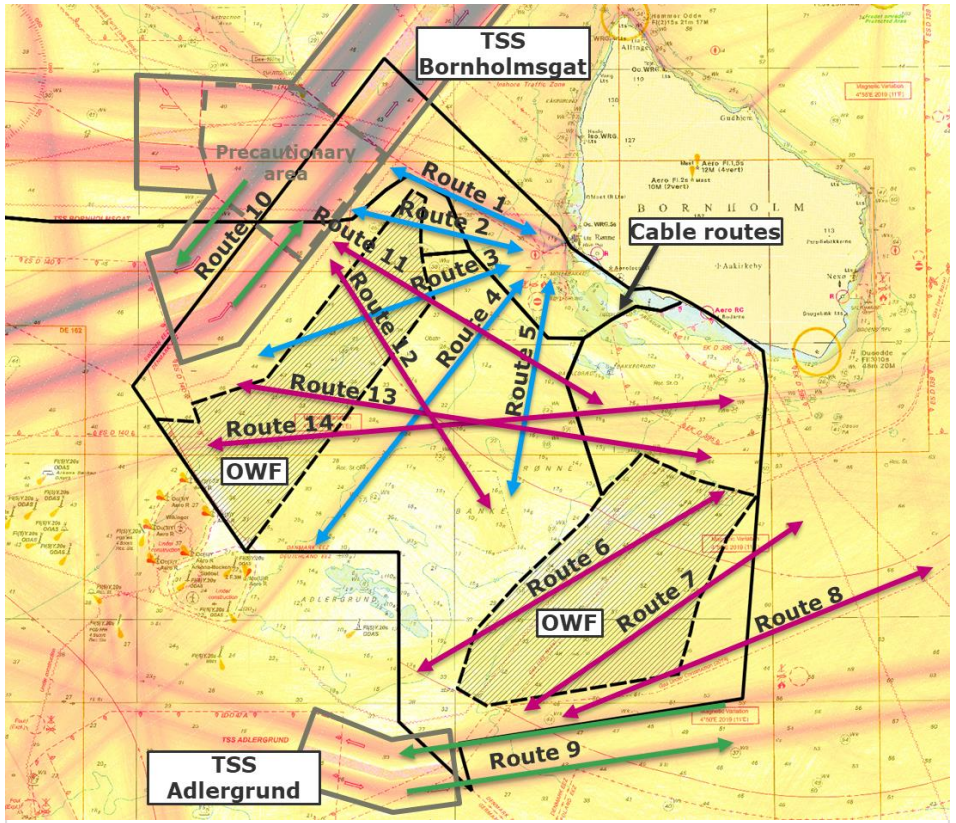
AIS data for 2019 pre-covid

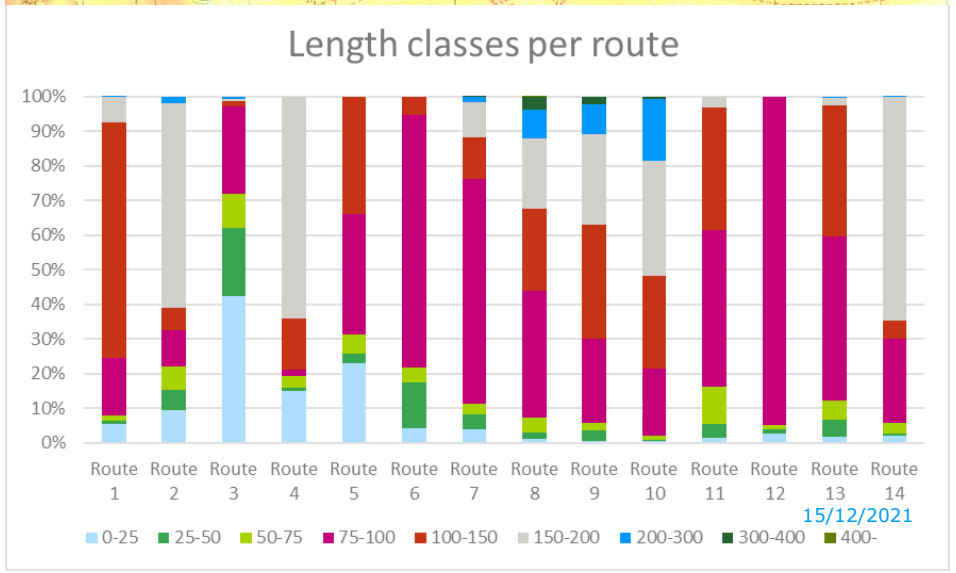


Ship sizes: Energy Island Bornholm

- Lots of traffic through the TSSs.
- Routes 9-10 primarily have ships over 75 m and a large proportion over 150 m.
  - Routes 6, 7 and 8 are similar to Route 9.
  - Routes 11 and 13 are similar to Route 10.
- Most routes are a preponderance of ships with a length of 75-150 m.
  - Routes 1, 2, 4, 14 differ by having longer ships up to 200 m.
  - Route 3 differs by having several short ships. Here is 40% 0-25 m, 20% 25-50 m, 10% 50-75 m and the rest is up to 100 m.

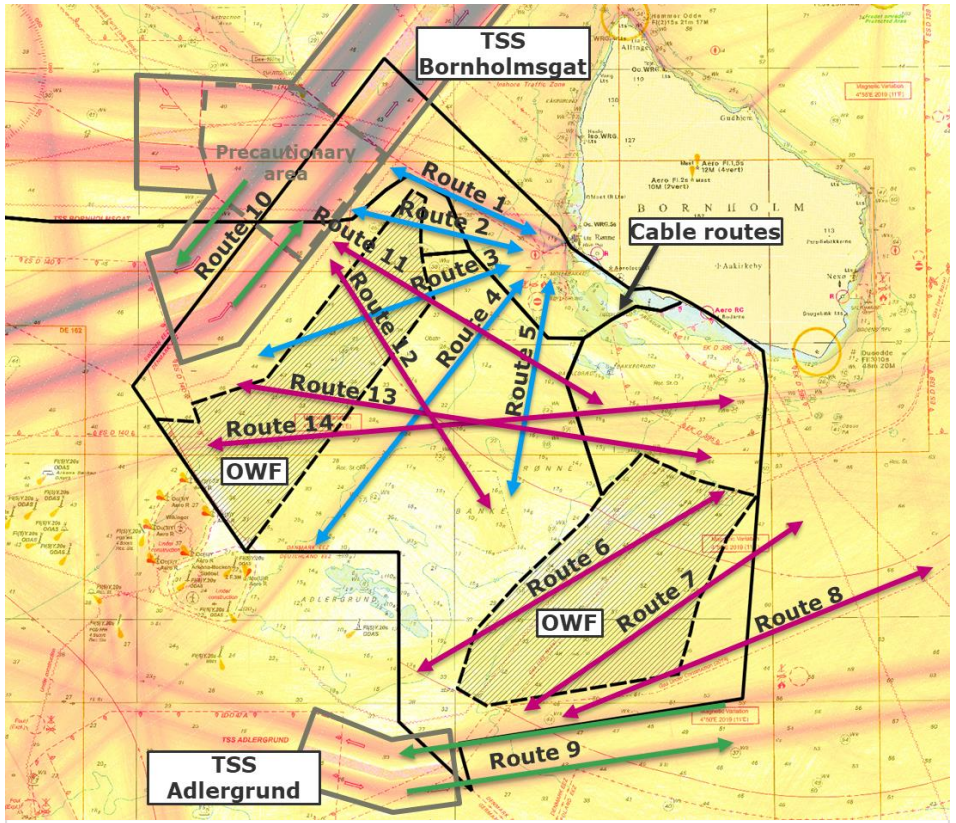
Route	North/West	South/East	Total
1	2075	1724	3799
2	119	560	679
3	100	182	282
4	359	354	713
5	112	124	236
6	85	80	165
7	289	251	540
8	504	285	789
9	2631	2623	5254
10	11248	13575	24823
11	160	173	333
12	124	121	245
13	556	559	1115
14	519	542	1061





Ship types: Energy Island Bornholm

- Traffic through or from and to the TSSs is freight ships.
  - This applies to routes 6-11 and 13.
- Routes 1, 2, 4, 14 are mainly ferries.
- Route 3 is a combination of recreational and cargo ships.
- Routes 5 and 12 are mainly support vessels sailing to the same location (a catchment area).



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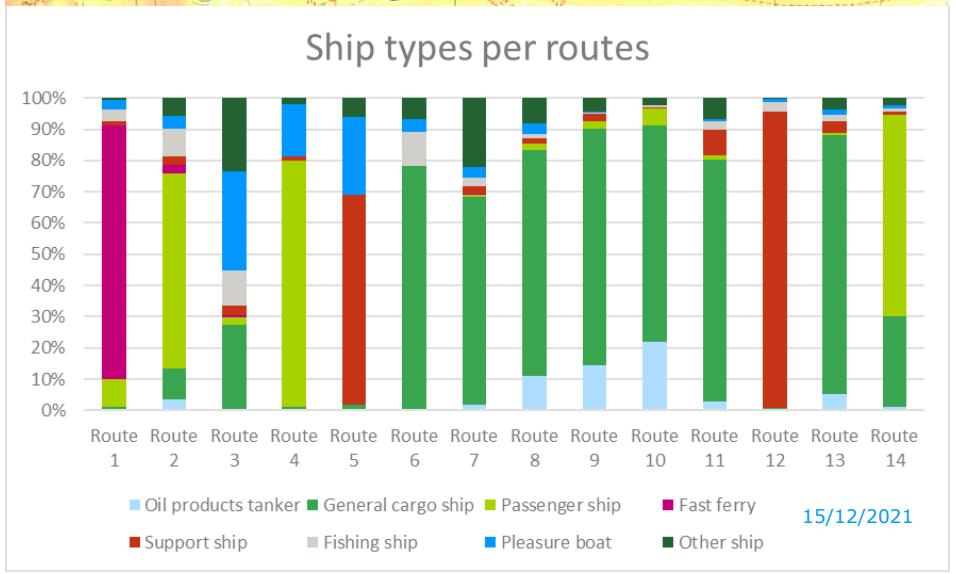
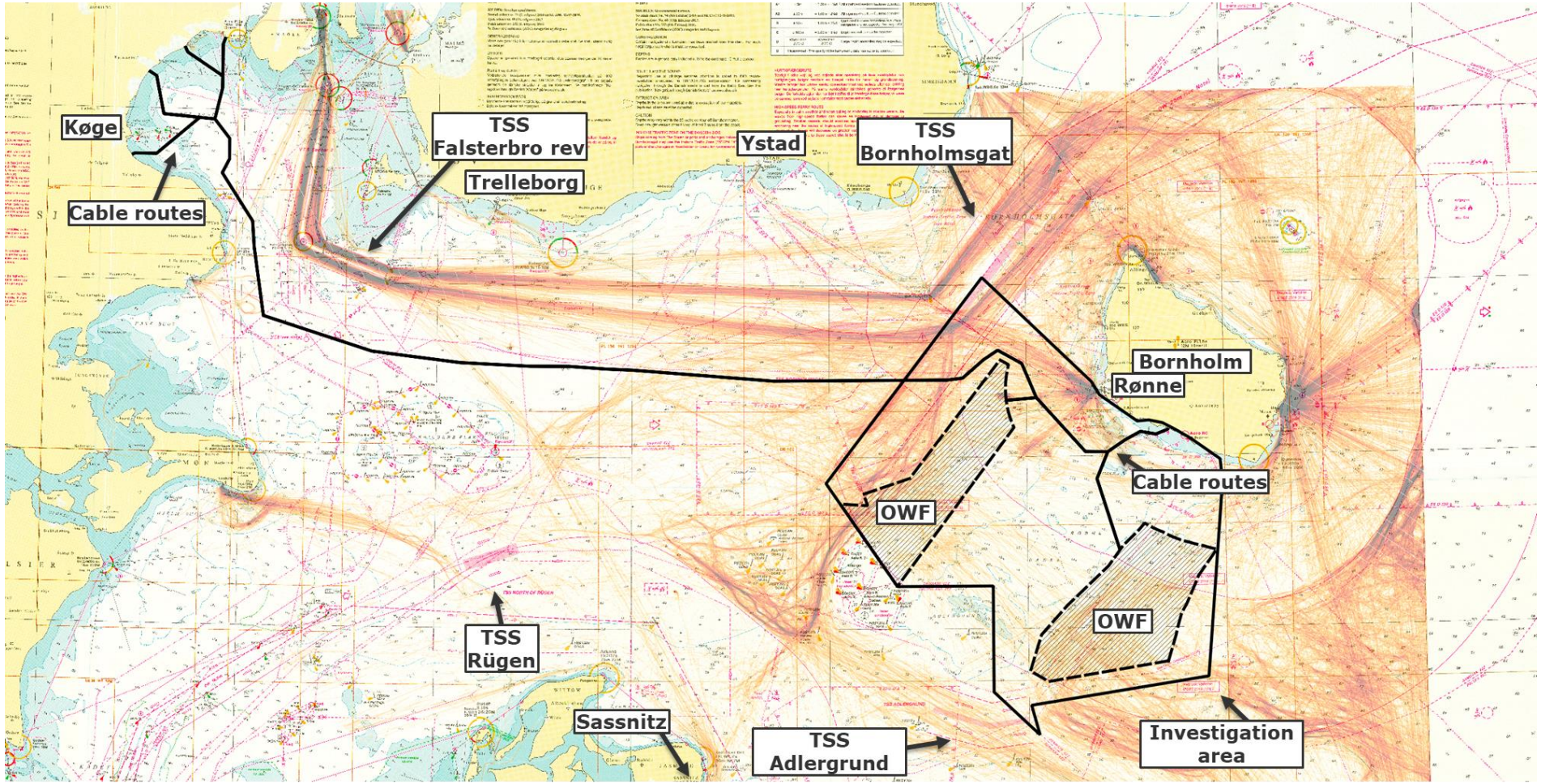
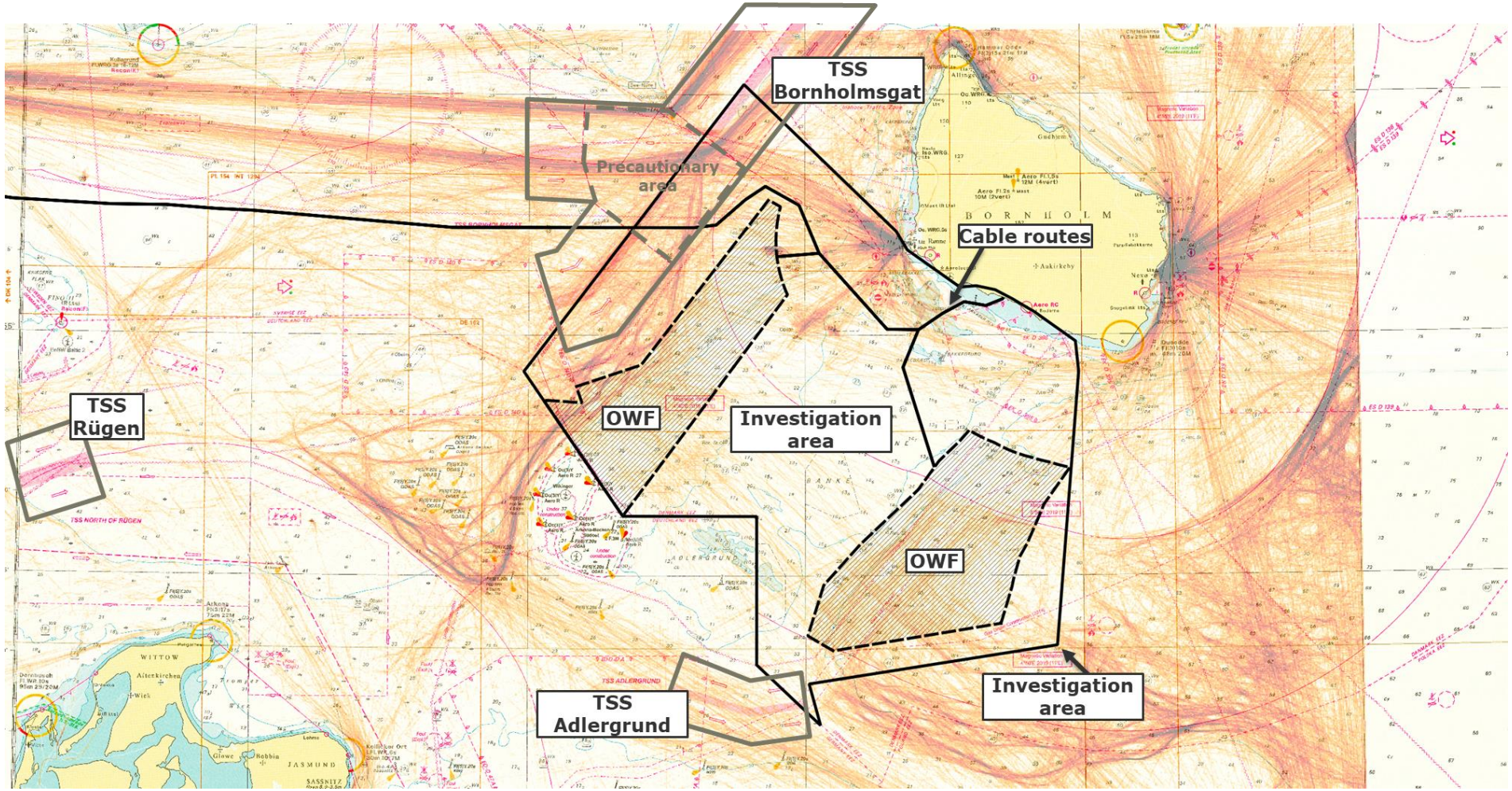


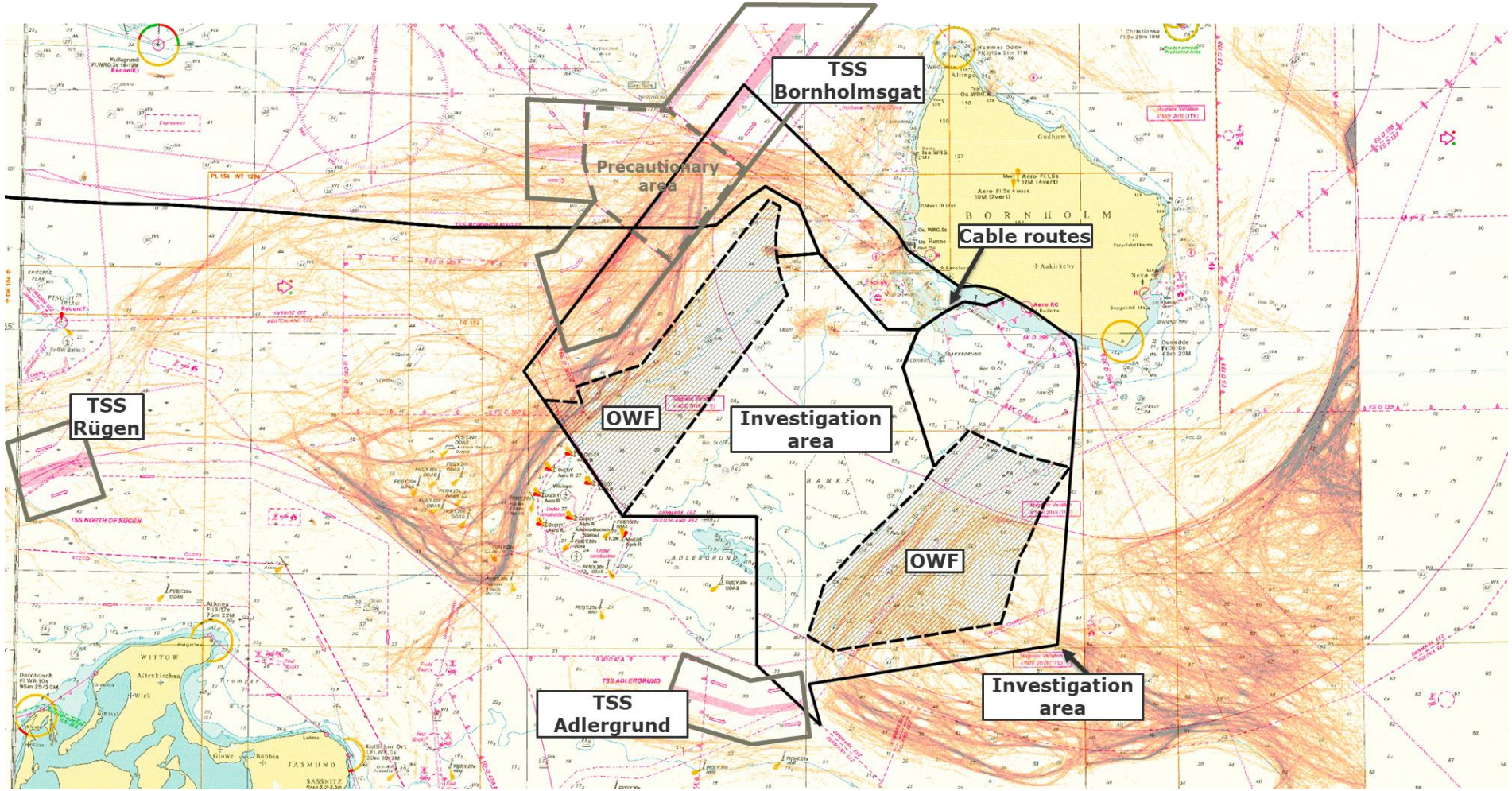
Specific intensity map for fishing ships in the Baltic Sea between Zealand and Bornholm



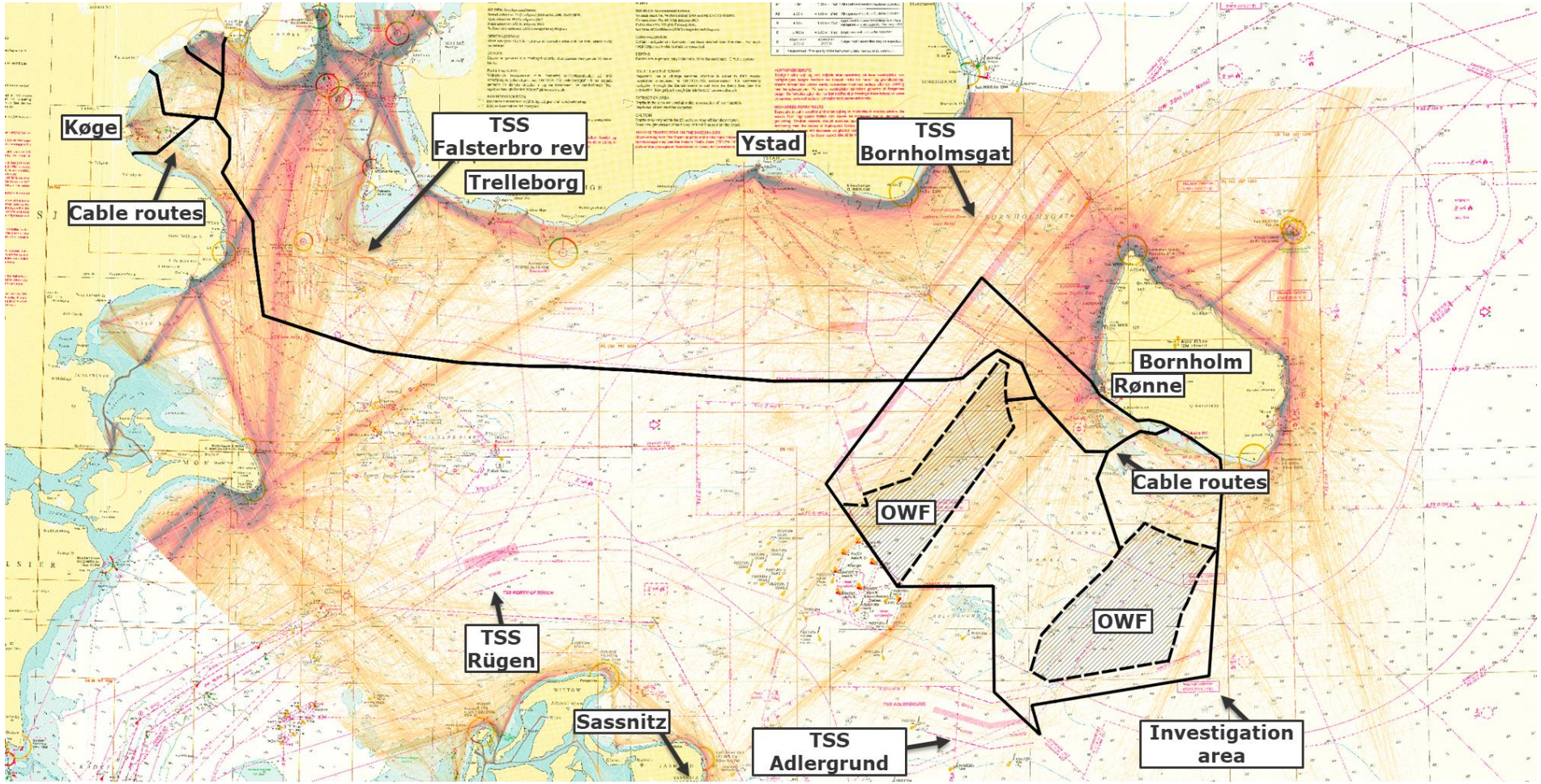
Specific intensity map for fishing ships around and in the area



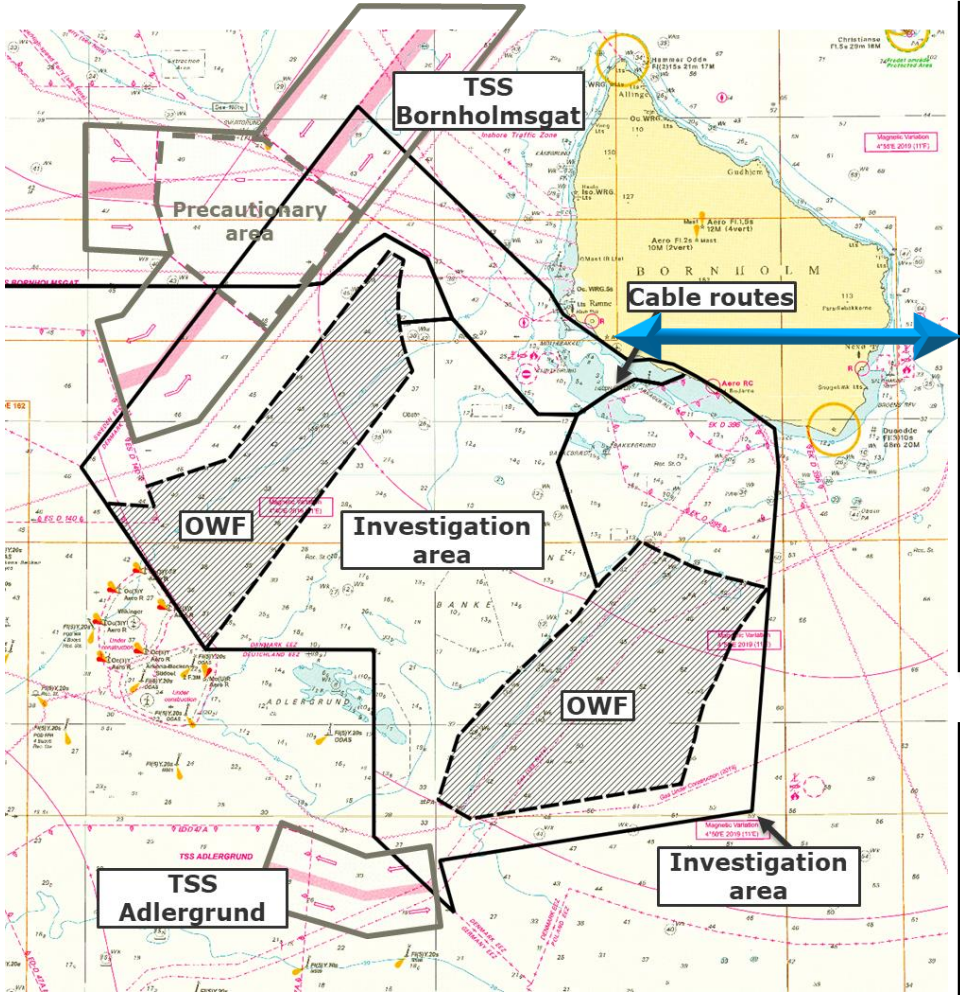
Specific intensity map for fishing ships – with 2-4 knots around and in the area

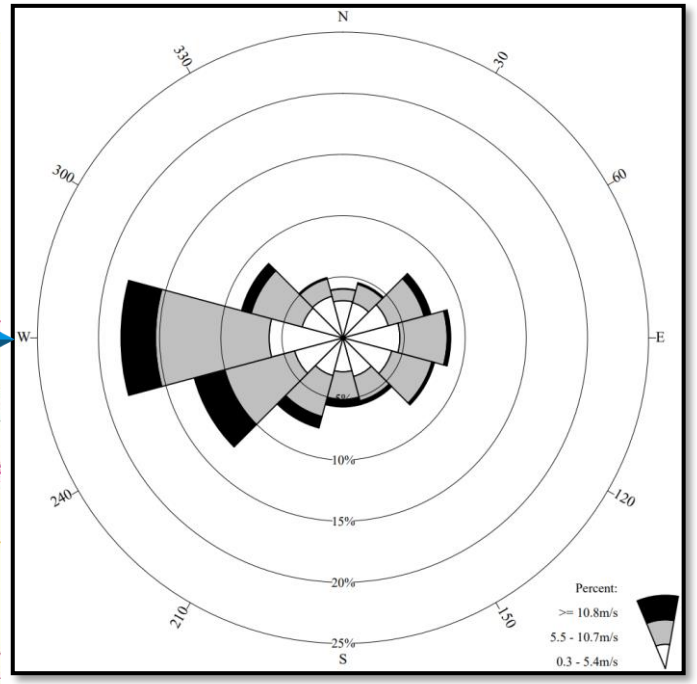


Specific intensity map for recreational ships in the Baltic Sea between Zealand and Bornholm



Vindrose for perioden 1971-2000



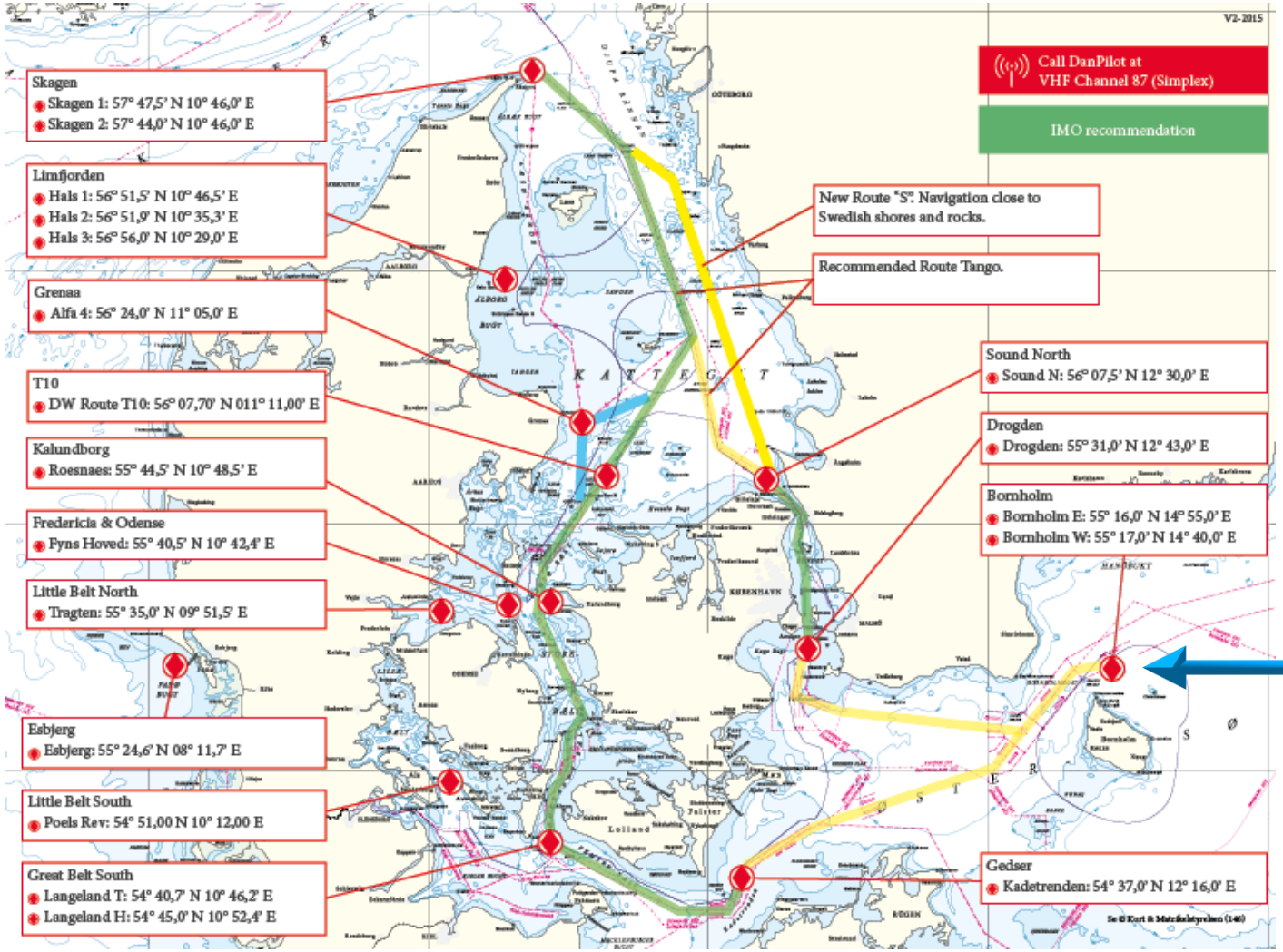


- The wind conditions in the area have been found for a 30-year period from 1971-2000.
- Primarily wind from the west.
- Strong winds also occur most frequently from the west.
- Winds from the north and south are rare, whereas easterly winds are more frequent.

	N	30	60	E	120	150	S	210	240	W	300	330	Total
%	4.0	4.7	7.4	8.8	7.7	5.6	5.7	7.6	12.6	18.2	8.6	5.1	96.1
% 0.3-5.4m/s	3.1	3.0	3.8	4.7	4.1	3.3	2.8	3.2	4.1	6.0	3.5	3.5	45.0
% 5.5-10.7m/s	0.9	1.6	3.0	3.9	3.4	2.1	2.3	3.5	5.9	9.3	4.3	1.5	41.6
% >= 10.8m/s	0.0	0.1	0.6	0.3	0.2	0.3	0.6	1.0	2.6	2.8	0.8	0.1	9.4
Mean wind speed	4.1	4.8	5.7	5.5	5.5	5.4	6.0	6.5	7.5	7.2	6.4	4.6	6.1
Max wind speed	13.4	15.4	18.5	16.0	16.9	19.0	21.0	19.5	27.0	26.8	22.2	16.5	27.0

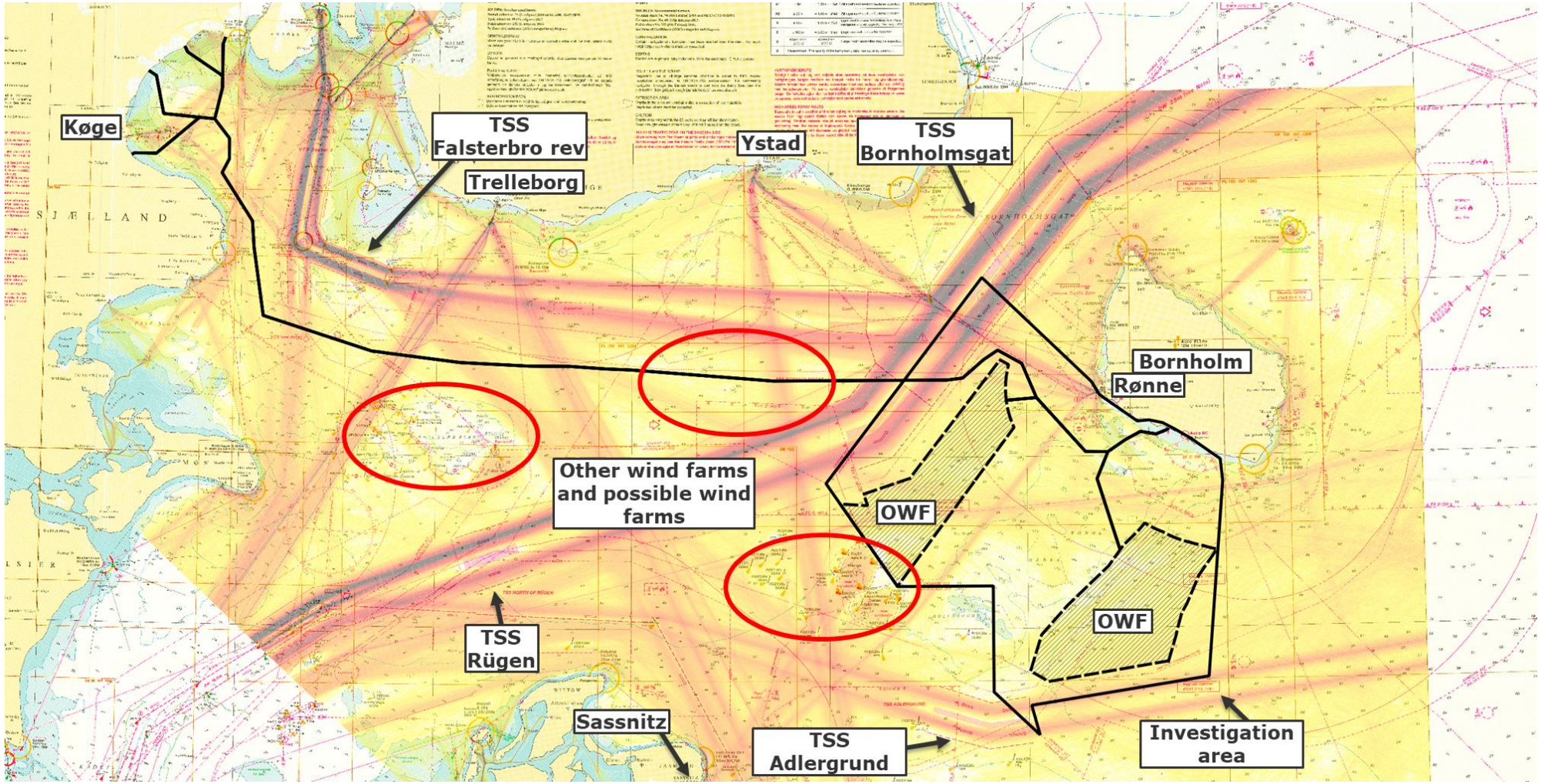
Number of observations = 83584 Source: DMI
Calm defined as wind speed <= 0.2m/s
Number of observations with calm/varying wind direction: 3266 = 3.9%
Observations with calm/varying wind direction are not used in the statistics

List of pilot marks in Danish straits



Nearest DanPilot station is located north of Bornholm

Other wind farms



Agenda

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15:45: Review of hazards, summary and final questions
16:00: Workshop ends

Comments by the marine users on the presentations

From a safety perspective, what are your main considerations?

For example:

- Changed directions, changed routing?
- Is there a requirement to transit the area for the planned wind farm?
- What impact(s) may it have on your activities?

Energy Island Bornholm

Considerations about:

- Only what has to do with navigational safety hazards
- Construction, operation and decommissioning of Energy Island Bornholm
- We will take note of any impacts or concerns mentioned during the workshop

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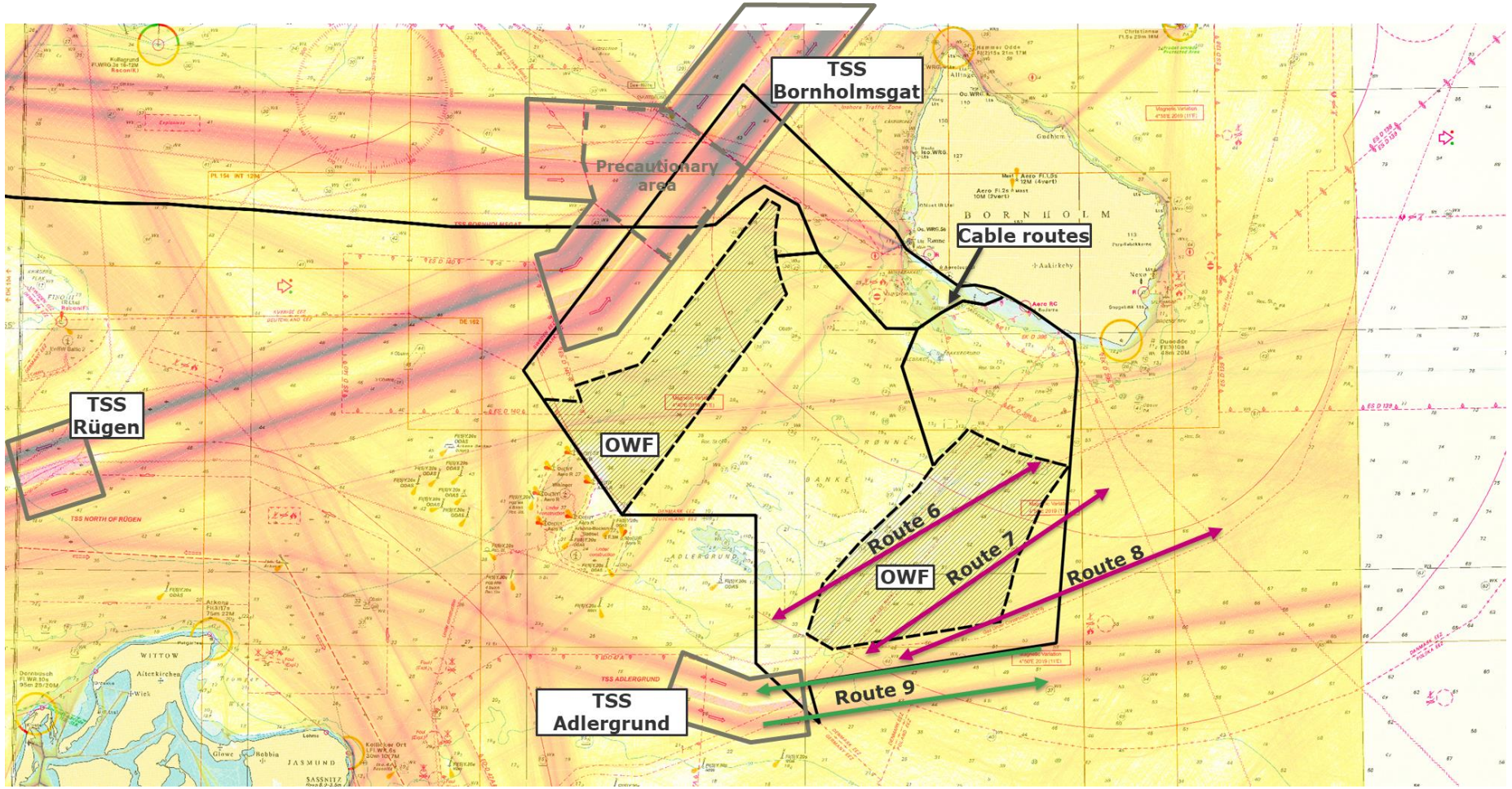
Hazards in the operational phase

Example of how it could look

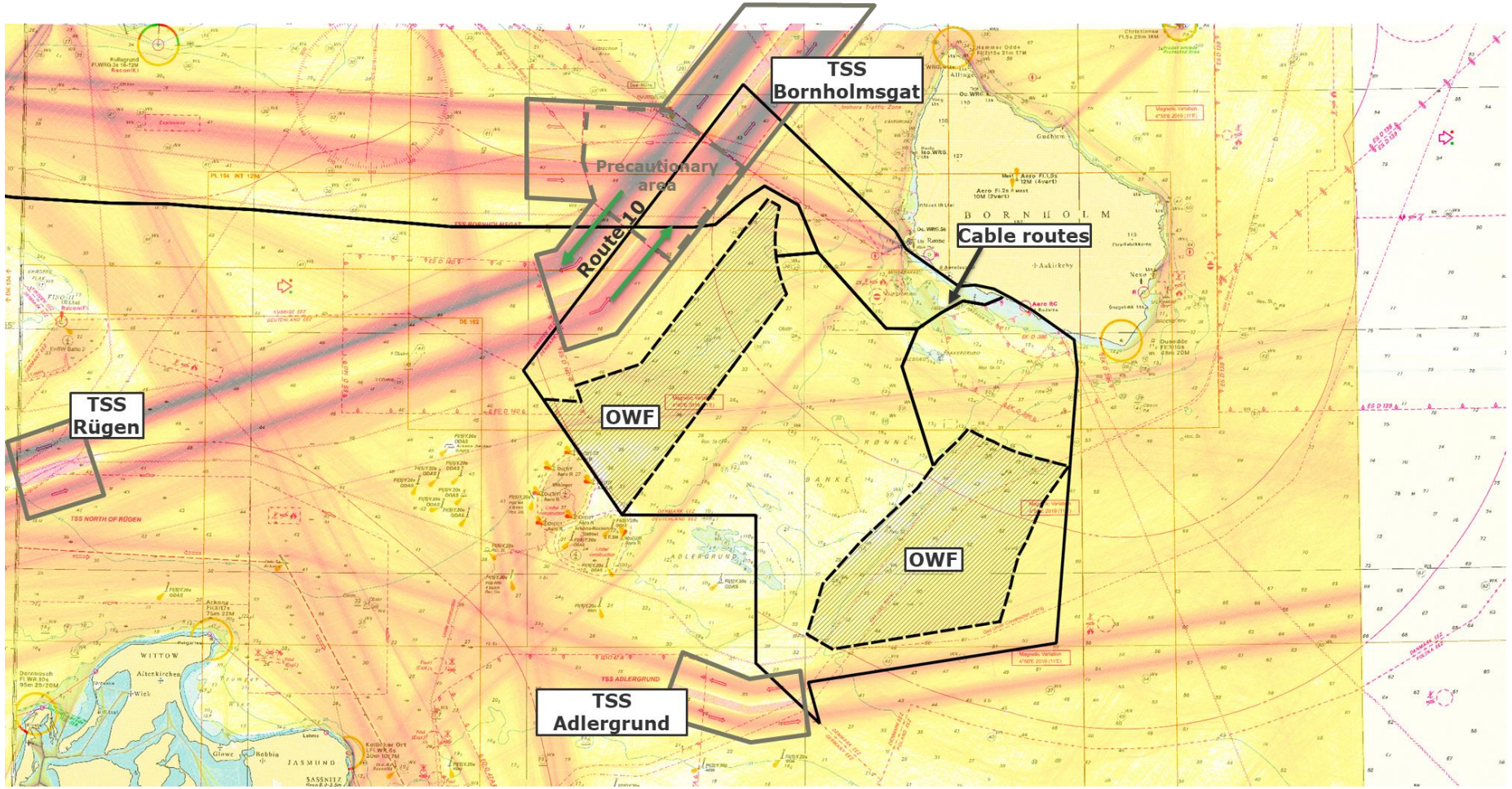
TSS Adlergrund and routes through Bornholm II (southern OWF area)

AIS data for 2019 pre-covid



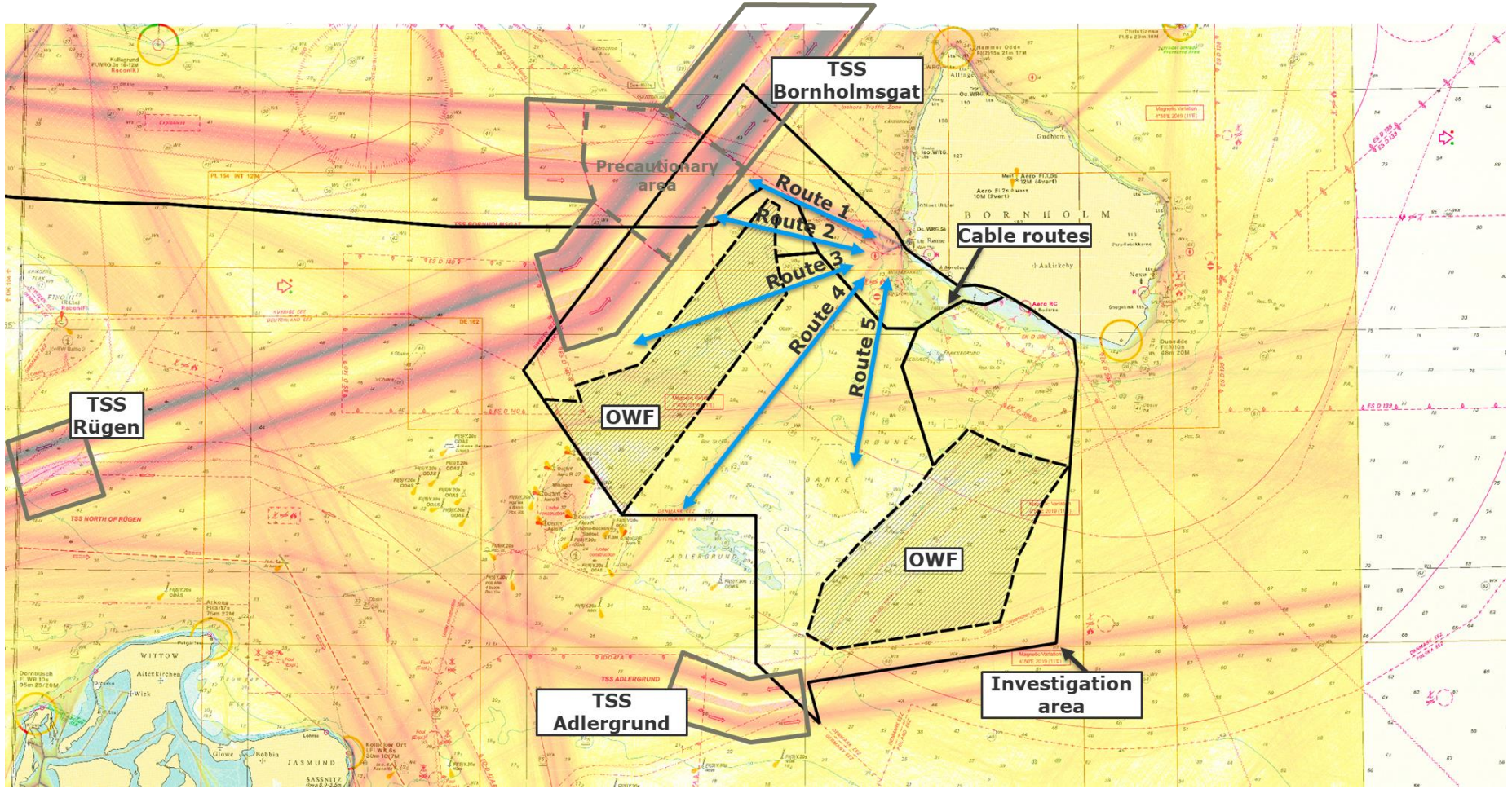
TSS Bornholmsgat and precautionary area

AIS data for 2019 pre-covid



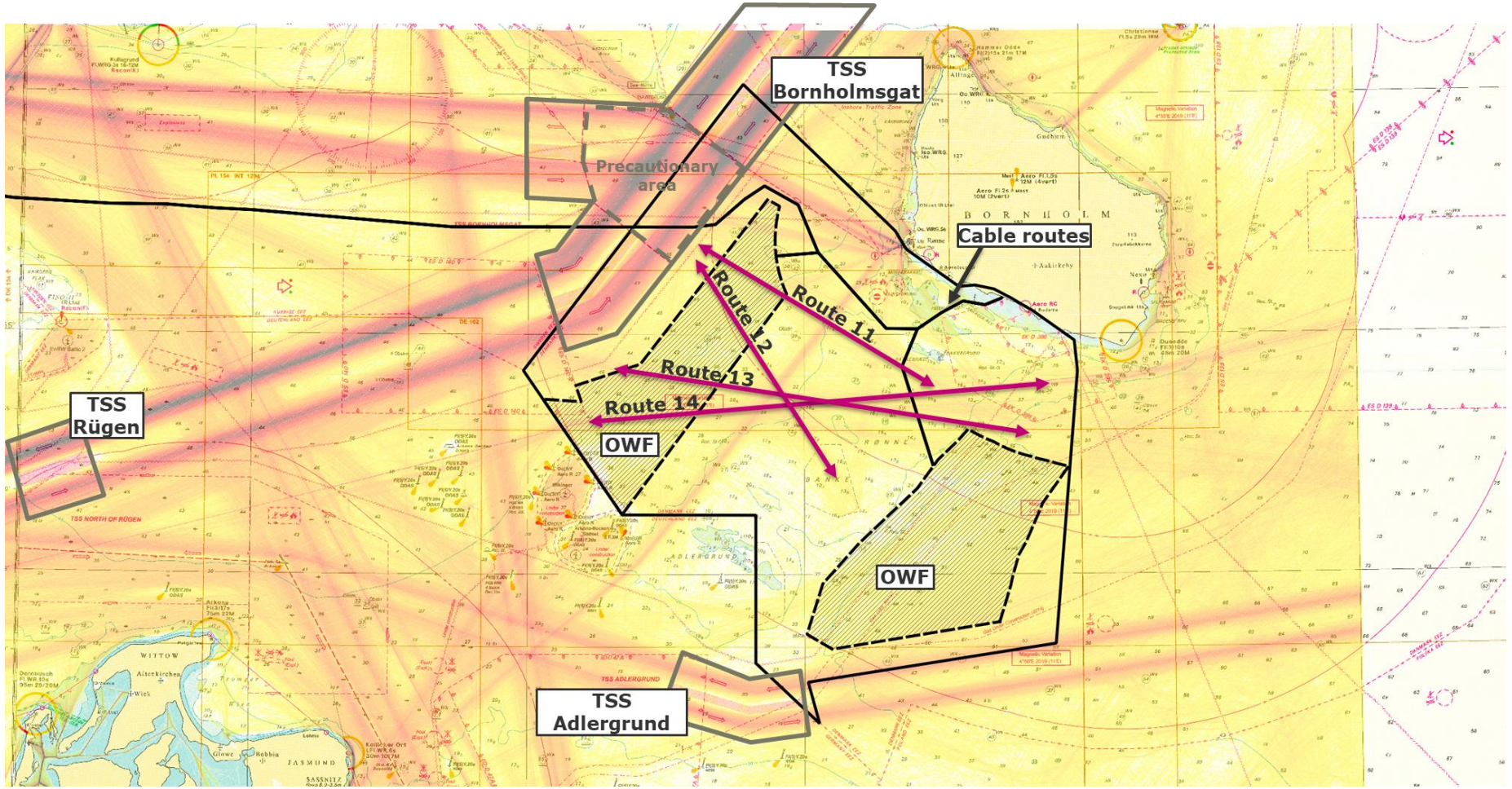
Access from/to Rønne harbour – ferries and other traffic (incl. corridor)

AIS data for 2019 pre-covid



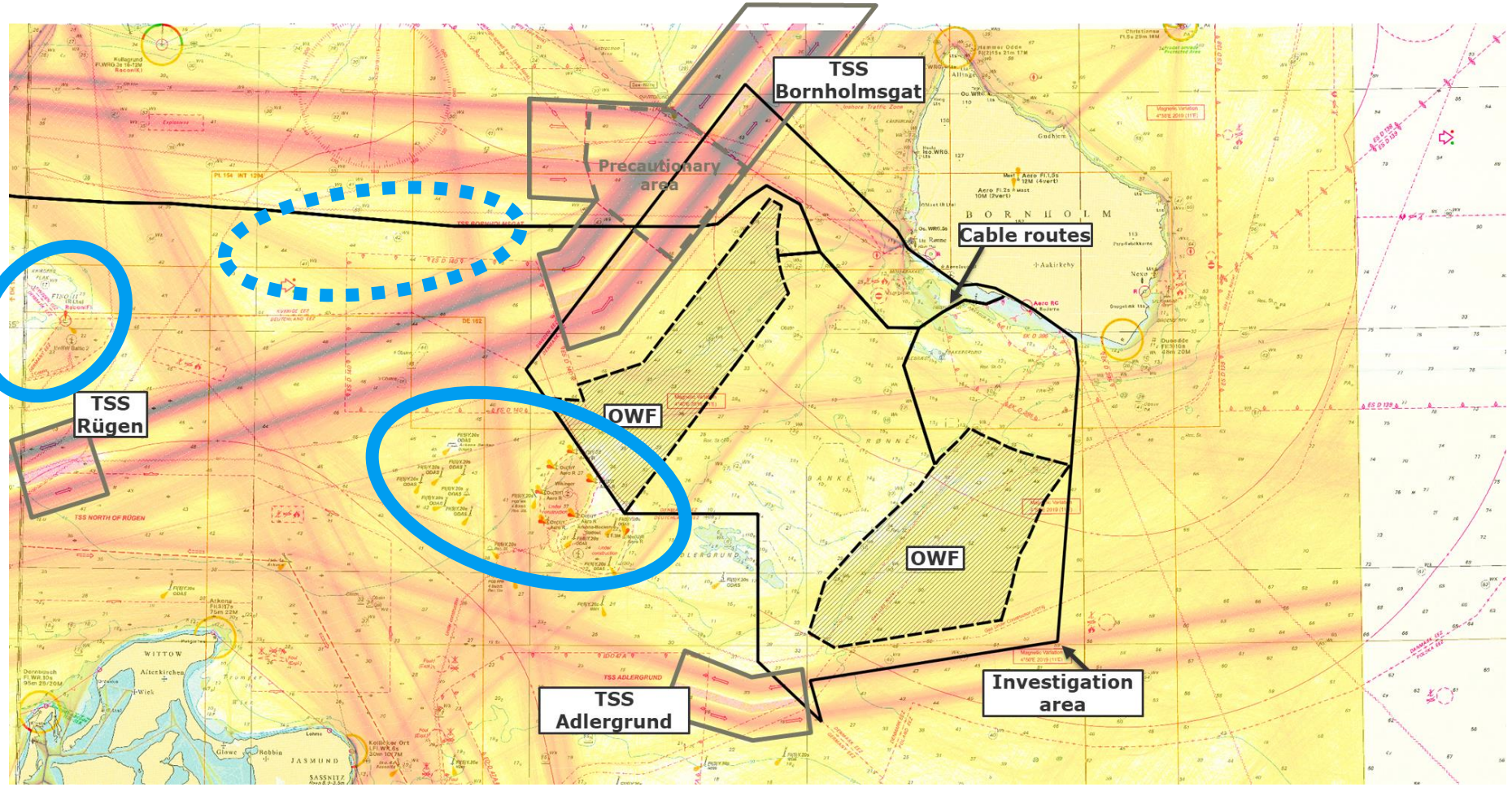
Corridors and traffic through Bornholm I

AIS data for 2019 pre-covid



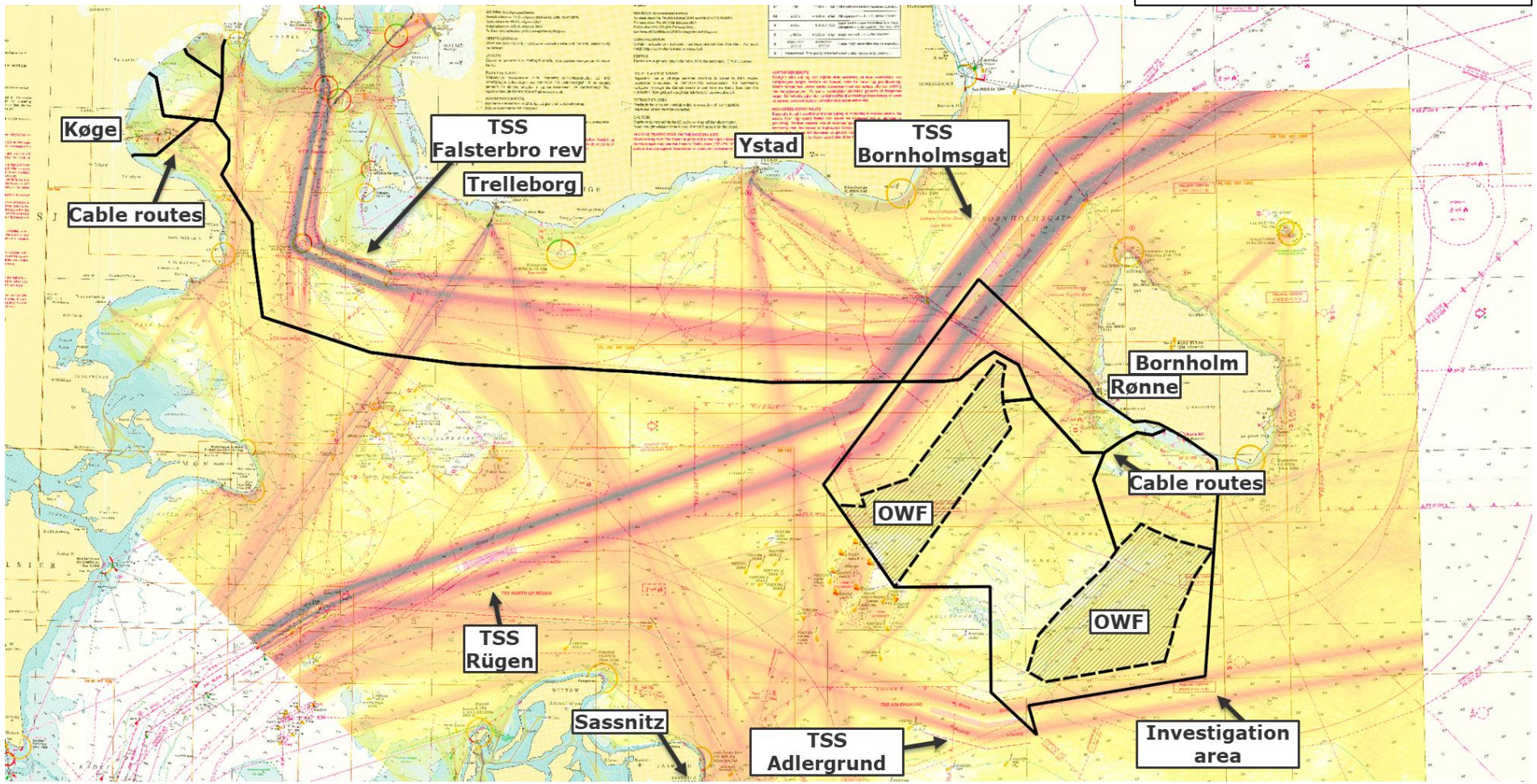
Boundary to existing wind farms in German waters

AIS data for 2019 pre-covid



Other aspects, cables and DC export cable, resource areas

AIS data for 2019 pre-covid



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Hazards in the operational phase

Example of how it could look

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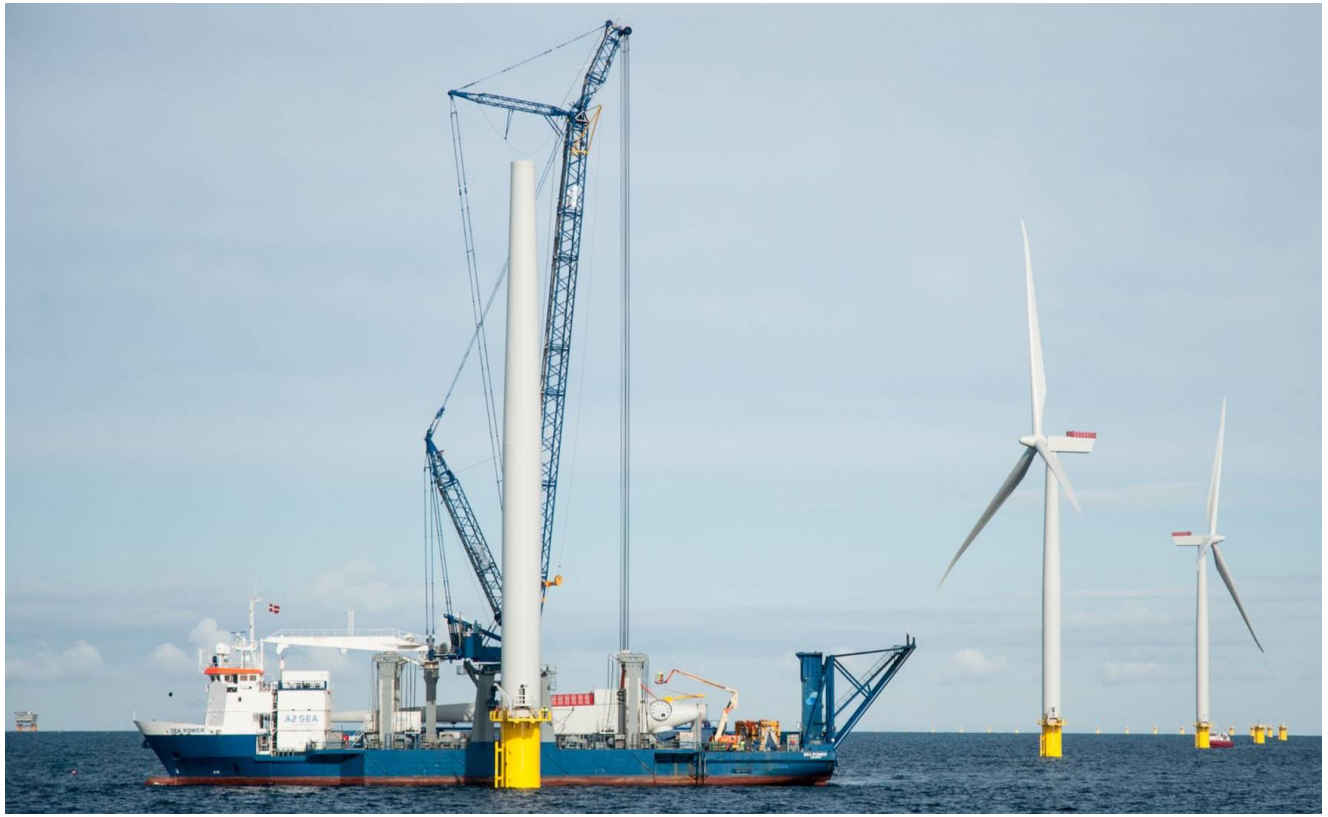
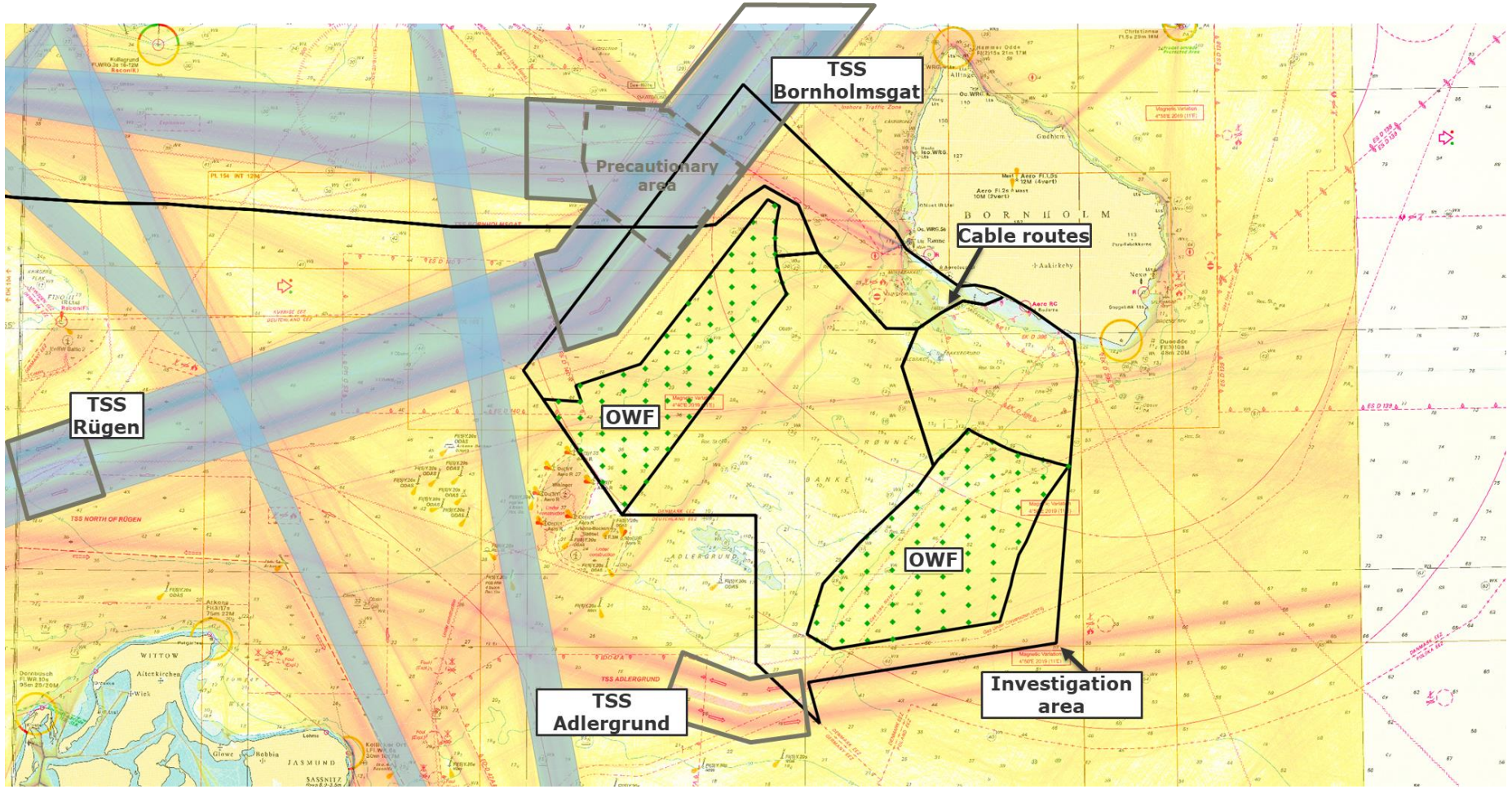
Hazards relevant for construction and decommissioning phase

Examples of how the construction phase might look like



Construction and decommissioning

AIS data for 2019 pre-covid



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The following actions

- Today we have written down your inputs on hazards and suggestions to mitigation measures (impact and risks).
- HAZID report will be sent out for comments

ID	Hazard	Cause(es)	Route ID	Ship type(s)	Type of accident	Project phase	Risk reduction measures	Comments
1								
2								
3								

Final questions?

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Thanks for your participation and inputs!

Toke K. Jensen
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Christian M. Faber
CMFA@RAMBOLL.DK
+45 5161 0513

Bright
ideas.
Sustainable
change.

RAMBØLL

APPENDIX 3
HAZID INVITATION RESPONSES

Christian Mathias Faber

From: [redacted]
Sent: 6. december 2021 17:32
To: Christian Mathias Faber
Cc: 'Signe Dons'; 'Morten Bak'; Toke Koldborg Jensen
Subject: SV: Energiø Bornholm - invitation til workshop om sejladssikkerhed

You don't often get email from [redacted] Learn why this is important

Hej Christian m.fl.

Jeg kan desværre ikke deltage i mødet den 15. december, så jeg fremsende hermed lidt bemærkninger og spørgsmål til projektet.

Det er et spændende projekt som jeg personligt ser meget frem til at det bliver en realitet hurtigst muligt. El er/bliver fremtidens energiform generelt og vindenergi er vel p.t. den bedste måde at fremstille strømmen på, især her i denne del af Østersøen, hvor vi lige nu oplever øgede vindmængder i forbindelse med den øgede globale opvarmning.

En stor del af de markerede områder bliver benyttet i forbindelse med trollingfiskeri efter laks. Det er primært i områder med vanddybden 35 – 50 meter vi benytter til trolling. På dybder 2-35 meter fisker vi ikke, men vi passerer områderne for at komme ud til fiskeområderne.
Hvis det bliver tilladt at sejle i vindmølle områderne er projektet både i forbindelse med fiskeri (hastighed ca. 2 knob) og passage (hastigheder ca. 15- 25 knob) på ingen måde til hindring for vores fiskeri. Det vil være den ideelle løsning for os.
Hvis vi ikke må komme ind i de skraverede vindmølleområder vil især det østlige område, som delvis dækker ”bakkerne”, være en hindring for vores fiskeri.

Spørgsmål: må vi når projektet er færdigt sejle/trollingfiske i de skraverede områder?

Generelt er møllerne gavnlige for navigationen i forbindelse med vores fiskeri, dog med undtagelse i meget tåget vejr. De fleste trollingfiskere har udstyr til at modtage AIS så møllerne burde udsende et AIS signal som viser placering (hvis det er muligt på stationære hindringer). Jeg kan se på Vesselfinder og Marrine Traffic at eksisterende vindmølleparker (som den på tysk område sydvest for Bornholm) ikke er udstyret med AIS sendere. Det burde være et krav at minimum de yderste møller i området var udstyret med AIS sendere (evt kun tændt i forbindelse med tåge). De fleste både er også udstyret med radar, hvor fundamenter/mølletårne formentlig vil være meget synligt .
Derudover har vi umiddelbart ingen yderligere betænkeligheder med sejladssikkerheden i de berørte områder.

I øvrigt ser vi lystfiskere frem til de mange møllefundamenter under havoverfladen, som vil danne grobund for ny fauna og liv i området. Jeg vil gerne opfordre til at der tages initiativ til at fundamenterne får en ujævn hullet overflade med så stort areal som muligt, som vil give en meget større artsrigdom end et glat betonfundament/stålrør. Det vil i kunne høste mange miljø point på. Når vi snakker miljø bør i også lave konstruktioner og teknik som har væsentligt længere levetid end der stilles krav om i dag. Rustfri konstruktioner, overdimensionerede smurte lejer, generatorer af høj klasse kan jo helt sikkert laves i dag så levetiden minimum er 50 år og serviceintervallerne minimale. Det vil også give meget miljø på den lange bane.

Med venlig hilsen
[redacted]

MARINE
HJEMMEVÆRNET

Til: Rambøll

Svar vedrørende invitation til Workshop om sejladssikkerhed – Energiø Bornholm

Marinehjemmeværnet (MHV) er inviteret til deltagelse i en workshop omhandlende sejladssikkerhed i relation til Energiø Bornholm.

Vi har gennemset det tilsendte materiale og vurdere på baggrund deraf, ikke at have kommentarer der relaterer til sejladssikkerheden i området.

MHV takker for invitationen, men ser ikke deltagelse i nærværende workshop, som værdiskabende for projektet.

Dato: 7. december 2021

Sagsbeh.: MHV-OPL01
Sagsnr.: 2021/010402
Dok.nr.: 17417
Bilag: Ingen

Marinehjemmeværnet
Garnisonen 1
4100 Ringsted

Tlf.: +45 7282 0400
E-mail: mhv-myn@mil.dk
www.hjv.dk

EAN: 5798000201224
CVR: 16 28 71 80

Sagsbehandleren direkte:
Tlf.: +45 7282 0421
E-mail: mhv-opl01@mil.dk

Mvh

[redacted]
Orlogskaptajn
Sagsbehandler

Ref.: Mail modtaget den 18. nov. 2021 – "Energiø Bornholm – Invitation til workshop om sejladssikkerhed"

Intern fordeling: CHOPL

HJEMMEVÆRNET (HJV)