

Conflict fiche 7: Maritime transport and offshore wind

Maritime shipping is a mature and growing sector that strongly depends on safe and efficient conditions of operation. Fixed installations such as offshore wind farms are a particular issue for maritime transport, leading to more obstructions in the water to avoid. This narrows the area in which vessels can operate and increases traffic density elsewhere. With regards to offshore wind farms, factors such as the number of turbines, turbine spacing, and tower design can all be relevant in terms of the risk of, and the consequences of accidents. This fiche sets out the range of issues to be considered and what MSP can do to avoid and mitigate conflicts between maritime transport and offshore wind.

1. Description of the two sectors

1.1. The maritime transport sector

Maritime transport is the shipment of goods (cargo) and people (passengers) by sea. The maritime transport industry is responsible for over 80% of world trade and 60% of global crude oil supply; as such it represents an important and strategic economic sector worldwide¹. Within the European Union, the maritime transport sector directly employs 640.000 people and has a direct gross value added contribution to GDP of €57 billion². On top of that, more than 400 million passengers pass through European ports each year. Short Sea Shipping (SSS) is especially important in European countries, in particular the Baltic and southern Mediterranean. 60% of total maritime transport of goods within Europe are transported via short sea shipping³.

Maritime transport not only requires seagoing vessels, but also ports as central logistics hubs, rendering the sector complex and intimately connected to land-based infrastructure. Maritime transport is also a highly diverse sector when looking at the type of vessels involved. Container ships transport the majority of the world's manufactured goods, while bulk carriers transport unpacked cargo, mostly consisting of raw materials. Tankers carry liquids, such as crude oil, liquefied gas, and chemical products, ferries carry passengers and vehicles, and cruise ships of various size transport thousands of passengers for tourism purposes. What results is a complex web of land-sea logistics chains, each of which is associated with its own operating conditions and demands on maritime space.

The United Nations Convention on the Law of the Sea (UNCLOS) does not confine shipping to pre-determined routes. Nevertheless, due to economic reasons, commercial vessels are usually

¹ UNCTAD (2017a)

² Oxford Economics (2017)

³ Eurostat (2018)

interested in taking the shortest possible route between two points. Ship routing systems have been established by the International Maritime Organisation (IMO) in congested shipping areas of the world for safety reasons. In addition to traffic separation schemes, these include two-way routes, recommended tracks, deep water routes, precautionary areas (where ships must navigate with particular caution), and areas to be avoided for reasons of exceptional danger^{4 5}.

Maritime transport is a growing sector, both in terms of vessel sizes (Figure 1) and number (Figure 2). This puts increasing pressure on the marine environment. For instance, tankers use cargo pumps, and large kitchen sanitary systems are needed for ship cruises, all of which consume a large amount of energy⁶. Fuel oil used for ships contains 3,500 more times sulphur than fuels used for street vehicles and thus add to air pollution in ports⁷. Beside fuels and emission, the creation of new ports as well as their enlargement - to cope with the increasing demand for goods - often has negative impacts on the local environments and destroys important ecosystems⁸.

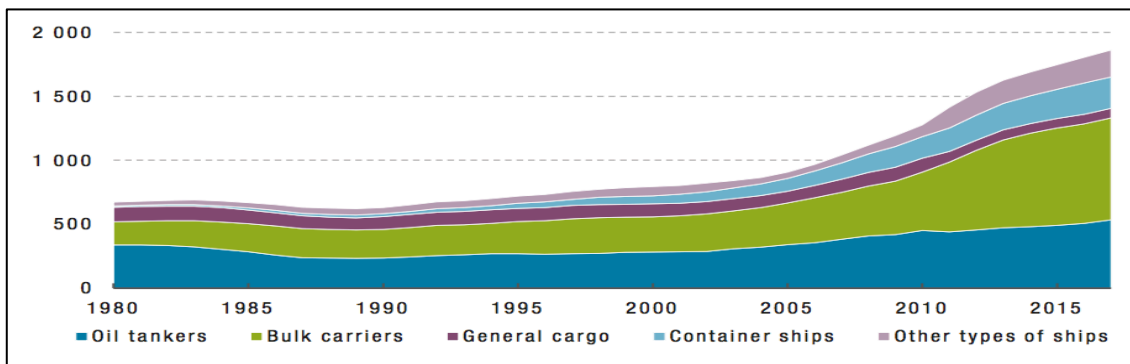


Figure 1: World fleet by principal vessel type (millions of dead-weight tons)⁹

⁴ International Maritime Organization (2018a)

⁵ International Maritime Organization (2018b)

⁶ Anderson et al. (2016)

⁷ Wan et al. (2016)

⁸ Ibid.

⁹ UNCTAD (2017b)

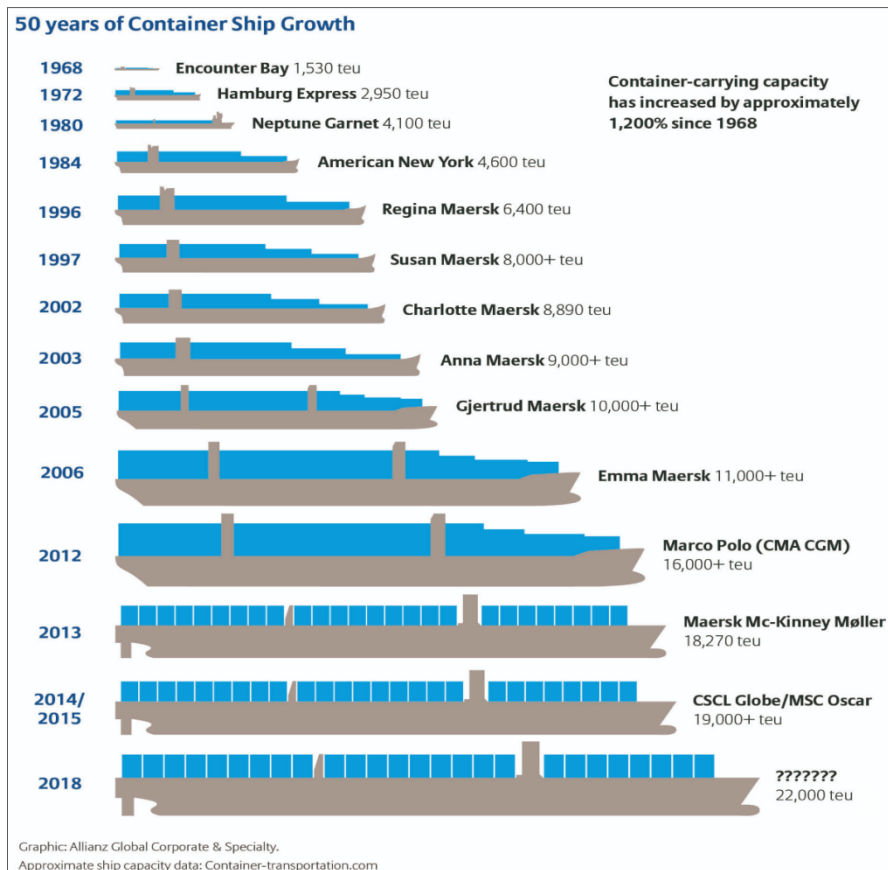


Figure 2: Container ship growth in size¹⁰

The shipping sector is largely international (many foreign flags), so there are few local operators. Sector representatives such as shipping associations usually need to be contacted through the IMO. While associations are willing to be part of MSP processes, suitable methods of involving them (usually remotely) may need to be found.

1.2. Offshore wind

Offshore renewable energy is the fastest growing sector of the blue economy in Europe, with considerable potential to deliver technological development and job opportunities. Direct employment in the EU more than doubled between 2014 and 2016, rising to about 160 000 and now exceeding total employment in the EU fishing fleet.¹¹ Strong policy drivers, as well as the continued development of the industry are expected to push offshore wind farming into further growth. The EU Renewable Energy Directive requires the EU to meet at least 20% of its total energy needs from renewables by 2020, to be achieved by attaining individual national targets. Prices for projects to be completed in the next 5 years are lower than previously as a result of the maturing of the industry, improved technology, growing investor confidence, and the introduction and

¹⁰ World Shipping Council (2018)

¹¹ European Commission (2018a)

deployment of a new generation of turbines, with enormous swept area and tremendous output¹². Developments are particularly strong in the Eastern Atlantic, North and Baltic Sea, but are also beginning in other sea areas. The UK currently has the largest amount of installed offshore wind capacity in Europe, with 40.8% of all installations¹³.

Offshore wind farm-related decisions have consequences in the long term as wind farms have a life span of 25-30 years. It is also a contentious sector as positive and negative externalities can be high. There are conflicts with many other sectors (such as impacts on the safety of navigation, environmental impacts) but also potential synergies, such as artificial reef formation or possibilities for co-location (e.g. mariculture).

COUNTRY	NO. OF FARMS	NO. OF TURBINES CONNECTED	CAPACITY INSTALLED (MW)	CAPACITY INSTALLED/ DECOMMISSIONED IN 2017 (MW)
UK	31	1,753	6,835	1,679
GERMANY	23	1,169	5,355	1,247
DENMARK	12	506	1,266	-5
NETHERLANDS	7	365	1,118	0
BELGIUM	6	232	877	165
SWEDEN	5	86	202	0
FINLAND	3	28	92	60
IRELAND	2	7	25	0
SPAIN	1	1	5	0
NORWAY	1	1	2	0
FRANCE	1	1	2	2
Total	92	4,149	15,780	3,148

Figure 1: Number of offshore wind farms with grid-connected turbines, number of turbines connected and MW grid-connected at the end of 2017 per country¹⁴

When developing offshore wind farms, planners and developers look for ways of reducing costs. Sea depth and distance from the shore are important factors in the costs of offshore turbines. Foundations are particularly expensive at sea, amounting to up to 21 per cent of the overall cost of the turbine¹⁵. Low depth zones are often closer to the shore and thereby more affordable for developing OWF, although shallow banks further offshore are also increasingly attractive due to

¹² Wind Europe (2018)

¹³ Wind Europe (2018)

¹⁴ Ibid.

¹⁵ Wind Energy the Facts (2008)

new ways of converting AC into DC, enabling the use of cheaper high voltage DC links for transmission¹⁶.

Approximately 75% of the total cost of energy for a wind turbine is related to upfront costs such as the cost of the turbine, foundation, electrical equipment, grid-connection and so on¹⁷. The higher capital costs of wind are offset by very low variable costs, due to the fact that fuel is free, but the investor will only recover those after several years. This is why regulatory stability is so important for the sector.

Development costs for wind farms may also be quite high in some jurisdictions due to stringent requirements for environmental impact assessments, for example, which quite often are costlier than wind resource mapping. The institutional setting, particularly maritime spatial planning and public permitting practices, has a significant influence on whether or not the wind farm is built and at what costs. Even in the most favourable cases permitting costs can range between 5 to 10% of the total costs¹⁸.

Some countries have set aside large areas as search areas for offshore wind to encourage investment. Theoretically at least, large parts of sea space could therefore become available to offshore wind farming, restricting other uses as a consequence.

2. Conflict description

2.1. Conflicting elements

Maritime transport and offshore wind can come into conflict when new offshore wind farms are to be built or existing ones expanded – e.g. into areas where shipping activity is intense. This implies possible negative impacts on the safety and efficiency of shipping. Most of the conflicts are triggered by concerns about possible accidents and diversion.

- *Risk of accidents*

The risk of accidents is increased by increased traffic density and reduced sea space, which might lead to the creation of choke points¹⁹. Certain layouts of offshore wind farms are also riskier in terms of accidents than others, which can become an issue in case there are problems with a ship's on-board navigation equipment. O&M (operations and maintenance) vessels might also pose a risk – and be at risk themselves – while crossing major shipping routes en route to an offshore wind farm. Maritime accidents can lead to large financial losses for all parties involved. In the worst-case scenario, such accidents can lead to human casualties or serious environmental damage.

¹⁶ <https://www.maritime-executive.com/article/new-system-optimizes-transmission-from-offshore-wind-farms>, accessed 7 January 2019

¹⁷ European Wind Energy Association (2008)

¹⁸ Ibid.

¹⁹ A choke point is a natural point of congestion between two navigable channels

- *Diversion*

Offshore wind farms may lead to additional costs for the maritime industry – if for example, vessels have to be diverted to take a longer route. Diversion can lead to following problems for the shipping sector:

- Increased time and fuel spent, more greenhouse gas emissions, higher wages for the crew;
- Financial penalties from the charter;
- Higher insurance costs due to riskier routes;
- Compliance with national and international law. Some countries have areas where certain restrictions apply, such as PSSAs in the Baltic;
- In case of short sea shipping, longer transit times which may make short sea services unable to compete with land-based transport services.

2.2. Spatial context

Conflicts between offshore wind farming and shipping occur mainly in the North Sea, Irish Sea and Baltic Sea where a large number of OWFs already exist and are planned. In small sea spaces as it is the case in Belgium and potentially the English Channel, limited spatial alternatives and solutions are major issues.

3. Drivers of conflict

The EU, as well as the EU member states have set themselves ambitious renewable energy targets. Offshore wind farming is attractive because of high wind speeds, the growing professionalism of the sector and decreasing costs. As a result, many countries have now decided to start building offshore wind farms. Confidence in offshore wind farming has grown due to technological maturity and falling costs, and expectations are that capacity will continue to increase, including in Europe. A recent forecast assumes 120 GW total installed capacity by 2030, with much of this growth achieved in Europe building on established capacity and proven low cost.²⁰

²⁰ GWEC (2018)

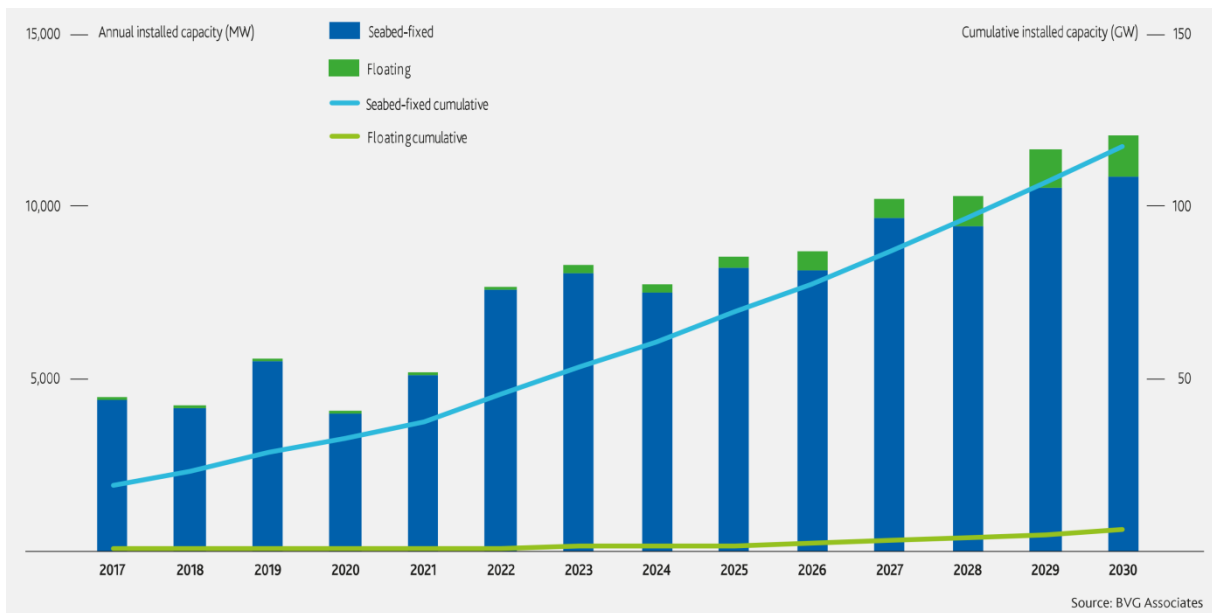


Figure 2: Projections for offshore wind development globally out to 2030²¹

Countries apply different regulatory regimes in regards to transit of vessels through the wind farms. Most of the Member States have stringent processes in place requiring OWF developers to demonstrate that they have thoroughly assessed the maritime risks and implemented adequate risk management measures^{22 23}. In Belgium and Germany, wind farms are considered maritime exclusion zones, a policy which is designed to prevent accidents which require SAR (Search and Rescue) actions or lead to damage to turbines. In the UK and Denmark, wind farms are open for transit and both commercial and recreational use. No special requirements regarding vessel equipment or limit on the vessel size are imposed.

Traditionally, maritime risk assessment and management is usually conducted in the licensing and approval stages of OWF project, rather than during the Maritime Spatial Planning process. This has led to problems where marine-areas-as-planned are often not the same as marine-areas-as-approved²⁴. Consequently, there have even been cases where coastal states have had to alter shipping routes or retroactively modify OWF layouts, leading to complaints from stakeholders and ineffective use of sea space²⁵

²¹ Ibid.

²² MCA (2013)

²³ BSH (2015)

²⁴ A case in point is Belgium, where OWFs had to be 'trimmed' around the corners during the approval stages, to ensure safety of navigation for shipping traffic

²⁵ Mehdi (2018)

Story 1: Belgium and the Netherlands working together to develop a solution

When Belgium and the Netherlands sought to develop offshore wind farms near the Scheldt estuary, conflict soon arose with the shipping sector. There was a risk that offshore wind developments would reduce the available space for navigation, and there were concerns that this could affect the safety and efficiency of shipping in this area. A wind farm that is spaced too tightly can be a challenge as ships may not see each other in time to prevent possible collisions. In this particular area, an added difficulty was the presence of sand banks, which further limit navigation and represent an added hazard in rough seas. When the problem first arose, there was a lack of understanding of the sectors involved – both private and public.

It soon became apparent that a sectoral approach to planning for offshore wind developments was insufficient in this case. There was a need for a more integrated approach to planning where the interests of the shipping sector would be taken into consideration early in the planning process, in order to avoid possible conflicts and associated financial losses down the line.

A Joint Belgium and the Netherlands consultation group consisting of public authorities, ports, former vessel operators, consultants, shipping companies and associations, as well as offshore wind farm developers was formed to define the best route and propose safety measures and rerouting to the International Maritime Organisation (IMO). However, the impact of the proposed measures on the safety of navigation had to be confirmed by the Formal Safety Assessment, an IMO requirement. For this reason, the countries jointly contracted the Maritime Institute Netherlands (MARIN) to conduct a risk assessment of the proposed routing measures using SAMSON model. A proposal by each country was then submitted and approved by the IMO. The cooperation between the two countries was crucial given the cross-border nature of this conflict. Also, the use of specialised institutes and tools has contributed to reaching a solution.

Story 2: Opening offshore wind farms for transit in the Netherlands

The Dutch government is planning to increase the number of offshore wind farms in the next decade. In order to reduce their impact on marine traffic, options are being considered for opening some of the future wind farms for transit and co-use.

In preparation for this, the Dutch Government (Rijkswaterstaat) carried out a risk assessment. A package of mitigating measures was prepared in consultation with relevant stakeholders, including wind farm owners (RWS - Bijl01, Dec. 2015). The wind farm owners also carried out their own risk analyses and introduced them into the process²⁶. The following regulations²⁷ were proposed for vessels transiting offshore wind farms:

- For ships up to 24 meters length;
- At daytime;

²⁶ ARCADIS (2018)

²⁷ Ibid.

- With functioning and active VHF and AIS installation;
- Seabed disturbing activities are forbidden;
- Third party diving activities are forbidden;
- Within the wind farms, a safety zone of 50 meters is established around the turbines. The 500 meters safety zones around offshore transformer stations will remain in place.

In 2016/2017, the Dutch government decided to pilot the new regulations. Three offshore wind farms, OWEZ, Amalia and Luchterduinen, were to be opened for transit for vessels up to 24 meter in length.

However, the wind farm operators and other stakeholders could not reach consensus on the costs and benefits of the proposed regulation. Although extensive studies were carried out, the parties were not unanimous in how to interpret the risk assessment. Wind farm operators had the following concerns²⁸:

- Who is to cover the costs of adapting the offshore installations to the new situation, and how does this relate to the contract between operator and the government;
- Concerns about damage to the wind farm infrastructure and increased operational expenses, which were not part of earlier business plans. An additional concern was that there was no proposal for compensation in case accidents happen;
- Loss of work time of operational & maintenance (O&M) teams and risks to OWF personnel due to responding to third party safety infringements;
- Damage to the image of the offshore wind energy sector and possibly the wind farm owner. This could be caused by accidents and any subsequent litigation which might occur after partial opening of the wind farms.

Due to these unresolved concerns, the Dutch Ministry of Economic Affairs and Climate Policy asked for an independent review (second opinion) of all relevant risk studies carried out. This was to assess the residual risk after implementing the suggested management measures. It was also to assess whether risks were properly mitigated, and whether risks might still be under- or overestimated. Once again, the focus of the risk assessment was on the three offshore wind farms to be opened for transit.

The second opinion was published in early 2018²⁹. It found no serious research gaps and saw the proposed rules and regulations as sufficient. The Dutch government thus proposed to open three out of four operational offshore wind farms to transit: '*Offshore Windpark Egmond aan Zee*', '*Prinses Amalia Windpark*' and '*Luchterduinen*'. The fourth wind farm, '*Gemini*', is to remain a safety area, as a result of its distance to shore and the relatively high costs of installing monitoring and law enforcement systems. The official pilot will take 2 years, but will be automatically extended. The

²⁸ Ibid.

²⁹ Ibid.

conditions for multi-use and transit of vessels might be adapted by then based on new insights. A longer-term solution is that new offshore wind farms will include a corridor which makes it possible for vessels up to 45 meters to transit them. These farms will be built in the period of 2019-2023.

Story 3: Potential conflict between shipping and planned offshore renewable energy installations in Estonia

AIS-based visualization (Figure 4) reveals that planned offshore wind developments off Hiiumaa Island are crossed by intensive shipping traffic. This spatial overlap is creating a critical transnational and cross-sectoral planning issue that needs to be resolved before wind farms are built there. One reason for this conflict becoming acute is that hazard analysis is not integrated in the process of designing safety buffer zones for offshore wind farms from the very beginning. The possible practical solution to the planning issue presented in Figure 4 has been discussed in the BalticLINES project. One way of potentially solving this issue is based on the UK's safety of navigation guidance requirements for offshore renewable energy installations³⁰. This sets out the following guidelines for estimating the safe distance of a turbine from a shipping route:

- 1) If the distance of the turbine boundary to the shipping route is less than <math><0.5\text{nm}</math> (<math><926\text{m}</math>) this is deemed intolerable;
- 2) If it is between 0.5nm - 3.5nm (926m - 6482m) this is deemed tolerable if the risk is being reduced to as low as reasonably practicable (ALARP) - additional risk assessment and proposed mitigation measures required;
- 3) If it is more than >3.5nm (>6482m) this is deemed broadly acceptable.

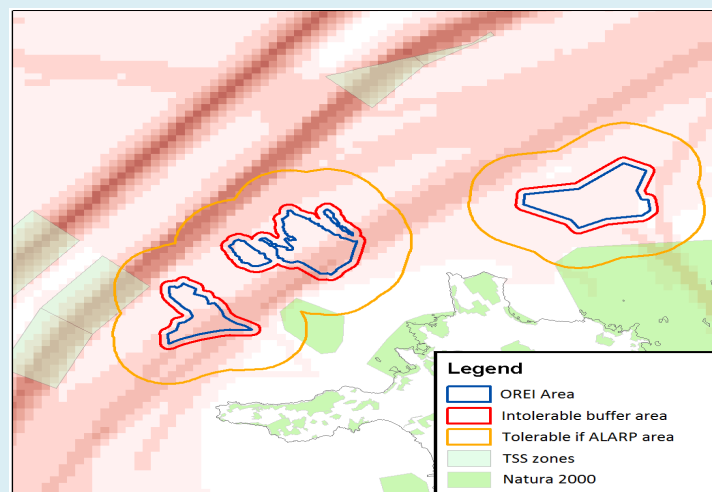


Figure 3: Intensive maritime traffic according to the AIS-based maritime traffic visualization in Hiiumaa Island, Estonia.³¹

³⁰ UK Maritime and Coastguard Agency (2016)

³¹ Fetissov et al (2018).

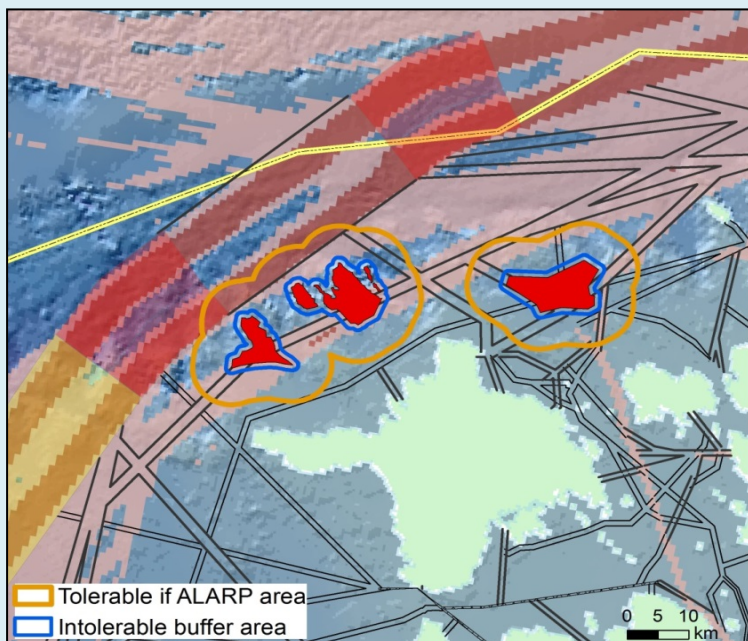


Figure 4: Area northwest of Hiiuma Island³².

Story 4: Resolving potential conflict between shipping and planned offshore wind farms during consultations - Dunkirk (France)

One of the busiest and shipping intensive areas in the world is the English Channel, which makes the area a major concern for choke points especially for OWF development. A case example is the Dunkirk OWF area proposed along the Flanders coast of France, which stretches out to the Belgian border (Figure 6). Due to the existence of Dover Strait/Pas-de-Calais traffic separation scheme (TSS) (the busiest in the world), and consideration of safety distances, the Maritime Prefecture (the competent authority for MSP and offshore wind in France) proposed an OWF zone (the 180-square-kilometer area) located only 5 km from the coast, instead of the required 10 km.³³ The proposal also included a 5 nm exclusion zone to the TSS but only 2.5 nm to the Dunkirk port access lanes (compared to the 3.5 nm recommended by the UK Offshore Renewable Energy Installations safety of navigation guidance requirements)

Although Dunkirk is the most profitable offshore wind farming area in the France, the demarcation of the proposed zone raised concerns from various stakeholders such as local residents, shippers

³² HELCOM map and data service on <http://maps.helcom.fi/website/mapservice/>

³³ La Voix du Nord (2016)

and fishers in both France and Belgium who stated that the area is too close to the coast³⁴ and encroaches on the access routes to the port. For example, the Maritime and Commercial Union stated that “the proposed surface of 180 km² subject to consultation presented a series of “incompatibilities” with the coastal access and shipping lanes to the two ports of Dunkirk”³⁵.

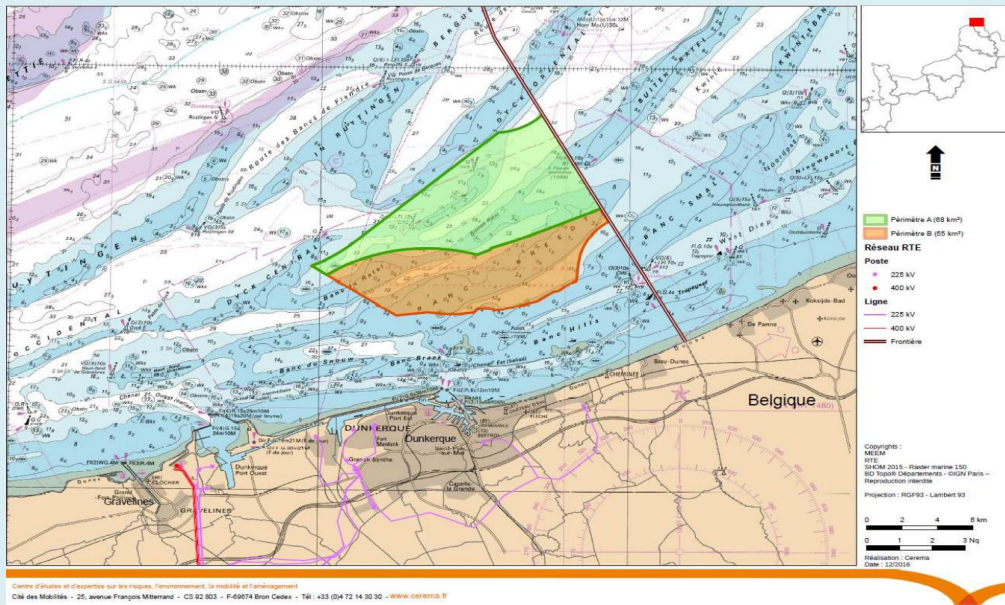


Figure 5: Selected OWF area off the coast and port of Dunkirk³⁶

After the first regional consultation,³⁷ the Maritime and Commercial Union worked on an alternative solution, and proposed a zone of 70 km² usable area rather than the 180 km² delimited by the Maritime Prefecture.

After these consultations two smaller areas (area A:68 km² and area B: 55 km²) were selected for tender (both 10 and 6 kilometres from the coast respectively). Further and early consultation and studies will be needed especially for area B during the construction and operation stages of the offshore wind farm due to its proximity to the port entrance and shipping lanes. Such consultation and studies in Dunkirk must explore various local mitigation measures with the responsible agency such as the Maritime Prefecture and local stakeholders.³⁸

³⁴ RTBF (2016)

³⁵ Lantenne (2016)

³⁶ CEREMA (2016)

³⁷ Premar Manche (2016)

³⁸ Ansong et al. (2018)

4. MSP solutions

This section presents solutions that have been developed by EU countries for this particular conflict. Preventative solutions are designed to stop the conflict from becoming acute, e.g. by appropriate location decisions for offshore wind farms. Mitigation is designed to reduce potential conflicts between the sectors once the decision has been taken to build offshore wind farms. Moving a shipping lane to accommodate offshore wind farms should only be used as a last resort as it is a complicated process and has many implications, not least financial, for the shipping industry. Many of the mitigation solutions presented concern the licensing process for offshore wind farms, indicating that MSP can only go so far in providing solutions. As with other conflicts, an important aspect is to use MSP as a platform for bringing together stakeholders and generating mutual awareness of the problems and issues at hand before – ideally – jointly developing solutions.

4.1. Preventative solutions

Solution 1: Co-design shipping routes in a collaborative process

In Belgium, the conflict between the offshore wind farm developments and shipping was a trigger for MSP as a whole as there was a need for a more holistic and integrated approach to planning offshore wind farms. Consultation with the shipping and offshore wind industry is a crucial first step in preventing this conflict. A thorough review of existing legislation and understanding of the complexity of the problem is another important prerequisite. In Belgium and the Netherlands (story 1), meetings of the Joint group were held twice a month, starting with explanations on how shipping works, the constraints acting in this case and the fact that moving a shipping lane is not a simple process.

Ideally, shipping lanes would be defined in a collaborative process, making sure the concerns of both sides and existing legislation (e.g. shipping safety) is fully considered. It is useful to form a consultation group to collect data and discuss the rerouting options. In the UK, the Nautical and Offshore Renewables Energy Liaison (NOREL) group is used a forum for government and industry from the two sectors to discuss and consult on matters related to navigation safety and OWF. In the case of Dunkirk/France (Story 5), the regional consultation process was used to engage with various stakeholders to discuss alternative scenarios and measures to address potential conflicts. Apart from relevant authorities, associations and OWF developers, engagement of current and former vessel operators is highly important as to collect the right data on shipping routes and other technical aspects, as was done in Belgium and the Netherlands.

Solution 2: Carry out a risk assessment on proposed options

The impact of any proposed measures (such as re-routing shipping lanes) on the safety of navigation has to be confirmed by a Formal Safety Assessment, an IMO (International Maritime Organisation) requirement. Belgium and the Netherlands jointly contracted a specialised institution

to conduct a study on the risks of proposed joint routing measures. Two parallel/complementary approaches can be used:

- **Formal Safety Assessment** – a qualitative assessment of the impact of the proposed measures on safety, based on local knowledge and expertise in shipping (expert judgement). This included a so-called HAZID workshop³⁹ with all relevant stakeholders including captains/pilots, port operators, shipping representatives, etc.
- **Quantitative Risk Assessment** based on a validated risk model (number of collisions, economic consequences, etc.). This contained two scenarios - with and without proposed risk control options.

The SAMSON model is one option for assessing risk in all situations and for considering collisions and other possible outcomes. The SAMSON model relies on AIS data to calculate the risk of navigational accidents in the locality of offshore wind farms. It calculates and compares the probability and consequences of navigational accidents for various base-case (i.e. no OWF) and future case (i.e. OWFs in different layouts/locations) scenarios. The model can also consider various factors such as ship types, sizes and speeds, effect of OWTs on ships' navigational equipment, as well as static and dynamic environmental factors, etc.

This model can be also used to

- predict the damage to turbines and ships;
- environmental damage in terms of oil spills or human casualties;
- assess the economic and efficiency-cost of various risk control options (e.g. re-routing), and supplement the cost-benefit analyses of different routing options.

Solution 3: Use existing design guides for the layout and placing of offshore wind farms

Shipping stakeholders have developed the following recommendations for more suitable wind farm layout⁴⁰:

- a minimum safety distance of 2 nautical miles between the outside borders of the offshore wind farm and the shipping route;
- avoid constructing many smaller wind farms in favour of one or two major offshore wind farming areas, which also contain shipping routes and corridors for ships between wind farms;
- between two wind farms, a corridor of a least 10 nautical miles is needed to create sufficient possibilities for shipping;
- the safety distances between maritime traffic and an offshore wind farm at the entrance and exit of a traffic separation scheme should be a minimum of 5 nautical miles;
- the minimal distance to an anchorage area should be 4 nautical miles.

³⁹ Bureau Veritas (2018)

⁴⁰ ARCADIS (2018)

Solution 4: Consider the seasonality of the shipping sector when planning OWF construction

To avoid possible spatial conflicts, OWF construction works or major maintenance activities can take place at selected times of year when shipping is less busy. For example, analysis⁴¹ of seasonal variations in traffic in 2016 showed that summer months are clearly the busiest in all parts of the North Sea including the coast of UK, i.e. the route from the English Channel to the entrance of Skagerrak and around the south coast of Norway. Subsequently, port areas and inland waters are also busier. This information was obtained by plotting the the Vessel traffic in 2016 from AIS (Automatic Identification System) data in density map format from European Maritime Safety Agency. European Maritime Safety Agency (EMSA) tasked all national governments in the North Sea to collect AIS information from their maritime areas and supplement it with data from other countries.

4.2. Mitigation

Solution 5: Use technical means to increase safety within wind farms

The ARCADIS (2018) *Review on risk assessment on Transit and co-use of offshore wind farms in Dutch coastal Water* recommends authorities to require/advise sailors to:

- carry radar reflectors that provide a minimum recommended radar cross-section.
- use a Personal Life Beacon (PLB) or AIS-SART device for each crew member, independent of vessel size.

The radar reflectors that provide a minimum recommended radar cross-section allow for effective SAR (search and rescue) action within and in proximity of the wind farm. A Personal Life Beacon (PLB) or AIS-SART device for each crew member, independent of vessel size, allows for tracing vessels within and in proximity to the wind farm. This is particularly important in case of small recreation vessels (less than 24m) which might not carry AIS and can lead to misrepresentation of shipping traffic density. Research from the SIMCelt project therefore recommends that planning authorities, shipping and navigational safety agencies should use radar, engagement with stakeholders e.g. shippers and local knowledge to determine vessels routes and to account for the data gaps in traffic density representation.

Solution 6: Foresee safe crossings for specialised vessels

Research done under the BalticLINES project recommends that when designating an area for offshore wind farming, authorities should also consider the specialized or smaller ships needed for construction and maintenance. While it is important to consider new shipping lanes as part of spatial management, it is also important to foresee safe crossings for these specialized vessels⁴².

⁴¹ Nilsson (2018)

⁴² North Sea Region (2018)

Solution 7: Early application of navigational risk assessment during the MSP process

A Navigational Risk Assessment (NRA) is usually conducted by offshore wind developers to obtain approval for their projects. Through this process, developers can demonstrate to approval authorities that their projects do not pose unacceptably high risk to maritime activities, and avoid conflicts in terms of impact on navigational safety and efficiency. Incorporating NRAs into the MSP process could substantially help to close the gap between marine-areas-as-planned, marine-areas-as-approved, and operational scenarios⁴³. For example, Belgium and the Netherlands have already started using NRA tools during their MSP processes. In the Netherlands, an NRA is used by authorities (i.e. MIW and Rijkswaterstaat) for approving the OWFs by comparing base-case with future-case scenarios. The results of the NRA are presented to developers, along with specific design specifications for potential wind farms. The authorities are then responsible for ensuring that developers adhere to the guidelines during the approval and licensing phase⁴⁴.

Solution 8: Consider existing documented experiences and guiding documents

Existing international guidelines such the AtoN strategy and the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) guidelines on MSP⁴⁵ can be applied during the pre- planning and development stage of offshore wind farms to mitigate risks such as choke points and foster cross border coherency. Sectoral agencies should be familiar with the guidelines other agencies have in place so as to better understand how they approach MSP. The UK authorities have extensive experience with navigational risk assessments which is reflected in multiple published guiding documents for OWF developers including 'Methodology for assessing the marine navigational safety and emergency response risks of offshore renewable energy installations' (MCA 2013) and 'MGN 543 (M+F) Safety of Navigation: Offshore Renewable Energy Installations - UK Navigational Practice, Safety and Emergency Response' (MCA 2016). These documents also provide a comprehensive list of factors (e.g. vessel traffic, types of vessels, traffic characteristics, location of routes, routing measures, bathymetry, waves, winds, currents, OWF layout, OWT marking and lightings, effect of turbines on navigational equipment, etc.) - as well as non-exhaustive list of stakeholders (e.g. RNLI, lighthouse authorities, Chamber of Shipping, recreational shipping, local fishermen, ship-owners and operators, etc.) that need to be considered during a NRA.

⁴³ Mehdi (2018)

⁴⁴ Whilst Denmark and UK also advocate the use of the FSA methodology for NRA, they do not have any particular recommendations as to which models should be used for probability and consequences calculations within the FSA

⁴⁵IALA (2017)

Aspect / Story	Story 1: The Netherlands and Belgium	Story 2: Estonia	Story 3: France
Main causes of conflict	Risk that offshore wind developments would reduce the available space for navigation, and affect the safety and efficiency of shipping.	Planned offshore wind developments off Hiiumaa Island are crossed by intensive shipping traffic, while hazard analysis is not integrated in the process of designing safety buffer zones for offshore wind farms.	Proposed OWF zone (the 180-square-kilometer area) located too close to the coast and encroaches on the access routes to the port, raising concerns from the shipping community and the port.
Role of stakeholders	A Joint Belgium and the Netherlands consultation group was formed consisting of a wide range of public and private stakeholders to define the best route and propose safety measures and rerouting.	Not known, discussed as a transnational planning issue under the NorthSEA project	Regional consultation
Escalating factors	A lack of understanding of the sectors involved - both private and public during consultations, about how shipping is functioning and what are the challenges of rerouting.	None	Objections from offshore wind sector to a new piloted regulation. Unresolved concerns - the parties were not unanimous in how to interpret the risk assessment.
Solution(s) found	Joint routing measures (re-routing shipping lanes) on the safety of navigation confirmed by a Formal Safety Assessment and approved by IMO.	Potential solution is based on the UK's safety of navigation guidance requirements for offshore renewable energy installations ⁴⁶ (guidelines for estimating the safe distance of a turbine from a shipping route)	After consultations two smaller areas further offshore were selected for tender.
Solution accepted by stakeholders	Yes	Yet to be solved	Yes, but additional local assessments and consultations will be needed during the construction and operation stages of the offshore wind farm.

Table 1: Short analysis of the three stories involving maritime transport and offshore wind

5. Outlook: Future trends and developments in the sectors (with a view to the likelihood of conflicts arising in the future)

5.1. Future trends in the offshore wind sector

Offshore wind developments in the EU will continue to increase mainly in the Baltic Sea and the North Sea, while the Mediterranean is also expected to have its first developments. According to Wind Europe, the UK offshore market will dominate developments up to 2020⁴⁷ with additional 5.2 GW or 42% of the new grid-connected capacity and playing a leading role in the wind energy market by 2030⁴⁸.

⁴⁶ UK Maritime and Coastguard Agency (2016)

⁴⁷ Wind Europe (2018)

⁴⁸ Ibid.

Floating wind turbines are of interest for the future development of the sector, especially in the deep-sea areas (i.e. Mediterranean and the Atlantic). These are capable of deployment in waters deeper than 35 metres. As such, they can potentially generate large amounts of energy without the constraints associated with turbines in shallower waters or closer to shore. One difference to fixed foundations is the potential for electro-magnetic fields that may be generated from cables within the water column. It is expected that similar rules would apply in terms of navigation and safety distances.

Member States are increasingly considering to open up their offshore wind farms to smaller vessels up to 24 meters long. In May 2018, the Netherlands opened two offshore wind farms close to the shore. Another trend is to design offshore wind farms to enable sailing vessels to travel through. With increasing size and innovative designs OWFs are becoming more attractive for potential boat visits amongst other multi use combinations with aquaculture or hydrogen storage. While this can boost the economy of a region⁴⁹, it can also potentially increase traffic and the risk of collision with shipping vessels in the area. A multi-use concepts of aquaculture and offshore wind farms potentially also combined with other uses such as tourism or hydrogen storage could also increase the O&M vessels traffic in the area.

5.2. Future trends in the maritime transport sector

Shipping volumes in European seas are ultimately determined by import and export flows. These in turn are driven by consumers' purchasing power, as well as the status and strength of the European economy versus the rest of the world. It is difficult to forecast developments as they are dependent on the wider political situation and economic development, both at the global and regional level. Nevertheless, the volumes transported by ship are expected to remain stable as a minimum and are very likely to grow. The trend towards larger ships is also set to continue. Another trend is towards larger ships no longer entering port. Cargo may increasingly be loaded onto smaller vessels to ferry it in and out of port. This will require new spaces in the sea and also create new environmental impacts while minimising others.

An important aspect is that shipping routes can shift in response to external events. These may be economic or political changes, but also infrastructure-related, such as the availability of new ports. With respect to cruising, for example, the geopolitical instability within the Middle East has benefited EU destinations in the Mediterranean⁵⁰. Shifting shipping routes can lead to new conflicts with marine conservation, or alleviate or exacerbate existing conflicts. A long-term example is the potential North West passage in the Arctic.

Vessel size is predicted to increase⁵¹ affecting traffic patterns. Short sea shipping is expected to increase⁵² with spatial implications along coastlines. Automation is also one of the trends to be

⁴⁹ Lukic et al. (2018)

⁵⁰ UNWTO (2017)

⁵¹ OECD (2015)

considered. Lloyds Register has proposed six autonomy levels (ALs) for shipping, depending on the technology, systems, and operating procedures involved. These levels should provide clarity to shipping stakeholders about the specific requirements of different automation strategies. It is likely that by 2020 there will be an autonomous ferry prototype operating between islands in Europe. Whether there will be unmanned cargo ships, tankers or other ship types remains to be seen. Platooning is also likely to become more frequent once autonomous shipping is in place, which is a fleet of unmanned vessels guided by one (manned) leader vessel. This technique could be used for crossing oceans, but most likely will be used to enter ports more inland, like the port of Antwerp or Hamburg⁵³. This may lead to new safety concerns and issues to be addressed.

References

- Anderson, K., Baldi, F., Brynolf, S., Lindgren, J. F., Granhag, L., and Svensson, E. (2016) Shipping and the Environment. In: Andersson, K., Brynolf, S., Lindgren, J. F. & Wilewska-Bien, M. Shipping and the Environment: Improving Environmental Performance in Marine Transportation. Springer: Berlin
- Ansong, J., MacMahon, E. & O'Hagan, A.M. (2018) Case Study 1 - Understanding specific cross border issues and opportunities: Offshore Renewable Energy and Shipping & Navigation (Deliverable 10). Online at: http://www.simcelt.eu/wp-content/uploads/D10_cs1_Specific-Cross-Border-Issues.pdf
- ARCADIS (2018) Review on risk assessment on transit and co-use of offshore wind farms in Dutch coastal water. Commissioned by the Dutch Ministry of Economic Affairs and Climate Policy
- BSH (2015) Minimum requirements concerning the constructive design of offshore structures within the Exclusive Economic Zone (EEZ). Hamburg: Federal Maritime and Hydrographic Agency
- Bureau Veritas (2018) Hazard Identification Studies (HAZID). Online at: <https://www.bureauveritas.co.uk/home/our-services/risk-safety/workshop-facilitation/hazid>
- CEREMA (2016) Consultation au large des côtes de Dunkerque : cartographie des données en présence. Online at: <http://cerema.maps.arcgis.com/apps/MapJournal/index.html?appid=7f5d1c9ec1e74dbab94320f3f1624db8>
- European Commission (2018a) Facts and figures on the Common Fisheries Policy. Basic statistical data: 2018 edition. <https://publications.europa.eu/en/publication-detail/-/publication/08d4994e-4446-11e8-a9f4-01aa75ed71a1>

⁵² European Commission (2015)

⁵³ https://northsearegion.eu/media/4836/northsee_finalshippingreport.pdf

European Commission (2018b) The 2018 annual economic report on the EU blue economy. Online at: <https://publications.europa.eu/en/publication-detail/-/publication/79299d10-8a35-11e8-ac6a-01aa75ed71a1>

European Commission (2015) Analysis of recent trends in EU shipping and analysis and policy support to improve the competitiveness of short sea shipping in the EU.

Eurostat (2018) Maritime transport statistics - short sea shipping of goods. Eurostat Statistics Explained. http://ec.europa.eu/eurostat/statistics-explained/index.php/Maritime_transport_statistics_-_short_sea_shipping_of_goods#Total_short_sea_shipping

EWEA (Wind Europe) (2008) The Economics of Wind Energy. A Report by the European Wind Energy Association. Available at: http://www.ewea.org/fileadmin/files/library/publications/reports/Economics_of_Wind_Energy.pdf

Fetissov, M. Aps, R., Katus, K., Konsap, A., Lees, L., Meyer, N., Peterson, A., Tönismaa, O. & Varjopuro, R. (2018) Towards navigational safety of ecosystem based Maritime Spatial Planning solutions. SHS Web of Conferences. 58. 01008. 10.1051/shsconf/20185801008.

GWEC (2018) Global Wind 2017 Report. A snapshot of top wind markets in 2017: Offshore wind. <http://gwec.net/wp-content/uploads/2018/04/offshore.pdf>

IALA (2017) Navigational safety within marine spatial planning. Online at: <https://www.iala-aism.org/product/g1121-navigational-safety-within-marine-spatial-planning/>

International Maritime Organization (2018a) Ships' routing. Online at: <http://www.imo.org/en/ourwork/safety/navigation/pages/shipsrouting.aspx>

International Maritime Organization (2018b) Particularly Sensitive Sea Areas. Online at: <http://www.imo.org/en/OurWork/Environment/PSSAs/Pages/Default.aspx>

International Association of Marine Aids to Navigation and Lighthouse Authorities (2017) IALA guideline G1121. Navigational Safety within Marine Spatial Planning

International Maritime Organization (2018a) Ships' routing. Online at: <http://www.imo.org/en/ourwork/safety/navigation/pages/shipsrouting.aspx>

La Voix du Nord (2016) Éoliennes en mer au large de Dunkerque: la zone d'implantation critiquée Online at: <http://www.lavoixdunord.fr/22419/article/2016-07-11/eoliennes-en-mer-au-large-de-dunkerque-la-zone-d-implantation-critiquee>

Lantenne (2016) Dunkerque: quel site pour accueillir le futur champ d'éoliennes offshore. Online at: https://www.lantenne.com/Dunkerque-quel-site-pour-accueillir-le-futur-champ-d-eoliennes-offshore_a33376.html

- Lukic, I., Schultz-Zehden, A. and Onwona Ansong, J. et al. (2018). Multi-Use Analysis, MUSES project. Edinburgh
- Maritime Transport 2015. Online at: http://unctad.org/en/PublicationsLibrary/rmt2017_en.pdf
- MCA (2013) Methodology for assessing the marine navigational safety and emergency response risks of offshore renewable energy installations (OREI). Southampton: Maritime and Coastguard Agency
- Mehdi, R. A. (2018) Improving the co-existence of Offshore Energy Installations & Shipping. Report on Work-package 4.4 of the NorthSEE Project
- Nilsson, H., Overloop, J., Mehdi, A. R., & Pålsson, J. (2018) Maritime Spatial Planning in the North Sea: The Shipping Context Report on Work-package 4 of the NorthSEE Project. Online at: https://northsearegion.eu/media/4836/northsee_finalshippingreport.pdf
- North Sea Region (2018) Transnational Maritime Spatial Planning in the North Sea: The Shipping Context. Online at: http://www.northsearegion.eu/media/4836/northsee_finalshippingreport.pdf
- OECD (2015) The Impact of Mega-Ships: Case-specific policy analysis.
- Oxford Economics (2017) The economic value of the EU shipping industry. Online at: <https://www.oxfordeconomics.com/my-oxford/projects/272456>
- Premar Manche (2016) Consultation du Public Sur L'éolien en mer au large de Dunkerque. Online at: <https://www.premar-manche.gouv.fr/consultation-public-sur-eolien-mer-large-dunkerque.html>
- Rocco, C. (2018) Offshore wind farms: too much energy is lost in cables. Online at: <http://www.youris.com/energy/energy-grid/offshore-wind-farms-too-much-energy-is-lost-in-cables.kl#ixzz5NahAKcqQ>
- RTBF (2016) La Panne s'inquiète de l'implantation d'un parc éolien offshore français à la frontière Online at: https://www.rtbf.be/info/regions/flandre/detail_la-panne-s-inquiete-de-l-implantation-d-un-parc-eolien-offshore-francais-a-la-frontiere?id=9352413
- UNCTAD (2017a) Review of Maritime Transport 2015. United Nations Conference on Trade and Development, Geneva. http://unctad.org/en/PublicationsLibrary/rmt2017_en.pdf
- UNCTAD (2017b) Handbook of statistics. United Nations Conference on Trade and Development, Geneva. https://unctad.org/en/PublicationsLibrary/tdstat42_en.pdf
- UNWTO (2017) UNWTO Commission for the Middle East, Forty second meeting, Dubai, United Arab Emirates, 24 April 2017. Online at: https://middle-east.unwto.org/sites/all/files/pdf/cme42_4b_gpw_16-17_reg_activities_iiadd.1_e.pdf

- UK Maritime and Coastguard Agency (2016) Safety of Navigation: Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response. Online at:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/502021/MGN_543.pdf)
- Wan, Z., Zhu, M., Chen, S., and Sperling, D. (2016) Pollution: Three steps to a green shipping industry. Nature Comment 530, pp.275-277
- Wind Europe (2018) Wind Energy in Europe. Outlook to 2022
- Wind Europe (2018b) Offshore Wind in Europe: Key trends and statistics 2017. Published February 2018. Online at: <https://windeurope.org/wp-content/uploads/files/about-wind/statistics/WindEurope-Annual-Offshore-Statistics-2017.pdf>
- World Shipping Council (2018) Container ship design. Online at:
<http://www.worldshipping.org/about-the-industry/liner-ships/container-ship-design>