Views & Experiences

Applying environmental assessment to find a good balance between growing offshore wind production and the marine environment

Case of the North Sea

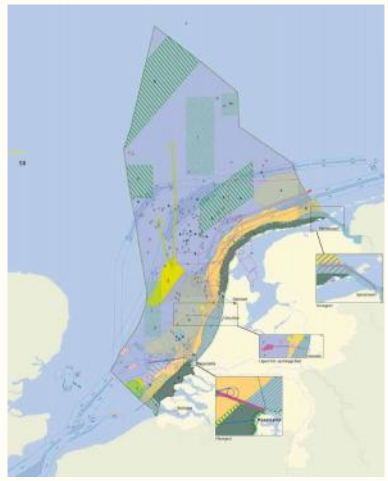
Netherlands Commission for
Environmental Assessment

1 Planning system at the North Sea amidst growing ambitions for offshore wind

Before 2013, the scale of offshore wind development in the Netherlands had been modest and mainly led by private developers. From 2013 onwards, this situation started to change with the adoption of a road map for offshore wind energy. ①
In the years that followed, the Dutch Government kept increasing its national targets for renewable energy and offshore wind energy became an integral part of the Dutch Energy system.

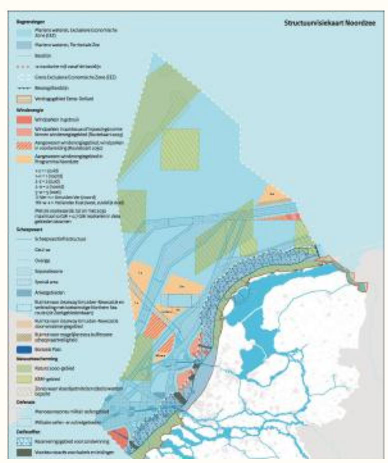
One planning instrument of the Dutch Government for the North Sea, where offshore wind energy developments takes place, is the National Water Plan. As shown in Figure 1, in 2009 this plan reserved two areas for offshore wind, while subsequent revisions designated more areas and set higher targets for energy generation. Once the National Water Plan is approved by the Parliament, the spatial elements are binding to all government agencies.

Figure 1 | National Water Plan (2009) and its revisions at the Dutch Exclusive Econimoc Zone (EEZ).



2009 | One far shore and one near shore area designated for offshore wind farms (light green areas).

2015 | 7 areas designated for offshore wind farms (pink) to achieve the target of 11,5GW wind energy in 2030.



2021 | 5 areas designated for offshore wind farms (orange) to achieve the target of 21,5GW wind energy in 2030.

2022 | 7 far shore areas designated for offshore wind farms (in green) to achieve the target of 50 GW wind energy in 2040. Space for an additional 20GW was still to be found to achieve the target of 70 GW in 2050.

① This change in policy direction was triggered by the Dutch Energy Agreement in 2013 and Paris agreement in 2015. The former was signed by the Dutch Government, wind developers, trade unions and Non-Governmental Organizations who among others agreed on building 1000 extra wind turbines with a minimum capacity of 700MW per windfarm and to lower energy taxes for sustainable energy generators. Later in 2023, the national Climate Law was adopted by the parliament with new targets for wind energy.

In addition to the National Water Plan, the Dutch planning system also has sub-plans that specify different components of the National Water Plan. The sub-plans for offshore wind energy are called '**Structural Visions**' which include the adoption of new areas for offshore wind and elaborate how developments will take place in the already designated areas. ②

Further down the line, plans for offshore wind are detailed through so called **plot decisions** ③ which define the scale and conditions to build and operate wind farms in designated areas.

② In Dutch, these are called Rijkstructuurvisie Windenergie op Zee.

③ This is an important element of the Dutch Offshore Wind Energy Act which was adopted in July 2015 and amended in 2021. Plot decisions are prepared by the Government and are adopted by the Parliament.

2 Added value of SEA and ESIA for offshore wind energy development

The North Sea is one of the world's busiest seas in the world with spatial demands for shipping lanes, fishing, sand extraction, wind energy, electrical and internet cables, gas and oil pipelines and platforms, areas for nature conservation/protection, military exercise and so on. It is therefore important that with any new intervention, like offshore wind energy, these functions are considered and that there is coordination with existing users to avoid conflicts or unsafe situations.

The North Sea also contains important ecological values and areas that are protected by conservation laws.[4] Especially when considered in cumulation, offshore wind farms can have a significant impact on these ecological values. The construction of wind farms and associated underwater noise can lead to destruction and loss of habitat for fish and put pressures on mammals, fish and benthos. During operations, the wind turbines may affect orientation and foraging of mammals because they form a barrier in the sea.

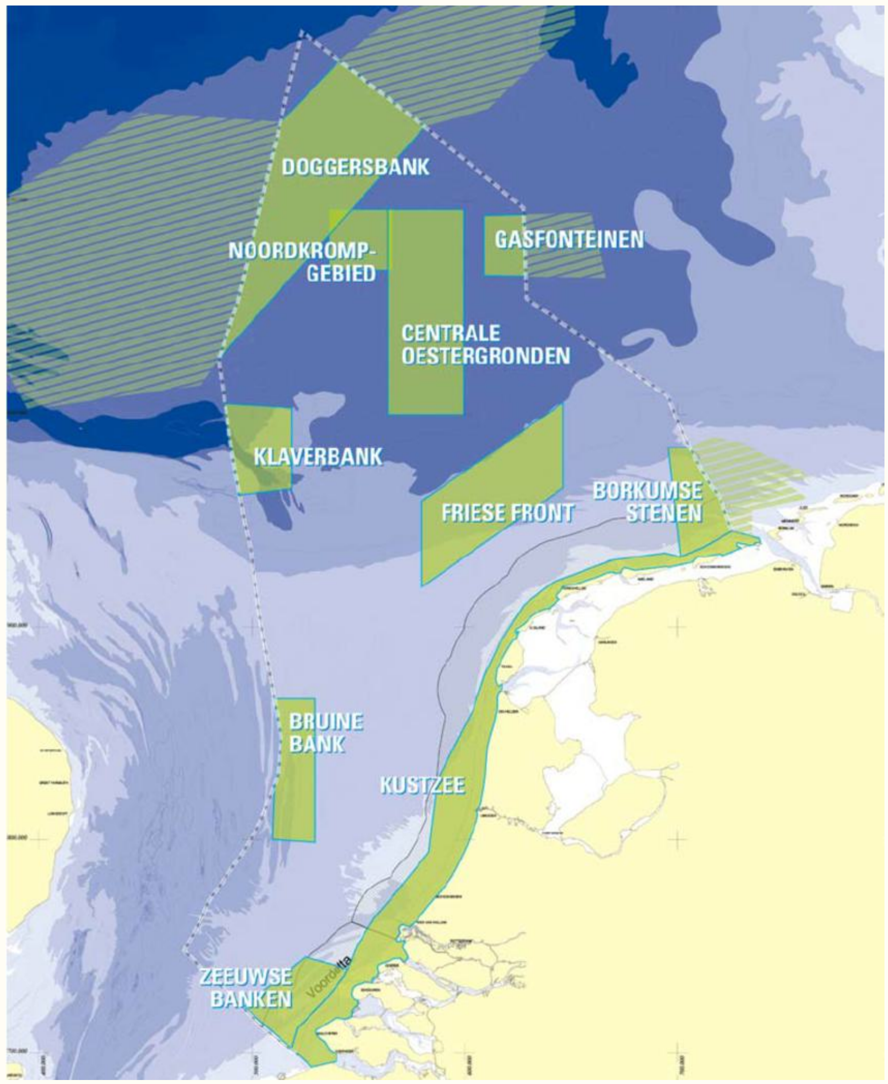


Figure 2 | Ecologically important areas (light green) in the Netherlands part of the North Sea (source: ResearchGate).

[4] At the North Sea, currently seven areas are registered as Natura 2000 which is a European network of nature protection areas that contain valuable and threatened species and habitats which are protected under various European and national laws.

During operation, the rotating turbine blades may lead to collisions with birds and bats. Also fish species (like sharks) may be impacted by electromagnetic fields of the array and transport cable to the shore. These are just some examples of impacts to consider.

Considering the above, it is essential that the Government balances the needs of different users and protects the ecology of the North Sea. One way the Dutch Government tries to achieve this is the application of SEA and ESIA in planning (See Table 1). According to the Dutch law, (revisions of) the National Water Plan must be accompanied by an SEA, meaning that all spatial elements and the designation of areas for offshore wind (see figure 1) are assessed through an SEA.

Also for structural visions for offshore wind energy, SEAs must be undertaken. These SEAs deliver insights that inform the developers of the strctural visions on dealing with spatial obstacles for finding (new) locations for wind energy and predict cumulative impacts.

Finally, before approving a plot decision, an ESIA must be carried out. ESIAs also form the basis for the tender documents that the Government prepares for developers, to ensure that they take the necessary measures to avoid, mitigate and manage impacts. The next sections provide examples on the application of SEA and ESIAs in the Netherlands and illustrate how these tools have changed planning and decisions.

Table 1 | Examples on the application of SEA and ESIA in the Dutch planning system for offshore wind

Planning level	Assessment	Decisions
National Water Plan	SEA	• Distributing the space at the North Sea for different uses including wind energy • National targets for wind energy generation • Formulate overall conditions for wind farms (e.g. reduction of hammering impacts during construction, maximum mortality rates for birds and bats).
Structural Vision for Offshore Wind Energy	SEA	• Locations for additional wind areas
Plot Decision	ESIA	• Wind energy capacity • Minimum and maximum turbine capacity and dimensions • Boundaries of the wind farm area • Locations of the turbines, offshore substations and cable connection routes to the shore • Mitigation measures to reduce impacts on the ecology • How to deal with already existing functions and users in the designated wind area • Obligations for data gathering and monitoring • Conditions for decommissioning

Example 1

SEA identifying spatial obstacles in planning

A good example how SEA can help in dealing with spatial obstacles is illustrated by the SEA that was undertaken for the partial revision of the National Water Plan in 2010.

One of the first steps in this SEA was to do an inventory on the existing uses in the North Sea, including stakeholder consultations. This was done to gain insight in the spatial constraints and to identify what opportunities existed to change locations and functions, in case the existing situation did now allow for certain developments (like wind energy). Based on this inventory, in the SEA 11 spatial alternatives were formulated and assessed. Three out of these eleven alternatives are shown in figure 3, outlining options for near shore wind energy development in combination with shipping lanes.

Left presents alternative 2 where wind farms are located in areas with only few obstacles to other functions. In the middle is alternative 5 with two large near shore areas and without substantial change to the shipping lanes coming from the Port of Rotterdam. Right is alternative 6 with two large near shore areas and with changes in shipping lanes coming from the Port of Rotterdam.

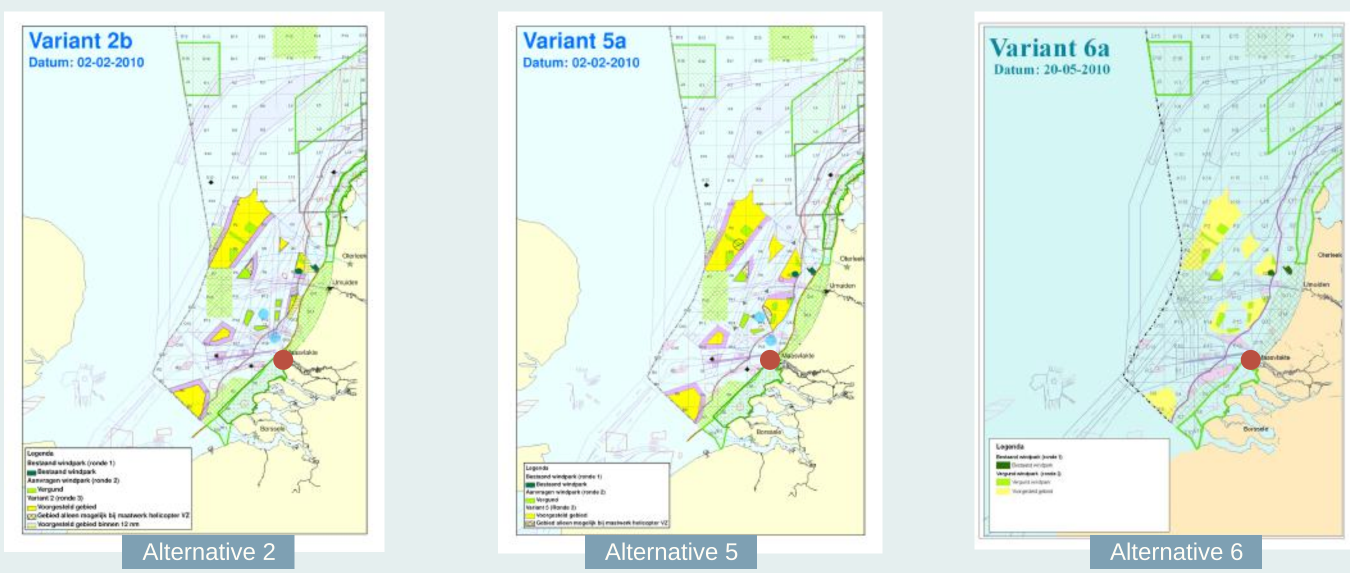


Figure 3 | Three out of eleven spatial alternatives, outlining options for near shore wind energy development in the North Sea. dark green = existing wind parks; light green = licensed area; yellow = proposed area. Red dot = Port of Rotterdam.

The comparison of these options in the SEA showed that alternative 2 (left) would not be in line with the policy goal to find two wind areas near shore of 1,4 and 0,7 GW wind capacity. It also revealed that alternative 5 (middle) would result in high risk of ship-turbine collision and increase the risk of collision between ships and oil/gas platforms. The assessment showed that changing the shipping lanes as proposed in Alternative 6 would sharply reduce collision risks and at the same time achieve policy targets. Based on these insights, the Dutch Government proposed to the International Maritime Organization (IMO) to change the shipping lanes emerging to and from Rotterdam. This was approved two years after. Alternative 6 was used as the starting point for the revision of the National Water Plan in 2015.

The developments at the North Sea are highly dynamic which requires continous adaptations of spatial elements in plans for the North Sea to accommodate for the changes in the legal and other planning frameworks.

For example, in 2015, the wind farm area designated in the National Water Plan at 'IJmuiden Ver' (Northern part of the Netherlands) was originally proposed to be 1,170 km2 . However, in 2021, the southern part of 'IJmuiden Ver' was formally transformed into a protected area [5] and at its northern side a ‘clear way’ was established for the safe passage of ships and the ferry connection between IJmuiden and New Castle in the United Kingdom. These changes led to the adjustment (a reduction) of boundaries of the wind farm zone at 'IJmuiden Ver'.

[5] Under Natura2000 and site called Brown Bank.

Example 2

SEA and addressing cumulative impacts

The SEA that accompanied the formulation of the Structure Vision for offshore wind 2014 is an example of how SEA can assist in addressing cumulative impacts.

Following the changes in policy direction in 2013, the Dutch Government wanted to expand the areas for wind energy. For this purpose, in 2014 the Structure Vision for offshore wind energy was formulated accompanied by an SEA. In order to find new suitable locations, this SEA assessed two alternatives against multiple criteria including landscape, existing uses like shipping lanes, collision risks and impacts on birds, bats and mammals. Figure 4 depicts the 'maximum' alternative assuming wind energy development in all purple striped areas and the 'minimum alternative' where fewer areas (pink colored) are designated for wind energy.

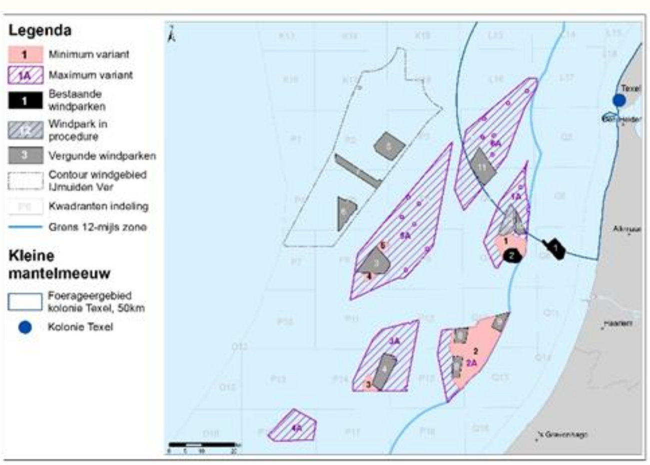


Figure 4 | Comparison between the 'maximum' (purple) and the 'minimum' (pink) wind energy production alternative.

One aspect the SEA considered was the impact on the landscape due to concerns about visual intrusion and impacts on tourism. The nearest proposed turbines to the coast were located at 22 km from the coast. The assessment showed that the average visibility of the turbines was 19% over the year and the impacts on tourism would be negligible. Later, during the monitoring phase, this conclusion was confirmed by the number of beach visitors which did not present any reduction after the wind farm was constructed.
Another aspect the SEA considered was the impact on birds, like the black-backed lesser gull. This bird has a protected reeding location on the northern island Texel and searches for food on the North Sea. At that time, little was known on the behavior of this protected species, such as

how far it flighs on the North Sea, at what height and with what frequency. In such circumstances, the Dutch law prescribes to apply the precautionary principle.⑥

Conform this principle, when assessing the impacts, the SEA set the flight distance of the gull width at 80km and calculated the area where the mortality rate of this bird as a result of collisions with wind turbines would be less than 1%, which is the legal maximum. Based on the assessment results, all areas proposed North-East of the blue line in figure 4 were excluded from development. This resulted in a new preferred alternative as shown in Figure 5.

Because this lack of knowledge on protected habitats and species was restricting offshore wind energy development, the Dutch Government started a large research programme called WOZEP, which investigates the cumulative impacts of existing and newly proposed windparks on birds, bats, marine mammals and their habitats.

One conclusion from this research was that the little black-backed lesser gull does not fly very far on the North Sea and that the collision impact is far less than predicted in 2015. Based on this and other insights, in later plans it has been possible to expand the areas for wind energy to for example the Dutch North coast.

The Dutch Government also supports the development of tools for assessing cumulative ecological impacts of wind farms, such as KEC.⑦ Currently, only government approved models are used in ESIAs to predict for example the risk of bird collisions. However, at the moment, cumulative impacts of multiple wind farms spread over the North Sea are not clear yet, scientific data is lacking on some species, and cumulative collision models are still under development. Therefore, until there is more clarity, SEAs and ESIAs need to apply worst case scenarios in predicting impact levels.

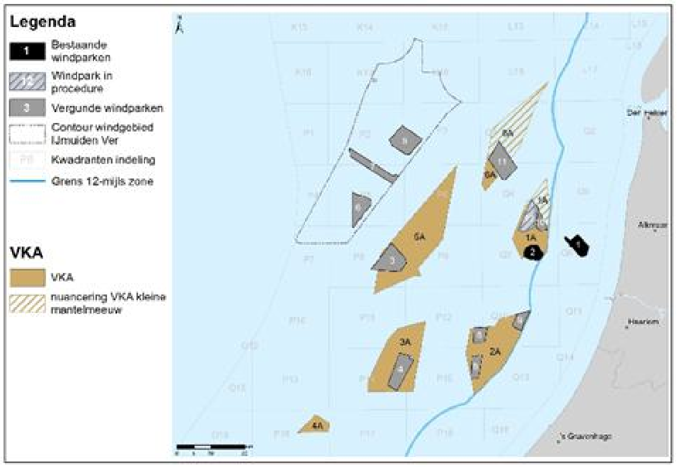


Figure 5 | The new preferred alternative, based on the assessment results

⑥ This means that it should be assumed that birds are flying at the height of the turbine blades and part of a huge flock of birds flies right through it. This leads to a high outcome of bird casualties of the models.

⑦ KEC ecological and cumulative impacts assessment and Framework for Assessing Ecological and Cumulative Effects (KEC) 4.0 for the roll-out of offshore wind energy and wind farm zones.

Example 3

Environmental assessment and impact mitigation

The wind farm plot decision of 'IJmuiden Ver' shows how impacts can be effectively mitigated through environmental assessment. Interesting here is the interaction between ESIA at plot level and SEA at plan level.

Wind energy area 'IJmuiden Ver' is located 62 kilometers offshore of the Dutch west coast. For this area, in 2022 and 2023, ESIAs were undertaken for four parts of the wind energy area, each generating 1GW of electricity.

The ESIA focused on assessing the impacts of alternative plot set ups with various turbine types (15 MW or 20 MW), arrangements and foundation methods. Alternatives were based on worst case situation (where most impacts are expected) and best case situation (where least impacts are expected). Because the effects varied for different environmental dimensions, these worst and best case situations were determined per environmental parameter (see table below).

Environmental dimenison	Alternative 1 best case / least effects	Alternative 2 worst case / most effects
Morphology and hydrodynamic	15 MW	20 MW
Birds and bats	20 MW	15 MW
Marine Life	20 MW	15 MW
Navigation	20 MW	15 MW
Energy and climate	20 MW	15 MW
Landscapes	15 MW	15 MW
Other uses	20 MW	20 MW

Figure 6 | ESIA for offshore wind IJmuiden Ver 2023: Capacity of wind turbines - Best case versus worst case.

Different alternative turbine dimensions and arrangements were assessed against environmental and ecological criteria as well as impacts on commercial and recreational users.
The assessment showed that in general the higher the capacity of a wind turbine, the lesser the impacts are on the ecology.
Based on such insights emerging from ESIAs, over the years, the Dutch government increased the minimum capacity of wind turbines in this and other projects from 4MW to 8MW and at some sites even to 14MW. The earlier mentioned tool for cumulative impact assessment KEC [8] is currently assuming 20MW turbine capacity as a possible option for 2030.

The ESIA concluded that generally speaking the impacts of the wind farm are neutral or not significant if good mitigation is applied, against a very positive effect on decreasing carbon and pollution emissions. In terms of mitigation, in the Netherlands, already during the tender process of offshore wind farms, the developer should indicate what is done to reduce impacts to an acceptable level . As a result of the ESIA, the measures are further detailed and embedded in the design of a project.
For birds and bats, mitigation measures need to be adopted to limit the number of bird collisions and to stay within the norms of maximum casualities allowed within each wind farm. One important measure is to increase the visibility of the turbines. Another is to temporarily stop and/or reduce the rotation of the blades in times when large numbers of birds approach the wind farm, especially during migration.
The smart camera detection system used for the obligatory monitoring of birds and bats crossing the wind farms, can be coupled with a standstill device, which results in the shutdown of turbines in such an occassion.
Specifically for bats, increasing the wind speed at which the turbines start to rotate (so called cut-in speed) has also proven to be an effective mitigation measure.

All data are to be presented to Governmental Research Institutes in order to improve the collision risk models, to refine detection techniques (also to avoid unnecessary shut downs) and to propose better mitigation measures in the future to reduce the impacts.
The example shows that when SEAs and ESIAs interact well at various levels, risks can be mitigated better at the plot level. In turn, data and research results are shared 'upwards', which results in better-informed policy.

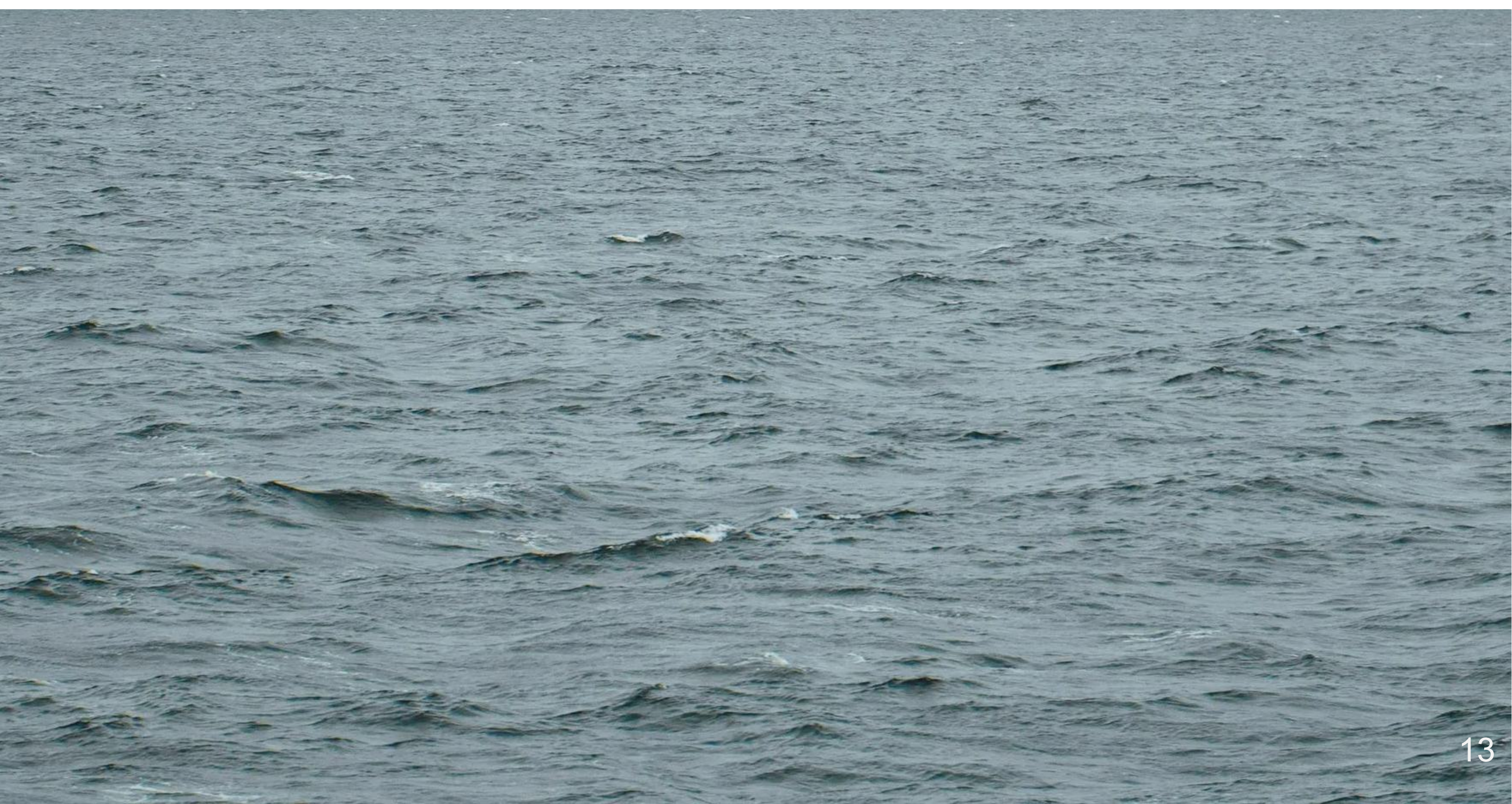
[8] KEC ecological and cumulative impacts assessment and Framework for Assessing Ecological and Cumulative Effects (KEC) 4.0 for the roll-out of offshore wind energy and wind farm zones.

Overall

Since 2013, the Dutch government is taking an active role in offshore wind energy development and has introduced several legal and planning tools to ensure this is done in a sustainable manner. SEA and ESIA have helped the Dutch government in balancing between different functions, protecting the marine ecology and adaptive management.

Various SEAs and the EISAs have clarified which gaps on the marine ecology exist to fully understand the impacts and to find the best mitigation measures. Therefore, a large research programme has been initiated and tools are being developed to assess cumulative impacts.

Due to stricter norms and regulations, innovations in construction and operation have led to reduced collision impact for birds and bats and reduced impact for marine mammals.



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