



PLAN FOR PROGRAMME ENERGY ISLAND BORNHOLM

Example visualisations - Visibility assessment

Appendix 1

Introduction

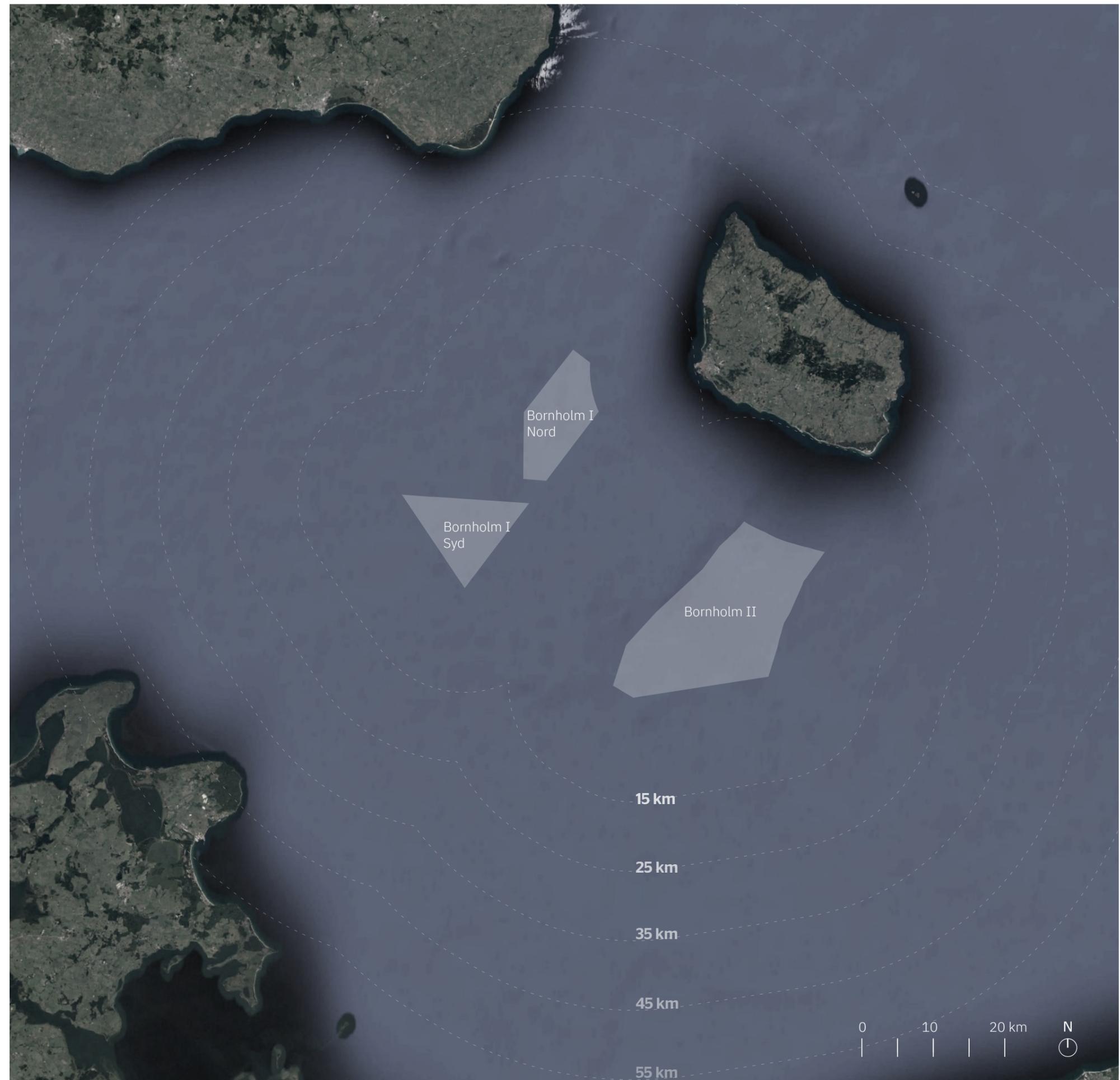
This appendix illustrates the maximum expected visibility of the off-shore wind farm (OWF) described in the Plan for Programme Energy Island Bornholm, based on site-specific example visualisations from selected viewpoints along the coastal areas of Denmark, Sweden, and Germany.

The appendix contains example visualisations of four scenarios for park dimensions and layout, and associated photos of the landscape as it looks today.

In addition, the appendix contains a description of how the example visualisations are prepared and an overview of the selected viewpoints.

This collection of example visualisations is an appendix to the technical report and primarily contains visualisations.

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I Project description

This appendix illustrates the maximum expected visibility of the off-shore wind farm (OWF) described in the Plan for Programme Energy Island Bornholm, based on site-specific example visualisations from selected viewpoints along the coastal areas of Denmark, Sweden, and Germany.

Example visualizations have been prepared for 4 scenarios for respectively 3.2 GW with a small wind turbine size of 15 MW and a large wind turbine size of 27 MW and 3.8 GW respectively with a small wind turbine size of 15 MW and a large wind turbine size of 27 MW.

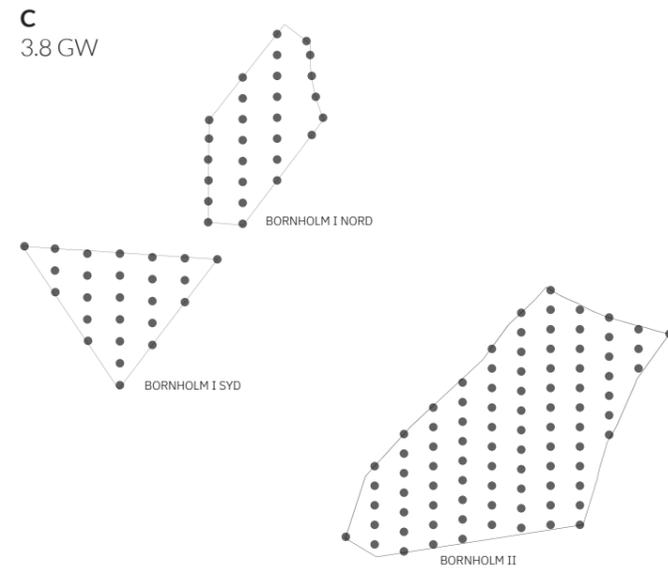
The layouts assume an even distribution of turbines within the planning area. Rotor overhangs outside the planning area are allowed, except towards the Danish-German EEZ.



119 wind turbines of 27MW



214 wind turbines of 15MW



141 wind turbines of 27MW



254 wind turbines of 15MW

II Viewpoints

To illustrate the visual impact of the OWF, 7 example visualisations have been prepared from the coasts of Bornholm, Sweden, and Germany, as well as from the hinterland at Bornholm.

The visualisations are prepared to exemplify the maximum visibility of the OWF if offshore wind turbines in a future project are installed in the entire planning area and thus utilise the maximum planning capacity of 3.2 GW or 3.8 GW.

This also means that the example visualisations show the offshore wind turbines with a location as close to land as the plan allows, and thus the highest visibility from the coast.

Example visualisations have been prepared from 7 viewpoints, at distances varying from approx. 15 km to approx. 47 km.

Thus, the example visualisations represent the maximum extent of expected visual impact from all surrounding coasts within approximately 50 km.

Bornholms Regionskommune (the municipality of Bornholm) has provided their input to the selection of viewpoints, including additional suggestions they wish to have included for the visualisations relating to the environmental impact assessment of a future concrete project.

Viewpoints

- Viewpoint 1 Galløkken
- Viewpoint 2 Boderne
- Viewpoint 3 Dueodde
- Viewpoint 4 Ruts Kirke
- Viewpoint 5 Dronningeklippen
- Viewpoint 6 Sandhammaren (SE)
- Viewpoint 7 Kap Arkona (DE)



III Methodology

Photo and visualisation technique

The example visualisations are based on photographs from Bornholm, Sweden, and Germany. Photos were taken in July 2022.

Photographs are recorded with a camera on a tripod, at eye height of 1.6 m. All photos were recorded with a digital 24 x 36 mm camera with a focal length of 50 mm. The viewpoints are determined by measuring GPS coordinates.

All visualisations are rendered in WindPRO 3.5.

The example visualisations for scenarios A and C have been prepared based on a wind turbine model with a rotor diameter of 300 m, a hub height of 180 meters and a total height (to the top of the blade tip in a vertical position) of 330 m. The size corresponds to a 27 MW wind turbine.

The visualisations for scenarios B and D have been prepared based on a wind turbine model with a rotor diameter of 233 metres, a hub height of 146.5 meters and a total height (to the top of the blade tip in a vertical position) of 263 metres. The size corresponds to a 15 MW wind turbine.

The example visualisations are deliberately rendered, so the wind turbines appear more visible than to show the “worst case”. The wind turbines’ rotors are turned to face the viewer to take up as much space as possible, and single rotors deviate from this to add a depth effect to the visualisations.

Where the wind turbines will be visible, they are rendered with a light/grey colour and only the visible parts are shown in the visualisation.

To compare the effect of the four scenarios’ variation in density and volume, the example visualisations have been deliberately prepared so that the wind turbines appear more clearly than they can be experienced. This is done by altering the contrast between the wind turbines and the background and leaving out the faded visibility of the wind turbines over the distance.

Panorama

Due to the extent of the OWF, the visualisations must be shown as panoramas over several pages, which must be seen in continuation of each other to see the grander scale of the offshore wind farm in context. From viewpoints 1-5, the panoramas span four pages. Viewpoints 6 and 7 span two pages each due to the distance from the OWF and viewing angle.

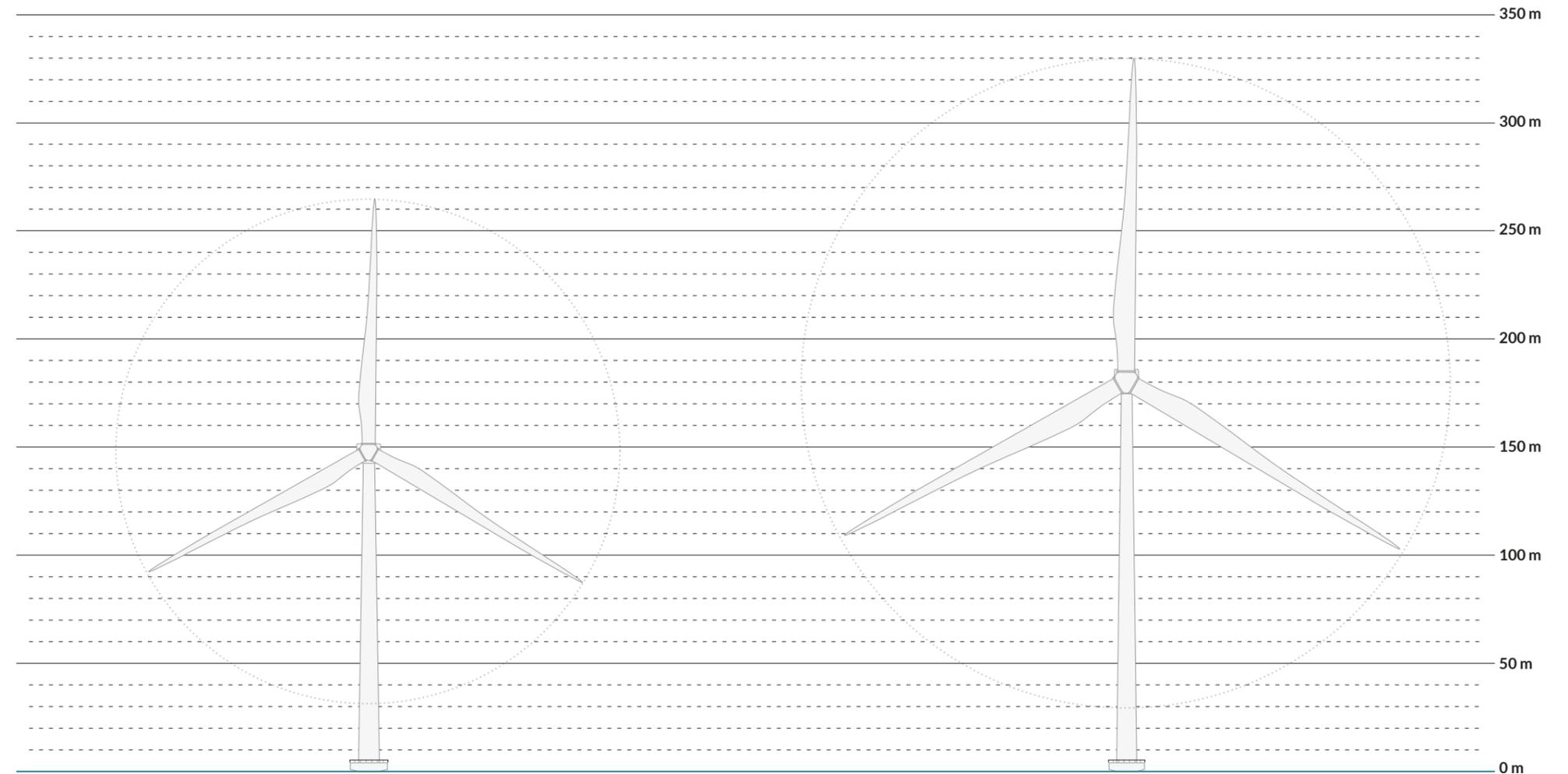
The experience of the visualisations

A visualisation is far from a realistic representation of how wind turbines will be experienced in the landscape or, in this case, on the sea along the coast.

The visualisations do not show the turbines or the movement of the sea, nor changes in light and shadow and thus changes in visibility.

The same applies to the reproduction of the light markings on the wind turbines; it can be complicated to reproduce both flashing and fixed lighting. This is because even though the flash of light is small and occupies a tiny part of the sky, it appears more clearly because it is artificial light. In the visualisations light markings has been rendered in front of the turbines to show the maximum intensity.

To make visualisations comparable, all visualisations are reproduced in the same magnification; the images are not scaled after they are recorded.



Wind turbine of 15MW

Rotor diameter: 233 meter
Hub height: 146.5 meter
Total height of turbine: 263 meter

Wind turbine of 27MW

Rotor diameter: 300 meter
Hub height: 180 meter
Total height of turbine: 330 meter

Viewpoint 1
Galløkken



The viewpoint is in Galløkken on the outskirts of Rønne Syd.

Rønne is where the west and south coasts around Bornholm meet. The city has both central harbour areas and a relatively large coastline that extends to the southeast past beach and residential areas along Strandvejen.

The nearest new wind turbine is approximately 15 km from the viewpoint.

Viewpoint 1

Galløkken



The viewpoint at Galløkken is recorded as a photographic panorama of four separate photographs stitched together to a continuous view of the OWF.

The image above shows a scaled-down version of the stitched panorama. The photographs used for the visualizations are shown on the following four pages.



The image above shows in white outline the maximum extent of the planning area in Plan for Programme Energy Island Bornholm for Bornholm I Syd and Nord, and Bornholm II, as seen from Galløkken.

The following 16 pages compare the existing conditions with scenarios A, B, C and D.

At last, for scenario D, visualisations have been carried out in dim light and at night time.

All photos and visualisations are reproduced in the same magnification for the visualisations to be comparable. The images used were recorded with a 50 mm focal length. If the report is printed on A3, the ideal viewing distance is around 60 cm for all the visualisations shown.



1: Galløkken
Existing conditions, first part of panorama



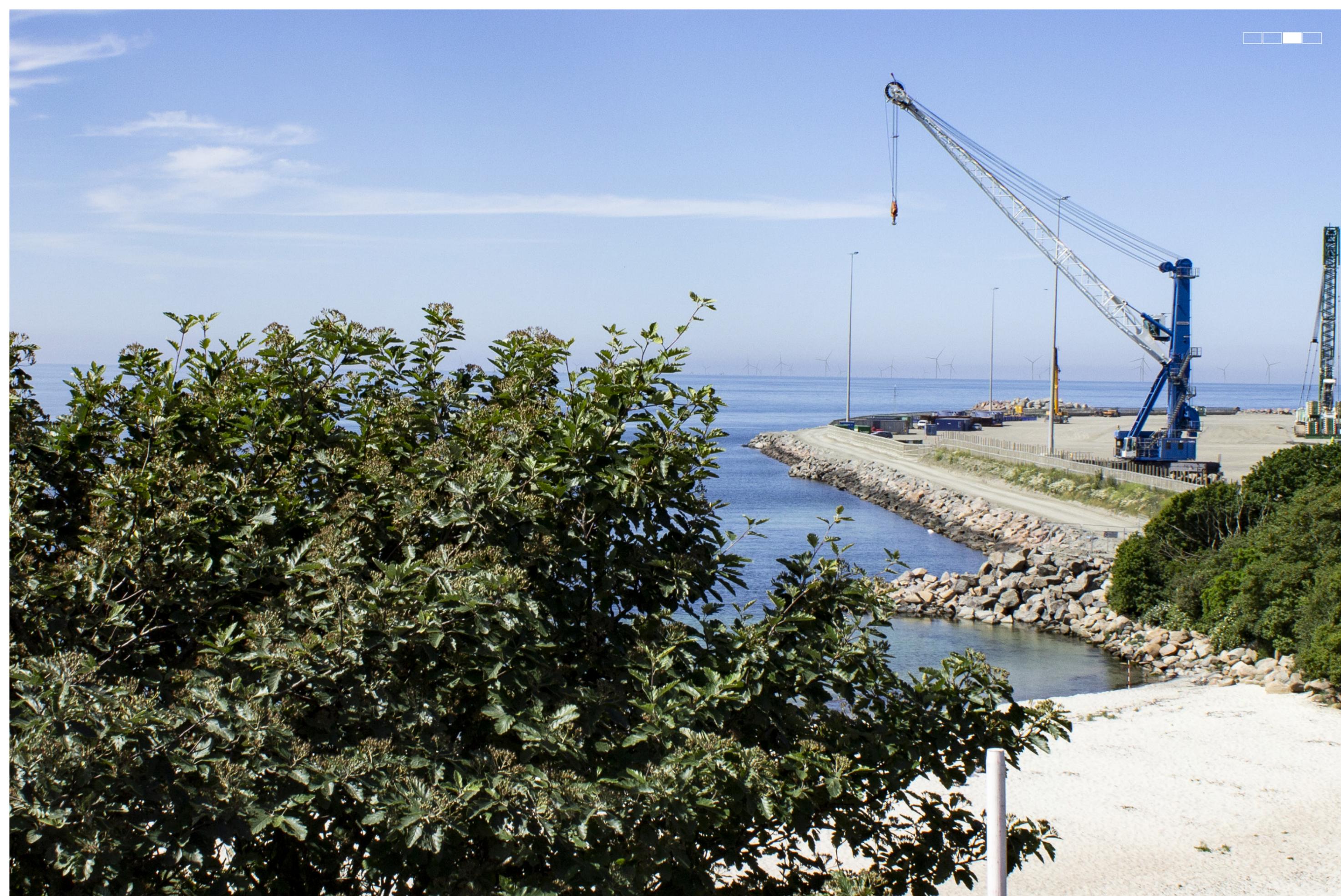
1: Galløkken
Existing conditions, third part of panorama



1: Galløkken
Existing conditions, fourth part of panorama



1: Galløkken
Scenario A: 3.2 GW, 119 wind turbines of 27MW, first part of panorama



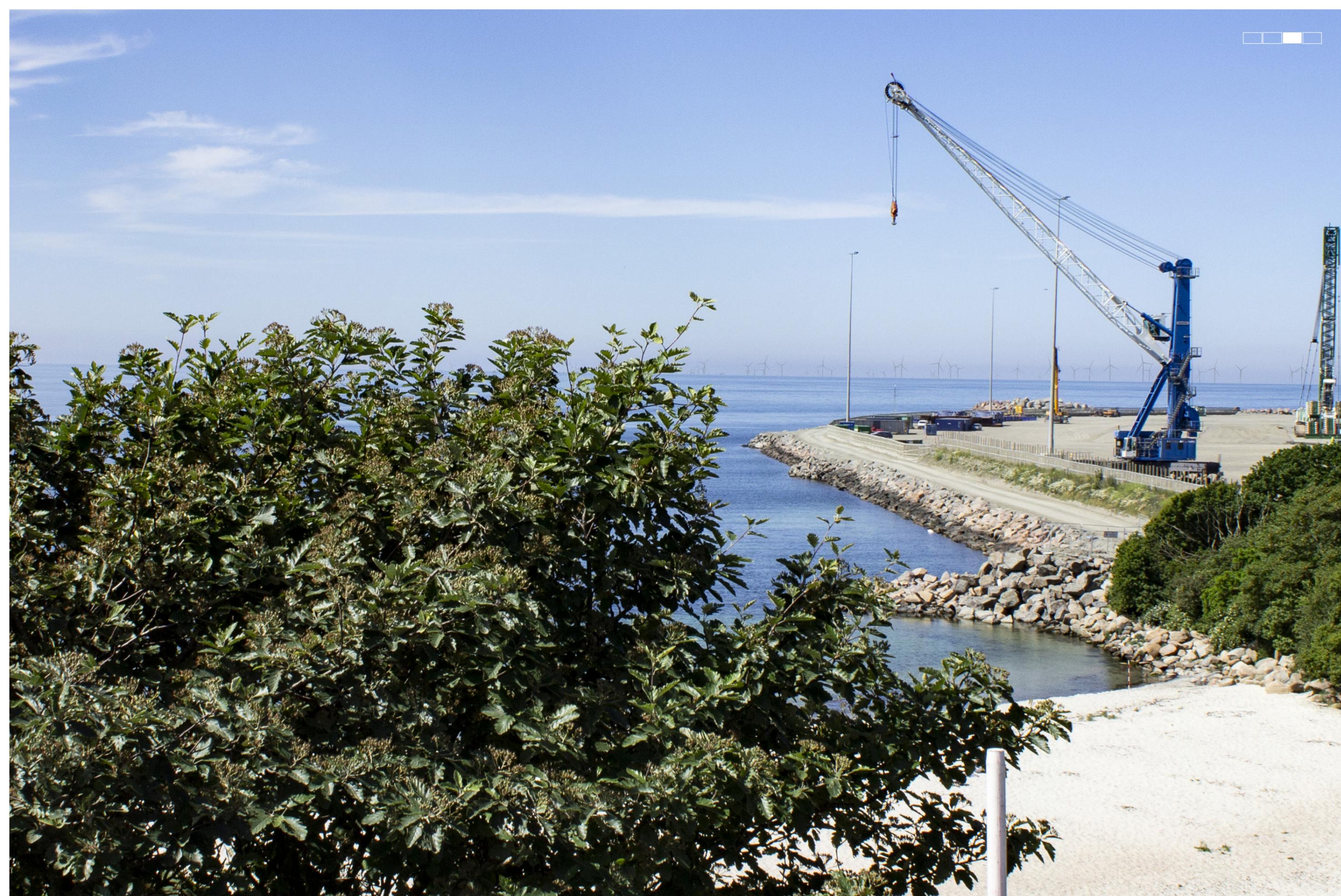
1: Galløkken
Scenario A: 3.2 GW, 119 wind turbines of 27MW, third part of panorama
PLAN FOR PROGRAMME ENERGY ISLAND BORNHOLM // EXAMPLE VISUALISATIONS



1: Galløkken
Scenario A: 3.2 GW, 119 wind turbines of 27MW, fourth part of panorama



1: Galløkken
Scenario B: 3.2 GW, 214 wind turbines of 15MW, first part of panorama



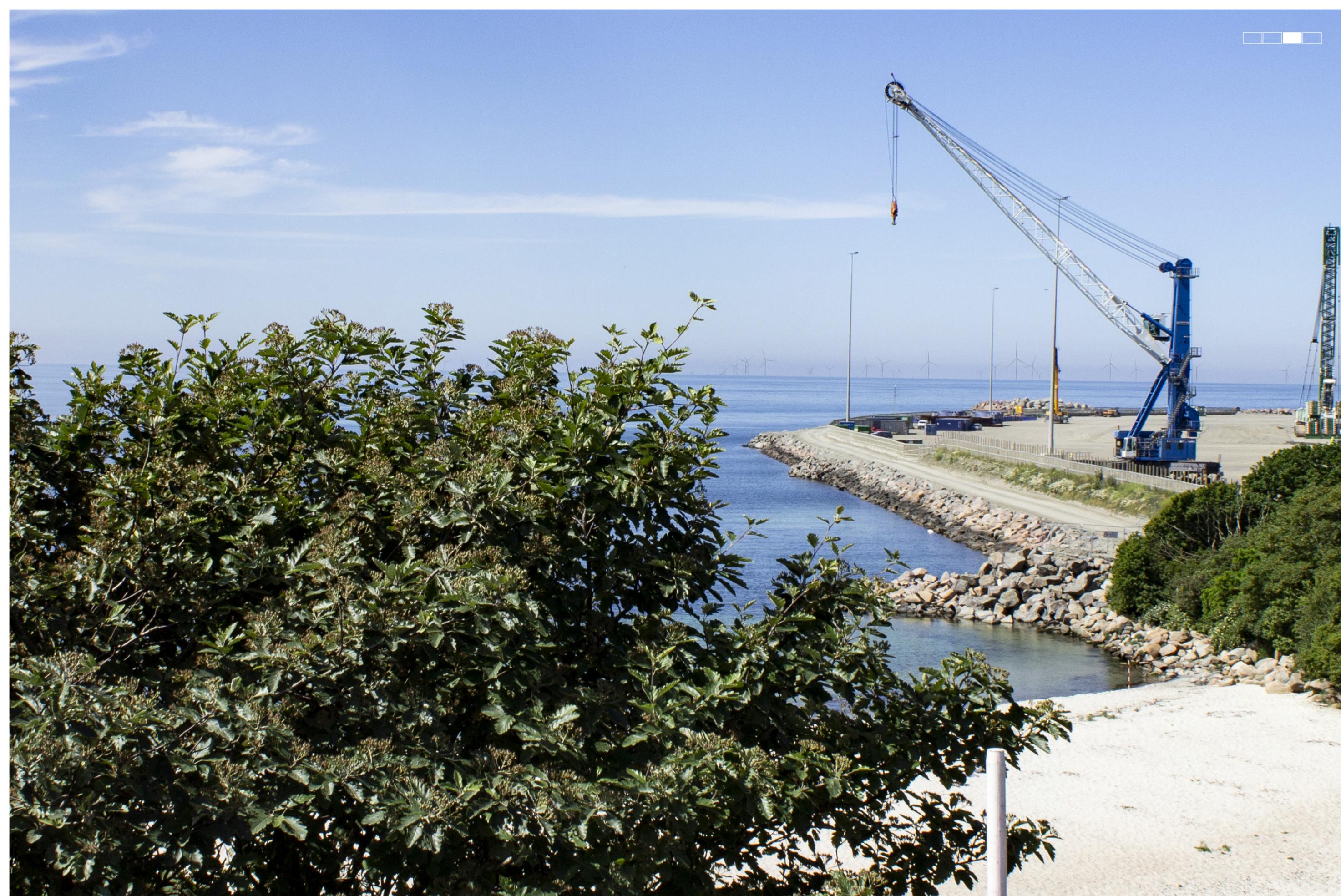
1: Galløkken
Scenario B: 3.2 GW, 214 wind turbines of 15MW, third part of panorama



1: Galløkken
Scenario B: 3.2 GW, 214 wind turbines of 15MW, fourth part of panorama



1: Galløkken
Scenario C: 3.8 GW, 141 wind turbines of 27M, first part of panorama



1: Galløkken
Scenario C: 3.8 GW, 141 wind turbines of 27M, third part of panorama



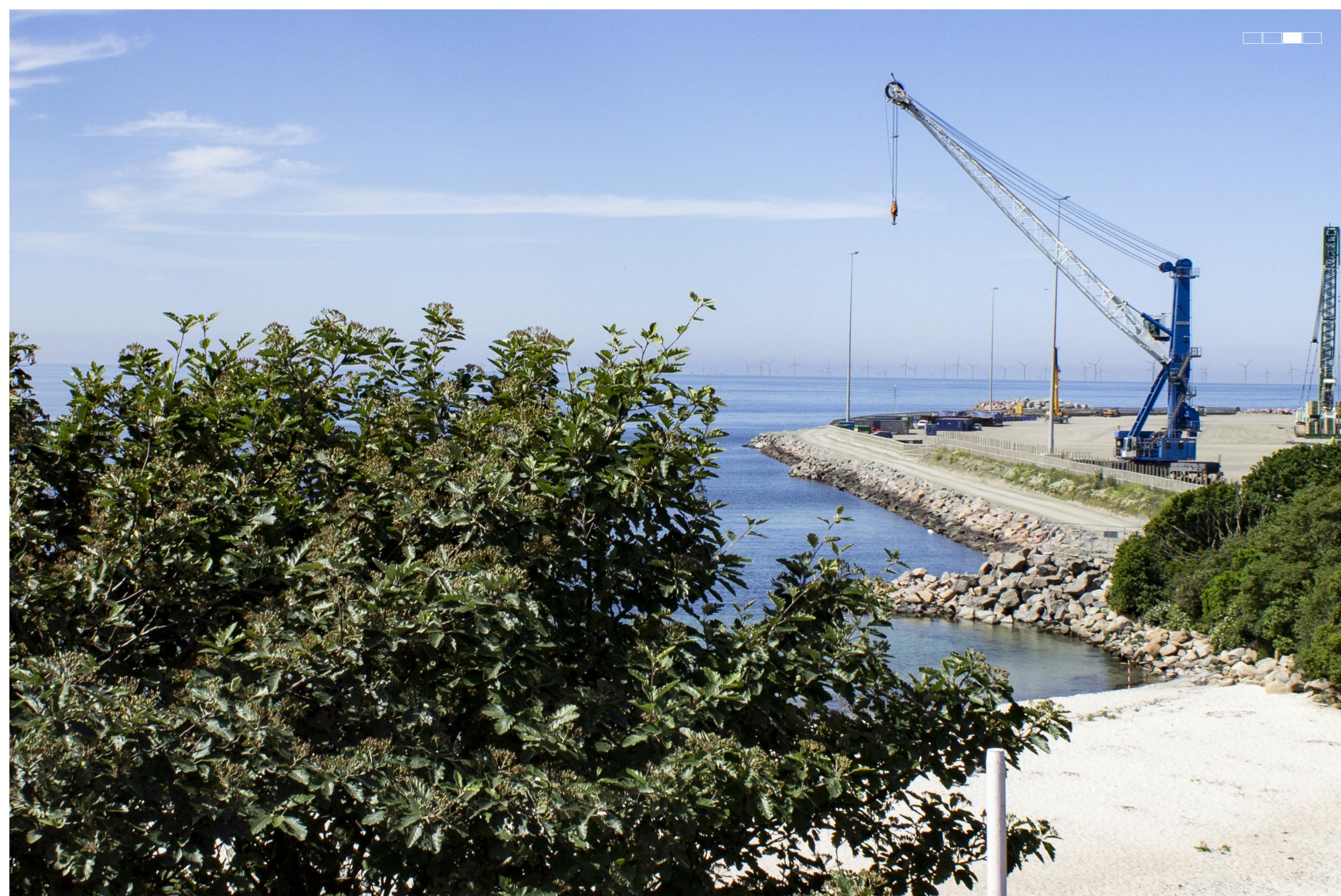
1: Galløkken
Scenario C: 3.8 GW, 141 wind turbines of 27M, fourth part of panorama



1: Galløkken
Scenario D: 3.8 GW, 254 wind turbines of 15MW, first part of panorama



1: Galløkken
Scenario D: 3.8 GW, 254 wind turbines of 15MW, second part of panorama



1: Galløkken
Scenario D: 3.8 GW, 254 wind turbines of 15MW, third part of panorama



1: Galløkken
Scenario D: 3.8 GW, 254 wind turbines of 15MW, fourth part of panorama

Galløkken Scenario D, moderate visibility



Marking according to aviation Safety

Light on the nacelle:
Day - white flashing light, 20,000 candela

Marking according to marine safety

Light markings are placed 15 m above MSL (mean sea level).
The lighting towards land will be yellow lights



1: Galløkken
Scenario D: 3.8 GW, 254 wind turbines of 15MW, first part of panorama



1: Galløkken
Scenario D: 3.8 GW, 254 wind turbines of 15MW, third part of panorama



1: Galløkken
Scenario D: 3.8 GW, 254 wind turbines of 15MW, fourth part of panorama

Galløkken Scenario D, night



Marking according to aviation Safety

Light on the nacelle:
Night - red flashing light, 2,000 candela

Light in the middle of the tower

Three red fixed candles, 32 candela

Marking according to marine safety

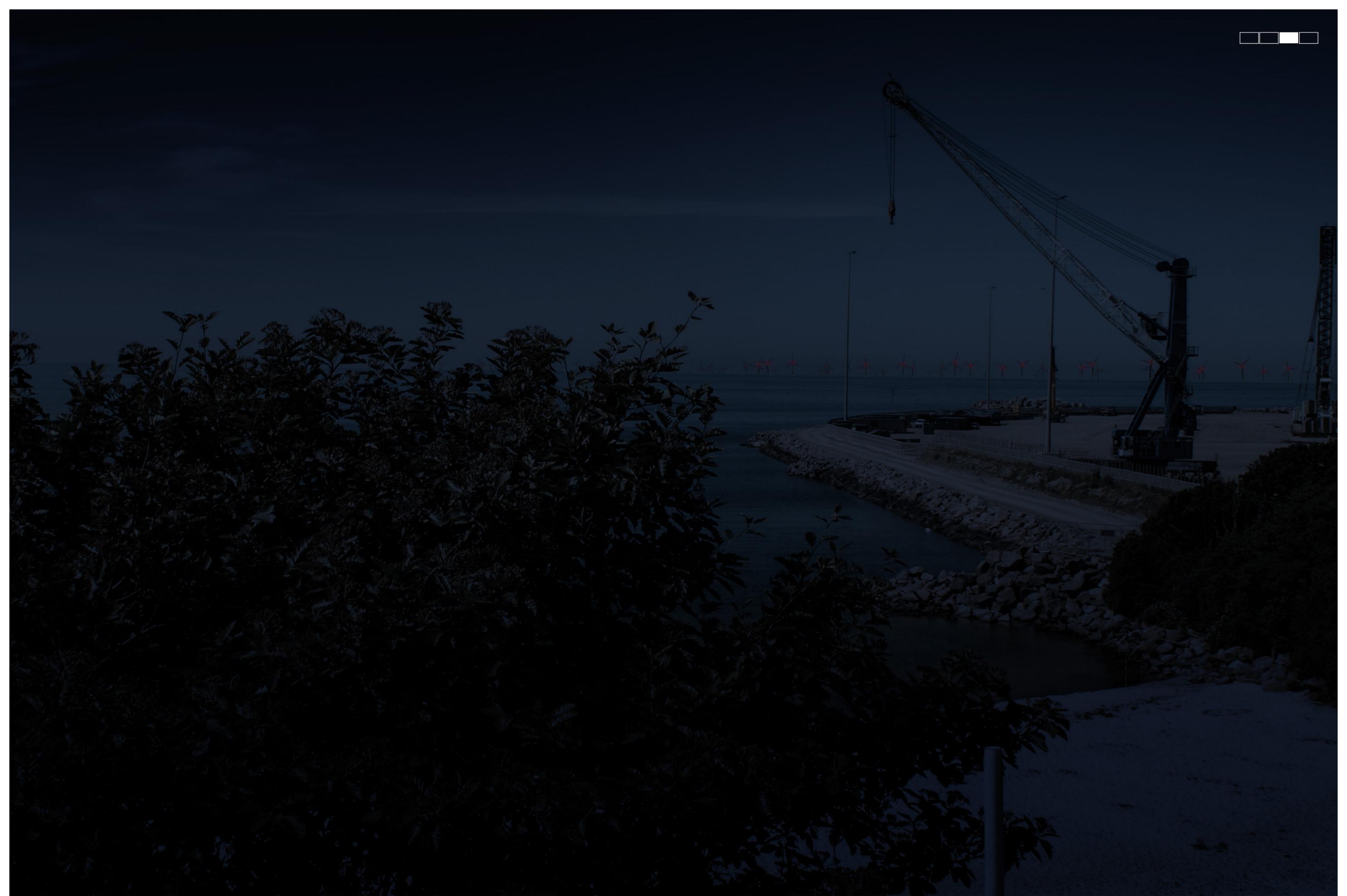
Light markings are placed 15 m above MSL (mean sea level)
The lighting towards land will be yellow



1: Galløkken
Scenario D: 3.8 GW, 254 wind turbines of 15MW, first part of panorama



1: Galløkken
Scenario D: 3.8 GW, 254 wind turbines of 15MW, second part of panorama



1: Galløkken
Scenario D: 3.8 GW, 254 wind turbines of 15MW, third part of panorama



1: Galløkken
Scenario D: 3.8 GW, 254 wind turbines of 15MW, fourth part of panorama