TRA-1 Consequences of possible sea-bed fishery in future offshore wind farms

for

Rijksdienst voor Ondernemend Nederland

by

primo marine
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2 Changes Table

Changes Table	
Revision	**Changes**
R2_00	Incorporation of Section 11.4 Cost and Appendix 13 (covering main assumptions)
R3_00	Incorporated comments of BZK, EZK, LNV, RVO, RWS as per memo dated 7th June 2019
R4_00	Reinserting Deeper Burial Calculations
R5_00	Incorporated comments
R6_00	Minor update p6 and p8 -> clarify what fishing is allowed in existing wind parks.

3 Management summary

3.1 Samenvatting in het Nederlands

"Rijksdienst voor Ondernemend Nederland" (RVO.nl) heeft een onderzoek verzocht naar de gevolgen van mogelijke visserij met bodemberoerend vistuig in de toekomstige windparken op zee Hollandse Kust (west), Ten noorden van de Waddeneilanden en IJmuiden Ver. In de bestaande windparken op zee mag geen andere vorm van visserij worden uitgeoefend dan met een hengel als bedoeld in artikel 1, vijfde lid, van de Visserijwet 1963.

Eveneens is op verzoek van RVO op 15 april 2019 een workshop gehouden, waarvoor de Nederlandse visserij (**Visserij**) organisaties (VisNed en Nederlandse Visserijbond), de windpark ontwikkelaars/exploitanten (**Windpark Ontwikkelaar/Exploitant**) en andere belanghebbenden waren uitgenodigd.

De workshop richtte zich op "hoe kunnen we het ontwerp van een windpark op zee aanpassen", zodat visserij met bodemberoerend vistuig kan worden gefaciliteerd en wat heeft de visserij nodig om hun schepen, bemanning en uitrusting geschikt te maken voor visserij met bodemberoerend vistuig in de toekomstige windparken op zee.

De **Visserij** staat open voor discussie over de mogelijkheden van visserij in toekomstige windparken op zee, ook al hebben zij bedenkingen met betrekking tot de nautische veiligheid ten aanzien van het manoeuvreren in het windpark. Deze voorbehouden betreffen het ontbreken van rechte, voldoende brede viscorridors en de aanvullende vereisten voor significante (technische) verbeteringen van het vissersvaartuig, de bemanning en de uitrusting, evenals de mogelijke stijging van de kosten van verzekeringspolissen.

Het belangrijkste doel voor de **Windpark Ontwikkelaar/Exploitant** is om een windpark op zee te ontwerpen, zodat deze op de meest optimale manier energie uit wind opwekt. Dit betekent niet noodzakelijk dat de huidige windparken op zee zijn geoptimaliseerd voor (enige) visserij activiteiten. Daarom kan elke wijziging aan een windpark op zee om bodemberoerende visserij activiteiten mogelijk te maken gevolgen hebben voor de indeling van en de afstand tussen de fundatiepalen (**zie figuur 7-2**) en de onderwaterinfrastructuren, b.v. de kabels (**zie figuur 7-8**).

Het toestaan van visserij activiteiten in een windpark op zee introduceert nieuwe risico's voor de **Windpark Ontwikkelaar/Exploitant**, omdat zij gedeeltelijk verantwoordelijk zijn voor de veiligheid binnen een windpark op zee.

Er is ook risico voor eigendommen, vooral in de buurt van offshore-constructies, waar kabels weliswaar worden beschermd door een kabelbeschermingssysteem (CPS) (**zie figuur 7-9),** maar toch kwetsbaar blijven om door vreemde voorwerpen te worden geraakt. Dit is met name het geval wanneer een vissersvaartuig om een fundatiepaal heen vaart, deze fundatiepaal op de vereiste 50 meter afstand houdt, maar het bodemberoerend vistuig binnen de afstand van 50 meter komt (**zie figuur 10-2**). Hiervoor zijn mogelijk mitigerende maatregelen nodig, zoals verruiming van veiligheidszone, zie ook **sectie 10.4.1**.

Andere belanghebbenden, zoals **Verzekeringsmaatschappijen,** waren ook aanwezig in de workshop.

Verzekeringsmaatschappijen zijn risicomijdend, aangezien het merendeel van de claims voor windparken op zee aan kabelstoringen zijn gerelateerd en het toestaan van visserij activiteiten nieuwe extra risico's introduceert.

De verzekeringskosten per jaar tijdens de operationele fase vormen al een aanzienlijk percentage van de totale operationele uitgaven.

Een verhoogd risico van claims, evenals een toename in frequentie en waarde van claims, zal resulteren in hogere verzekeringskosten (premie en / of eigen risico) voor de **Windpark Ontwikkelaar/Exploitant**, hetgeen effectief leidt tot verhoging van de operationele uitgaven en uiteindelijk het elektriciteitstarief.

In het geval van schade kan de **Windpark Ontwikkelaar/Exploitant** een beroep doen op het vissersvaartuig, maar de vergoeding onder de verzekeringsdekking van de eigenaar van het vaartuig is niet vergelijkbaar met de totale omvang van de potentiële claim.

In het slechtste geval zouden **Verzekeringsmaatschappijen** kabelschade in de verzekeringspolis voor de **Windpark Ontwikkelaar/Exploitant** kunnen uitsluiten.

Het platform en (een kort deel van) de export kabels van de netbeheerder TenneT (**TSO**) bevinden zich eveneens in het windpark op zee. De kabels zijn echter met 1 meter grond dekking reeds afdoende beschermd voor bodemberoerende visserij. Om het platform is een 500m veiligheidszone van kracht. Het lijkt dan ook niet waarschijnlijk dat bodemberoerende visserij tot extra kosten zal leiden voor de **TSO**, maar het kan niet worden uitgesloten dat de **Verzekeringsmaatschappijen** hier toch reden in zien hun premie of polis aan te passen.

De eindconclusie van dit rapport is dat visserij met bodemberoerend vistuig in de toekomstige windparken op zee alle belanghebbenden zal raken en de prijs van energie opgewekt door de betreffende windparken op zee zal verhogen. Het wordt aanbevolen de (kosten) effecten te vergelijken met de voordelen voor de **Visserij**, hetgeen het onderwerp is van een andere studie. Alternatieve locaties voor (extra) visgebieden buiten de windparken op zee kunnen eveneens overwogen worden.

De belangrijkste redeneringen zijn:

- **Windpark Ontwikkelaar/Exploitant** is gedeeltelijk verantwoordelijk voor de veiligheid binnen een windpark op zee. In het geval een vissersvaartuig betrokken is bij een ongeval of noodhulp nodig heeft, is de **Windpark Ontwikkelaar/Exploitant** de partij die mogelijk aansprakelijk wordt gesteld. Onder de huidige regelgeving is de **Windpark Ontwikkelaar/Exploitant** uitsluitend verantwoordelijk voor het gebied binnen de 50 m veiligheidszone rondom hun eigendom. In de overige delen van een windpark op zee is de staat (RWS) verantwoordelijk. Ook de **Visserij** kan aansprakelijk zijn. Welke partij uiteindelijk verantwoordelijk is, zal afhangen van de precieze toedracht van het incident.
- De indeling van een windpark op zee geschikt voor bodemberoerende visserij is niet verenigbaar met de business case van de **Windpark Ontwikkelaar/Exploitant**, hetgeen mogelijk van invloed is op de financiële beslissing om de ontwikkeling van het windpark op zee te beginnen. Om een windpark op zee geschikt te maken voor bodemberoerende visserij, zal de **Windpark Ontwikkelaar/Exploitant** de indeling van het windpark (locatie van de fundatiepalen) moeten aanpassen, de kabels binnen het windpark dieper moeten begraven en deze beschermende begraving gedurende de levensduur van het windpark op zee moeten onderhouden. Om "precisie" visserij mogelijk te maken dienen de vissersschepen aangepast te worden. **Sectie 11** behandeld een raming van de kostenverdeling.
- De door **Visserij** gewenste 1.85km brede viscorridors zijn niet realistisch haalbaar. Met dergelijke afstanden tussen de windmolens, zouden de windmolens niet meer binnen de grenzen van het windenergiegebied passen.
- **Windpark Ontwikkelaar/Exploitant** wordt mogelijk geconfronteerd met aanzienlijke verliezen ten aanzien van kabel storing veroorzaakt door bodemberoerende visserij. Deze verliezen betreffen kabel reparatie en gederfde inkomsten. **Windpark Ontwikkelaar/Exploitant** zal een beroep doen op verzekeringen om deze schade te vergoeden. Visserij zal een beroep doen op verzekeringen voor aansprakelijkheid, hetgeen slechts een klein deel van de schade zal vergoeden (conform de maximum dekking onder de polis voor het vissersvaartuig). Het overblijvende (grootste) deel wordt verhaald bij de verzekeraar van het windpark op zee. Tevens zullen beide partijen het eigen risico niet vergoed krijgen.
- Het primaire voordeel is de beschikbaarheid van delen van de windparken op zee voor bodemberoerende visserij, i.e. de beschikbaarheid van (extra) visgebieden. Alternatieve locaties voor (extra) visgebieden buiten de windparken op zee kunnen overwogen worden.
- Er is een verhoging van de kosten voor beide partijen, d.w.z. investeringen in vissersvaartuigen, diepere ingraving van de kabels in het windpark, het waarborgen van voldoende beschermende gronddekking boven de kabels gedurende de levensduur.
- Het risicoprofiel is niet in evenwicht (geen voordelen, uitsluitend nadelen) voor belanghebbenden zoals **Windpark Ontwikkelaar/Exploitant**, **Verzekeringsmaatschappijen**.

3.2 Management summary in English

"Rijksdienst voor Ondernemend Nederland" (RVO.nl) requested a study into the consequences of possible sea-bed fishery in future Offshore Wind Farm (OWFs), Hollandse Kust (west), Ten noorden van de Waddeneilanden and IJmuiden Ver. In the existing wind farms fishing is not allowed, except fishing with a rod, as meant in Article 1, fifth paragraph of the Dutch Fishing law 1963.

Also, at the request of RVO a workshop was conducted on the 15th April 2019, where the Dutch Fishery (**Fishery**) organisations (VisNed and Visserijbond), the wind farm developers/operators (**Wind Farm Developer/Operator**) and other stakeholders were invited.

The workshop focused on "how can we adapt the design of an OWF", such sea-bed fishery can be facilitated and what is required by the fisheries to make their vessels, crew and equipment suitable for sea-bed fishery in future OWFs.

The **Fishery** are open to discuss the potential of fishing in future OWFs, even though they have reservations regarding nautical safety when manoeuvring in the windfarm. These reservations being the absence of straight, sufficiently wide fishing corridors and the additional requirements for significant technical improvements of the fishing vessel, crew and equipment, as well as the potential increase in cost of insurance policies.

The main objective, for the **Wind Farm Developer/Operator** is to design an OWF so it is generating energy from wind in the most optimum way. This does not necessarily mean present OWFs have been optimised for (any) fishing activities. Therefore, any modification to an OWF to facilitate sea-bed fishing activities may have consequences for the layout of and the distance between the monopiles (**see Figure 7-2**) and the underwater infrastructures, e.g. the cables (**see Figure 7-9**).

The allowing of fishing activities in an OWF, introduces new risks to the **Wind Farm Developer/Operator**, as they are ultimately responsible for the safety within an OWF.

There is also risk to property, especially near to offshore structures, where although protected by a Cable Protection System (CPS) **(see Figure 7-10)**, cables remain vulnerable to being hit by foreign objects. This is especially in the case where a fishing vessel sails around a monopile, clearing it by the required 50 meter, but with the sea-bed fishing gear encroaching within the 50 meter distance (**see Figure 10-2**). This may require mitigating measures, such as enlargement of the safety zone, reference is made to **section 10.4.1.**

Other stakeholders such as **Insurance Companies** were also present at the workshop.

Insurance companies are risk averse, as presently the majority of claims for OWFs are related to cable failures and allowing fishing activities introduces new additional risks.

Insurance costs per year during the operational phase are already a significant percentage of the overall operational expenditure.

An increase in risk of claims being made as well as an increase in frequency and value of claims, will result in a higher insurance cost (premium and/or deductible) for the **Wind Farm Developer/Operator**, effectively leading to increasing the operational expenditure and ultimately the electricity tariff.

In the event of damage, the **Wind Farm Developer/Operator** can seek recourse from the fishing vessel, however the compensation via the insurance coverage held by the vessel owner, is not comparable with the overall size of the potential claim.

In a worst-case scenario, **Insurance Companies,** could exclude cable damage from their policies to the **Wind Farm Developer/Operator**.

The platform and (a short section of) the export cables, owned by the transport system operator TenneT (**TSO**), are located within the OWF as well. The cables are already sufficiently protected for sea-bed fishery by a 1 metre cover. Around the platform a 500m safety zone is enforced. It is not considered likely that sea-bed fishery will lead to an increase of costs for the **TSO**, however, it cannot be excluded that the **Insurance Companies** would consider this a justification to amend the premium or policy.

The end conclusion of this report is that sea-bed fishery in future OWF shall affect all stakeholders and increase the cost of energy produced by affected offshore wind farms. It is recommended to compare the (cost) impacts with the benefits for the **Fishery**, which is the subject of another study. Alternative locations for (additional) fishing grounds outside offshore wind farms could be considered as well.

The main reasoning is:

- **Wind Farm Developer/Operator** are partly responsible for the safety within an OWF. In the event a fishing vessel being involved in an accident or requiring emergency assistance, the party deemed liable may be the **Wind Farm Developer/Operator.** The current regime is that the **Wind Farm Developer/Operator** are only responsible for the areas within the 50m safety zone around their assets. In the remaining areas of a WFZ the state (RWS) is responsible. **Fishery** can be liable as well. Which party is ultimately liable, shall depend on the precise circumstances surrounding of the incident.
- The layout of an OWF suitable for sea-bed fishery is not compatible with the business case of the **Wind Farm Developer/Operator**, potentially impacting the financial decision of commencing the development of the offshore wind farm itself. In order to make a wind farm sea-bed fishery friendly, **Wind Farm Developer/Operator** will have to reconfigure the lay out of the wind farm (monopiles), increase the depth of burial of the infield cables and maintain this protective burial over the lifetime of the offshore wind farm. In order to perform "precision" fishing the fishing vessels have to be modified. Please refer to **section 11** for the breakdown of the estimated costs.
- The 1.85km wide fishing corridors requested by **Fishery** are not realistically feasible. With the wind turbines at such spacing, the wind turbines would not fit within the wind farm zone boundaries.
- **Wind Farm Developer/Operator** is potentially facing significant damages in terms of cable failure caused by sea-bed fishery. These damages pertain to the cable repair as well as the loss of revenue. **Wind Farm Developer/Operator** will make an insurance claim to recover this loss. **Fishery** will make an insurance claim to cover liabilities, which will only settle a small proportion of the loss (as per the maximum of the insurance policy held by the fishing vessel). The remaining (larger) part will be settled by the insurer of the offshore wind farm. Furthermore, the deductibles for each party shall not be recovered.
- The primary benefit would be the availability of parts of the offshore wind farms for sea-bed fishery, i.e. availability of (additional) fishing grounds. Alternative locations for (additional) fishing grounds outside offshore wind farms could be considered.
- There is an increase cost for both parties, i.e. investment in fishing vessels, non-optimal wind farm lay-out, deeper burial of the infield cables in the windfarm, ensuring sufficient protective cover on the infield cables over the lifetime.
- The risk profile is not balanced in favour of (no benefits, only disadvantages) stakeholders such as **Wind Farm Developer/Operator**, **Insurance Companies.**

4 List of Abbreviations and Definitions

Abbreviation	Description
AIS	Automatic Identification System (Based on VHF providing vessel location to other vessels, authorities, harbours, locks, etc.)
AXA	Insurance company
BI	Business Interruption
BZK	Ministerie van Binnenlandse Zaken en Koninkrijksrelaties Ministry of the Interior and Kingdom Relations
CBRA	Cable Burial Risk Assessments
CAPEX	Capital Expenditure
Client	RVO.nl (Rijksdienst voor Ondernemend Nederland)
Consultant	Primo Marine
CPS	Cable Protection System
DCS	Dutch Continental Shelf
DoB	Depth of Burial (of the cable)
EZK	Ministerie van Economische Zaken en Klimaat Ministry of Economic Affairs and Climate Policy
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
kWh	Kilo Watt Hour (energy)
LNV	Ministerie van Landbouw, Natuur & Voedsel Kwaliteit Ministry of Agriculture, Nature and Food Quality
MI	Mass-impregnated (cables)
MWh	Mega Watt Hour (energy)
NOGEPA	Nederlandse Olie en Gas Exploratie en Productie Associatie Netherlands Oil and Gas Exploration and Production Association
NWEA	Nederlandse WindEnergie Associatie Netherlands Wind Farm Developer/Operator Association
OHVS	Offshore High Voltage Station
OPEX	Operational Expenditure
OWF	Offshore Wind Farm(s)
PD	Property Damage
PI	Protection & Indemnity (Insurance Policy)
RBBD	Risk Based Burial Design
RVO	Rijksdienst voor Ondernemend Nederland Netherlands Enterprise Agency
RWS	Rijkswaterstaat Zee en Delta Rijkswaterstaat Sea and Delta (the executive agency of the Ministry of Infrastructure and Water Management, dedicated to promote safety, mobility and the quality of life in the Netherlands)
TSO	Transmission System Operator
VHF	Very High Frequency (Marine radio band)
WFZ	Wind Farm Zone
WTG	Wind Turbine Generator
XLPE	Cross-linked polyethylene (cables)

Table 4-1 List of abbreviations

5 Reference documents

Ref	Title, Author, Date	Document Nr.
[Ref. 1]	Proposal by Primo Marine, Daryl Lynch, dated 11 March 2019	0509A_ RVO_Windpark_Visserij_PROP_0001_R1_00_20190311.pdf
[Ref. 2]		
[Ref. 3]		
[Ref. 4]		
[Ref. 5]		
[Ref. 6]		
[Ref. 7]		
[Ref. 8]		
[Ref. 9]		

Table 5-1 List of reference documents

6 Introduction

6.1 General

Primo Marine (**Consultant**) has been engaged by "Rijksdienst voor Ondernemend Nederland" (RVO.nl), to conduct a study, to provide an inventory of the requirements in order for the future Dutch Offshore Wind Farms (OWF) to be "accessible" for sea-bed fishery.

In addition, the financial consequences for **Wind Farm Developer/Operator**, **Fishery**, **Insurance Companies**, the **Transmission System Operator (TSO)**, caused by enabling sea-bed fishery in offshore windfarms are to be quantified.

The future OWFs are the part of route map 2030 and comprise of the following:

- Hollandse Kust (west).
- Ten noorden van de Waddeneilanden.
- IJmuiden Ver.

6.2 Scope of Work

This report is the form of "Desktop study", covering the possibilities of adopting the design of an OWF, in such a way to become "sea-bed fishery accessible".

The approach taken is outlined as follows:

- Describe the layout of an existing Dutch OWF.
- Describe the risks of such a lay out for sea-bed fishery.
- Describe the requirements of a future OWF to make it "sea-bed fishery accessible".
- Describe the requirements for future sea-bed fishery and specific gear suitable for fishing in offshore wind farms.
- Describe the financial consequences for **Wind Farm Developer/Operator**, **Fishery**, **Insurance Companies**, the **Transmission System Operator (TSO).**
- Conclude and make a recommendation.

During the study an external workshop was conducted. The purpose of this workshop was to collect the views of all stakeholders.

A summary of this workshop has been incorporated in **section 9.2** of the desk top study.

7 Current situation of wind farms on Dutch Continental Shelf

7.1 Introduction

This section is a brief description for the layout of a typical OWF on the Dutch Continental Shelf (DCS). **Consultant** has previously been involved in the Eneco Luchterduinen and Gemini OWF projects, experience and (public) information has been retrieved from these projects.

In **Figure 7-1** the OWF comprises 43 monopiles (support structures for wind turbines), an Offshore High Voltage Station (OHVS) and a number of power cables. The developer has designed the OWFs, to allow the generation of energy from wind in the most optimum way. The design culminates in an optimum pattern of the wind turbines (e.g. location and spacing).

It is noted that **Figure 7-1** is typical for an older generation windfarm, having the wind turbine generators in more or less straight lines. Current optimised windfarm designs applicable for the WFZs of Roadmap 2030 will almost certainly not have turbines in straight lines, but in more staggered patterns to avoid the turbines being in each other's wake.

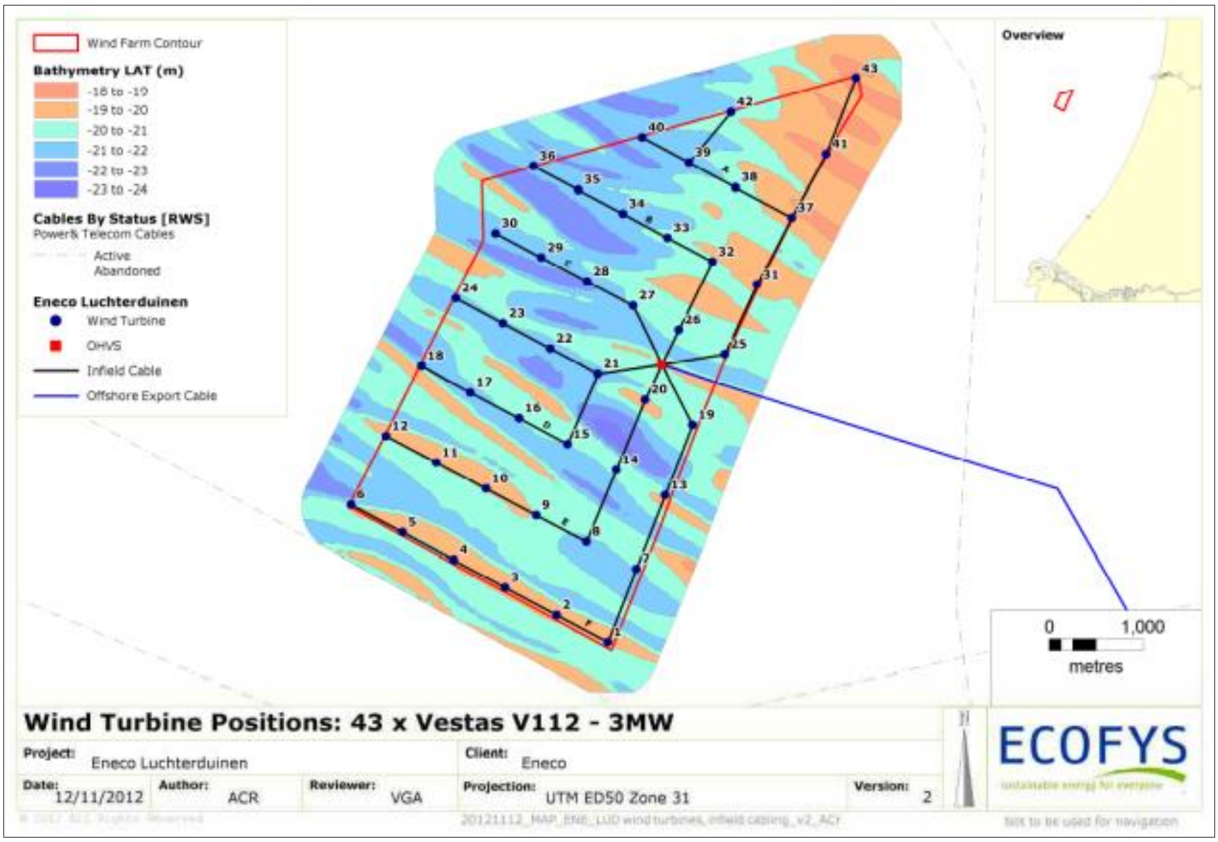


Figure 7-1 Schematic of an OWF

When allowing, entry into an OWF, the following describes what the fishing vessels will be "encountering". In this regard a distinction has been made between:

- Obstacles above water.
- Obstacles underwater and on the seabed.

7.2 Obstacles above water

A typical monopile (support structure) with wind turbine is presented (In **Figure 7-2)**. The monopile comprises a small platform for a boat landing. Above water these wind turbines have rotating blades.

Figure 7-2 Monopiles with wind turbines (OWF Luchterduinen)

In addition, there is an OHVS, where the cables (typically referenced as inter-array) from all wind turbines combine together and also from where the energy is transported to the high voltage grid system onshore (via an export cable).

The OHVS is presented in **Figure 7-3** and **Figure 7-4.** At the water level the OHVS is fitted out with boat landing(s), protection frames. Underneath the topsides there is the jacket which has been conserved against corrosion (a.o. by a paint system above water and partly underneath the waterline).

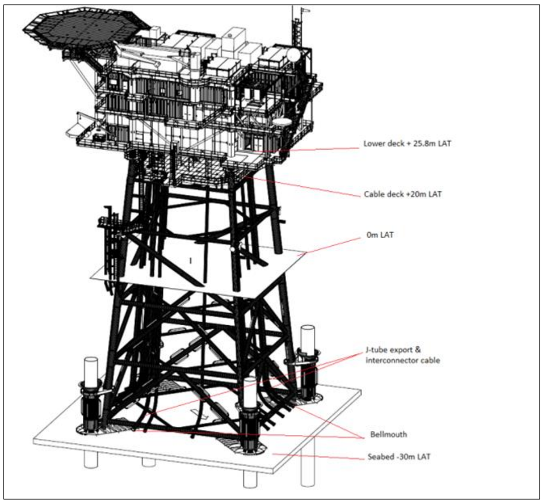


Figure 7-3 OHVS (OWF Gemini)

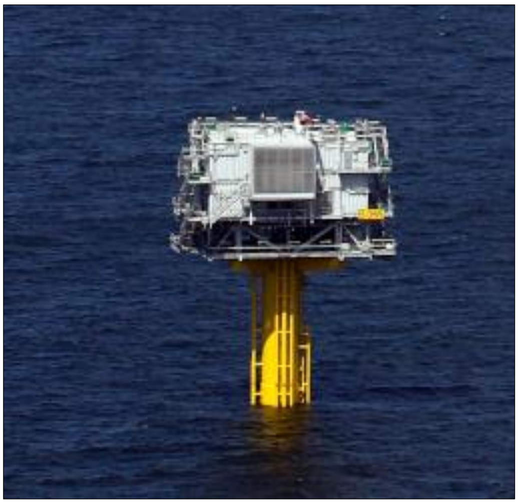


Figure 7-4 OHVS (OWF Luchterduinen)

7.3 Obstacles under water

The monopile is driven (by a technique called piling) into the seabed. Due to water currents around a monopile the seabed mainly comprising sand, erodes away, this erosion, is known as scouring.

In order to prevent this erosion anti-scour protection is installed. This anti-scour protection comprises of the top layer (called armour layer of large stones) and an underlying layer (called filter layer of small stones). This is presented in **Figure 7-5.**

Figure 7-5 Monopile and anti-scour protection (OWF Gemini)

There is also a Cable Protection system (the yellow "tube") which is described later in **section 7.5.** The OHVS protrudes the water surface and "stands" on the seabed. It comprises:

- The jacket.
- The piles (with which the jacket is secured to the seabed).
- The anti-scour protection (rock).

As shown below in **Figure 7-6**

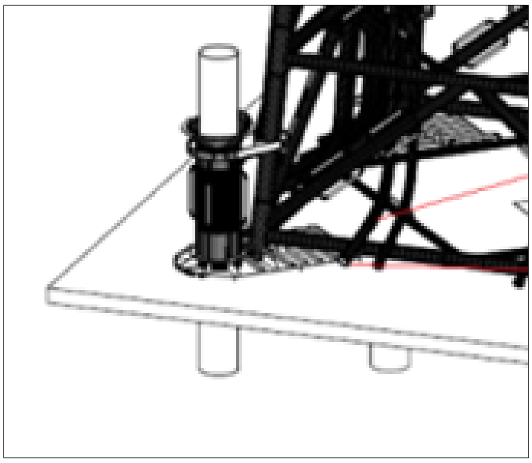


Figure 7-6 Anti-scour protection around an OHVS pile (OWF Gemini)

7.4 Underwater cables

As mentioned previously an OWF has underwater cables (subsea power cables) which are outlined as follows:

7.4.1 Infield

Infield cable (also called inter-array) these link wind turbine to wind turbine (referenced as strings) and then from the final wind turbines in each string, into the OHVS **(**see **Figure 7-7).**

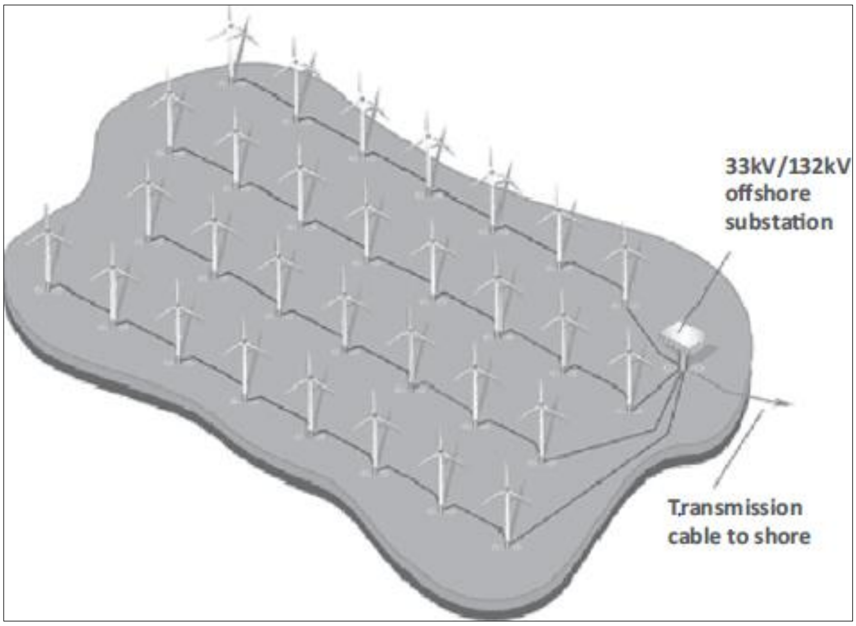


Figure 7-7 Schematic of an offshore wind farm

7.4.2 Export

Export cables link the OHVS to the high voltage grid system onshore. The export cable routes from the OHVS to the landfall, where it crosses the sea defence (e.g. dunes). Beyond the landfall the export cable changes from offshore to land cable. It should be noted part of the export cable is within the wind farm boundary and the remainder is outside the wind farm boundary.

There are 1, sometimes 2, export cables from one OHVS, also some OWFs will have 2 OHVSs, i.e. with 2 (or 4) export cables.

7.4.3 Interlink

Interlink cables are used to connect two OHVS. As in the case with the future Borssele OWF.

The infield cables and the export cables are presented below in **Figure 7-8**.

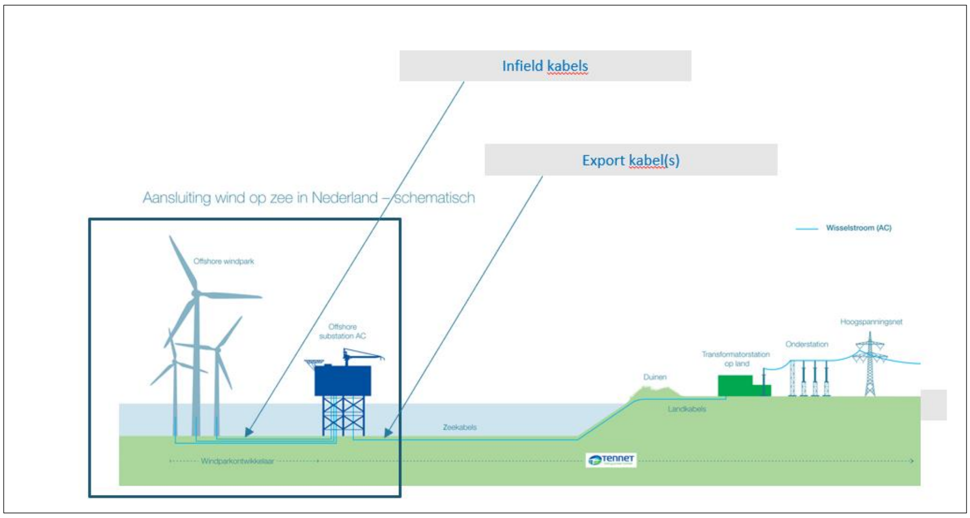


Figure 7-8 Wind farm cables (courtesy TenneT)

7.4.4 Cable Type

For OWFs both High Voltage Alternating Current (HVAC) and High Voltage Direct Current (HVDC) cables will be used. The main types of cable design are (1) Cross-linked polyethylene (XLPE) which include an extrusion thickness for insulation. (2) Mass-impregnated (MI), which is a paper-lapped insulation but the impregnation compound is highly viscous and does not exit when the cable is damaged. OWF Luchterduinen has been designed using a HVAC export cable (**See Figure 7-9**).

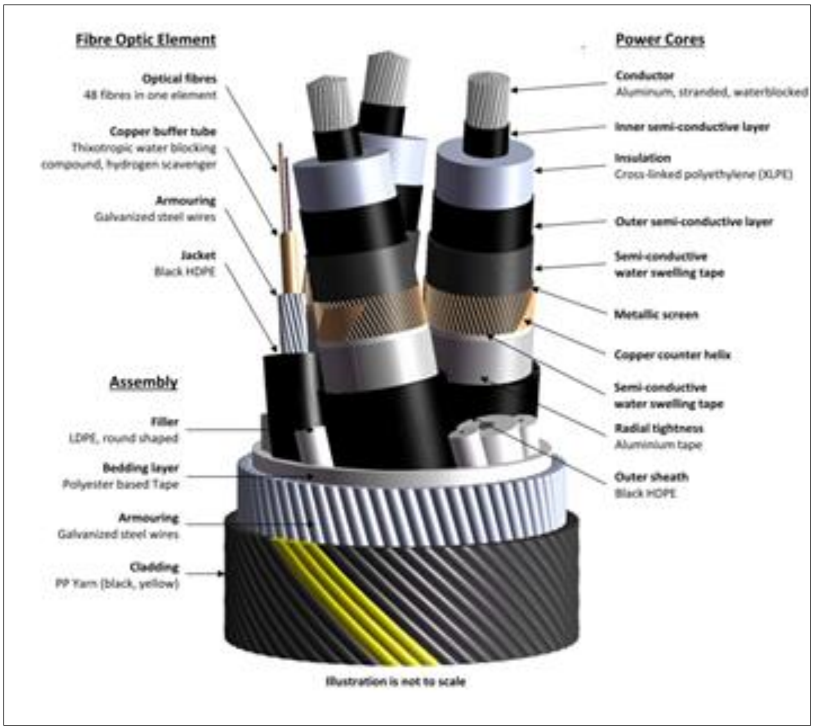


Figure 7-9 HVAC cable

7.5 Protection Systems

Cable Protection Systems (CPS) are generally polymer based compounds, which are designed to protect damage to the cable caused by fatigue, overbending etc, and to provide protection of the cable until it reaches an area of burial. The infield cables which route from monopile to monopile and monopile into the OHVS are protected at **both ends** by a CPS, so one CPS at the monopile end and 1 CPS at the OHVS end. In **Figure 7-10** a schematic of a CPS is presented. A more detailed configuration of the CPS is presented in **Figure 7-11.** This CPS is also an under-water obstruction.

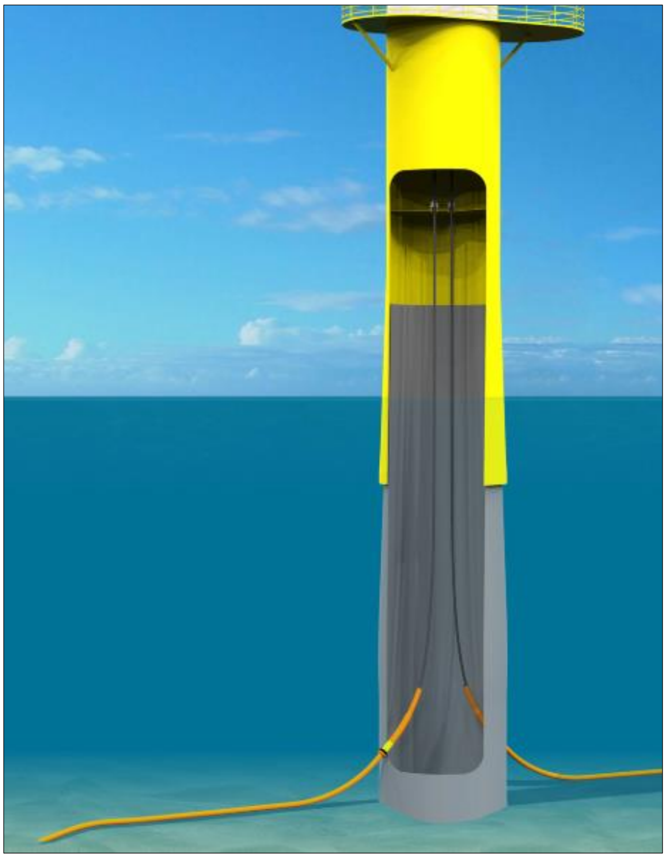


Figure 7-10 Cable Protection System

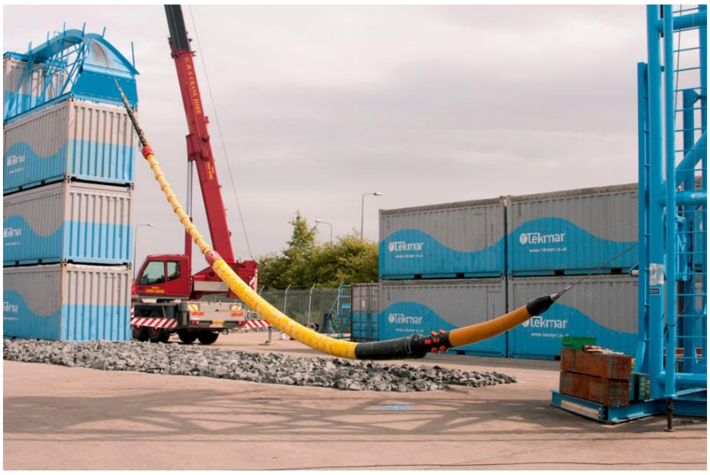


Figure 7-11 CPS under pull in testing (courtesy Tekmar)

7.6 Underwater crossings

There is a potential for an OWF, to have been planned in an area where existing subsea structures are present i.e. telecom cables, export cables and pipelines.

These structures are referred to as 3rd party (noting the owners of these structures referred to them as assets). This implies cable belonging to the OWF have to cross these existing 3rd Party structures.

The assets being crossed have to be protected by rock, this form of protection is called a rock berm (see **Figure 7-12**). This rock berm is also an under-water obstruction.

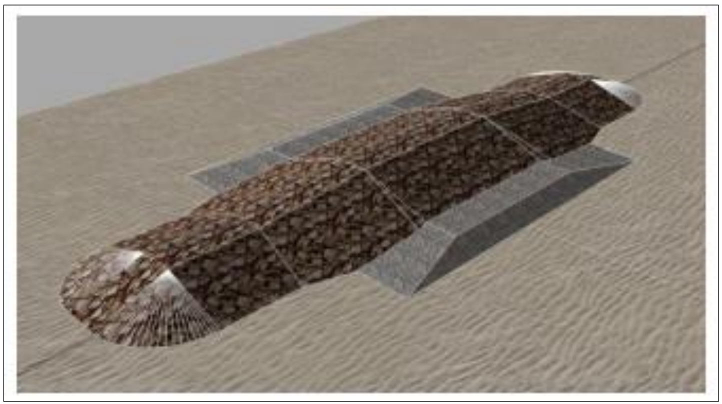


Figure 7-12 Typical crossing design (rock berm)

7.7 Cable protection by burial

The subsea cables are buried below the seabed to protect them against damage caused by deemed external threats (foreign objects), as well as to protect other users of the sea against those very same cables. The burial depth into the seabed is intended to provide the required optimum protection. Therefore, cables in future OWFs will have to be buried deeper than present when taking sea-bed fishery into consideration. In case of mobile seabeds, burial has to be increased even more as well as ensured over the offshore wind farm's lifetime.

More notably, if sea-bed fishery within future OWFs would be permitted, sufficient protection, i.e. sufficient protective cover on top of the cables, has to be maintained at all times. The persistent presence of sea-bed fishing gear increases the probability of striking an infield cable to an almost certainty, in case such cable would not have sufficient protection.

A cable can be damaged by:

i. Hitting it (on impact).
ii. Hooking/snatching.

The 66kV infield cables are XLPE cables (cross linked polyethylene). These cables can endure a small impact and also must resist rock being dropped (placed) on top (for crossings). They are not type tested for large impacts imposed by heavy (order tonnes) sea-bed fishing gear.

It is even worse when a sea-bed fishing gear snatches an infield cable and lift it off the seabed. This has 3 consequences:

i. The cable is also impacted.
ii. The Minimum bending radius of the infield cable is compromised.
iii. The allowable maximum axial tension is comprised.

Also, it is important to take into consideration, the cable ends which are protected by the CPS are not buried and remain exposed. The CPS cannot be completely protected e.g. rock, as it would require a significant sized rock berm, up to the entry into the monopile, which is metres above the anti-scour protection. Therefore, the CPS will always remain the most “vulnerable” part of the OWF subsea development.

It is noted that the safety zones of 50 m around the turbines can only be entered by maintenance vessels of the **Wind Farm Developer/Operator**. The CPS system is situated in this 50 m safety zone, so should not be affected by sea-bed fishing gear, provided mitigations are implemented as described in **section 10.4.1.**

7.8 The impact of seabed mobility and erosion (scour)

The seabed in the Western part of the North Sea is mobile, i.e. due to water (tide driven) currents the seabed will not remain flat, but move in the form of sand dunes. These sand dunes (aka sand waves) can be e.g. as high as 5m or more. Profile of sand waves along a cable route is presented in **Figure 7-13.**

This has repercussions on the burial depth requirements of the cable. If 1m burial is required for the cables in the OWF and the seabed is mobile, the cables may become exposed (i.e. unburied condition) over time (time being the design life of the OWF).

In order to prevent such exposure, the cables must be buried even deeper than 1m, so they will “never” become exposed. This requires additional time during the installation campaign of the cables. Deeper burial has an impact on the Capital Expenditure (CAPEX) for the **Wind Farm Developer/Operator**. Therefore cables (in mobile seabeds) in future OWFs will have to be buried deeper than present when taking sea-bed fishery into consideration.

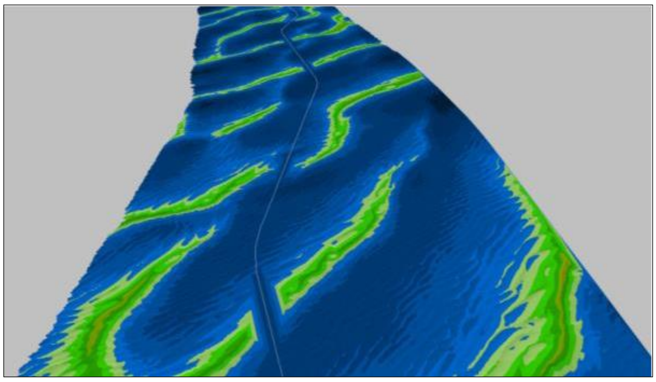


Figure 7-13 Typical sand waves along a cable route (Archives Primo Marine)

At the perimeter (edge) of the anti-scour protection, new (additional) scour also may occur both around the monopiles and the OHVS. This has further repercussions for the CPS as it has been installed in such a way to rest on (lay-on) the anti-scour protection, but due to the new (additional) scour it can start to suspend/collapse (hang free) just above the anti-scour protection. This will make the CPS more vulnerable to external threats (i.e. anchors and fishing gear). A suspended CPS has been presented in **Figure 7-14**.

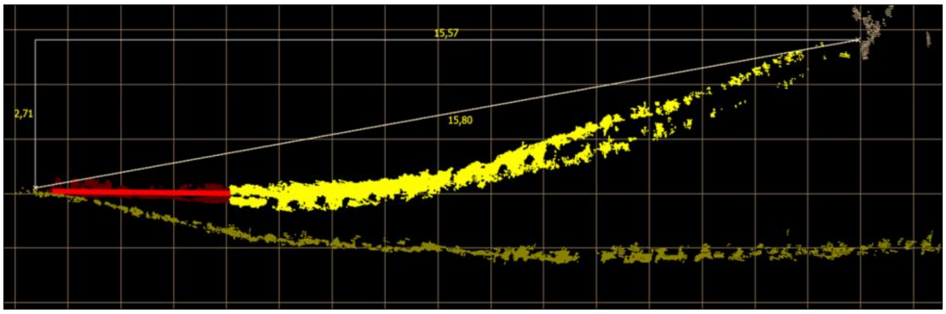


Figure 7-14 Suspended CPS (Archives Primo Marine)

8 Guidance towards Dutch Wind farms

At present the following guidance is in place for OWFs on the DCS.

- The current OWFs are in accordance with the Routekaart Windenergie op Zee 2023 (Offshore Wind Energy Roadmap 2023), which does not permit entering the OWF.
- The future OWFs are in accordance with Routekaart Windenergie op Zee 2030, for which the regulations have not yet been defined.

Reference is made to:
https://www.noordzeeloket.nl/functies-gebruik/windenergie-zee/windparken-zee-0/doorvaart/

Currently there are only three offshore wind farms open for vessels with a length up to 24m:

- OWF Egmond aan Zee.
- OWF Luchterduinen.
- OWF Prinses Amalia.

Crossing an OWF is permitted under the following restrictions:

- Vessel length < 24m.
- Only from sunrise to sun set.
- Each vessel is to be equipped with Automatic Identification System (AIS).
- VHF watch.

There are NO GO zones within the OWF:

- 50 m zone from the monopile.
- 500 m from the OHVS.

Within the OWF it is forbidden to touch the seabed. This implies no anchoring or sea-bed fishery.

9 Workshop - Future wind farms

9.1 Introduction

A workshop was conducted on Monday 15 April 2019 with Stakeholders related to OWFs on the DCS. The subject was exploring the possibilities of enabling sea-bed fishery, e.g. beam trawl fishing, in future offshore wind farms. These future OWFs were presented in **Figure 9-1**.

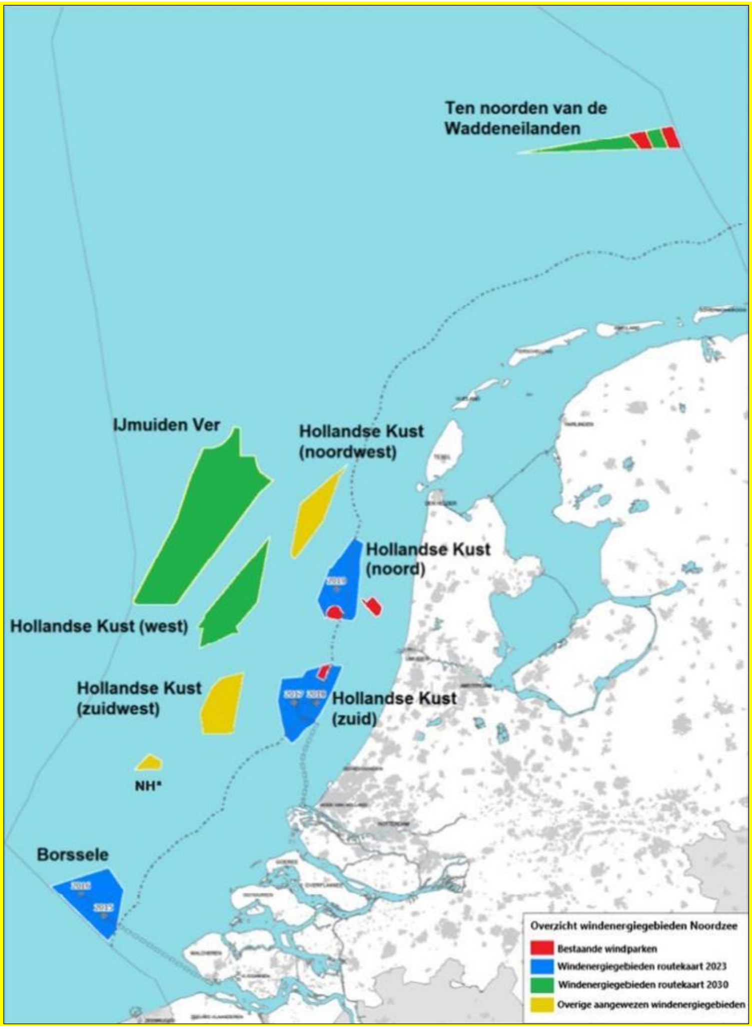


Figure 9-1 Future wind farms

9.2 Workshop

The objective of the workshop was to collect the views of the various stakeholders on the potential impacts on OWF and sea-bed fishery design requirements. Equally the workshop had to collect the requirements from the **Fishery** representatives as in (1) what they see is required where/when they are allowed to enter into OWFs for sea-bed fishery.

The attendees were:

- Representatives from VisNed and de Nederlandse Visserijbond.
- **Wind Farm Developer/Operator**, Eneco and Ørsted.
- RWS (Rijkswaterstaat).
- BZK (Min. van Binnenlandse zaken en Koninkrijksrelaties).
- LNV (Min. van Landbouw, Natuur & Voedsel Kwaliteit).

- EZK (Min. van Economische Zaken en Klimaat).
- NWEA.
- **Insurance companies,** Nationale Nederlanden, Canopius.
- RVO.
- Primo Marine.

TenneT TSO B.V., NOGEPA, Havenbedrijf Rotterdam, AXA (insurance company), were invited, but were unable to attend.

9.3 Views collected during the workshop

9.3.1 Introduction

The views of the following parties are summarised:

- **Fishery**.
- **Wind Farm Developer/Operator**.
- **Insurance companies**.
- **Dutch Government.**

9.3.2 Representatives from Fishery

The **Fishery** in The Netherlands perceive they are being pushed into a difficult situation, where the area(s) for fishing is/are diminishing due to various developments for example Brexit, nature areas, and OWF developments. Also, the fishing industry is in a difficult position due the pulse fishing ban and the landing obligation. The enquiry is whether the **Fishery** should be allowed into future OWFs and, if this is the case, what are the consequences for both **Wind Farm Developer/Operator** and **Fishery**.

Various types of sea-bed fishing gear are currently in use. After the workshop Visned provided the report 190603 Verdiepingsdocument Visserij DEF1 (003).pdf, further describing the methods.

From this report it can be seen there are 4 types of fishery methods that operate (very) close to the seabed:

- Pulse fishing
- SumWing, a fishing method where the beam is replaced by 'wing' style of beam.
- SeeWing, a shrimp fishing method, where an inverted aerofoil beam maintains a lower front-end profile of the trawl, reducing the opening and, with it, by-catch, drag, etc.
- JackWing, comparable with Sumwing.

Especially for trawl nets the report elaborates on potential fishing activity in wind farms.

9.3.2.1 Crossing wind farms

Fishermen require allowance to cross the wind farms in order to keep optimum access (‘alleyways’) to fishing grounds for fishing vessels under 46 m.

9.3.2.2 Fishing in wind farms

At first there should be a study which indicates the influence of wind farms on the presence of fish, crustaceans, and shellfish.

The fishing vessel shall be “insurable” and premiums shall be of an acceptable level.

At present no conclusion can be drawn whether fishing activities in wind farms are profitable.

A study is required, which is not limited to a nautical study.

For fishing vessels with a demersal rig (for fishing at seabed level), the following requirements apply:

- Wind farm configuration such that fishing vessels can safely perform their work.
- Cables have been sufficiently buried (1m) and burial depth is guaranteed, even after a storm.

The report concludes with: At present the opinion is demersal fishery with a trawled net (shrimp fishery, demersal fishery with beam trawl or twinrig) with existing fishing vessels in existing wind farms is not a safe, nor a viable option in the short term.

From the workshop, it can be concluded the **Fishery** is open to discuss “precision” sea-bed fishery within the future offshore wind farms.

Though, they have certain requirements and reservations being future wind farms should be designed to accommodate sea-bed fishery:

- A (straight) fishing corridor should be wide enough for safe fishing and manoeuvring.
- 1 nautical mile distance between the mono piles was deemed to be sufficient for manoeuvring within a wind farm.
- Beam currents when manoeuvring in a confined wind farm is seen as a problem.
- It is easier to tow sea-bed fishing gear over a flat seabed than over a mobile seabed, which comprises sand ripples and/or sand dunes.
- Their vessels and fishing gear shall be adapted for this precision fishing (this requires technical improvements which is substantial investment).
- Insufficient cable burial is seen as a problem.
- In general, the **Fishery** is not enthusiastic about fishing in OWFs, due to substantial investment (CAPEX) consequences to accommodate technical improvements required to vessel, crew and fishing equipment.
- Possible increase in insurance costs. i.e. vessel may incur a higher P & I (Protection & Indemnity) insurance premium.

9.3.3 Representatives from Wind Farm Developer/Operator

The **Wind Farm Developer/Operator** design their OWFs, to allow the generation of energy from the wind in the most optimum way.

This design culminates in an optimum pattern of the wind turbines (e.g. location and spacing) and does not necessarily mean the present OWFs have been optimised for (any) fishing activities. Also, the responsibility for safety within a windfarm remains partly with **Wind Farm Developer/Operator**. The current regime is that **Wind Farm Developer/Operator** are only responsible for the areas within the 50 m safety zone around their assets. In the remaining areas of a WFZ the state (RWS) is responsible.

Although in the workshop **Wind Farm Developer/Operator** held an open mind towards the discussions regarding fishing activities, they did have the following reservations:

- At present **Wind Farm Developer/Operator** do not allow sea-bed fishery into their wind farms.
- **Wind Farm Developer/Operator** wish to avoid collisions by 3rd Party vessels to their offshore (above and under water) assets at all times.
- No Corridors for fishing can be provided, since turbines in a modern development are generally not aligned.
- The morphology of the seabed may affect the actual (horizontal) location of the cables, i.e. the as-built route of the cable may have been shifted over time.
- In order to protect the cables, adequately from fishing activities, it has to be sufficiently buried into the seabed.
- Due to natural seabed lowering (morphology) the cables can lose their protective cover. This implies deeper burial than anticipated has to be conducted.
- Even deeper burial for the fishing activities has investment (CAPEX) consequences.

- Also, there is an effect on operation and maintenance i.e. the reburial operations of the cables will increase the Operational Expenditure (OPEX). The OPEX applies to the lifetime of the development, ultimately resulting in an increase in the tariff of the kWh.
- Any damage to cables caused by sea-bed fishery requires an "expensive" repair and incurs loss of revenue for the development.

9.3.4 Representatives of the Insurance Companies

Insurance Companies protect **Wind Farm Developer/Operator** for damage to their assets (Property Damage, PD) and loss of revenue (Business Interruption, BI) resulting from standstill caused by the damage.

The cost of such policies consists of annual premium amounts, usually based on the original CAPEX value, number of turbines, distance from shore etc. Depending on the willingness **Wind Farm Developer/Operator** to retain part of the risk by varying deductibles and the loss history of the development or involved parties the premium rates are fluctuating.

Until a few years ago there were only a limited number of **Insurance Companies** willing to cover offshore construction and asset risks, but as the industry has evolved and matured it has become easier (and cheaper) to obtain insurance (still a significant part of the overall OPEX cost).

In the light of high offshore costs associated with repairs and damages **Insurance Companies**, remain very risk averse and the possible introduction of fishing vessels, would in their view create potential new risks such as monopile and cable damage.

The **Insurance Companies** have the following exposures:

- Without fishing activities in offshore wind farms, the majority of the claims, around 80%, are related to cables. Therefore, **Insurance Companies** have no appetite for additional cable risks.
- The insurance cost during the construction phase is a % of the CAPEX. However, at the operational phase, this cost per year is a significant % of the overall OPEX.
- An increase in claims (or the risk in claims being made) will ultimately result in a higher premium and/or deducible for the developer, effectively increasing the OPEX.
- Worst case scenario could be exclusion of cable damage coverage from insurance policies.

Example were provided for damages and consequential revenue losses:

- The cost for a damaged subsea cable is 3-6 Mio EUR for an infield cable repair and 6-10 Mio EUR for an export cable repair.
- In terms of BI, exposure can equate to several months of revenue for the whole development, for example in the event of the export cable not being accessible for repair during the winter due to bad weather.
- Maximum BI cover ranges from 12 to 18 months loss of revenue resulting from one event.

9.3.5 Representatives of the Government

Regarding legislation the Representatives of the **Dutch Government** stated:

- For Export cable clear legislation on burial depth.
- For Infield cable no clear legislation on burial depth. (Note **Wind Farm Developer/Operator** refer to industry guidance and best practise).
- If the regime will change to allow trespassing or sea-bed fishery within a WFZ, infield cables shall have to be buried at least 1m and shall have to be surveyed regularly.
- The monopile distance shall be larger than 4 x the diameter of the blade.

10 Requirements and consequences for allowing fishing activities in future wind farms

10.1 Introduction

Consultant has taken note of the views/observations of all participants in the Workshop. Based on its own experience related to Offshore Assets and Power cables, **Consultant** will further inform on the subject matter in this section and provide the requirements for considering allowing fishing activities in future OWFs.

In the event fishing activities are to be allowed, there must be a mechanism which supports both the **Wind Farm Developer/Operator** and the fishing vessel.

10.2 The main risks associated with allowing fishing in wind farms

10.2.1 Nautical risks

There are nautical aspects to fishing within an offshore wind farm, providing a fishing vessel is allowed to enter, the manoeuvring of a fishing vessel with sea-bed fishing gear, in a congested offshore wind farm, is a risk.

Therefore, the vessel has to take into consideration the presence of all the monopiles of the wind turbines, which has to cleared by at least 50 m, this also applies to the subsea sea-bed fishing gear. Neither shall the fishing gear penetrate the seabed and damage any cables.

The biggest risks for a vessel and the **Wind Farm Developer/Operator** are:

- Vessel “Blackout”.
- Adverse weather conditions.
- Drifting vessel, due to wind, current.

10.2.2 Risks to wind farm cables and wind farm assets

The cables are buried in order to provide the necessary protection against external threats. This protective cover requires maintenance over the lifetime of the development and seabed changes (morphology) can have a negative impact on this maintenance.

The real “vulnerability” is the CPS at the end of each cable, which is the part not buried, and remains exposed on top of the scour protection. In the worst-case scenario, it is even “hanging”. There is no physical mechanism or equipment which will provide any protection against sea-bed fishing gear. Therefore, a hit by sea-bed fishing gear on the CPS will result in a damage.

Although the **Fishery** claim they can carry out “precision fishing”, there is no guarantee all fishing vessels behave consistently in accordance with the wind farm requirements.

To reduce the risks to the exposed CPS section, it is proposed to increase the safety zone around the monopiles, reference is made to **section 10.4.1**.

10.3 Fishery and Wind Farm Developer/Operator working together

Within an Offshore Oil & Gas Installation (e.g. a production platform), when a vessel enters the 500m zone, advance permission has to be requested from Offshore Installation Manager. However, permission is not always automatically provided or access is restricted i.e. certain areas or times due to other activities, e.g. maintenance. This system could be adopted by fishing vessels entering into an offshore wind farm.

The ultimate aim for **Fishery** and **Wind Farm Developer/Operator** is to:

- Communicate adequately.
- Mitigate risks and to ultimately avoid damages.

This communication system has following advantages:

- The **Wind Farm Developer/Operator** are always aware "who" is present with the development and can monitor the location of the vessel with radar and AIS.
- The fishing vessel should be equipped with a system which provides the actual location of its sea-bed fishing gear. This is of utmost importance to clear any subsea structures, such as the CPS. It can also provide evidence of activities which may arise in damage.

However, this system and navigational aids, will have substantial financial impacts on both parties and makes fishing activities in offshore wind farms less financially attractive.

10.4 Consequences

10.4.1 Consequences for the fishing vessel

The **Fishery** state they can accurately manoeuvre in the wind farm and carry out "precision fishing". However, this requires quantifying. As oppose to investigating such statements (which may not be proven or able to be proven) it is recommended to upgrade the nautical instruments of the fishing vessels, as well as train the crew of the fishing vessel before entering into an offshore wind farm. Note this training is standard for all professions prior to entering into an offshore wind farm. Training within the Oil & Gas industry is also common practice for those working within the 500 m zone of an installation.

The sea-bed fishing gear is roughly 4 times the water depth behind the vessel. A side view of a fishing vessel in beam trawling mode is presented in **Figure 10-1.**

This will bring the sea-bed fishing gear closer than 50 m to the monopile, with the risk of hitting and damaging the CPS.

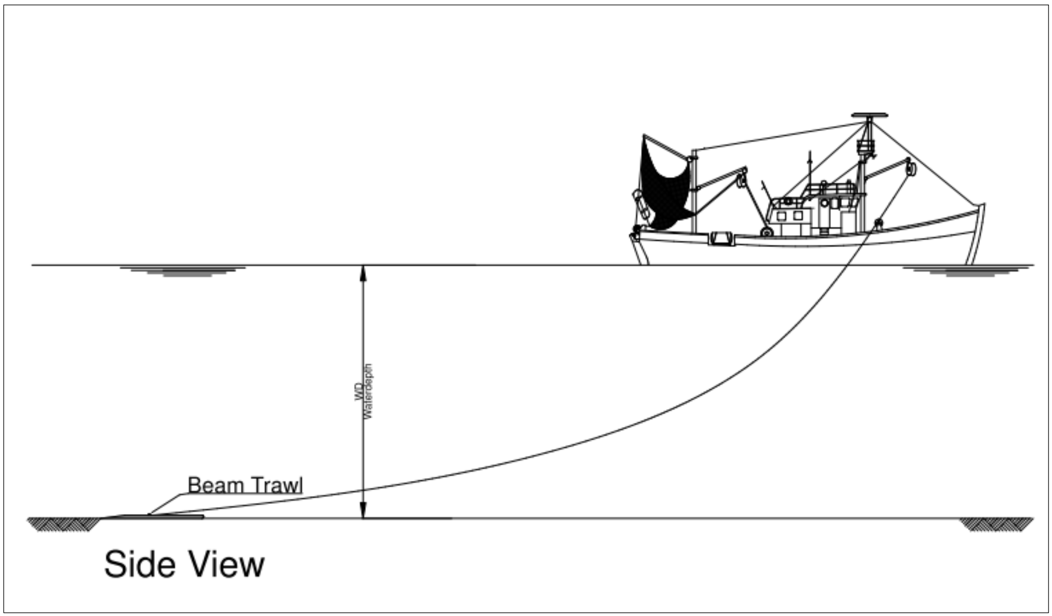


Figure 10-1 Fishing vessel with deployed beam trawl

When manoeuvring (turning) around a monopile, the sea-bed fishing gear trailing behind the fishing vessel will follow a different path than the vessel, towards the inside of the turn. This has been presented in **Figure 10-2**, where the vessel steers the outer trajectory and the sea-bed fishing gear follows the inner trajectory. Although the sketch is not to scale it gives a good impression of the situation.

During such a turn, even is the vessel clears the monopile at a “safe” distance of 50 m, the sea-bed fishing gear will come very close to (within 50 m of the monopile) or even in touch the exposed and/or hanging CPS near this monopile. This may result to damage of the CPS with the cable inside.

Even if the CPS is protected by rock, there is still the transition between rock and seabed, where scour may occur and where the CPS is vulnerable.

To mitigate this risk, the safety zones around the wind turbines may be increased. An assessment of the extent of the increased safety zone shall have to account for the local water depth, expected maximum lay-back of the sea-bed fishing gear, design of the fishing gear and method the gear is towed by the vessel.

An indication for approximate safety zones is given below.

The following assumptions have been made:

- The water depth is 30 m / 40m (two approximations are made, e.g. OWF Borssele has water depths up to 38m).
- The WTG is 12 MW, the associated monopile diameter = 10 m (rough estimate).
- The anti-scour protection extends 4 - 5 times the monopile diameter from the monopile, i.e. 50 m (conservative value).
- The full cable protective burial depth is achieved 10 m beyond the anti-scour protection.
- This result is that the area with limited cable protection extends ½ * 10 + 50 + 10 = 65 m around the centre of the monopile.
- The vessel is taken as a “standard” trawler. The sea-bed fishing gear is towed approximately 4 * 30 m = 120 m / 4 * 40 m = 160 m behind the “pulling” point of the fishing vessel.
- The towing point is located 5 m from the vessel’s centreline.
- The vessel’s positioning inaccuracy is 10 m. This accounts for inaccuracies in the positioning system and the vessel course followed.
- The safety margin between the area with limited cable protection and the sea-bed fishing gear is 50 m. Note this is not a conservative value and should probably be raised.
- Please note, this approach does not take the restrictions due to the rotor blades into account, if any.

Requirements:

- If the fishing vessels sails in a concentric circle round the monopile (hypothetical), the distance from the reference point on the fishing vessel (mast) shall never be less than the safety distance from the centre of the monopile. This is theoretical, since the vessel will “measure” the distance to the monopile, not the centre of the monopile (RADAR).
- If the vessel follows above course, the inner sea-bed fishing gear shall remain at a distance from the area with limited cable protection no less than the safety margin defined earlier.

Indicative approximations for the **safety distance** defining the safety zone around a WTG:

- For water depths up to 30 m the approximate safety distance should be 180 m.
- For water depths up to 40 m the approximate safety distance should be 215 m.

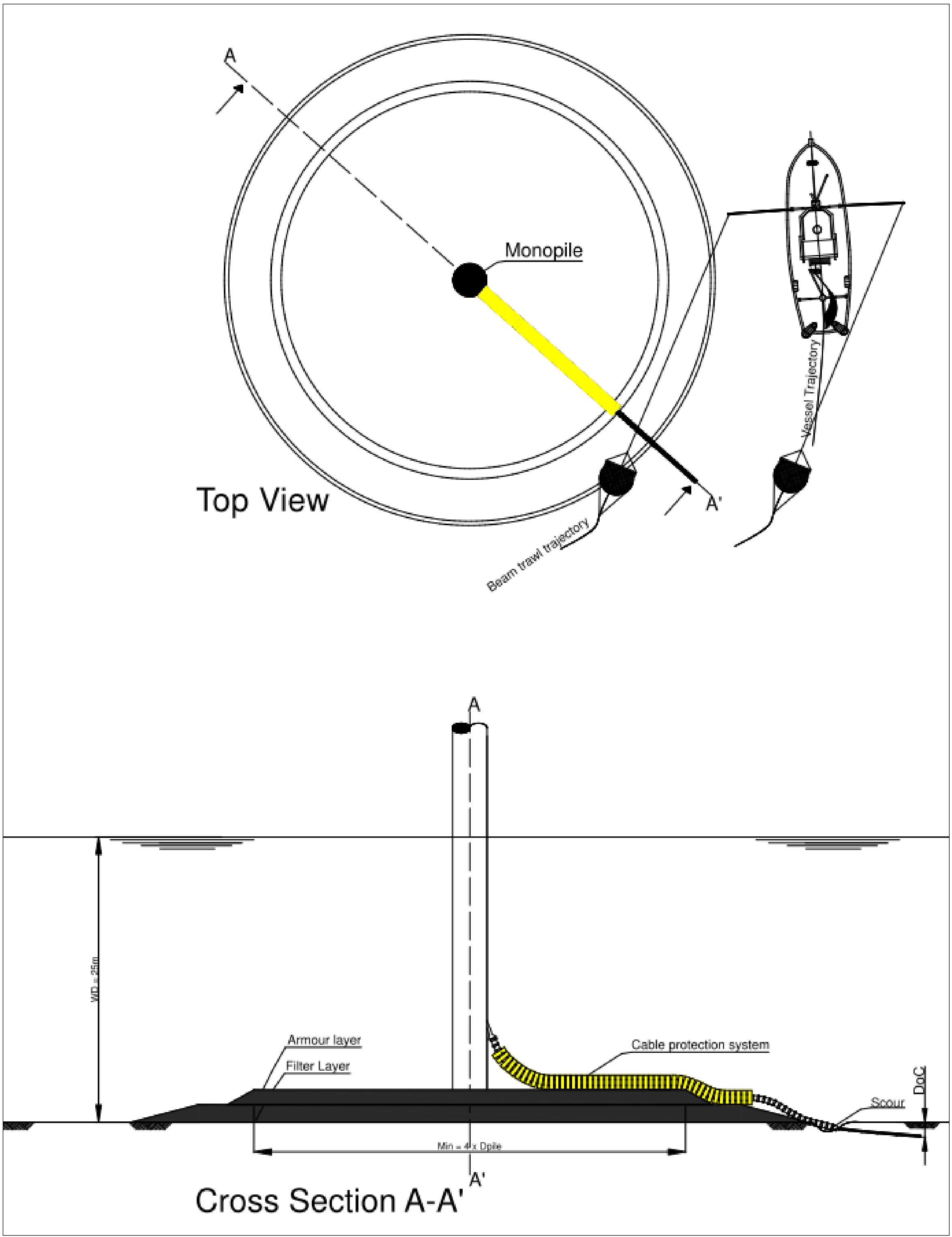


Figure 10-2 Fishing vessel pulling the beam trawl around the monopile

Therefore, the crew must know the location of the sea-bed fishing gear and it should be equipped with subsea location beacons providing the location of the sea-bed fishing gear relative to the vessel.

This requires at least:

- Acoustic beacons on the sea-bed fishing gear.
- Acoustic receiver on the vessel.
- Electronic system to provide the captain the relative location of the sea-bed fishing gear.
- Training of the crew with such a system.
- Optionally: change in vessel type to obtain a better manoeuvrability.

10.4.2 Consequences for the Wind Farm Developer/Operator

The wind farm design requires a different approach, where the configuration not only has to take the electricity production into account, but also the requirements (e.g. safe corridors) for fishing.

At least this has a consequence for:

- The centre to centre distance of the monopiles.
- The burial depth of all the cables.
- The length of all the cables, more cable length is required.
- Increase in cable installation cost i.e. more cable, deeper burial.
- Regular monitoring surveys to verify cable burial.
- Re-burial of cable(s) in case of insufficient cover.

In addition, the wind farm developer has to be able to:

- Communication and coordination with Coast Guard, accounting for other ongoing activities in the windfarm i.e. maintenance, inspection, crew vessels etc. Note supervising of the fishing vessels is a task currently performed by the Coast Guard.

This requires an expansion of the operations room, to not only monitor the performance of the offshore development, but also the monitoring of an increase of other vessels in addition to the maintenance vessels.

The current norm regarding cable burial in The Netherlands is:

- In essence (interconnector and export) cables at sea require a minimum burial depth of 1 metre, this is for safety and for a flora / fauna point of view. This 1 m is below the morphologic reference level. It appears there should be scientific research regarding the safety aspect and the impact on flora / fauna due to the heat provided by the cables. No requirements exist for infield cables. It is noted that in some other countries the authorities allow the depth of burial to be established based on risk based methods, i.e. CBRA (Cable Burial Risk Assessment) or RBBD (Risk Based Burial Depth).
- There seems no international norm for burial of cables, however, there are the ICPC recommended practices and the recommended practice from DNVGL-RP-0360.

10.4.3 Consequence for insurance

In the event of damage, the **Wind Farm Developer/Operator** can claim against the fishing vessel. Although, the P & I insurance of a fishing vessel is a function of its tonnage and liability is limited by maritime law.

In the event of a (cable) damage by the fishing vessel, which can easily be € 6 -8 mio the maximum amount possibly recoverable by **Insurance Companies** from the vessel's owner is a small % of the overall repair costs and loss of revenue.

This is likely to have repercussions on the insurance premium of the **Wind Farm Developer/Operator** and ultimately for the electricity tariff.

11 Financial consequences for allowing fishing activities in future wind farms

11.1 Introduction

For an order of magnitude financial consequences for adaptions of the wind farms and the fishing vessels a qualitative financial analysis has been carried out.

11.2 Qualitative Financial consequences for the Wind Farm Developer/Operator

For the wind farm the design requirements are:

- Increasing minimum centre to centre distance of the monopiles.
- Purchase and install additional length of cables.
- Increase cost of Rock Berm over crossings (if acceptable within design criteria).
- More frequent surveys to monitor erosion, anti scour protection, crossings and exposed CPS.
- Increase the burial depth of all cables.
- Maintain the burial depth of all cables during the lifetime.
- Absorb an increase in the CAPEX insurance premium, absorb an increase in the OPEX (base) premium.
- Increase regulatory costs for access i.e. HSE, Emergency Response.
- Rise in OPEX insurance premium due to claims during lifetime of the development.

11.3 Qualitative Financial consequences for the individual fishing vessel

For the fishing vessel the additional costs incurred are:

- Acoustic beacons on the sea-bed fishing gear.
- Acoustic receiver on the vessel.
- Electronic system to provide the captain the relative location of the sea-bed fishing gear.
- Training of the crew with such a system.
- Maintenance of these systems, including certification.
- Increase in P & I premium.
- Training for access into offshore wind farms.

11.4 Cost

The basis of all assumptions is outlined in **section 13**.

Estimation of the additional costs to accommodate fishing activities (new lay-out) are made for three different Wind Farm Zones (WFZs), assuming up to 10 WTGs in a single string:

- Hollandse Kust (west) Wind Farm Zone 126 WTGs, 2 OHVSs.
- Ten noorden van de Waddeneilanden Wind Farm Zone 63 WTGs, 1 OHVS.
- IJmuiden Ver Wind Farm Zone 267 WTGs, 2 OHVSs.

It should be noted that these estimates are for the additional CAPEX and OPEX in respect of deeper burial only, it excludes additional costs for other OPEX, e.g. surveys, future maintenance of burial depth and additional power loss, and for decommissioning at end of lifetime. The basis for comparison is as follows:

- The present more typical average distances between the WTG's of 1000 meters (1 km).
- The potential increase in distances between WTG's to accommodate their increase in size of 12 and/or 15 MW of 1300 meters (1.3km)
- The requested increase in distances by **Fishery** (theoretical) between the WTG's of 1852 meters (1.852 km). It is noted this increase in distance will not be able to accommodate within the present boundaries of the OWF's and therefore the potential cost of extending i.e. additional surveys is excluded. It is also recognised the boundaries cannot automatically be increased when taking into account shipping lanes and third-party assets i.e. existing pipelines and cables (telecoms etc).

11.4.1.1 Hollandse Kust (west) Wind Farm Zone

The development consists of 126 WTGs (approx. 13 strings of 10 WTGs) and 2 OHVS. As presented below in **Table 11-1.**

Existing layout is on average 1km (1000 meters) spacing between structures.

- Therefore, total cable length (based on straight lines) = 126 WTG cables + 13 connecting cables x 1 km per cable = 139 km in total.
- Adjusting layout to accommodate the potential increase of (1300 meters) spacing between structures. Therefore, total cable length (based on straight lines) = 126 WTG + 13 connecting cables x 1 km per cable = 181 km in total
- Adjusting layout to accommodate fishing requires 1 nautical mile (1852 meters) spacing between structures. Therefore, total cable length (based on straight lines) = 126 WTG + 13 connecting cables x 1852 per cable = 257 km in total.
- The assumption used for Deeper Burial is slowing the speed of the trencher (jetter) from 350 meters to 265 meters an hour. It is noted there are other means available to the developer which may achieve deeper burial (without incurring additional cost) i.e. contractual requirements between developer and contractor.

Main Activity	Lay-out 1km spacing (present) (a)	Lay-out 1.3km spacing Potential (b)	New Lay-out 1.852 km spacing Requested (c)	Delta (a)-(c)	Delta (b)-(c)
Description	€m	€m	€m	€m	€m
Offshore Lay	20	21	23	3	2
Offshore Burial (length)	12	14	18	6	4
Sub Additional CAPEX				**9**	**6**
Cost of Cable from Manufacturer		18	28	28	10
Sub Additional CAPEX				**28**	**10**
Total Additional CAPEX				**37**	**16**
Offshore Burial (deeper)		1	2	2	1
Total Additional OPEX				**2**	**1**

Table 11-1 Hollandse Kust West

11.4.1.2 Ten noorden van de Waddeneilanden Wind Farm Zone

The development consists of 63 WTGs (approx. 7 strings of 10 WTGs) and 1 OHVS. As presented **Table 11-2**.

- Existing layout is on average 1km (1000 meters) spacing between structures. Therefore, total cable length (based on straight lines) = 63 WTG cables + 7 connecting cables x 1 km per cable = 70 km in total.
- Adjusting to potential new lay-out of 1.3km (1300 meters) spacing between the structures. Therefore, total cable length (based on straight lines) = 63 WTG cables + 7 connecting cables x 1 km per cable = 91 km in total.
- Adjusting layout to accommodate fishing requires 1 nautical mile (1852 meters) spacing between structures. Therefore, total cable length (based on straight lines) = 63 WTG + 7 connecting cables x 1852 per cable = 129 km in total.
- The assumption used for Deeper Burial is slowing the speed of the trencher (jetter) from 350 meters to 265 meters an hour. It is noted there are other means available to the developer which may achieve deeper burial (without incurring additional cost) i.e. contractual requirements between developer and contractor.

Main Activity	**Lay-out 1km spacing (present) (a)**	**Lay-out 1.3km spacing Potential (b)**	**New Lay-out 1.852 km spacing Requested (c)**	**Delta (a)-(c)**	**Delta (b)-(c)**
Description	€m	€m	€m	€m	€m
Offshore Lay	11	12	13	2	1
Offshore Burial (length)	7	8	10	3	2
Sub Additional CAPEX				**5**	**3**
Cost of Cable from Manufacturer		9	14	14	5
Sub Additional CAPEX				**14**	**5**
Total Additional CAPEX				**19**	**8**
Offshore Burial (deeper)		0.5	1	0.5	1
Total Additional OPEX				**0.5**	**1**

Table 11-2 Ten Noorden

11.4.1.3 IJmuiden Ver Wind Farm Zone

The development consists of 267 WTGs (approx. 27 strings of 10 WTGs) and 2 OHVS. As presented below in **Table 11-3.**

- Existing layout is on average 1km (1000 meters) spacing between structures. Therefore, total cable length (based on straight lines) = 267 WTG cables + 27 connecting cables x 1 km per cable = 294 km in total.
- Adjusting to potential new lay-out of 1.3km (1300 meters) spacing between the structures. Therefore, total cable length (based on straight lines) = 267 WTG cables + 27 connecting cables x 1 km per cable = 382 km in total.
- Adjusting layout to accommodate fishing requires 1 nautical mile (1852 meters) spacing between structures. Therefore, total cable length (based on straight lines) = 267 WTG cables + 27 connecting cables x 1 km per cable = 545 km in total.
- The assumption used for Deeper Burial is slowing the speed of the trencher (jetter) from 350 meters to 265 meters an hour. It is noted there are other means available to the developer which may achieve deeper burial (without incurring additional cost) i.e. contractual requirements between developer and contractor.

Main Activity	**Lay-out 1km spacing (present) (a)**	**Lay-out 1.3km spacing (potential) (b)**	**New Lay-out 1.852 km spacing Requested (c)**	**Delta (a)-(c)**	**Delta (b)-(c)**
Description	€m	€m	€m	€m	€m
Offshore Lay	39	41	47	8	6
Offshore Burial (length)	24	29	33	11	4
Sub Additional CAPEX				**18**	**10**
Cost of Cable from Manufacturer		38	58	58	20
Sub Additional CAPEX				**58**	**20**
Total Additional CAPEX				**77**	**37**
Offshore Burial (deeper)		2	3	3	1
Total Additional OPEX				**3**	**1**

Table 11-3 Ijmuiden Ver Wind Farm

11.4.2 Table Estimation of cable failure and structure damage (due to fishing)

i. Repair to an export cable circa €7.8.m (range €6m to €10m).
- *The period from an out of operation event occurring, to being back into operation (service) is on average between 90 to 120 days.*

ii. Replacement of an infield cable circa €4.8 (range €3m to €6m).
- *The period from an out of operation event occurring, to being back into operation (service) is on average between 40 to 60 days.*

iii. Repair to a structure being a WTG (due to a collision) circa €1m.
- *The basis is the same duration as an in-field cable replacement*

iv. Replacement of structure WTG (due to collision).
- *Based on this event being unrealistic (no cost has been estimated). The structures are likely to cause more damage to the fishing vessel. The impact is would require structure repair (e.g. secondary steel structures), loss of generating power. The repair scenario is considered to be a more likely outcome than the alternative being the removal and replacement of a WTG structure (including the respective connected cables, CPS and anti-scour protection), followed by a complete reinstallation campaign of structure and cables.*

11.5 Loss of Income

11.5.1 Loss of Income due to Export Cable Failure

i. The basis is complete loss of grid connectivity.

ii. The following is based on theoretical worse case scenarios i.e does not take into consideration the differing yields and production capacity per WTG.

iii. Loss of electricity generation is based on the duration of 100 days (noting the period from an out of operation event occurring, to being back into operation (service) is on average between 90 to 120 days.

iv. The summary loss of income is €45m / €90m, based on an assuming:
- *Loss of one export cable / loss of both export cables. The latter is a less likely event.*
- *Strike price of €54 MWh.*
- *Development size 700 MW.*
- *Operating at full capacity (24 hours per day).*

v. Excludes consequential losses i.e. penalties, buying grid capacity from another source, increase in insurance premiums etc and claims for insurance market.

11.5.2 Loss of Income due to infield Cable Failure

*i. The basis is loss of partial capacity based on three scenarios (**see Figure 11-1**). It is noted this figure is for illustration of the fault locations, future infield cables shall be 66kV.*

ii. The following is based on theoretical worse case scenarios i.e does not take into consideration the differing yields and production capacity per WTG.
- *Scenario 1, infield cable between final WTG and OHVS i.e. complete string of 10 WTGs not generating i.e. capacity reduced.*
- *Scenario 2, infield cable in the middle of a sting i.e. 5 WTGs not generating.*
- *Scenario 3 infield cable at the end of a string i.e. 1 WTG not generating.*

iii. The duration is 50 days (The period from an out of operation event occurring, to being back into operation (service) is on average between 40 to 60 days).

iv. The high-level loss of income is €7m, €3.5m and €0.7m, based on an assuming:
- *Strike price of €54 MWh.*
- *Development size 700 MW.*
- *Full capacity required (24 hours per day).*

v. Excludes consequential losses i.e. penalties, buying grid capacity from another source, increase in insurance premiums etc and claims for insurance market.

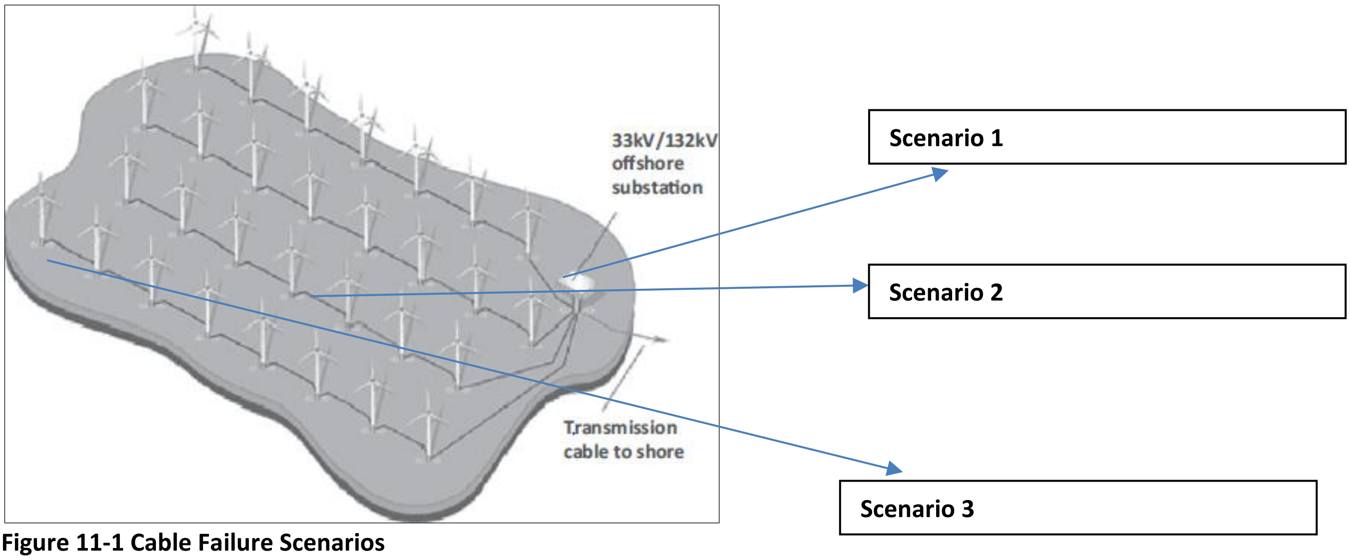


Figure 11-1 Cable Failure Scenarios

11.6 Probability of Incident

11.6.1 Probability of an incident (infield cable damaged by sea-bed fishing gear, specified for the specific type of fishing gear)

As outlined within **section 7.7** of this document, cables outside wind farms are protected against external threats. The main external threats being; fishing, dropped objects, anchoring by transit vessels, anchoring by project equipment, grounding/stranding vessels and dredging.

In summary the depth of protection (burial) is determined by following a detailed quantified approach, namely reviewing marine traffic crossing/in the vicinity of the cable, by analysing actual AIS data over a duration i.e. two years against a predetermined probabilistic risk of these external threats damaging the cable (note a certain width either side of the cable route is also taken into consideration).

This approach follows industry guidelines such as "Carbon Trust Cable Burial Risk Assessment Methodology, Guidance for the Preparation of Cable Burial Depth of Lowering Specification CTC835, February 2015", combined with "Recommended practice by DET NORSKE VERITAS (DNV), titled "DNV-RP-F107 Risk Assessment of Pipeline Protection, October 2010". (this guidance provides the recommended probability factors and for fishing all activities use the same probabilistic risk factor).

The main external threat is fishing, as activities including crossing the cables (more frequently), whereas other vessels tend to remain in official shipping lanes. The cable route always ensures as much as possible it is outside shipping lanes and where cables cross shipping lanes, normally in areas such as the entrance to ports and harbours, the cable is well protected against this risk by deeper burial.

Also, in terms of trends, as fishing activities have not occurred within offshore wind farms, there is no statistical references for cable faults.

Therefore, the probability of incident is determined on route by route basis due to the requirement of determining the actual marine traffic.

While above assessments try to establish the minimum requirement for the depth of burial to protect the cable(s), the penetration of sea-bed fishing gear into the seabed is generally limited to a few decimetres. Therefore, a prescribed burial of the infield cables of at least 1 m would reduce the probability of damage by sea-bed fishing gear to a very low level. However, following should be well noted:

- Protection only exists if sufficient cover on the cables is provided and maintained over lifetime. Seabed erosion may reduce this cover and increase the probability of damage;
- Cover by very soft soils (soft muds or clays) provides little protection, this shall have to be evaluated on a case by case basis;
- In case a cable becomes insufficiently covered or even exposed, the probability of a strike by sea-bed fishing gear is very high, as the gear is in constant contact with the seabed.
- Protection of exposed cable sections, such as the CPS, shall require additional mitigations and safeguards.

Information obtained from one of the **Insurance companies** active in the offshore cable and wind industry learned that to date hardly any damages have been received from offshore wind farms, which is due to the prohibition to perform fishing activities in the wind farms. And, in addition, due to the unwillingness of the fishermen to cross an offshore wind farm.

The insurance company also has forwarded information from Kingfisher (UK). This information has been presented in the **section 14**.

11.6.2 Probability of an incident Collision between a structure and a vessel

Similar to cable protection (burial), the probability of collision incident is determined by following a detailed quantified approach, namely reviewing marine traffic in the vicinity of the structure, by analysing actual AIS data over a duration i.e. two years against a predetermined probabilistic risk of these external threats damaging the cable.

This approach follows industry guidelines such as “Recommended practice by DET NORSKE VERITAS (DNV), titled “DNV-RP-F107 Risk Assessment of Pipeline Protection, October 2010”. (this guidance provides the recommended probability factors).

Therefore, the probability of incident is determined on route by route basis due to the requirement of determining the actual marine traffic.

12 Conclusions and Recommendations

From the workshop it appears the **Fishery** and the **Wind Farm Developer/Operator** are open to further discuss any "precision" fishing in the future offshore wind farms, but there are many reservations/concerns from both Parties as well as other stakeholder, including additional financial impacts.

The fishing vessel is a lower costs asset, which can inflict a major (unintended) damage to higher cost assets.

The CPS is the main "vulnerable" aspect of the electricity transportation system, i.e. the subsea cables. Damage to this electricity transportation system is relatively expensive and the loss of revenue is significant.

The costs of repair and the loss of revenue is covered by an **Insurance Company**, but the recourse on the Protection and Indemnity of the Fishing Vessel, does not compare to the size of the claim from the **Wind Farm Developer/Operator**. Ultimately the **Insurance Company** will increase the premium on the policy costs, which will have a significant impact on the OPEX of offshore wind farm developments. Similarly, the P&I premium costs of the fishing vessel will increase.

In the event an offshore wind farm is made (technically) suitable for sea-bed fishery a substantial increase in CAPEX and OPEX will be incurred.

It is recommended to consider the following for future study work:

- Additional costs to increase enforcement in wind farms, when allowing fishing activity.
- Additional insurance costs for fishing vessel to obtain P & I insurance.
- Additional insurance costs for the offshore wind farm.
- Additional costs for wind farm developers to make the offshore wind farm fishing friendly.
- Additional study how to optimise the fishing methodology and equipment for effective and safe (both for fishing vessel and infield cables) fishing within an offshore wind farm.
- Generic RBBD for sea-bed fishery within an offshore wind farm.
- Assessment of appropriate safety zone around the wind turbine generators.

The end conclusion of this report is that sea-bed fishery in future OWF shall affect all stakeholders and increase the cost of energy produced by affected offshore wind farms. It is recommended to compare the (cost) impacts with the benefits for the **Fishery**, which is the subject of another study. Alternative locations for (additional) fishing grounds outside offshore wind farms could be considered as well.

The main reasoning is:

- **Wind Farm Developer/Operator** are partly responsible for the safety within an OWF. In the event a fishing vessel being involved in an accident or requiring emergency assistance, the party deemed liable may be the **Wind Farm Developer/Operator**. The current regime is that the **Wind Farm Developer/Operator** are only responsible for the areas within the 50 m safety zone around their assets. In the remaining areas of a WFZ the state (RWS) is responsible. **Fishery** can be liable as well. Which party is ultimately liable, shall depend on the precise circumstances surrounding of the incident.

- The layout of an OWF suitable for sea-bed fishery is not compatible with the business case of the **Wind Farm Developer/Operator**, potentially impacting the financial decision of commencing the development of the offshore wind farm itself. In order to make a wind farm sea-bed fishery friendly, **Wind Farm Developer/Operator** will have to reconfigure the lay out of the wind farm (monopiles), increase the depth of burial of the infield cables and maintain this protective burial over the lifetime of the offshore wind farm. In order to perform "precision" fishing the fishing vessels have to be modified. Please refer to **section** 11 for the breakdown of the estimated costs.

- The 1.85km wide fishing corridors requested by **Fishery** are not realistically feasible. With the wind turbines at such spacing, the wind turbines would not fit within the wind farm zone boundaries.

- **Wind Farm Developer/Operator** is potentially facing significant damages in terms of cable failure caused by sea-bed fishery. These damages pertain to the cable repair as well as the loss of revenue.

Wind Farm Developer/Operator will make an insurance claim to recover this loss. **Fishery** will make an insurance claim to cover liabilities, which will only settle a small proportion of the loss (as per the maximum of the insurance policy held by the fishing vessel). The remaining (larger) part will be settled by the insurer of the offshore wind farm. Furthermore, the deductibles for each party shall not be recovered.

- The primary benefit would be the availability of parts of the offshore wind farms for sea-bed fishery, i.e. availability of (additional) fishing grounds. Alternative locations for (additional) fishing grounds outside offshore wind farms could be considered.
- There is an increase cost for both parties, i.e. investment in fishing vessels, non-optimal wind farm lay-out, deeper burial of the infield cables in the windfarm, ensuring sufficient protective cover on the infield cables over the lifetime.
- The risk profile is not balanced in favour of (no benefits, only disadvantages) stakeholders such as **Wind Farm Developer/Operator**, **Insurance Companies.**

13 Appendix

13.1 Assumptions for additional costs to accommodate fishing activities (new lay-out)

13.1.1 CAPEX Installation, Burial and Cable re Hollandse Kust (west), Ten noorden and Ijmuiden Ver & Opex (Deeper Burial)

Basis:

- Basis for offshore is typical two vessel campaign (both 24-hour operations):
  - (1) cable installation vessel completing first end pull in, installation and temporary hang off of second end.
  - (2) trenching support vessel completing pre-survey, post trenching, second end pull in and post survey.
- For installation the additional time offshore is based principally on the extra length of cable.
- Burial is assumed to be completed by means of a jet-trenching, no issues with seabed conditions or soils has been taken into account.
- In terms of trenching typical (average speeds) of < 100 meters an hour (cutter) > 600 meters and hour for plough. In between it is assumed the soils are jettable (a range of speeds could be used) however based on experience, track record, information extracted from projects a speed of 350 meters an hour (has been assumed).
- The assumption used for Deeper Burial is slowing the speed of the trencher (jetter) from 350 meters to 265 meters an hour. It is noted there are other means available to the developer which may achieve deeper burial (without incurring additional cost) i.e. contractual requirements between developer and contractor.
- In terms of installation a lay speed of 500 meters an hour has been assumed.
- The market is able to accommodate the extra length cable i.e. no capacity issues have been foreseen. Cost of cable is at present prevailing rates i.e. no inflation for copper etc.
- The contractors are assumed to have been selected via an open market competitive tender process i.e. cost includes reasonable mobilisation, demobilisation and project management fees.
- No allowances for fluctuations in inflation, exchange rates, materials etc.

Excluded Costs:

- Additional cost for Cable Protection Systems.
- Additional cost for rock re anti-scour and crossings.
- The costs related to fuel and lubes, port calls, agency costs, crew transfer vessels and in-field transits.
- The costs related to additional schedule risk between foundation and cable installation campaigns.
- The additional cost in respect of increasing the boundary areas to accommodate 1.852m distances i.e. geotechnical and geophysical survey campaigns. Noting there are potential restrictions on increasing boundary areas i.e. shipping lanes etc.

Included Costs:

- Full vessel cost of i.e. vessel, marine crew, construction crew, cable lay, trenching and surveys equipment. Cost are within the range of existing market rates (competitive tender process).
- Time for the following activities (assumed the same for both layouts):
  - Mobilisation.
  - 1 x Initial Transit to Field.
  - 1 x Initial Approval to Enter i.e. set-up trenching assets, vessel trials etc.
  - Set number of port calls.
  - Standby and Weather allowances.
  - 1 x End Transit to Port (upon final completion).
  - Demobilisation.
- Time for the following Installation activities (the difference is based on additional length of cable):
  - Setup vessel at WTG.

- Messenger transfer.
- 1st End Cable Pull in.
- Fit temporary hang off clamp.
- Lay operations.
- Cut, seal and installation of 2nd end CPS on cable.
- 2nd end pull in.
- Fit clamp, strip and test cable.
- Survey.

- Time for the following burial activities (the difference is based on additional length of cable and deeper burial):
  - Setup and installation of CPS.
  - Launch trencher over CPS.
  - Trench from 1st to 2nd End.
  - Recover trencher.
  - Post Trench Survey.

13.2 Assumptions for estimation of cable failure and structure damage

13.2.1 Estimation cost of cable repair (export)

Basis:

- The cable (export) is repaired by means of an offshore jointing campaign i.e. removing a proportion of cable (damaged area plus contingency), replacing damaged part with new cable and connecting by means of offshore joints.
- The period from an out of operation event occurring, to being back into operation (service) is on average between 90 to 120 days.
- The market is able to accommodate the extra length cable i.e. no capacity issues have been foreseen. Cost of cable is at present prevailing rates i.e. no inflation for copper etc.
- The contractors are assumed to be available and selected via an open market competitive tender process i.e. cost includes reasonable mobilisation, demobilisation and project management fees.
- The contractors are assumed to have capabilities to complete the full repair i.e. fault finding, cutting and capping cable, deburial recovery of cable, jointing, lay down and burial.
- No allowances for fluctuations in inflation, exchange rates, materials etc.
- The duration is assumed to have factored in availability, schedule delays as well as initial requirements to commence repair (i.e. ensuring market availability, approvals, document reviews etc).
- The cable is assumed to be repaired, without encountering issues.
- The water depth is assumed for a one-vessel solution i.e. no requirement for shallow and/or near shore barge.
- Duration is calculated as a one vessel campaign, 24-hour operations, no requirement for port calls.

Excluded Costs:

- Cost for managing the repair i.e. project management, engineering, safety and quality.
- Cost for assisting the fault finding and back into operation requirements i.e. technicians and operators in converter stations.
- Loss of revenue and other such consequential losses.
- Additional cost of insurance (to TenneT TSO) or loss of policy cover (TenneT TSO). Due to an increase in risk.
- Cable Protection Systems.
- Rock re anti-scour and crossings.
- The costs related to fuel and lubes, port calls, agency costs, crew transfer vessels.

Included Costs:

- Full vessel cost of i.e. vessel, marine crew, construction crew, lay, trenching and surveys equipment. Cost are within the range of existing market rates (competitive tender process).
- Jointing include team and equipment (cost incorporates mobilisation and demobilisation fees).
- New spare cable including transport (cable assumed to be transported from a European Cable Manufacturer).
- Weather and Standby Allowances.
- Time for the following activities:
    - Mobilisation (principally based on jointing spread, assumed vessel is equipped with other equipment).
    - 1 x Initial Transit to Field.
    - 1 x Initial Approval to Enter i.e. set-up trenching assets, vessel trials etc.
    - Surveys and Fault Finding.
    - Cutting and Capping of Cable.
    - Deburial.
    - Recovery to deck (and cutting cable).
    - Jointing.
    - Lay down.
    - Reburial.
    - 1 x End Transit to Port (upon final completion).
    - Demobilisation includes offloading cable and demobilising of jointing spread.

13.2.2 Estimation cost of cable repair (infield)

Basis:

- The cable (infield) is repaired by means of replacement i.e. remove existing damaged cable including each CPS and replace with new cable.
- The period from an out of operation event occurring, to being back into operation (service) is on average between 40 to 60 days.
- The market is able to accommodate the extra length cable i.e. no capacity issues have been foreseen. Cost of cable is at present prevailing rates i.e. no inflation for copper etc.
- The contractors are assumed to be available and selected via an open market competitive tender process i.e. cost includes reasonable mobilisation, demobilisation and project management fees.
- The contractors are assumed to have capabilities to complete the full repair i.e. fault finding, cutting and capping cable, deburial recovery of cable, lay down and burial.
- No allowances for fluctuations in inflation, exchange rates, materials etc.
- The duration is assumed to have factored in availability, schedule delays as well as initial requirements to commence repair (i.e. ensuring market availability, approvals, document reviews etc).
- The cable is assumed to be repaired, without encountering issues.
- The water depth is assumed for a one-vessel solution i.e. no requirement for shallow and/or near shore barge.
- Duration is calculated as a one vessel campaign, 24-hour operations, no requirement for port calls.

Excluded Costs:

- Cost for managing the repair i.e. project management, engineering, safety and quality.
- Cost for assisting the fault finding and back into operation requirements.
- Loss of revenue and other such consequential losses.
- Additional cost of insurance (to Developer) or loss of policy cover (Developer). Due to an increase in risk.
- Additional cost of new regulation and safety regimes to allow entry.
- Additional cost related to updating operations and maintenance to allow entry i.e. marine coordination and monitoring systems.
- Cable Protection Systems.
- Rock re anti-scour and crossings.

- The costs related to fuel and lubes, port calls, agency costs, crew transfer vessels.

Included Costs:

- Full vessel cost of i.e. vessel, marine crew, construction crew, lay, trenching and surveys equipment. Cost are within the range of existing market rates (competitive tender process).
- Replacement new cable including transport (cable is assumed to be transported from a European Cable Manufacturer).
- Weather and Standby Allowances.
- Time for the following activities:
  - Mobilisation (principally based on jointing spread, assumed vessel is equipped with other equipment).
  - 1 x Initial Transit to Field.
  - 1 x Initial Approval to Enter i.e. set-up trenching assets, vessel trials etc.
  - Deburial.
  - Remove including first and second end CPS.
  - Recovery to deck (and cutting cable).
  - Setup vessel at WTG.
  - Messenger transfer.
  - 1st End Cable Pull in.
  - Fit temporary hang off clamp.
  - Lay operations.
  - Cut, seal and installation of 2nd end CPS on cable.
  - 2nd end pull in.
  - Fit clamp, strip and test cable.
  - Survey.
  - Setup Trencher and installation of CPS.
  - Launch trencher over CPS.
  - Trench from 1st to 2nd End.
  - Recover trencher.
  - Post Trench Survey.
  - 1 x End Transit to Port (upon final completion).
  - Demobilisation includes offloading cable.

13.2.3 Estimation cost of WTG structure repair

Basis:

- There is a collision between the WTG and vessel. The damage caused can be repaired.
- The period from an out of operation event occurring, to being back into operation (service) has been assumed as similar to the average duration of Infield cable damage i.e. between 40 and 60 days.
- The contractors are assumed to be available and selected via an open market competitive tender process i.e. cost includes reasonable mobilisation, demobilisation and project management fees.
- The contractors are assumed to have topside capabilities to complete inspection, repair ranging from fabricating, sanding, blasting, painting.
- The contractors are assumed to have subsea capabilities in terms of inspection i.e. CPS, anti-scour protection etc (i.e. ensure during impact, collision, no dropped objects occurred).
- No allowances for fluctuations in inflation, exchange rates, materials etc.
- The duration is assumed to have factored in availability, schedule delays as well as initial requirements to commence repair (i.e. ensuring market availability, approvals, document reviews etc)
- Duration is calculated as a one vessel campaign, 24-hour operations, no requirement for port calls.

Excluded Costs:

- Cost for managing the repair i.e. project management, engineering, safety and quality.

- Loss of revenue and other such consequential losses.
- Additional cost of insurance (to Developer) or loss of policy cover (Developer). Due to an increase in risk.
- Additional cost of new regulation and safety regimes to allow entry.
- Additional cost related to updating operations and maintenance to allow entry i.e. marine coordination and monitoring systems.
- Cable Protection Systems.
- Rock re anti-scour and crossings.
- The costs related to fuel and lubes, port calls, agency costs, crew transfer vessels.

Included Costs:

- Full vessel cost of i.e. vessel, marine crew, construction crew, repair equipment. Cost are within the range of existing market rates (competitive tender process).
- Weather and Standby Allowances.
- Time for the following activities:
    - Mobilisation (principally based on jointing spread, assumed vessel is equipped with other equipment).
    - 1 x Initial Transit to Field.
    - 1 x Initial Approval to Enter i.e. vessel trials etc.
    - Survey.
    - Remove Damage.
    - Repair Damage.
    - Survey.
    - 1 x End Transit to Port (upon final completion).
    - Demobilisation.

14 Appendix - UK

This information has been forwarded by the insurance company and can be found on: http://www.kis-orca.eu/safety/reducing-risks-whilst-fishing#.XPp9BlNcKdM

14.1 Reducing Risks Whilst Fishing

It is essential to be aware of the locations of subsea cables and renewable energy infrastructure, when fishing in the vicinity of such structures. It is essential you have all the information in relation to their positions available to you and the KIS-ORCA project is designed to provide exactly that for all seabed users. Charts, fishing plotter files and an interactive map, showing subsea cables and renewable energy structures surrounding the UK, may be viewed or downloaded, free of charge.

14.2 Current Regulation

The risks associated with fishing around offshore structures and submarine cables has been widely discussed. Nevertheless, the risks still remain, and it is important fishermen are aware of these and also have the best possible information to hand.

Regulations governing how close fishermen can sail to renewables structures (turbines and substations) was issued in 2007 and states that whilst under construction, during repair, or major maintenance, a 500m safety zone applies to turbines etc, but thereafter during normal operations, an operator may apply for a 50m safety zone. This was agreed after consultation with all stakeholders as the best solution and keep disruption to mariners to a minimum. More details can be found here: (**Safety Zone Explanatory Memo**).

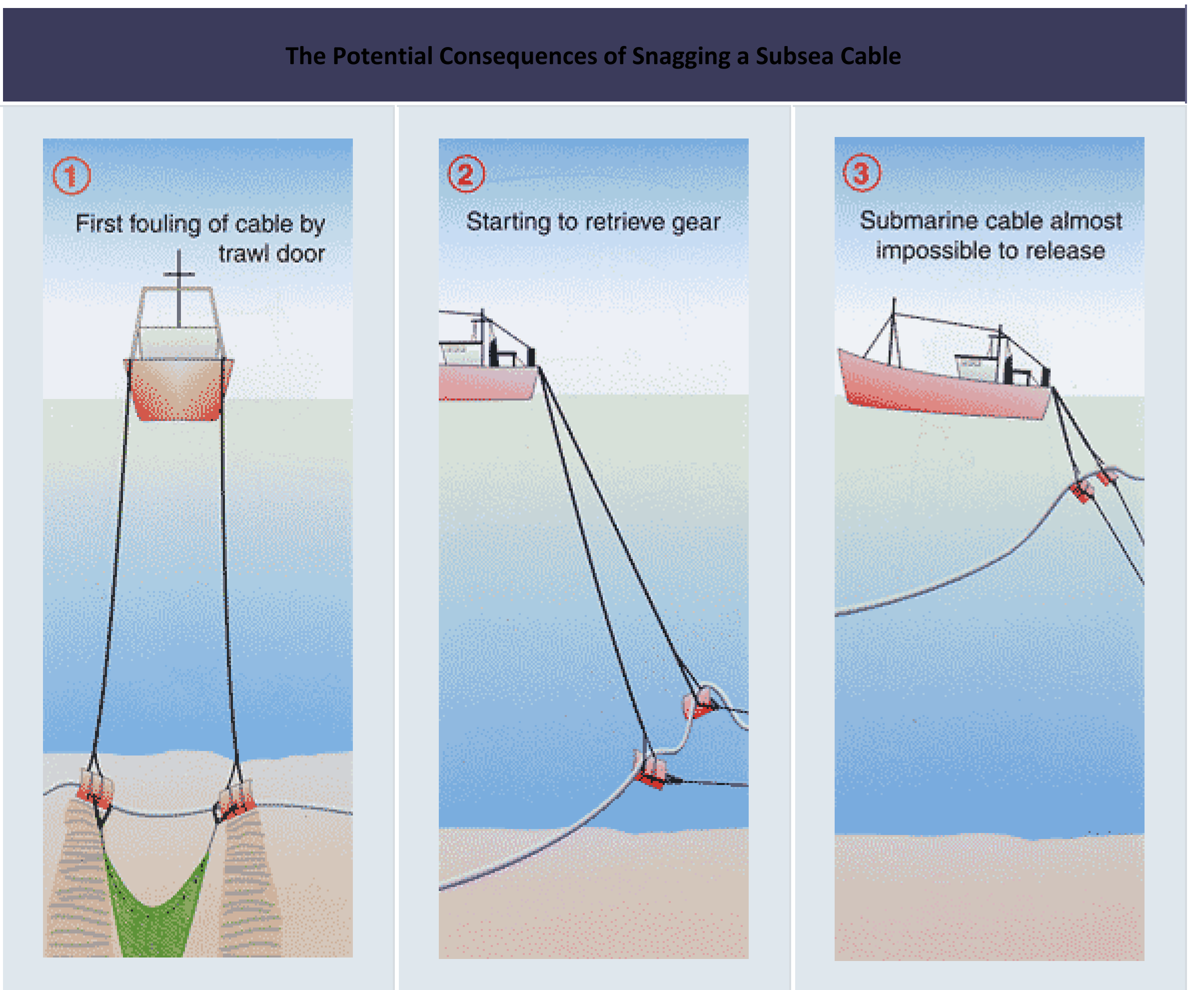
Fishing in areas where submarine cables exist are still governed by archaic laws, however, a modern and sensible approach must be applied to this area of operation. The greatest level of risk to vessels engaged in fishing operations, are to those which penetrate the seabed in any way such as trawling, dredging and anchors from nets or crab/lobster pots.

14.3 Snagging a Cable

The most serious risk affecting fishermen when fishing in areas where submarine cables exist, is to snag their gear on a cable. Submarine cables are initially buried on installation, although may become exposed due to current and seabed erosion. It is therefore best to avoid fishing in such areas, if at all possible. Operators of subsea cables are aware that fishing does take place in the vicinity of cables, however, it must be stressed how important it is to take extreme caution when doing so. A vessel and its crew could become in danger if a vessel attempts to lift a cable from the seabed.

If you do foul a cable, make sure you follow the **emergency procedures** to safeguard your vessel and your crew.

The following sequence of events shows what can happen if a vessel fouls a submarine cable.



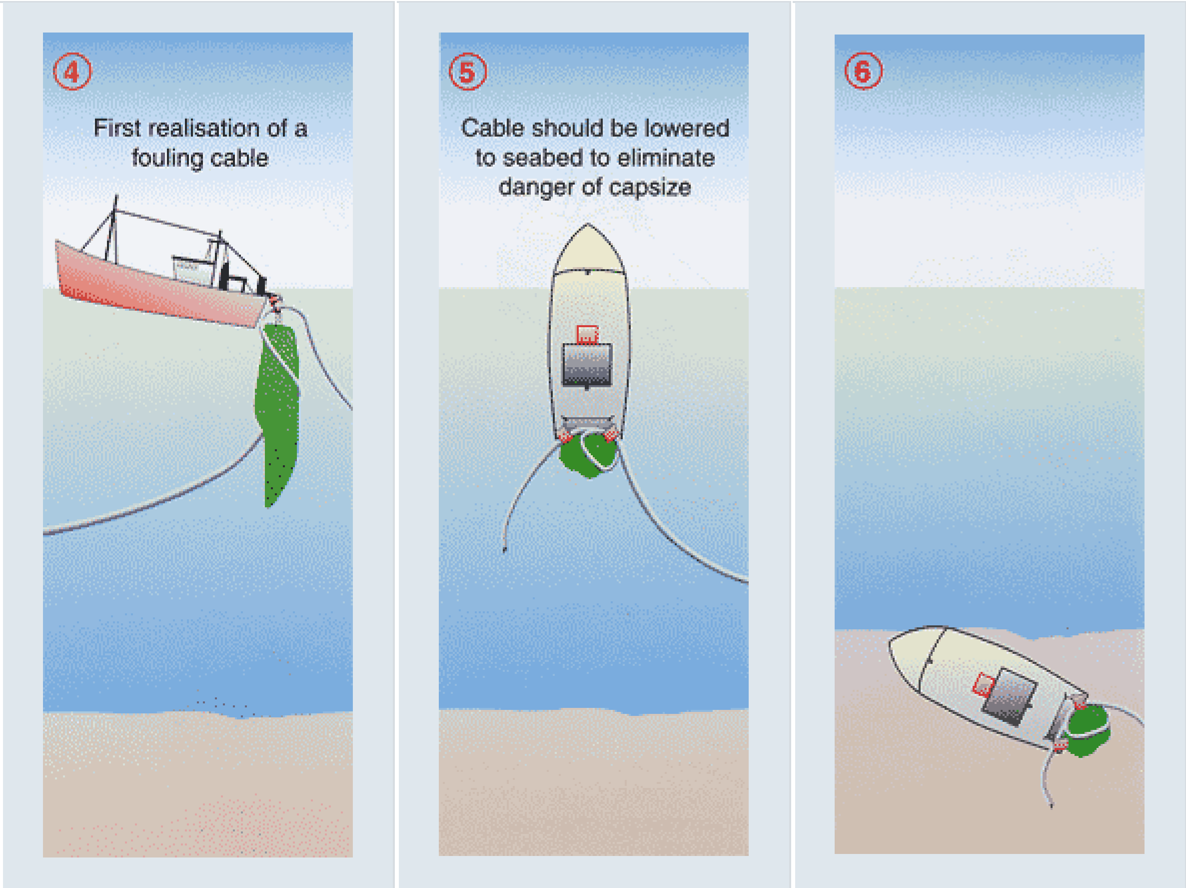


Figure 14-1

14.4 Fishing within a Windfarm Area

Current legislation does not prohibit fishing from taking place within offshore windfarm areas. As stated above, operators may apply for a 50m safety zone in place around turbines and offshore substations during normal operations. When remedial work, or maintenance is being carried out, this safety zone is extended to 500m.

Smaller fishing vessels may decide to work within the confines of wind farms, working crab/lobster pots, gill nets, etc. As described in other areas of this site, each turbine is linked to the next by a subsea cable and where the cable joins up with the turbine, there is potential for snagging on these sections. Therefore, if fishing using ground gear within wind farms, extreme caution should be taken at all times.

Due to the presence of so many submarine cables and surface structures in a windfarm area, other types of fishing such as trawling or dredging is unlikely to take place, especially from larger vessels. This is due to their restricted ability to manoeuvre, due to potential winds and currents and the penetrative nature of their gear, which would enhance the risks of snagging.