抄本

檔　　號：
保存年限：

內政部　函

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主旨：檢送本部113年6月21日海岸管理審議會第78次會議紀錄1份，請查照。

說明：依據本部113年6月7日台內園字第1131280254號開會通知單續辦。

正本：劉主任委員世芳、董副主任委員建宏、吳委員堂安、王委員筱雯(水利及海洋工程學系)、李委員佩珍(生命科學系)、李委員玲玲、李委員素馨(地理學系)、邱委員文彥、林委員宗儀、林委員愛龍、張委員容瑛(都市計劃研究所)、張委員桂鳳(不動產經營學系)、陳委員璋玲、簡委員伃貞(景觀及都市設計系)、簡委員連貴(河海工程學系)（以上依姓氏筆劃排列）、邊委員孝倫、黃委員琮逢、徐委員淑芷、吳委員俊良、盧委員清泉、賴委員郁晴、陳委員兼執行秘書茂春、陳委員貞蓉、徐委員燕興、國家發展委員會、環境部、農業部、農業部林業及自然保育署、農業部漁業署、經濟部水利署、經濟部能源署、文化部文化資產局(以上含討論事項1、2)、國家通訊傳播委員會、經濟部、經濟部國營事業管理司、經濟部水利署水利規劃分署、經濟部水利署第二河川分署、經濟部水利署第七河川分署、國防部、交通部航港局、財政部國有財產署、財政部國有財產署南區分署澎湖辦事處、海洋委員會海洋保育署、澎湖縣政府、澎湖縣政府文化局、澎湖縣政府建設處、澎湖縣政府農漁局、澎湖縣馬公市公所、澎湖縣望安鄉公所、苗栗縣政府、苗栗縣竹南鎮公所、苗栗縣後龍鎮公所、台灣中油股份有限公司、本部地政司、本部國土管理署、台灣電力股份有限公司、穩晉港灣工程股份有限公司

副本：本部國家公園署環境規劃組、遊憩管理組、保育解說組、綜合計劃組

本部海岸管理審議會第78次會議紀錄

壹、時間：113 年6月21日（星期五）上午9 時30分

貳、地點：本部國家公園署第1會議室

參、主席：劉主任委員世芳（董副主任委員建宏代）

紀錄：陳俊賢、吳雅品

肆、出列席人員：詳後附簽到簿

伍、確認第77次會議紀錄

決議：第77次會議紀錄確認。

陸、討論事項：

第1案：審議台灣電力股份有限公司申請「澎湖風櫃～桶盤～虎井及望安～將軍海纜敷設統包工程」案

決議：

一、本案經審議會審查，尚符合海岸管理法第 26 條之規定（詳附表 1)。請台灣電力股份有限公司(以下簡稱申請人)就審查會議簡報內容、回應說明之事項及本次會議承諾之事項，納入本案海岸利用管理說明書（以下簡稱說明書)。

二、有關問題一，以圖示說明本案申請範圍、面積(含海纜左右各 300公尺廊道維護管理範圍)，並說明採 300 公尺原因部分，申請人補充說明係因考量船隻在施工及維運期間作業空間，另亦考量迴船空間需求及人員作業安全性，故本案申請範圍應包括廊道維護管理範圍，面積約438.6公頃，同意確認，並請納入說明書。

三、有關問題二，依「一級海岸保護區以外特定區位申請許可案件審查規則」(以下簡稱審查規則)第 2 條第 1 款「海岸保護原則」許可條件部分，以圖示就本次適用許可範圍說明是否位「二級海岸保護區」及「整體海岸管理計畫建議應優先劃設之潛在保護區」部分：

(一)申請人補充說明本案非位於「二級海岸保護區」，同意確認，並請納入說明書；另申請人補充說明本案桶盤段及望安段涉及優先劃設潛在保護區之地質公園，惟上岸點位置已避開鄰近之桶盤嶼地質公園及望安島地質公園(天台山)，且因海纜敷設工程範圍小，並未涉及任何開挖或擾動地質敏感區等施工行為，故應無影響之虞部分，同意確認，並請納入說明書。

(二)另請於說明書圖 7.1-1(本計畫海纜舖設路線套繪海岸地區管理資訊網初步成果圖)(或另製作其他圖)，補充本案涉及望安島綠蠵龜產卵棲地保護區、海龜路徑、珊瑚礁、水下文化資產、漁民漁業作業之範圍，同時套繪 3 公里範圍內之環境敏感地區；並儘可能避開上述相關範圍，並列為應辦承諾事項。

四、有關問題三，審查規則第 2 條第 2 款「海岸防護原則」許可條件「開發利用行為未造成海岸災害」及「不影響既有防護措施及設施功能」、第 2 條第 3 款「海岸永續利用原則」許可條件之「訂定長期監測計畫，並規劃及擬訂有效之管理方式」部分：

(一)申請人以圖示補充本案與附近既有海岸防護措施及設施之空間關係及距離部分，同意確認，並請納入說明書。

(二)說明穿越海堤處之施工工法、施工時間，並說明是否有相關影響及因應措施，另說明簽證技師就開發利用行為對於海岸防護安全之影響狀況之簽證內容部分，申請人補充說明預計取得許可後至114年7月期間完成各項施工作業、於近岸段實際施工期短，另補充說明技師簽證內容略以「本案既有海岸防護設施之量體規模較小，依設計規劃乃基於採用水平導向鑽掘工法(HDD)施工，預定自海堤下方至少約3至5公尺深穿越，兩側進出穿越點距離依現況調整距離防護設施約5~10公尺，海堤安全性已獲保障」，同意確認，並請納入說明書。

(三)說明本案管線通過範圍之地質、地形及地貌，並說明施工相關影響及因應措施部分，申請人補充說明本案於風櫃至桶盤間、桶盤至虎井間之水深皆為60公尺內、涉及地質皆以硬質底質或是礁岩碎屑與砂混合組成為主；於望安至將軍間水深為 20 公尺內，且地質皆以硬質底質或是礁岩碎屑與砂混合組成為主，同意確認，並請納入說明書。

(四)說明本案開發利用行為是否可能影響海岸地形變遷，及是否有相關監測計畫部分，申請人補充說明本案施作完工後立即恢復原灘面，對海岸地質、地形及地貌環境影響時間短暫且輕微，同意確認，並請納入說明書；另監測頻率部分，修正為「施工前1次、完工後1年內1次、運轉期間每3年1次，如監測結果與前1次有明顯變化、緊急事件、重大氣候事件與颱風，則額外增加監測頻率」，並列為應辦承諾事項。

（五）另請申請人補充說明本案是否有相關監控機制，可即時確認海纜運作、損壞情形，並補充損壞情形之緊急應變計畫內容。

（六）另有關本案施工方式及範圍部分，請補充交通部觀光署澎湖國家風景區管理處意見。

五、有關問題四，審查規則第 4 條「保障公共通行或具替代措施」許可條件「維持且不改變海陸交界及海域既有公共通行空間或設施」等部分：

（一）說明施工及營運期間，對於鄰近利用漁港及相關船隻是否有影響船舶航行安全之虞，及是否有相關因應措施部分，申請人補充說明施工前將透過行政機關及漁會事先公告，施工期間將儘量避開漁汛期施工，並於事前與漁會做好協調公告以降低漁撈作業影響，又施工期間配合設置警戒船，故不致影響船舶航行安全，同意確認，並請納入說明書；另有關是否取得航政及漁業主管機關同意文件或書面意見部分，本次會議交通部航港局及農業部漁業署皆已出席說明意見(如後附發言重點摘要)，後續仍請申請人取得澎湖縣政府同意文件或書面意見。

（二）考量海纜設置之設施本體及路徑範圍，將獨占近岸海域、部分公有自然沙灘且屬人為設施，申請人依「整體海岸管理計畫」之「5.2 近岸海域有關獨占性使用之認定原則」，補充本案之特殊性、必要性及區位無替代性之認定原則部分，同意確認，並請納入說明書。另請補充說明公有自然沙灘設施登陸點區位之考量原則及如何降低對沙灘既有使用活動之衝擊。

(三)另考量沿近海域為漁業作業較密集區域，請申請人依說明書規劃，於開工作業前洽相關漁會，將作業方式、期程、範圍與聯絡窗口等資訊確實說明，建立雙方溝通管道，達成共識後再行施工。另作業 7 日前透過建立之管道提供資訊，並於作業期間注意警戒往來漁船(筏)航行安全及完善夜間警示標示，並將作業時程及範圍於作業 7 日前提供相關漁會公告周知，以上並列為應辦承諾事項。

六、有關問題五，審查規則第 2 條第 3 款「海岸永續利用原則」許可條件「有助於促進鄰近地區之社會及經濟發展。位於發展遲緩地區或環境劣化地區者，應訂定具體可行振興或復育措施」，及第 7 條「應考量事項」第 7 款「是否對申請案件利用之海岸地區，提出具體有效之管理措施」部分，申請人補充說明若有工作機會將優先提供給在地居民，支持公私部門辦理海岸地區發展遲緩或環境劣化地區之發展、復育相關推動工作，及在地里山里海行動計畫或方案，同意確認，並請納入說明書，另列為應辦承諾事項。

七、有關問題六略以，審查規則第 5 條許可條件「對海岸生態環境衝擊採取避免或減輕之有效措施」，說明於海域及各上岸點工法，是否有影響海岸生態環境之虞，及是否有相關減輕措施部分：

(一)申請人補充說明上岸點部分，僅於退潮期間開挖灘面以降低水質污濁情形、溝槽及岸端人孔清淤採即挖即埋方式以避免溝壁坍陷及達最小開挖面積；海域部分，佈纜船沿設計路徑將海纜加裝石墨鑄鐵保護管佈放後，

可防止外力直接作用於海纜上，另本案海纜施工期短且規模小，故對浮游性生物及魚類影響應不顯著，同意確認，並請納入說明書。

(二)另請申請人參考國際研究及相關報導(如附件1至3)，補充說明如何於施工、營運過程中降低對於生態環境影響，申請人後續倘有相關海纜鋪設案件，應就受影響之物種辦理環境生態監測，並列為應辦承諾事項。

(三)另本案涉及國土生態綠網的澎湖離島保育軸帶，有燕鷗及相關植物關注物種，請補充相關資料。

八、有關問題七，審查規則第 7 條應考量事項「六、是否對於既有合法設施或有關權利所有人造成之損失，承諾依法補償或興建替代措施」部分：

(一)本案與台灣中油股份有限公司(以下簡稱中油)所領臺濟採字第 5638 號天然氣、石油礦礦業權似有重疊範圍部分，申請人補充說明中油 112 年 10 月 19 日探採海域發字第 11202793930 號函及依中油提供書面意見略以，目前中油於本案範圍內無海域探採作業，另未來若中油於該區域鄰近海域進行探採作業，仍須視屆時實際狀況協調之，同意確認，並請納入說明書。

(二)說明是否與其他既有管線(通信、能源等) 有交疊情形，部分，申請人補充說明已獲台灣自來水股份有限公司 112 年 12 月 20 日台水七澎營室字第 1124906370 號函及 113 年 5 月 15 日台水七防漏字第 1130010777 號函回復略以，自來水公司對於本案與該公司既有管線之交疊情形，採取之工法施作同意備查，同意確認，並請納入說明書。

以上意見請申請人補正，於3個月內將修正之海岸利用管理說明書送本部國家公園署，經查核無誤後，核發許可函。

第 2 案：審議苗栗縣政府擬訂之「苗栗縣二級海岸防護計畫（草案)」案

決議：

一、海岸防護計畫之陸域防護區劃設原則及範圍(災害防治區及陸域緩衝區)，提請討論。

（一）本案海岸防護區之陸域防護區範圍部分，苗栗縣政府輔以圖表回應說明已依 109 年 12 月 11 日本部海岸管理審議會第 39 次會議決議之劃設原則，納入海岸線相關設施，且經該府說明「……因無都市計畫區、工業區、商港之保護區，防護區內均為未登錄之公有地，無明顯的保全對象。又海岸保安林區依森林法第 24 條及保安林經營準則，為利保安林區之維護，……後續農業部林業及自然保育署依據行政院秘書長室 106 年 3 月 8 日函示，各項目的事業之資源利用與管理，由目的事業主管機關依循其規定及法令分工辦理。」故本案僅劃設龍鳳漁港部分區域為陸域緩衝區，同意確認，請苗栗縣政府修正本計畫書相關內容。

（二）本案海岸防護區範圍之完整性及妥適性部分，經苗栗縣政府說明「暴潮溢淹影響範圍分析無海岸防護設施情況:……圖 7-2(藍色斜線處)青草漁港南側亦有暴潮溢淹潛勢範圍未達 EL3.281 公尺，陸側地區為保安林，其地面高程為 EL6.0 公尺以上，海岸防護設施後側至防汛道路，皆無海岸侵蝕、暴潮溢淹之潛勢風險。另暴潮溢淹災害部分經評估後，考量沿岸現況有海岸沙丘，且地勢高程較 50 年重現期距暴潮水位 EL3.281 公尺高，陸側保安林地面高程為 EL6.0 公尺以上，無重要保全標的，亦無暴潮溢淹歷史災害紀錄故未劃設緩衝區」，同意確認，請苗栗

縣政府修正本計畫書相關內容。

二、「防護措施及方法」、「海岸防護設施之種類、規模及配置」是否妥適，提請討論。

（一）專案小組會議審查意見二，本次修正新增「龍鳳漁港周邊海岸段」1處侵蝕防治之砂源補償工程內容，經苗栗縣政府說明「……濱海森林遊憩區假日之森侵蝕處佈置 300m(長)×30m(寬)×1.0m(高)之回填淤砂數量為 1,350m^3/年……」等內容，且表示目前苗栗縣轄內漁港或河口疏濬土方數量,每年約2萬方，故土方砂源數量足以供給目前 2 處侵蝕防治之砂源補償工程內容，同意確認，惟請苗栗縣政府將補償回填淤砂之規劃區位、面積、設置原因、權責單位、現況環境條件、每年漁港或河口疏濬土方數量、未影響自然海岸及輸砂平衡等相關內容說明，納入修正本計畫書相關內容。

（二）承上，查計畫書第陸章「青天泉至中港溪」海岸侵蝕災害防治區之因應對策相關論述，有關「措施及方法」提及「4.渠道工 II 及青草漁港防波堤之拆除」工程部分，經苗栗縣政府簡報第 71 頁已修正納入第柒章「三、防護設施之種類、規模及配置」方案 1「青天泉至中港溪」砂源補償工程內容項目之一，同意確認，請苗栗縣政府修正本計畫書相關內容。

三、「事業及財務計畫」及「其他與海岸防護計畫有關之事項」內容之妥適性，以及涉及目的事業主管機關協調事宜，提請討論。

有關專案小組會議審查意見三(二)，本案涉及「其他與海岸防護計畫有關之事項」各目的事業主管機關應

辦及配合事項，就其防護屬性項目及權責單位「表 9-2 監測調查及配合措施」該岸段整體監測調查資料之掌握及統籌彙整權責分工內容部分，經經濟部水利署第二河川分署表示「除了一般性海堤結構安全性評估及防護設施之定期監測，……本分署持續辦理海岸基本監測調查分析」及苗栗縣政府表示「……應視海岸情況做滾動式檢討及每五年通盤檢討一次並作必要之變更。」同意確認，並請苗栗縣政府統整監測等相關資料等納入修正本計畫書對應內容，並於核定計畫後定期追蹤控管計畫進度，以確保計畫目標達成，結合相關海岸監測管理機制，評估防護計畫執行成效，作為下次海岸防護計畫通盤檢討重要參據。

以上意見，請苗栗縣政府補充修正逐一列表回應，並重新修正苗栗縣二級海岸防護計畫（草案）（請標示修正處）後，儘速送本部國家公園署，俾辦理核定事宜。

柒、臨時動議：無。

捌、散會：上午 12 時 30 分。

附表1審議台灣電力股份有限公司申請「澎湖風櫃～桶盤～虎井及望安～將軍海纜敷設統包工程」案

海岸管理法第26條許可條件	海岸管理審議會審認結果
一、符合整體海岸管理計畫利用原則： （一）海岸保護原則：應避免位於二級海岸保護區，或整體海岸管理計畫建議應優先劃設之潛在保護區。	（一）有關「海岸保護原則」部分： 1. 依據內政部國土管理署「環境敏感地區單一窗口查詢」平台於112年11月7日航測會字第1129028103號及112年11月10日航測會字第1129032164號函示之查詢結果，本計畫範圍未涉及任何二級海岸保護區。 2. 請依會議決議三辦理。
（二）海岸防護原則： 1. 開發利用行為未造成海岸災害，或針對可能造成之海岸災害已規劃適當且有效之防護措施。 2. 不影響既有防護措施及設施功能。 3. 前二目應經水利或海岸工程相關技師簽證。	（二）有關「海岸防護原則」部分： 1. 本計畫海纜登陸引接上岸後，經新設之管道和人孔連結至簡易開關設備，土地使用規模小且工程施作侷限；而在近岸海域海纜敷設於海床上，施工擾動海床範圍小而侷限，且立即恢復原海床面，故本計畫無衍生增加海岸災害風險之虞。 2. 本計畫在虎井及將軍端之既有海岸防護設施為虎井海堤與將軍保護工等防護設施。近岸海纜登陸引接上岸作業，係規劃利用人孔引接，且獲主管機關同意。實際於該段海岸在短暫施工期間及後續營運維護期間，不會影響既有防護措施及設施功能。 3. 本計畫於設計規劃乃基於採用水平導向鑽掘工法

海岸管理法第 26 條許可條件	海岸管理審議會審認結果
	(HDD)施工，且因既有海岸防護設施之量體規模較小，依設計規劃考量預定自海堤下方至少約3~5公尺深穿越，兩側進出穿越點距離依現況調整距離防護設施約5~10公尺，海堤安全性已獲保障。同時亦可透過施工期間之即時目視檢查以及前後現況照片、影片之對照確認防護設施是否有受影響。於施工完成後每年亦已預定安排人員進行巡查，檢視有無水平移動、上下落差、外觀損傷、下陷、裂紋、等受損情形，故於該段海岸在短暫施工期間及後續營運維護期間，已針對可能造成之海岸災害規劃適當且有效之防護措施，以及不會影響既有防護措施及設施功能。技師評估相關資料（詳附件十八） 4. 請依會議決議四(一)至(三)辦理。
（三）海岸永續利用原則：	（三）有關「海岸永續利用原則」部分:
1. 除目的事業主管機關認定必要之氣象、科學研究、保育、環境教育、導航及國防設施外，不得位於無人離島。	1. 本計畫非位於無人離島區域。
2. 訂定長期監測計畫，並規劃及擬訂有效之管理方式。	2. 請依會議決議四(四)辦理。
3. 因應氣候變遷可能引發海平面上升及極端氣候，造成申請許可案件之衝擊，應提出具體可行之調適措施。	3. 本計畫土地使用規模小而侷限，且無施作任何建築物，故現階段尚無受海平面上升及極端氣候等可能

海岸管理法第 26 條許可條件	海岸管理審議會審認結果
4. 有助於促進鄰近地區之社會及經濟發展。位於發展遲緩地區或環境劣化地區者，應訂定具體可行振興或復育措施。	衍生海岸災害風險之虞。 4. 請依會議決議五辦理。
5. 應符合漁港、海岸公路、海堤、觀光遊憩、海岸地區保安林之營造及復育等項目之政策原則，並取得該管目的事業主管機關同意文件或書面意見。	5. 本案非屬漁港、海岸公路、海堤、觀光遊憩、海岸地區保安林之營造及復育範疇。
6. 對於保存原住民族傳統智慧，保護濱海陸地傳統聚落紋理、文化遺址及慶典儀式等活動空間，應有合理規劃。	6. 本計畫並無涉及利用或影響濱海陸地傳統聚落紋理、文化遺址及慶典儀式等活動空間情形，無礙於上述活動空間的保護、原住民族傳統智慧等人文資產的永續保存與資源利用。
7. 不得新建廢棄物掩埋場。但符合下列規定者，不在此限： (1)具有必要性及區位無替代性。 (2)非緊靠海岸線設置或離海岸線有相當緩衝距離。 (3)無邊坡侵蝕致垃圾漂落及滲出污水致海洋污染之疑慮。	7. 本計畫無新建廢棄物掩埋場，無邊坡侵蝕致垃圾飄落及滲出污水致海洋汙染之疑慮。
二、符合海岸保護計畫、海岸防護計畫所載明之相容使用，且非屬禁止使用項目。	
（一）符合海岸保護計畫、海岸防護計畫所載明之相容使用，且非屬禁止使用項目。	（一）本計畫非屬106年公告之整體海岸管理計畫指定之海岸保護區位及海岸防護區位，未來倘有相關海岸保護計畫及海岸防護計畫公告實施涉及本計畫者，將配合該計畫內容辦理
（二）海岸保護計畫或海岸防護計畫公告實施前，依下列規定辦理：	（二）海岸保護計畫或海岸防護計畫公告實施前，依下列規定

海岸管理法第 26 條許可條件	海岸管理審議會審認結果
1.提出區位無替代性評估。	辦理： 1.本計畫基於地理、地質特性、有助於海域使用管理、增加海纜安全及最小使用海域空間等因素考量，選定在澎湖風櫃~桶盤~虎井及望安~將軍各島嶼間之海域舖設海纜，具區域無替代性的要件。
2.不得影響保護或防護標的，並徵詢海岸保護計畫或海岸防護計畫擬訂機關之意見。	2.本計畫規劃海纜登陸引接上岸後，經新設之管道和人孔連結至簡易開關設備，土地使用規模小而侷限，無任何新增構造物等工程施作；而在近岸海域海纜敷設於海床上，施工擾動海床範圍小而侷限，且立即恢復原海床面，故本計畫無影響保護或防護標的之虞。另請依會議決議二辦理。
（三）本法第13條第2項規定依其他法律規定納入保護而免訂定海岸保護計畫之地區，已徵得海岸保護區目的事業主管機關同意。	（三）本案非屬海岸管理法第13條第2項規定之依其他法律規定之依其他法律規定納入保護之地區。
三、保障公共通行或具替代措施，其許可條件如下。但屬依本法第31條第1項但書規定，因申請許可案件性質特殊，且現地環境無法規劃或規劃結果低於原公共通行功能，經中央主管機關審查許可者，不在此限： （一）維持且不改變海陸交界及海域既有公共通行空間或設施。 （二）妨礙或改變海陸交界及海域既有公共通行空間或設施者，應設置提供適當公眾自由安全穿越或跨越使用之入口及通道，並標示明	（一）本計畫規劃海纜登陸引接上岸後，經新設之管道和人孔連結至簡易開關設備，舖設路線除未涉及陸上公共道路外，亦不影響人車通行、灘岸自由通行與民眾親水之權

海岸管理法第 26 條許可條件	海岸管理審議會審認結果
確指引。 （三）海陸交界及海域原無公共通行空間或設施，已於使用範圍內妥予規劃保障公共通行之具體措施，並設置入口與通道，及標示明確指引。 （四）有影響船舶航行安全之虞者，應取得航政及漁業主管機關同意文件或書面意見。	益。近岸海域海水面下海纜舖設於海床上，完工後僅為一條極為纖細的線狀人工物件，設施規模極小而侷限，無礙於海上各類船舶公共通行及民眾使用公共水域的權益。故本計畫將維持且不改變海陸交界及海域既有公共通行空間或設施。 （二）本計畫並未妨礙或改變海陸交界及海域既有公共通行空間或設施 （三）本計畫無佔用海陸交界空間，故維持且不改變海陸交界及海域既有公共通行空間或設施。 （四）請依會議決議五辦理。
四、對海岸生態環境衝擊採取避免或減輕之有效措施，其許可條件如下： （一）避免措施： 1. 避免納入自然海岸、潮間帶及河口等敏感地區。 2. 基於整體規劃需要，對於不可避免夾雜零星之敏感地區，應妥予規劃，且不影響其原有生態環境功能。 （二）減輕措施： 1. 增加緩衝空間或設施。 2. 降低開發強度。 3. 改善工程技術。 4. 修正分期分區開發時程。 5. 調整施工時間。 6. 改善營運管理方式。 7. 加強對海岸生態環境之衝擊管理。 8. 其他可減輕衝擊之相關措施。 前項避免或減輕措施，經其他機關核准者，得依核准之措施辦理。	（一）避免措施： 1. 本計畫海纜登陸上岸段風櫃、桶盤及望安海岸現況灘岸為礁岩與沙灘混合，而在虎井及將軍則為人工海岸。依據內政部「國土利用監測計畫」將海岸線分為自然與人工海岸線二類的定義，則本案係歸屬為自然海岸線。本計畫近岸海纜登陸上岸段利用自然海岸僅為一條極為纖細(直徑約僅20cm)且埋設於海床下(約1.2ｍ)的線狀人工物件，對海岸生態環境影響之時間短暫且輕微。 2. 本計畫未夾雜零星之敏感地區，且海纜施工期間在近岸海纜登陸引接上岸

海岸管理法第 26 條許可條件	海岸管理審議會審認結果
	後，經新設之管道和人孔連結至簡易開關設備，土地使用規模小而侷限；而在近岸海域敷設海纜於海床上，施工擾動海床範圍小而侷限，且立即恢復原海床面。故本計畫應無影響原有生態環境功能之虞。 （二）減輕措施： 1. 本計畫土地使用規模小而侷限應無影響原有生態環境功能之虞，施作完工後，即恢復原灘面，故無需增加緩衝空間或設施。 2. 本計畫為進一步保護海岸生態環境，於初始規劃階段即基於最小資源需用與對生態環境衝擊干擾最少的規劃原則，結合申請人過去累積的豐富經驗，進行妥善的海纜舖設作業規劃。本計畫於海纜登陸上岸段無任何新增海岸構造物等工程施作，於海纜敷設於海床段施工範圍小，整體工程對於現況影響不顯著，故無需降低開發強度。 3. 本計畫已採用目前常見的水平導向鑽掘工法(HDD)，其將使用水平導向鑽掘機進行鑽掘，在不破壞海堤構造物之情況下由底部穿越，故對於環境影響亦最小，故無需改善工程技術。 4. 本計畫施工期間甚短，無

海岸管理法第 26 條許可條件	海岸管理審議會審認結果
	分期分區開發時程。 5. 本計畫預計可於114年4月至8月期間辦理完成本計畫海纜舖設工程各項施工作業,故無調整施工時間。 6. 本計畫完工後針對海纜定期檢測，其主要經由供電狀況判斷海纜是否遭受破壞或受損。一般電纜修護作業，係利用修復船行駛至海底電纜斷損處，使斷損纜線藉由固定海底電纜的機器輔助，將斷裂海底電纜兩端拉上水面進行替換修補作業，然此為海纜受損時之修護作業，非屬例行工作，應不致對生態環境產生過大衝擊。 7. 本計畫海纜施工相對單純，海纜登陸引接上岸後，經新設之管道和人孔連結至簡易開關設備，無任何新增海岸構造物等工程施作；於海纜敷設於海床段海域，其施工範圍小而侷限，且立即恢復原海床面，對海床的沉積物干擾亦極為有限。而海纜完工後亦僅為一條極為纖細的線狀人工物件，設施規模極小而侷限。此外，營運期間使用海域性質，相較於在海洋之上、中、下層佈放實體的魚礁，或是連接海岸興建防波堤等實體海岸結構物，或海上鑽油平台等離岸海洋構造物均明顯不同，營運設備實

海岸管理法第 26 條許可條件	海岸管理審議會審認結果
	際為敷設於海床的纖細纜線，故本計畫對生態環境之衝擊實屬有限。 （三）請依會議決議七辦理。
五、採取彌補或復育所造成生態環境損失之有效措施，其許可條件如下： （一）最小需用原則： 1. 改變自然海岸之長度或面積最小化。 2. 填海造地之開發基地形狀，以接近方形或半圓形為原則。 3. 應以整合、集中、緊密之方式規劃。 （二）彌補或復育所造成自然海岸損失之有效措施： 1. 彌補或復育之面積比例原則應達到一比一，其面積比例不足時，應提出其他替代方案，並維持海岸之沙源平衡與生態系穩定。 2. 應優先於申請範圍內營造同質性棲地。 前項彌補或復育措施，經其他機關核准者，得依核准之措施辦理。	（一）本計畫並無填海造地，亦無新設任何海岸構造物等開發行為。使用海岸土地的主要樣態為海水面下海底或近岸陸域地區地下之電纜舖設，完工後亦僅為一條極為纖細的線狀人工物件，海纜舖設完工後沿線土地均回復原地形地貌，土地使用樣態單純且符合最小需用原則。 （二）如前述本計畫並無填海造地行為，土地使用樣態單純，完工後僅為一條極為纖細的線狀人工物件，設施規模小而侷限，且採即挖即埋方式施作，將不會造成自然海岸之損失，故尚無訂定彌補或復育措施的規劃。
六、除依第2條至前條規定辦理外，並應考量下列事項： （一）填海造地之申請案件，是否屬行政院專案核准之計畫，或經中央目的事業主管機關核准興辦之電信、能源等公共設施或公用事業。 （二）位於重要海岸景觀區者，是否符合本法第11條第1項所定之都市設計準則。 （三）是否經目的事業主管機關同意，	（一）本計畫並無填海造地，亦無新設任何海岸構造物等開發行為。 （二）本計畫非位於內政部108年03月25日台內營字第1080803463號公告之「重要海岸景觀區景觀道路類(第一階段)範圍圖」區域內。未來如有公告之計畫與本計畫相關者，將依該計畫內容據以配合執行。 （三）本計畫自民國96年8月6日監

海岸管理法第26條許可條件	海岸管理審議會審認結果
確有使用、設置需要。	察人視察澎湖地區之會議，針對離島易受船錨鉤斷而引發停電事故，指示辦理本案工程，經國營會108年8月19日經國二字第10800114890號函與經濟部109年4月9日經營字第10902602650號指示，本計畫為照顧離島地區居民生活便利性，具公益性質，已獲行政院經濟部同意辦理。
（四）是否取得土地使用同意文件或公有土地申請開發同意證明文件。	（四）本計畫涉及土地已取得財政部國有財產署南區分署澎湖辦事處112年9月7日，台財產南澎二字第11208033300號同意函及澎湖縣政府112年10月20日，府工土字第1120058673號同意函，另有關海域及未登錄土地已於113年3月20日取得國有財產署回覆略以，海域非如陸域以「土地」管理方式，其空間區域之管理利用非屬財政部及該署業務職掌，該署無權責同意使用
（五）是否符合土地使用管制規定。	（五）本計畫纜線經過澎湖縣風櫃、桶盤、虎井、望安及將軍5處岸邊土地，包含風櫃東段578、579及710地號、桶盤段001地號、虎井段1004-5地號及將軍澳段574-22、574-23地號等土地。此7筆土地皆為公有土地，而其工程施作工法、開發利用均與土地使用計畫相符，相關土地容許使用已獲澎湖縣政府同意；海域部分相關用地已於112年12月4日依「非都市土

海岸管理法第26條許可條件	海岸管理審議會審認結果
	地使用管制規則」向內政部(國土管理署)申請海域用地區位許可。
（六）是否對於既有合法設施或有關權利所有人造成之損失，承諾依法補償或興建替代設施。	（六）請依會議決議八辦理。
（七）是否對申請案件利用之海岸地區，提出具體有效之管理措施。	（七）請依會議決議六辦理。。
（八）是否為其他法令所禁止。	（八）本計畫未有牴觸其他法令禁止之事項。

附錄1　討論事項第1案委員及相關單位發言重點摘要：

一、委員1

目前所提背景說明(如生態敏感區位、漁民使用現況等)並不完整，難以從空間分布上理解施工及目前工程規劃對各面向之可能關係及影響，宜具體補充圖資套疊及充分說明。

二、委員2

（一）呼應海洋委員會海洋保育署書面意見，請台電考量訂定執行除役計畫，雖然海纜體積小，但畢竟是人造物，在除役後仍應妥為處理，避免對自然環境之影響。

（二）說明書p.47建議施工前仍先進行預設路線之珊瑚礁分布確認，若有重疊，請儘量避開，不宜將海纜直接佈放於珊瑚礁表面，如此可減少對生態可能的負面影響，維持民眾對申請人之良好觀感，並避免未來維修海纜可能的生態破壞。

（三）說明書p.44至47，本案所列的海洋自然生態資料並非本案所調查(表6.2-1可看到文獻引用)、p.44的用語不宜(「本研究分述上述地區抽樣調查……」)。

（四）請考慮套疊海洋委員會海洋保育署之海龜標放路線圖。

三、委員3

（一）雖海纜為民生重要設施，但海纜路線規劃的方法應有周延考慮，包括各種漁業作業區，海龜生態廊道、水下文化資產等進行套疊，納入說明書並附比例

尺。

（二）沙灘為海岸管理法關切的環境/景觀單元，建請申請人未來規劃海纜路徑時應能避免破壞其完整性。

（三）緊急應變計畫請依近年金馬地區海纜被拖斷情況，研修相關內容。

（四）附帶建議環境部，海纜應考慮進行環評，申請人請考慮參考國外資料，納入監測計畫中。

（五）未來於國家公園、國家風景區內之開發行為，不宜直接進入大會審議。

四、委員 4

（一）本案環境部改制前行政院環境保護署 108 年 10 月 29 日環署綜字第 1080078831 號函認定免實施環境影響評估。

（二）澎湖附近亦有多件離岸風場之規劃，海纜鋪設上岸點、饋線等，倘有需求宜考慮未來相容預設空間規劃安排。

（三）施工期間應避開特有動物(珊瑚、海龜及燕鷗等)繁殖期，並加強與當地漁民及居民之溝通。

五、委員 5

（一）施工範圍涉及漁業作業較密集區域，請申請人於施工前將作業方式、期程、範圍及窗口與當地漁會及漁民代表溝通，建立溝通管道，開工作業前 7 日提供漁會公告周知，避免影響漁民權益。

（二）另本案涉及漁業作業範圍請務必洽澎湖縣政府。

六、委員 6

請確依交通部航港局意見處理，及於施作前通知航港局窗口發布航船布告，並務必確實掌握施作期間海氣象變化，如遇緊急狀況，請即依所擬應變計畫妥為因應，並隨時與交通部航港局保持聯繫。

七、委員 7

（一）申請人已於 109 年就海龜部分函詢海洋委員會海洋保育署，當時海洋保育署已請澎湖縣政府協助查詢，確認本案海纜鋪設路線未經過望安島綠蠵龜產卵棲地保護區。

（二）海洋污染防治法（下稱海污法）於 112 年 5 月 31 日修正公布，請依修正後之海污法及相關子法規定辦理。

（三）依海污法第 17 條第 1 項規定，各目的事業主管機關應查核經許可於海污法第 2 條第 1 項所定範圍內投設、敷設或佈放之各類海洋設施、漁業設施及其他人工構造物，並要求訂定、執行除役計畫，請依海污法規定辦理。

八、委員 8

查申請人刻向國土管理署申請海域用地區位許可，惟申請資料與本案說明書之坐標點位置不一致，請修正；並請將坐標點編號順序與本案說明書調整成一致。

九、委員 9

本案為國家重要基礎設施，其海纜鋪設範圍及海底地形相關資料皆為國家重要資訊，請申請人務必注意必須掌握於國內不得外流。

十、農業部林業及自然保育署

本案範圍係屬「澎湖離島保育軸帶」，該軸帶關注物種有鳳頭燕鷗、蒼燕鷗、紅燕鷗、小燕鷗、白眉燕鷗、玄燕鷗、澎湖大豆、濱斑鳩菊、烏芙蓉、繖楊等，提供申請開發單位參考。餘林保署尚無意見。

十一、交通部航港局

（一）請申請人於本案海上作業進行前 14 日，將相關作業資訊，包括作業內容、地點、影響海域範圍及圖說、作業時間、安全警示作為、統包廠商緊急聯絡資訊、主管機關同意證明文件函送航港局發布航船布告。

（二）倘因緊急狀況需變更或取消海上作業，最晚請於 3 日前，將施工位置含經緯度通知航港局，俾即時更改航船布告，供來往船隻掌握即時正確資訊。

（三）另請申請人於施工結束後將海纜位置經緯度通知海圖發行相關單位(包含電子海圖等單位)，更新海圖最新資訊，維護航行安全。

（四）本案說明書所提緊急應變及防災計畫，涉及發生海難船隻協助部分，建議增列航港局受理案件之單一通報窗口海事中心資訊。

（五）另說明書所述倘生緊急事件時，通報附近船隻及請臺灣港務股份有限公司高雄港務分公司協助救援部分，建議申請人先與高雄港務分公司確認是否可配合辦理。

十二、海洋委員會海洋保育署（書面意見）

（一）海洋污染防治法（下稱海污法）於 112 年 5 月 31 日修正公布，請依修正後之海污法及相關子法規定辦理。

（二）依海污法第 17 條第 1 項規定，各目的事業主管機關應查核經許可於海污法第 2 條第 1 項所定範圍內投設、敷設或佈放之各類海洋設施、漁業設施及其他人工構造物，並要求訂定、執行除役計畫，請依海污法規定辦理。

十三、農業部漁業署（書面意見）

（一）本案涉及各漁港權管，依漁港法第 4 條規定皆為澎湖縣政府，爰請就澎湖縣政府同意文件或書面意見為準。

（二）依說明書 p.102 所述申請人承諾於開工前辦理施工說明及工程協調會議。考量沿近海域為漁業作業較密集區域，請申請人依說明書規劃，於開工進行作業前洽相關漁會，將作業方式、期程、範圍與聯絡窗口等資訊確實說明，建立雙方溝通管道，達成共識後再行施工。另作業 7 日前透過建立之管道提供資訊，並於作業期間注意警戒往來漁船(筏)航行安全及夜間警示標示完善，並將作業時程及範圍於作業 7 日前提供相關漁會公告周知。

十四、內政部國土管理署（書面意見）

（一）本案前由台灣電力股份有限公司澎湖區營業處依非都市土地使用管制規則第 6 條之 2 第 1 項規定，於 109 年 1 月 7 日函檢具申請書向國土署申請海域用地區位許可，嗣申請人依國土署 109 年 1 月 14 日函修正意見及 109 年 3 月 4 日函會商有關單位所提意見，於 113 年 3 月 26 日函送補正後之申請書件予國土署，考量已歷經 4 年，國土署遂再於 113 年 4 月 17 日函會商有關機關審查，將續辦核發許可作業。

（二）本案說明書四、位置及範圍之申請範圍所列坐標，部分與前開海域用地區位許可申請書申請範圍所列坐標有不一致情形，請申請人再釐清，並調整表格及圖面之坐標序號及點位數值一致。

十五、澎湖縣政府農漁局（書面意見）

本計畫完工後僅為一條極為纖細的線狀人工物件，針對航安問題較無影響，另請申請人於施工前逕向農業部漁業署或交通部航港局告知並請協助發布航船布告。

十六、台灣中油股份有限公司（書面意見）

本案範圍重疊於中油所領臺濟採字第 5638 號礦業權，目前中油於該計畫區域內無海域探採作業。另未來若中油於該區域鄰近海域進行探採作業，仍須視屆時實際狀況協調之。

附錄 2、討論事項第 2 案委員及相關單位發言重點摘要：

一、委員 1

竹南人工溼地位於竹南防潮堤內，海岸防護設施是否破壞或減損保護區之環境、生態、景觀及人文價值，請依海岸管理法第 15 條第 2 項檢視。

二、委員 2

氣候變遷下，依據現況暴潮重現期所劃設之陸域緩衝區難以滿足未來調適需求，建議納入氣候變遷計畫綜整考量，滾動檢討。

三、委員 3

(一)本計畫第 81~82 頁，是否可補充列出各風力發電計畫之區位。

(二)第 66 頁，本防護計畫之主管機關為苗栗縣政府，因此在論述應避免「請苗栗縣政府優先處理……」等用語，從別的機關為出發點的論述方式，不適合本計畫。

(三)第 22~23 頁(表 2-9)與第 26~27 頁(表 2-10)之各區間(A1~A33)似乎無法對應到圖 2-19、圖 2-1 之 No.10~No.60，請補充說明。

四、內政部國土管理署

簡報第 7 頁及計畫草案第 84 頁所提「苗栗縣國土計畫」之目標值為「本計畫公告實施後 2 年內」辦理，惟因苗栗縣國土計畫已於 110 年 4 月 28 日公告實施，故建議修正為「苗栗縣國土計畫通盤檢討」，辦理時間為 119 年 4 月 30 日前。

五、經濟部水利署第二河川分署

本分署除了一般性海堤結構安全性評估及防護設施之定期監測外，亦涵蓋整個苗栗縣海岸段，後續本分署持續辦理海岸基本監測調查分析，以掌握海岸變遷情形。

六、環境部

本案「苗栗縣二級海岸防護計畫（草案）p.59，表5-1苗栗縣二級海岸防護區海岸侵蝕災害防治區使用管理事項一覽表，其中海岸傾蝕之相容事項第2點『災害防治區內除為保護海岸所需防護設施外，其他開發行為如有妨礙鄰近開發範圍以外之其他地區侵蝕之顧慮者，應經政策環境影響評估及中央主管機關同意後，始得施工。』經查政策環境影響評估（以下簡稱政策環評）細項未規定海岸傾蝕災害防治等行為應辦理政策環評，爰擬建議苗栗縣政府刪除相關文字，並請釐清確認。

七、海洋委員會海洋保育署

第82頁，因海污法於112年5月31日修正公布，海污法涉及海域工程條文部分原為第19條，請修正為「依海洋污染防治法第22條規定辦理」。

八、農業部漁業署（書面意見）

本案無意見。

九、農業部林業及自然保育署（書面意見）

（一)本案涉本署應辦及配合事項包含保安林應依「保安林經營準則」及「保安林施業方法」等相關規定辦理海岸侵蝕防護措施、落實工程生態檢核、配合海岸高灘

地及沙丘造林環境營造管理以及本計畫通盤檢討事宜。經查尚無礙本署保安林經營管理及相關業務執行，本署配合辦理。

(二)有關計畫書表 8-1 各目的事業計畫防護區屬性及權責單位範圍(第 71 頁)中，崎頂濱海遊憩區(前崎頂海水浴場)之屬性及權責機關欄位請再確認修正。

討論案1附件1

How undersea cables may affect marine life

2 February 2023

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By Adrienne Bernhard, Features correspondent

Jean-Sebastien Evrard/Getty Images

Submarine cables carry electricity and information across vast oceans and seas, but we're only beginning to understand their possible impact on delicate marine life.

Tens of thousands of miles of cables crisscross our deep seas, ferrying data between continents and carrying renewable power from offshore energy platforms to the land. These snaking, artificial structures can serve as shelter to a vast array of bottom-dwelling sea life: anemones, sponges, corals, sea stars, urchins, worms, bivalves, crabs and other invertebrates have been found to take up residence on or near undersea cables.

But marine scientists believe we need a greater understanding of how electromagnetic fields (EMF) generated by submarine power cables might affect some of these delicate creatures, many of which rely on their own internal sense of magnetic north to navigate or use electric fields to help them hunt. Given that the number of submarine cables will only multiply as the marine renewable energy sector grows, what threats do they pose to life underwater, one of the last spots on Earth largely untouched by humans?

Undersea cables can be divided into two broad categories: telecommunication cables and high-voltage power cables. Telecommunications cables are laid on the surface of the seabed where they cross deep seas, while power cables, which tend to be found closer to shore, are typically buried under sediment for protection. Today, around 380 underwater telecommunications cables are in operation around the world, spanning a

length of over 1.2 million kilometres (745,000 miles). This **map** shows all active subsea fibre-optic telecommunications cables – many of them featuring whimsical names like Apricot, Concerto, Topaz, Polar Express or Meltingpot.
Telecommunications cables provide the information pathways for more than 95% of international data. And offshore wind and hydrokinetic power plants also rely on submarine cables. Over the past few decades, as renewable energy projects proliferate, researchers have begun studying their environmental effects.

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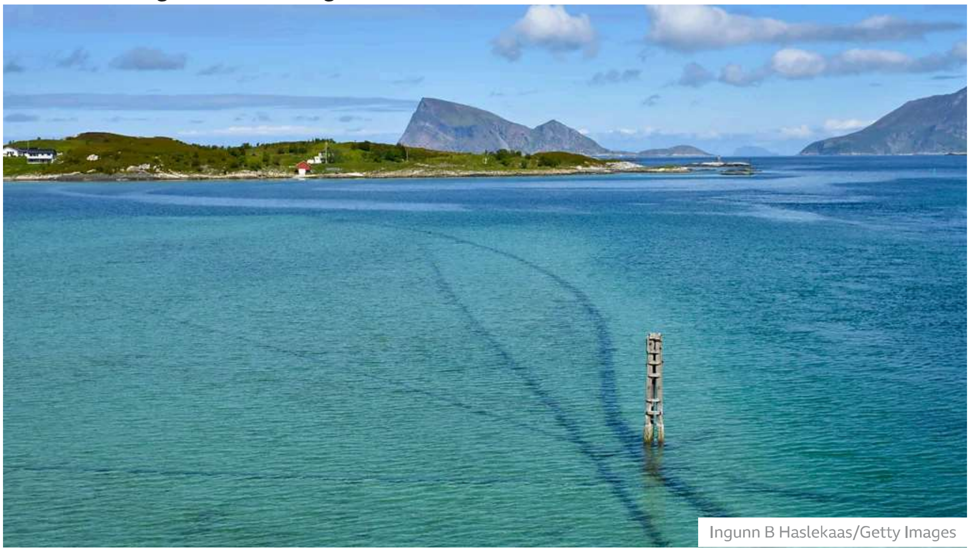
For most of its journey along the ocean floor, a telecommunications cable is about as wide as a garden hose, its digital data-carrying filaments no larger in diameter than a human hair. Power cables are generally larger in size (between 7-30 cm/2.75-12in) and are sheathed in a few layers of metal for enhanced protection. Subsea cables are carefully routed to avoid hazards that could damage them, such as earthquakes and underwater landslides. To minimise any accidental damage that may occur in shallower waters (for example, damage caused by human activities such as fishing, ocean trawling and anchoring), cables must be buried below the seafloor.



In shallower water, boats may be prohibited from coming near cables, which can result in healthier fish stocks (Credit: Ingunn B Haslekaas/Getty Images)

"During subsea installation, companies will try to bury a [power] cable beneath the sediment to protect it," says Bastien Taormina, a researcher at the **Norwegian Institute of Marine Research** in Bergen. "This has a much bigger impact on the surrounding habitat." Taormina is the lead author of an **oft-cited study** on the effects of artificial structures on marine ecosystems, published in the Journal of Environmental Management. Over a span of five years, he and his team studied the submarine power cable of a tidal energy test, taking pictures of species that colonised the cable and associated structures.

Installation of a cable disturbs the surrounding seabed. Somewhat paradoxically, that can lead to greater initial biodiversity, says Taormina. "Opportunistic species will survive, but that doesn't mean it's a good ecosystem, because these species, while diverse, won't stick around." This phenomenon is what's known as ecological succession: the process by which communities gradually replace one another until a "climax community" – such as a mature coral reef – is reached, or until a disturbance, like a fire (or in this case an electrified submarine cable), occurs.
With nearly all of the world's internet and banking transactions conducted over underwater cables, there is growing concern about their vulnerability.

Critical cables

In January 2022, Tonga was cut off from the rest of the world after the Hunga Tonga-Hunga Ha'apai volcano exploded and **severed a submarine internet cable**. Full connection was not restored until February when the cable linking it to Fiji was repaired.

There are other threats, too. Researchers recently discovered underwater "rivers" flowing along sea beds. One running south from Newfoundland cuts across many cables connecting the US to Europe. In 1929, 23 underwater telegraph cables were cut when a **rush of sediment roared down the river's channel**. (***Read more here***.)

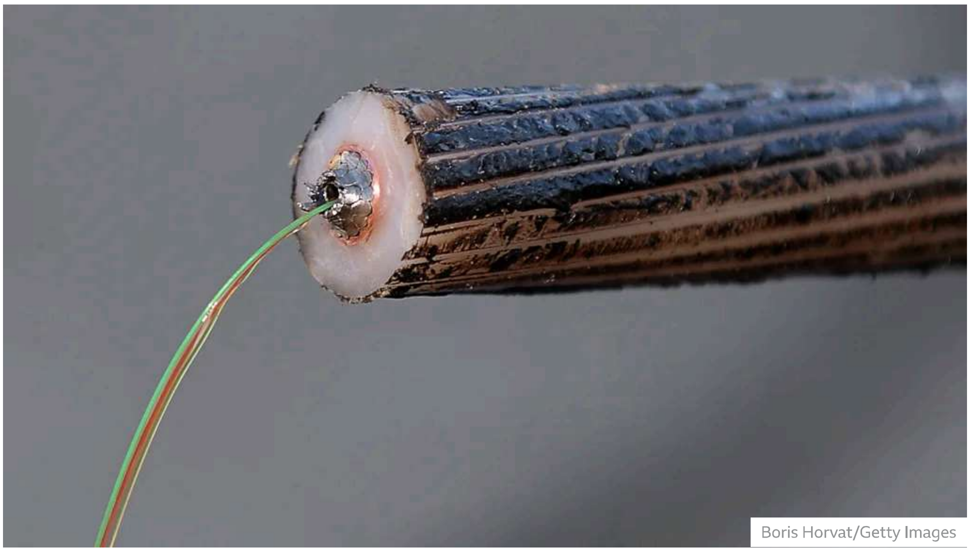
Today, undersea cables could be targeted by states wishing to sabotage the economies of their rivals, threats heightened over growing tension with Russia.

Another possible consequence of undersea power cables is their generation of electromagnetic fields (EMF). The intensity of EMF is a direct function of the current passing through a cable and the depth at which it is buried, as well as the distance between cables (if multiple cables are running in close proximity, for example). EMF can distort the natural geomagnetic field that marine organisms rely on to navigate, particularly if they swim or drift 10 metres near the cables.

"There is a need to further study electro-magnetically susceptible species," says Michael Clare, leader of Marine Geosystems at the **National Oceanography Centre**. "What's the threshold at which EMF presents a problem for these sea creatures?" Most institutions and scientists (including Clare) are hesitant to make any causal link between subsea cables and the behaviour of marine organisms.

"It has been suggested that behavioural movements in organisms such as skates and lobsters can be affected by EMFs, but whether they are affected by the EMF intensities generated by power cables remains unclear and the subject of ongoing research," Clare adds.

After completing several **impact studies**, the US Department of the Interior **noted** that "brief lingering activity near undersea cables have been observed, the data do not currently support a finding that overall navigational capabilities in fish are impaired". Much of the available peer-reviewed field studies performed to date also support this statement.



Telecommunications cables provide the information pathways for more than 95% of international data (Credit: Boris Horvat/Getty Images)

In experimental studies performed in aquariums, marine organisms sensitive to magnetic fields have been shown to **exhibit behavioural responses to EMF**, although at exposure levels far larger than those emitted by power cables. But sharks, rays and chimaeras, for example, are known to have evolved organs that are exquisitely sensitive to electrical fields: the ampullae of Lorenzini. These electroreceptors form a network of mucous-filled pores in the skin of cartilaginous fish – highly specialised organs optimised to detect prey, and that have a threshold sensitivity of less than a single microvolt.

"Future field studies – particularly that represent a collaboration between ocean researchers and cable operators and owners – will help further our understanding," says Clare. Taormina's study suggests animals that migrate along the continental shelves might be affected by a cable's electromagnetic field, moving either inshore or offshore away from their normal path, but he also agrees that more study on EMF is needed.

> “ *Submarine cables do not pollute: they are stable, inert structures that can even be recovered and recycled after they've served their time*

While studies of the deep sea are expensive, time-consuming and resource-heavy, they can help fill that information gap. Almost two decades ago, researchers at the Monterey Bay National Marine Sanctuary, in collaboration with the National Oceanic and Atmospheric Administration (NOAA), conducted **a survey** of a seamount thermometry cable on the deep seafloor off the coast of central California – a survey considered unique at the time for investigating the biological impact of subsea cables. Remote operated vehicles (ROVs) carried electronic cable-tracking systems into the deep waters of Half Moon Bay, allowing researchers to find parts of the cable that had been buried under sediment (the cable was initially laid down in 1995 as part of an experiment to detect changes in ocean temperature by monitoring the speed of sound waves in the deep sea). As the ROVs scanned the cable's roughly 95-kilometre (59-mile) length, scientists collected sediment samples, video and still images of animals living on or near the cable.

In silty areas, the most obvious biological effects of the cable were the neat lines of sea anemones that researchers discovered growing on the cable itself. Frequently, these sea anemones were attached directly to parts of the cable that had been buried under mud or silt. Researchers concluded that these anemones likely would not have been able to colonise such soft-bottom areas without the presence of the seafloor cable, which provided a firm footing for the animals. Removal of such cables would therefore affect a small ecosystem of marine creatures who call that cable home.

Sean Scott/Getty Images

Certain sea creatures, such as sharks and rays, seem to be more sensitive to the electrical signals sent out by some cables (Credit: Sean Scott/Getty Images)

Beyond localised habitat damage or loss, submarine power and communication cables may temporarily or permanently impact the marine environment through heat, turbidity (during cable burial), risk of entanglement and the introduction of artificial substrates. Still, areas through which cables pass are often designated as protected, meaning anchors, bottom trawls and even fishing can be restricted. The Cook Strait Cable Protection Zone (CPZ) in New Zealand, for example, **restricts fishing near cables**, effectively creating a reserve and thus improving fish stocks.

And submarine cables do not pollute: they are stable, inert structures that can even be recovered and recycled after they've served their time (about 20-40 years, on average). "The carbon footprint is actually relatively low compared to most of the internet's infrastructure," says Nicole Starosielski,associate professor at NYU. Her book, **The Undersea Network**, examines the cultural and environmental dimensions of transoceanic cable systems, and she adds an important social science perspective to the discussion. "We've actually advocated for more cables, connecting large onshore data centers on renewable grids, in order to minimise fossil fuel consumption."

Indeed, small developing island states are crucially tethered to these elaborate cable systems, without which they would struggle to obtain green energy, telecommunications, remote-work technology, e-medicine and other digital services.

Ocean life – and its often-complex interaction with human activities – is riddled with unknowns; for ecologists worried about environmental conservation, these subsea cables remain a serpentine question mark.

But, as Clare explains: "There is value in the research, which will help industry leaders, policy-makers, cable companies and other parts of the wider Blue Economy strive to ensure any development of the seafloor is as sustainable as possible."

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Oceans Biology

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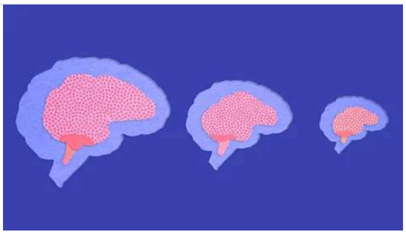

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How Submarine Cables are Threatening the Fragile Ecosystem of the Mediterranean Seabed

The undersea cables that criss-cross the Mediterranean's seabed carry power and data across its shores, facilitating trade and communication. But they are also risk factors for the environment, fisheries and cybersecurity.

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Michele Calamaio
| 14 December 2023

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“Mare Nostrum” has been the haven for a wide variety of marine species, the hub for perfect biodiversity conservation. Over the ages, however, it has emerged as one of the major global trading centers in the quickly evolving global economy, a distinct and delicate ecosystem that has been facing several environmental risks brought on by human activity. Among these, submarine cables.

Though both recyclable and necessary for worldwide energy supply, the installation and operation of these global communication infrastructures has sparked many concerns about the potential environmental impact, the economic issues arising from complex fisheries management, and the need for sustainable policies and regulatory changes to prevent a cyber-war on the seabed.

Cable industry vs. science: game on!

The submarine cables framework appears to be a huge infrastructure that facilitates the flow of data and energy between continents from offshore energy stations to the mainland. In layman's terms, about 67,000 kilometers of new cables were installed worldwide between 2016 and 2020, with a current estimation of 113,000 kilometers to be installed annually by the end of 2023. A huge anthropological ecosystem through which $10 trillion worth of financial transactions are conducted every day on ever-more complicated supply chains, accounting for around 95% of all Internet traffic worldwide. A sizable industry that is projected to increase by 12.9% between 2022 and 2030, reaching a value of $48 billion, according to MarketResearch.com.

The cost of a single cable in the submarine cable sector can reach hundreds of millions of dollars, contingent upon the route's complexity and length. The “private owner” model, wherein a single IT corporation owns and operates the cable for its own purposes, has recently become more prevalent, although the “consortia” one – between telecommunications, large technology businesses, and infrastructure specialized companies – has always been looked upon favorably. Collectively holding more than 66% of the submarine cable network's capacity, submarine cable routes are being redesigned by these companies to connect their data centers in order to scale up digital production and storage, a recent industry report predicts.

High-voltage power cables are bigger and heavier: composed of insulating sheath-encased copper or aluminum conductors, they're usually buried beneath the seafloor for protection as they carry large currents of concentrated electricity. A recent construction concerning the Mediterranean, laid with the new power line built by Italy’s Terna to connect the island of Elba and Piombino city, according to the company’s press release, will “affect on its way out of the Piombino landing a Posidonia oceanic meadow for a stretch of about 3 km in length”. Despite potential biodiversity effects, Terna assures that there is “maximum focus on the environmental impact with the transplantation of Posidonia oceanica from the affected area to a 1,650 m² site in the Gulf of Follonica”. In its official statements, the company speaks of “improvement for the quality of the local infrastructure, bringing significant benefits in terms of security, reliability, and sustainability". Yet it is important to acknowledge that a number of Posidonia, the plant most representative of the Mediterranean infralittoral zone, was removed and replanted during the project, somehow disturbing the marine ecosystem of the area.

> "While burying the power cables lessens the intensity of the electromagnetic field at the seabed's surface, it does not completely eliminate it", says Bastien Taormina, a marine ecology researcher at the Institute Marine Research.

According to one of his papers, their placement can disturb the marine ecosystem by generating electromagnetic fields: "the higher the voltage and current, the stronger the electromagnetic field, the worse the environmental impact". Taormina believes in the potential of renewable energy, "but its benefits must be weighed against the environmental impact of installing the vulnerable infrastructure to support it", he says, mainly if it affects the navigation of electrosensitive marine species, such as sharks and even eels, who use their internal magnetic north sense to prey and orientate.

High-voltage cables, also, can be connected to offshore wind farms too that float in the open sea. "If they are also placed on the water surface, the environmental risks will not only affect the benthic environment but also influence the pelagic one", says Alessandro Cresci, Postdoctoral Research Scientist at the same research institute as Taormina, following the expansion of floating offshore wind farms in the Mediterranean. According to research, the behavior, ecology, and survival of species are among the aspects of life processes that are mostly impacted by EMFs associated with electricity production by offshore wind turbines that have both kinds of wires in marine habitats.

Telecommunication cables, instead, when ashore, end up in a concrete structure embedded in the beach, for later merging with a counterpart that travels to a landing station. Made of optical fiber, they are rather deposited on the seabed's top because the currents they carry are milder, conveying only simple data at low voltage. Much safer then? According to Michael Clare, leader of the Marine Geosystems department at the National Oceanography Centre, they are. To safeguard cables from human activity in shallow waters, burying them may be necessary. In this scenario, "the seabed will be disturbed, but studies have shown that the benthos rapidly recolonizes", he says.

The greatest differentiation of Clare's vision on the impact of submarine cables on the marine environment from Taormina's lies in their degree of influence on the sea bottom, as well as the potential ecological repercussions: in his recent article, indeed, Clare presents a more "tentative" perspective on the tenuous relationship between environmental influences and marine organism behavior. "Telecommunication cables do have an impact in terms of electromagnetic field disturbance for sea creatures", he says, "but this is a minimal or even benign footprint on the marine environment". And this applies to high-voltage power ones too: "Whether they are affected by the EMF intensities generated by power cables", he says, "remains unclear and the subject of ongoing research".

So Giuseppe Valentino says too. Telecom Italia Sparkle's Data Product Manager defends his company's strategy in implementing the construction of the BlueMed submarine cable by reiterating one message: "We want to consolidate Sparkle's leadership in the Mediterranean basin through the extension and enhancement of our regional backbone". With a total system capacity of up to 400 terabits per second and a total length of about 1,000 kilometers, Sparkle's wholly owned BlueMed is an integral part of the Blue & Raman submarine cable system project, together with Google and other operators. This means that the entire project is based on a consortium model in which part of the shares belong to Google and a third partner. In addition, the cable itself shares fiber pairs with Blue.

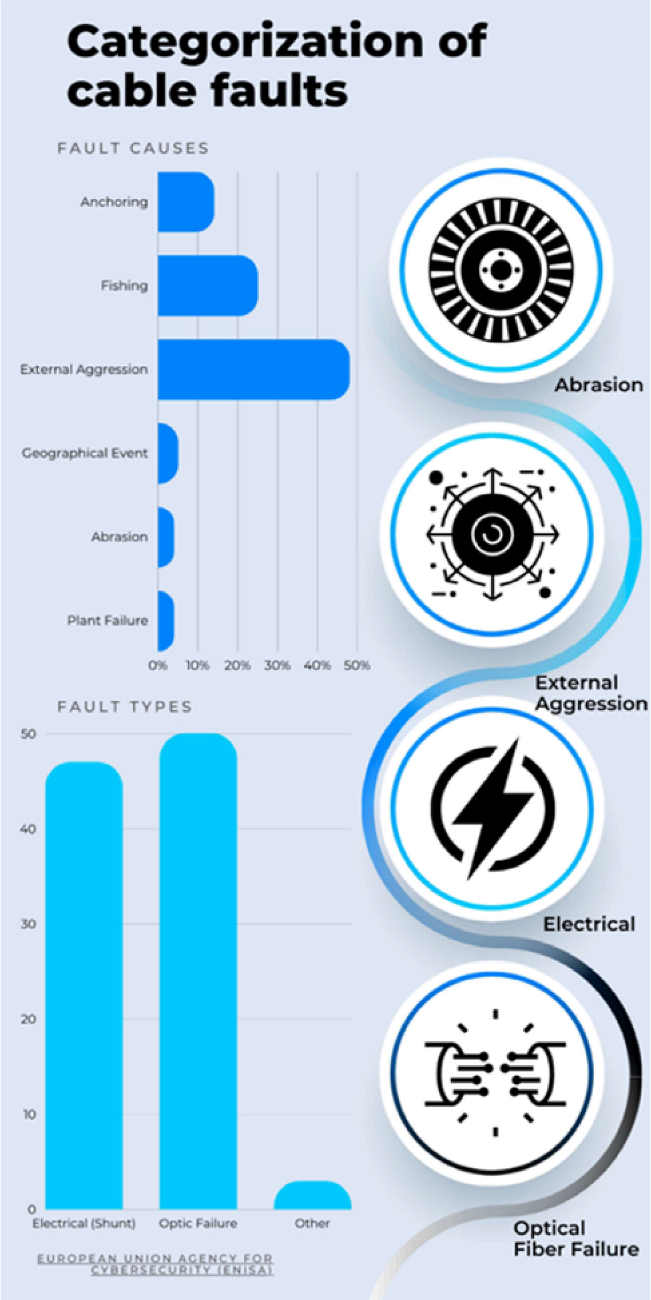
The Blue & Raman submarine cable system from the consortium of Google, Sparkle and other operators, that includes the BlueMed cable owned exclusively by Sparkle (Telecom Italia Group) / Credit: TeleGeography 2023.

According to Valentino, "BlueMed has very little, if any, impact on the environment," mainly thanks to its mechanical nature: "it is one centimeter wide in diameter and" – despite the very high voltage path that can reach up to 11,000 volts – "the amperage is very low, making it environmentally friendly for both laying and maintenance". Valentino also highlights that "Sparkle received all authorizations from Italy's Ministry of the Environment and the Navy to lay on the bottom in Italian seas". Although the regulations are fairly strict, "there is a great emphasis on maintaining environmental integrity during the cable installation and maintenance process in Europe", he says.

Cresci, however, speaks of potential effects of underwater communication cables on the ecosystem too: even though EMFs are a poorly understood but potentially important and increasing emission into the marine environment, he says that sensitive species might not receive critical environmental cues due to the electromagnetic fields produced by electric telecommunication cables at high frequencies, which may have negative effects on the local ecology. This is because undersea cables used for power transfer are known sources of EMFs, but telecommunication cables and undersea communication cables also generate alternating current (AC) and direct current (DC) EMFs. Seabed damage, disturbance of organisms, and electromagnetic noise also pertain to this category of impacts. And his thesis is backed up by research: according to it, despite the small physical size of optical cables, which transmit data using pulses of light (it can be considered a form of high-frequency AC), activities such as surveying of cable routes, laying, protecting, and repairing submarine cables may cause pollution or harmful changes to the marine environment.

Fishing...cables? Pulling up...cyber-spies!

The environmental impact found in both high-power and fiber-optic submarine cables, therefore, seems to be common, and characterized by other phenomena such as turbidity, pollution, entanglement, and habitat disturbance. These latter, more specifically, deal with the fishing activity: ICT Solutions and Education reports of around 100 cable breakdowns annually, while European Union Cybersecurity Agency most recent data indicates that human engagement, whether through inadvertent mistakes or deliberate malicious actions, is responsible for 87% of cable incidents. Among these, damages from fishing gear like gillnets and trawls – which can cut them directly by ripping apart or snapping the cable – are very likely since they are usually buried or laid beneath the seabed.



Categorization of cables faults / Credit: European Union Agency for Cybersecurity (ENISA).

"For years there has been no concrete dialogue between the fishing sector and the submarine cable industry," says Roberto Arciprete, vice-president of the Italian Cooperative Alliance. The middle ground for a greater integration of shared practices "is necessary", he says, otherwise the "risk of being left out increases, and our demands will never meet a fair industry regulation". At the European level, it's Juan Manuel Trujillo Castillo, president of the European Federation of Transport Workers, who raises his voice: "While we are not against these activities", he says, "we call for a balanced approach between the parties."

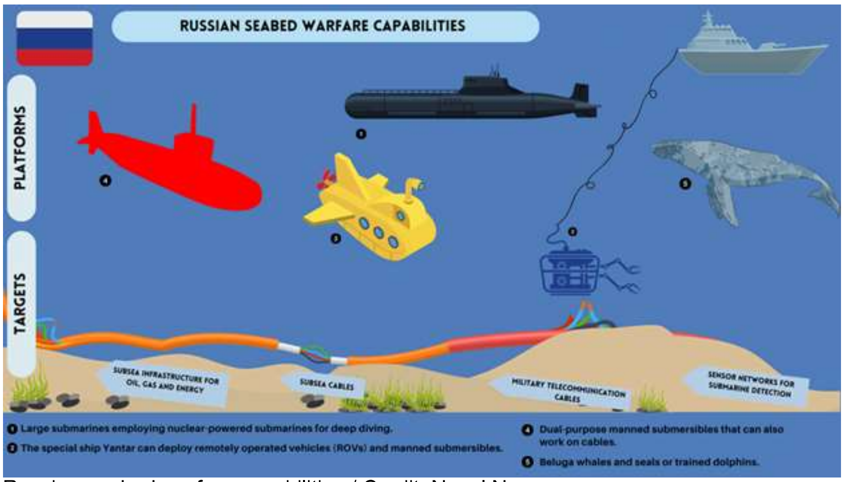
Trujillo has a strong stance on fisheries: since fishermen contribute to the EU's food supply and food sovereignty, "why are energy and telecommunications more important than healthy and essential food?". According to Marevivo, an NGO that focuses on marine conservation, "no human activities have zero impact". The NGO states that the EU Marine Strategy Framework Directive's eleven descriptors of good environmental status "serve as a measure of the application of the environmental impacts of submarine cables" and that the Environmental Impact Assessment (EIA) commissions must question the construction of any cables that do not meet these sustainability standards. "If the presence of the cables is an obstacle to legal and sustainable fishing activities, then we think it is fair that those who lay the cables compensate the fishermen for the losses."

According to Clare, even if fishing activity is nevertheless occasionally conducted near these laying locations, "the volumes of sediment disturbed as a result of cable burial are greater than those disturbed by fishing activity". According to the 2023 European Commission's EU Action Plan on sustainability of fish stocks, instead, the impact of fishing on both the seabed and sensitive species is higher and overfishing is projected to have an annual economic effect of over 3 billion dollar per year – significantly above the sustainable level – with an average exploitation rate of 1.4%, says FAO's The State of Mediterranean and Black Sea Fisheries 2022. So, what's more dangerous for the ecosystem? Cybercrime. Submarine cables are intrinsically geopolitical: they define the physical boundaries of the digital world, manage global power by carrying ever-more-important data and – most importantly – do not wave national flags. Distributed in a system made of jurisdictions, international conventions, and sea laws, they are "invisible" to governments: their "sea blindness" condition – if armed – can increase supply chain risks, technological dependence, and vulnerabilities related to unwelcome foreign interventions.

Mondo Internazionale G.E.O. head researcher Saverio Lesti released a report on the seabed's growing strategic significance, affirming that the primary instruments of the "cyber warfare threat to undersea cables" are sabotage – to inflict financial harm on companies – and cyberattacks – to interfere with vital intelligence networks. "The Mediterranean Sea's undersea cables are a vital target for potential adversaries, as it is a key node in the global communication network", he says. Therefore, governments must implement "submarine warfare" strategies to "diversify routes to reduce the risk of a single attack, improve security with surveillance systems, and develop international agreements".

Simple, right? Not quite, as there are competing interests to consider, including "the lack of political will and legal complexity to regulate the use of the seabed". Same issues encountered by Christian Bueger in his recent paper on the European governance to fight security threats to submarine cables. The professor of ocean governance at the University of Copenhagen argues that "a basic mechanism for information sharing" – initially run by a cross-community working group that includes the cable industry – "needs to be established". He emphasizes that the European Parliament should push Member States to investigate cables on their own, evaluate any vulnerabilities, identify available reaction mechanisms, and communicate the findings with all EU agencies.

To do this, the institutions ought to establish a special budget to help with cable maintenance as well as the investigation and creation of new technologies to increase the technologies' durability. "The main obstacles to an EU-wide governance of the cable network are the lack of systemic data on regulatory agencies, current regulatory protection measures, and national surveillance operations", the professor claims. The necessity of preventing attacks on vital infrastructure is growing as the world observes the conflict between Russia and Ukraine: will Europe act accordingly and fast enough?



Russian seabed warfare capabilities / Credit: Naval News.

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討論案1附件3

OSPAR COMMISSION

Assessment of the environmental impacts of cables

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OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the “OSPAR Convention”) was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain.

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, la Finlande, la France, l’Irlande, l’Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d’Irlande du Nord, la Suède et la Suisse et approuvée par la Communauté européenne et l’Espagne.

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Contents

Executive summary

Submarine cables have a long history within the OSPAR Maritime Area and new cable connections are to be expected

Sub-sea cables are found throughout the five OSPAR regions. Most of the more than 300 cables laid since the middle of the 19th century are cables intended to provide fast telecommunication links. Most long-distance telecommunication cables are found in the southern parts of both the Greater North Sea (Region II) and the Celtic Seas (Region III) and in a corridor crossing the Wider Atlantic (Region V) to North America. Longer-distance power cables to date are confined to the Greater North Sea (Region II) and the Irish Sea (in Region III). These cables supply islands or offshore installations with electrical power or serve as transfer cables between the terrestrial grids of different countries. Transmission cables from offshore wind farms in coastal areas of the North Sea and the Celtic Seas (Region II and III) have been installed over the last decade. It is expected that the number of submarine telecommunication and in particular power cables will increase in the coming years. In particular, the number of offshore wind farm transmission cables is predicted to grow rapidly. This could intensify potential environmental impacts resulting from submarine cables. Developments in the European energy market may also result in an increase in submarine electricity transfer cables.

Cable-laying temporarily disturbs seabed habitats

As far as the construction phase (*i.e.* the placement) of both power and telecommunication cables is concerned, the associated impacts (disturbance, habitat damage) are generally not likely to be detrimental to the overall quality status of the OSPAR region because they are mostly local and temporary. The main long-term impact of submarine cables is the presence of the cable itself and any accompanying protective structures. These can provide artificial hard substrate habitats that attract flora and fauna that may not be typical of the area. Again, since it is confined to the cable route itself, such change is not likely to be significant.

Operational power cables may disturb electromagnetically sensitive or temperature-adapted species

Submarine cables, particularly power transmission lines, may have operational impacts in the form of electromagnetic fields and thermal radiation. Although only few long-distance power cables are in use in the OSPAR maritime area, a final assessment of their effects on the overall environmental state is difficult. For example, the effects of the electromagnetic fields on migrating species (fish, marine mammals) are not sufficiently understood and significant impacts cannot be excluded. Field studies into changes in benthic communities and microbial sediment processes due to increased temperatures in the immediate vicinity of sub-sea cables have not been conducted to date.

Appropriate mitigation measures are available and should be applied

Since there is sufficient evidence that the placement and operation of submarine cables may affect the marine environment, the precautionary principle should be applied and appropriate mitigation measures should be taken. Available measures to minimise or even avoid most of the anticipated environmental impacts include careful routeing and scheduling of installation activities, suitable choice of cable types, appropriate burial of the cable and use of inert material if protective cover is necessary. In addition, further scientific investigations into the environmental impacts of the placement and operation of cables should be conducted in order to close existing gaps in knowledge.

Common guidelines for the placement of submarine cables should be developed

Common guidance on environmental considerations for the placement and operation of submarine cables should be developed by OSPAR. This should include issues to be covered in an environmental impact assessment as well as a description of appropriate mitigation measures related to the choice of cable types, routeing (location), timing of installation, bundling, placement (including burial) and operation of cables. The purpose of the guidance will be to assist OSPAR Contracting Parties, developers, consultants, regulators or any other party interested in the identification and consideration of the environmental impacts of the placement and operation of submarine cables.

Récapitulatif

La question des câbles sous-marins dans la zone maritime OSPAR est de longue date et on peut s'attendre à de nouveaux raccordements de câbles

Des câbles sous-marins sont présents dans les cinq Régions OSPAR. Plus de 300 câbles ont été posés depuis le milieu du XIXème siècle et la plupart sont prévus afin de permettre des liens télécommunications rapides. La plupart des câbles pour télécommunication à longue distance se trouvent dans les parties méridionales de la mer du Nord au sens large (Région II) et des mers celtiques (Région III) et dans un couloir qui traverse l'Atlantique au large (Région V), en direction de l'Amérique du Nord. Les câbles électriques à plus longue distance se limitent à la mer du Nord au sens large (Région II) et à la mer d'Irlande (dans la Région III). Ces câbles amènent le courant aux îles ou aux installations offshore ou assurent le transfert entre les réseaux électriques terrestres des divers pays. Des câbles de transmission pour les parcs d'éoliennes offshore dans les zones côtières de la mer du Nord et des mers celtiques (Régions II & III) ont été installés au cours des dix dernières années. On s'attend à une augmentation du nombre de câbles sous-marins pour télécommunication et en particulier de câbles électriques au cours des prochaines années. On prévoit en particulier que le nombre de câbles de transmission pour les parcs d'éoliennes offshore augmentera rapidement. Ceci pourrait intensifier les impacts potentiels des câbles sous-marins sur l'environnement. Les avancées du marché de l'énergie européen ont également entraîné une augmentation des câbles sous-marins de transfert électrique.

La pose de câbles perturbe temporairement les habitats du fond marin

En ce qui concerne la phase de construction (c'est-à-dire la pose) des câbles électriques et des câbles pour télécommunication, les impacts correspondants (perturbations, dégradation des habitats) ne sont pas dans l'ensemble susceptibles de nuire à l'état de santé général de la région OSPAR car ils sont surtout locaux et temporaires. Le principal impact à long terme des câbles sous-marins est la présence du câble proprement dit et des structures de protection correspondantes. Ceux-ci peuvent constituer des habitats de substrat dur artificiels qui attirent une flore et une faune qui risquent de ne pas être propres à la zone en question. Puisque ces impacts sont limités à la route des câbles, ces modifications ne risquent donc pas d'être significatives.

Les câbles électriques opérationnels risquent de perturber les espèces sensibles à l'électromagnétisme ou adaptées à la température

Les câbles sous-marins, en particulier les câbles électriques, risquent d'avoir des impacts opérationnels sous forme de champs magnétiques et de radiations thermiques. Il est difficile d'effectuer une évaluation définitive des effets, sur l'état général de l'environnement, des câbles électriques à longue distance, bien que peu d'entre eux soient utilisés dans la zone maritime OSPAR. Par exemple on ne comprend pas suffisamment les effets des champs électromagnétiques sur les espèces migratoires (poisson, mammifères marins) et il n'est pas possible d'exclure des impacts significatifs. On n'a pas encore entrepris, à ce jour, des études sur le terrain des modifications subies par les communautés benthiques et les processus microbiens dans les sédiments causés par l'augmentation de la température à proximité immédiate des câbles sous-marins.

Des mesures d'atténuation adéquates sont disponibles et devraient être appliquées

On devrait appliquer le principe de précaution et prendre des mesures d'atténuation adéquates puisque l'on dispose de preuves suffisantes que la pose et l'exploitation de câbles sous-marins risquent d'affecter le milieu marin. Des mesures disponibles permettant de minimiser ou même d'éviter la plupart des impacts environnementaux anticipés sont notamment le soin apporté au choix d'un itinéraire, du calendrier des activités d'installation et du type de câble pertinent, à l'enfouissement adéquat des câbles et à l'emploi de matériau inerte lorsque une couverture de protection est nécessaire. Il faudrait de plus réaliser des enquêtes scientifiques supplémentaires sur les impacts environnementaux de la pose et de l'exploitation de câbles afin de combler les lacunes actuelles des connaissances.

Il faudrait élaborer des lignes directrices communes pour la pose de câbles sous-marins

OSPAR devrait élaborer des orientations sur les considérations environnementales de la pose et de l'exploitation des câbles sous-marins. Il s'agira notamment des questions qu'une évaluation de l'impact environnemental devra couvrir ainsi que d'une description des mesures de mitigation adéquates correspondant à la sélection du type de câble, à l'itinéraire (emplacement), au calendrier de l'installation, au groupement, pose (notamment l'enfouissement) et exploitation des câbles. Ces orientations auront pour objectif d'aider les Parties contractantes OSPAR, les exploitants, les consultants, les régulateurs ou autre partie intéressée à déterminer et à étudier les impacts environnementaux de la pose et de l'exploitation des câbles sous-marins.

1. Introduction

Submarine cables have a long history in the OSPAR maritime area. Telecommunication services started in the middle of the 19th century with the deployment of the first commercially successful telecommunication cable, the England to France link across the English Channel. In 1858 the first trans-ocean telecommunication cable, the Atlantic Cable connecting Ireland and the USA, commenced operation. Since then numerous cables have been put into operation world wide (www.atlantic-cable.com). Nevertheless, the demand for fast communication links is still growing rapidly and results in cable-laying activities around the globe.

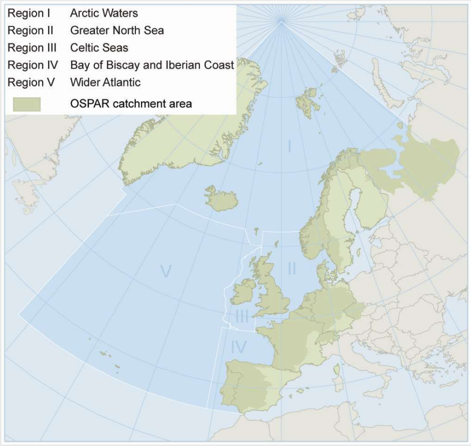
A second aspect of submarine cables gaining more and more importance is the transmission of electric power. Power cables are used to supply islands and offshore facilities or to transport electricity from one country to another. In May 2008, the world's longest sub-sea power cable (NorNed) crossing the North Sea between Norway and the Netherlands was commissioned. A growing number of cables will be needed in the future to transmit electric power supplied from offshore renewable energy sources such as wind farms, tidal power plants and wave power devices into the various terrestrial grids.

In 2008, OSPAR published the 'Background document on potential problems associated with power cables other than those for oil and gas activities' (OSPAR Commission 2008a). The following assessment of the environmental impact of power cables is based on this background document, which contains more details on the scientific background to these issues. It has been prepared as part of the series of assessments of the environmental impact of human activities on the marine environment of the OSPAR maritime area and its Regions (see box). The series of assessments contributes to the Quality Status Report 2010. The assessment of the environmental impact of cables complements the assessment of other activities (see box).

Electronic navigator to complementary QSR assessments

- Offshore wind-farms (OSPAR, 2009a)
- Construction or placement of structures (OSPAR, 2008b)
- Underwater noise (OSPAR, 2009b)

Map: OSPAR maritime area and its five Regions



2. What are the problems? Are they the same in all OSPAR regions?

2.1 Generic Impacts

Modern submarine telecommunication systems are fibre optic cables using pulses of light to transport information. Coaxial cables, as the former standard, use electric current to carry information and are sporadically still in service. However, long-distance optical cables require repeaters and thus also need a constant power supply. Whereas coaxial cables have a diameter of up to 10 cm, fibre optic cables are only 2 – 5 cm thick.

Power cables are deployed to transport electrical energy. As with terrestrial cables, marine power cables use either Alternating Current (AC) or High Voltage Direct Current (HVDC) transmission. Cables may be monopolar (using the sea water as return conductor), bipolar or three-phase systems. Depending on their design the diameter of power cables may be up to 15 cm. Power cables may have a capacity of several hundred megawatts (MW), for example, 700 MW in the case of the NorNed cable between Norway and the Netherlands (www.statnett.no).

Submarine cables are usually buried to minimise the risk of damage by, for example, anchors and fishing gears. Drew & Hopper (1996) and Emu Ltd (2004) reported cables to be buried in areas with water depth of up to 1000 m and 1200 m, respectively. According to Deutsche Telekom AG (pers. comm.), telecommunication cables installed over the last decade have been buried as far as technically feasible, but not in areas with a water depth of more than 3000 m. Where cables cannot be buried, for example, in areas of exposed bedrock, they are laid directly on the seabed and may be (partially) covered with mechanical protection (for example, rock armour).

Submarine cables have a wide range of potential impacts on the marine environment due to their placement (i.e. cable-laying) as well as due to their operation. The various potential impacts of submarine cables differ considerably in terms of their spatial extent, duration, frequency and reversibility. A general overview is given in Table 1.

The various impacts act on different components of the ecosystem in different ways. Seabed disturbance and thermal radiation may impact benthic organisms, underwater noise is most relevant for marine mammals, electromagnetic fields may have effects on sensitive fish and marine mammals and visual disturbance (including visual and aerial noise) has the potential to displace sensitive sea birds and seals. The extent of such impacts is determined by the technical design of the cables, the laying equipment, and in the case of power cables, the amount of electrical power transmitted. Some environmental impacts are mainly linked to the installation phase and/or maintenance, repair activities and removal. Others are only relevant during operation.

*Table 1: **Main environmental impacts associated with submarine cables***

	Installation, Maintenance and Repair work, Removal	**Operational phase**
Telecommunication cable	Seabed disturbance Damage/disturbance of organisms Re-suspension of contaminants Visual disturbance Noise (vessels, laying machinery) Emissions and wastes from vessels	Introduction of artificial hard substrate
Power cable	Seabed disturbance Damage/disturbance of organisms Re-suspension of contaminants Visual disturbance Noise (vessels, laying machinery) Emissions and wastes from vessels	Introduction of artificial hard substrate Electromagnetic fields Thermal radiation

2.2 Seabed Disturbance

The laying of cables leads to seabed disturbance and associated impacts of damage, displacement or disturbance of flora and fauna, increased turbidity, release of contaminants and alteration of sediments. Along with noise and visual disturbance, these effects are mainly restricted to the installation, repair works and/or removal phase and are generally temporary. In addition, their spatial extent is limited to the cable corridor (in the order of 10 m width if the cable has been ploughed into the seabed). Such impacts relate to both submarine telecommunications and power cables. Some mobile benthos (for example, crabs) are able to avoid disturbance (Emu Ltd, 2004) and though sessile species (bivalves, tubeworms etc.) will be impacted, the principal risk is in sensitive habitats which include, for example, slower growing vulnerable or fragile species. Avoidance of such areas for cable placement would be an appropriate mitigation measure.

The application of protection along the cable route in areas characterized by soft sediments will lead to artificial introduction of hard substrates. The submarine cables themselves, if not buried, will also provide a solid substrate for a variety of species (Figure 1). This 'reef effect' has been extensively discussed in literature (see for example, Wenner *et al.,* 1983; Reimers & Branden, 1994; Birklund & Petersen, 2004) and essentially leads to the introduction of non-local fauna and thus to an alteration of the natural benthic community. In most cases effects will be localized although long-term. In general, if armouring is required, inert natural stone material should be used to minimise the degree of impact.

Figure 1:*Sub-sea cable, in place for approximately 50 years, covered with sessile encrusting organisms at Vancouver Island (BCTC, 2006).*

Though modern equipment and installation techniques can reduce the re-suspension of sediment during cable burial or removal, remaining turbidity may nonetheless obstruct the filtration mechanisms of some benthic and pelagic organisms at least temporarily (Söker *et al.*, 2000). It can also affect the growth of the macrobenthos and may have a lethal effect on some species.

Contamination arising from seabed disturbance is only a risk in heavily contaminated locations. Again, avoidance of such areas would be an appropriate mitigation measure. Release of contaminants into the environment from the cable itself can only occur if cables are not removed after decommissioning or if operational cables are damaged, in particular if fluid-filled cables are damaged.

2.3 Noise

There are no clear indications that underwater noise caused by the installation of sub-sea cables poses a high risk of harming marine fauna. Richardson *et al.* (1995) provide an overview of investigations into behavioural responses of cetaceans to dredging, an activity emitting comparatively higher underwater noise levels. However, it is not clear if behavioural responses were due to sound or the increased presence of ships. Appropriate scheduling of cable-laying activities will minimise the potential for such impacts on sensitive species (for example, marine mammals or turtles). In addition, performing aerial or other surveys, with suspension of activities if sensitive species are found, are possible mitigation measures.

2.4 Visual disturbance

Some sea bird species, for example, divers, are very sensitive to visual disturbance and are displaced by ship traffic (Mendel *et al.*, 2008). It can be expected that the working vessel during the installation process will have the same effect and that these birds will avoid these areas during the cable-laying. Scheduling these activities and/or avoiding of wintering, resting and foraging areas of such sensitive species are possible mitigation measures.

2.5 Electromagnetic fields

Electromagnetic fields are generated by operational transmission cables. Electric fields increase in strength as voltage increases and may be as strong as 1000 µV per m (Gill & Taylor, 2001). In addition, induced electric fields are generated by the interaction between the magnetic field around a submarine cable and the ambient saltwater. Magnetic fields are generated by the flow of current and increase in strength as current increases. The strength may reach the multiple of the natural terrestrial magnetic field. In general, HVDC cables produce stronger electromagnetic fields than AC cables. Magnetic fields are best limited by appropriate technical design of the cable (for example, three-phase AC, bipolar HVDC transmission system). Directly generated electric fields are controllable by adequate shielding, however, induced electric fields generated by the magnetic field will occur. Because the strength of both magnetic and electric fields rapidly declines as a function of the distance from the cable, an additional reduction of the exposure of marine species to electromagnetic fields can be achieved by cable burial.

Magnetic fields generated by cables may impair the orientation of fish and marine mammals and affect migratory behaviour. Field studies on fish provided first evidence that operating cables change migration and behaviour of marine animals (Klaustrup, 2006). Marine fish use the earth's magnetic field and field anomalies for orientation especially when migrating (Fricke, 2000). Elasmobranch fish can detect magnetic fields which are weak compared to the earth's magnetic field (Poléo *et al.*, 2001; Gill *et al.*, 2005).

Marine teleost (bony) fish show physiological reactions to electric fields at minimum field strengths of 7 mV*m-1 and behavioural responses at 0.5-7.5 V*m-1 (Poléo *et al.*, 2001). Elasmobranchs (sharks and rays) are more than ten-thousand fold as electrosensitive as the most sensitive teleosts. Gill & Taylor (2001) showed that the dogfish *Scyliorhinus canicula* avoided electric fields at 10 µV cm-1 which were the maximum expected to be emitted from 3-core undersea 150kV, 600A AC cables.

2.6 Thermal radiation

Thermal radiation from submarine cables has become an issue of increasing concern over the past few years. When electric energy is transported, a certain amount gets lost as heat, leading to an increased temperature of the cable surface and subsequent warming of the surrounding environment. Important factors determining the degree of temperature rise are cable characteristics (type of cable), transmission rate and characteristics of the surrounding environment (thermal conductivity, thermal resistance of the sediment etc.). In general, heat dissipation due to transmission losses can be expected to be more significant for AC cables than for HVDC cables at equal transmission rates.

Published theoretical calculations of the temperature effects of operational buried cables are consistent in their predictions of significant temperature rise of the surrounding sediment. The one field study carried out so far, at the Nysted wind farm, did not provide conclusive results (Meißner *et al.*, 2007). The rise in temperature did not exceed 1.4°C in 20 cm depth above the cable, but the capacity of the cable was only 166 MW. In addition, it was not possible to establish a correlation between temperature increase and power transmitted due to lack of data. Furthermore, the coarse sediment of the study location allowed for increased heat loss through the interstitial water than would be the case in common fine sands or mud.

There is evidence that various marine organisms react sensitively to an even minor increase in the ambient temperature. For example, the recruitment of eastern populations of Atlantic cod (*Gadus morhua*) decreases with increasing water temperature (Drinkwater, 2004) and the mortality rates of some intertidal gastropods increases due to rising temperatures (Newell, 1979). Nevertheless, field studies on operational submarine cables are almost completely lacking. Preliminary laboratory experiments revealed that the polychaete worm *Marenzellaria viridis* shows the tendency to avoid areas of the sediment with increased temperature whereas the mud shrimp *Corophium volutator* does not (Borrmann, 2006). Knowledge of warming effects on bacterial and other microbial activity and, thus on biogeochemical processes is currently insufficient.

Due to the lack of field data, the effects of artificially increased temperature on benthos are difficult to assess. It has to be assumed that a permanent increase of the seabed temperature will lead to changes in physiology, reproduction or mortality of certain benthic species and possibly to subsequent alteration of benthic communities due to emigration or immigration. The temperature increase of the upper layer of the seabed inhabited by the majority of benthos depends, amongst other factors, on the burial depth of the cable. To reduce temperature rise an appropriate burial depth should be applied.

Other than direct effects on the marine biota, temperature rise of the sediment due to heat emission from the cable may also alter the physico-chemical conditions in the sediment and increase bacterial activity (Meißner & Sordyl, 2006). Processes set off in deeper sediment layers are likely to finally affect the entire seabed above the cable due to contact with pore water. Alteration of sediment chemistry might possibly exert secondary impacts on benthic fauna and flora. It should be noted that the content of organic matter in the sediments determines these processes.

2.7 Status of submarine cables within the OSPAR region

A comprehensive catalogue of cables in service or planned within the OSPAR maritime area does not exist. Since the middle of the 19th century more than 300 long-distance cables have been laid within the OSPAR maritime area including about 40 trans-ocean connections (http://www.atlantic-cable.com). Figure 2 gives an (incomplete) overview of existing submarine cables in the OSPAR maritime area:

Most long-distance (especially transatlantic) submarine cables in the OSPAR maritime area serve telecommunication purposes. About half of these cross the Greater North Sea (Region II), mainly in the southern part (Figure 2). Since the 1950s about 20 000 km of telecommunication cables have been laid here. Cables crossing the Wider Atlantic (Region V) towards Canada and the USA are concentrated in the Channel and the southern part of the Celtic Seas (Region III). Only few further cables are in use in the Arctic Waters (Region I) and the Bay of Biscay and Iberian Coast (Region IV).

Since 1998, more than 44 new telecommunication cables, several thousands of kilometres long, have been laid within the OSPAR maritime area (http://www.atlantic-cable.com). This represents an increase of more than 15% over the total number laid prior to 1998. Approximately half of the newly-laid cables are in Region II including connections to offshore installations. Eight of the nine new trans-oceanic cables laid since 1998 are to North America and cross Region III and V. This increased the number of intercontinental connections by about 30%. It is likely that future demand for increased communication capacity will lead to further cables being installed.

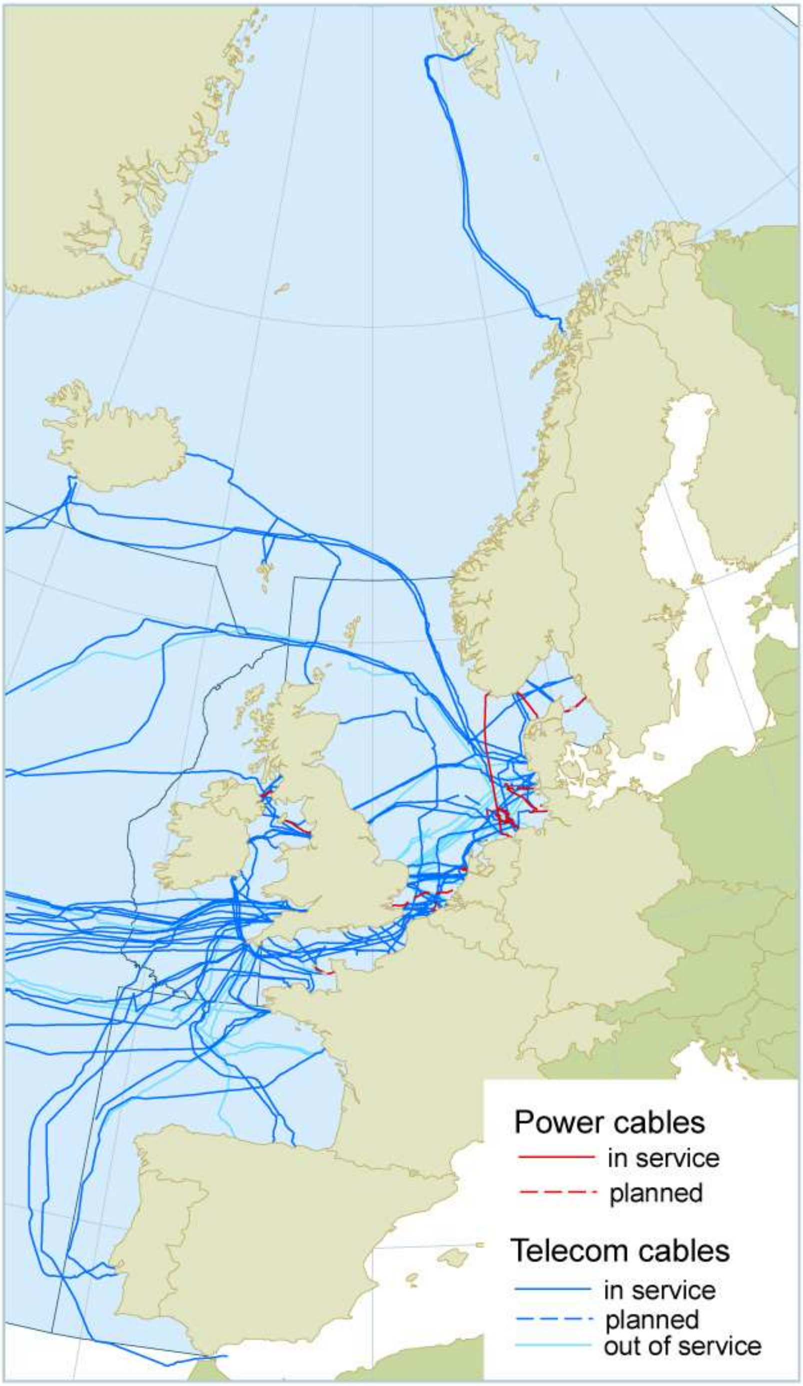


Figure 2*:Submarine cables in the OSPAR Maritime area (incomplete). Compiled from different sources by the German Federal Agency for Nature Conservation.*

A number of short power cables are in use to supply islands with electricity from the mainland (see for example OSPAR Commission, 2008b) or to transmit electric energy produced by offshore wind farms to the terrestrial grids (see below). Longer-distance power cables in service in the OSPAR Maritime Area connecting countries are the Konti-Skan cable in the Kattegat linking the grids of Denmark and Sweden, the cross-Skagerrak cable between Norway and Denmark, the cross-Channel cable between France and England and the NorNed cable between Norway and the Netherlands. The BritNed connection between England and the Netherlands is currently under construction. All these cables are

HVDC cables and are situated in the Greater North Sea (Region II). In Region III, a HVDC cable connects Scotland and Northern Ireland and the world's longest submarine AC cable links the Isle of Man with England.

The two longest power cables in use to date, the Isle of Man connection and the NorNed cable both have been built in the last decade leading to a 200% increase of the length of operational submarine power cables. It is reasonable to assume that in the future more power cables will be required to allow exchange of electricity within the European grid. Nevertheless, no further information is available on other planned sub-sea power cables in the OSPAR maritime area.

There will be an increasing number of cables entering service as the number of offshore wind farms increases in various OSPAR member states. Beside the cables transporting electricity to the grids, wind farms also have cables connecting the turbines with each other and with transformer stations. To date there are 17 offshore wind farms in operation or under construction in the OSPAR maritime area and more than 100 additional wind farms have been authorised or have been applied for. In the medium-term, development of marine renewable energy projects (wave and tidal energy) will create a similar requirement for new cables.

For technical and economic reasons, in the near future offshore wind farms and the respective cables will be mainly restricted to coastal waters and the adjacent EEZs. Offshore power generation is likely to move further out to sea thus leading to an increasing number and length of cables perpendicular to the coast. Within the OSPAR regions this development is expected to take place mainly in the Greater North Sea (Region II), the Celtic Seas (Region III) and may be followed by the Bay of Biscay and the Iberian Coast (Region IV). Reference is made to OSPAR Assessment of the environmental impact of offshore wind-farms (OSPAR 2008 and OSPAR's database on wind farms and the associated maps indicating the location, status (application, authorisation, operation) and size of wind farms in the OSPAR Maritime area (www.ospar.org).

3. What has been done? Did it work?

So far, no common programmes or measures have been developed by OSPAR with respect to the placement of sub-sea cables.

The EIA Directive 85/337/EEC (as amended by Directive 97/11/EC) does not require an environmental impact assessment for the placement of submarine cables, though this may be required by the permitting system of individual Contracting Parties. For example, in Germany an environmental impact assessment has to be provided in the framework of the application procedure (www.bsh.de). The respective permission will include specifications concerning cable routeing, placement time, burial, design of the cable (for example, no monopolar systems) etc.

To increase knowledge on potential effects of the operation of cables, the UK is funding an ongoing investigation into the effects of electromagnetic fields (EMF). This project includes an experimental mesocosm study of the response of sensitive organisms to controlled EMF with the characteristics and magnitude associated with offshore wind farm power cables (Gill *et al.* 2009).

Also in the context of offshore wind farms, Germany facilitated field measurements of seabed temperature changes in the vicinity of the 33 kV and 132 kV AC power cables at the Danish Nysted wind farm. The results (Meißner *et al.*, 2007) underlined in principle the correlation between temperature rise and power transmission. However, so far only qualitative information could be provided since quantitative data on power transmission were not available.

In Germany the nature conservation authorities agreed on a threshold of a maximum tolerable temperature increase of 2 K in 20 cm depth in the sediment in the German offshore areas (which requires burial of cables in depths of about one meter and more). This 2 K value was considered appropriate for applying the precautionary approach to protect benthic organisms and communities from cable-induced temperature rises. The effectiveness of this measure has not been monitored to date.

4. How does this affect the overall quality status?

From the ecological perspective, the most significant environmental impacts of the installation of submarine cables are disturbance effects, especially if the cables are buried. It is difficult to assess how far the status of the marine environment has been affected due to the laying of new-cables since the publication of the QSR 2000. However, it can be assumed that in the Greater North Sea (Region II) and in the Celtic Seas (Region III) cables have often been buried whereas within large parts of the Arctic Waters (Region I) and the Wider Atlantic (Region V) cables have not been buried because of the great water depth.

Impacts of placement are limited to narrow but long stripes along the cable routes and are in most cases temporary. In case of habitat changes due to the introduction of artificial hard substrate, longer-term effects such as the introduction of non-local fauna may occur. Another longer-term impact may arise where unburied cables are moved by tides and currents causing repeated physical disturbance to the seabed in the cable corridor. Provided that no valuable or sensitive habitats have been disturbed and heavily contaminated areas have been avoided, the wider impacts of the placement of cables are of low intensity in OSPAR Regions II and III and probably negligible in Regions I, IV and V.

With respect to the operational phase, the main impacts on the marine environment are expected from the generation of electromagnetic fields and heat. Both these effects are much more relevant to power transmission cables than to telecommunications cables, even though modern fibre-optic cables are equipped with electrical power supplies. While most power cables are found in the coastal waters of all OSPAR regions except the Wider Atlantic, the few longer distance power cables to date are restricted to the Greater North Sea (Region II) and the Celtic Seas (Region III). Most of these HVDC connections use separate monopolar cables for much of their length[1] thus emitting much stronger magnetic fields than do bipolar cables or bundled systems of comparable capacities.

The operation of power cables generates electromagnetic fields that are probably detectable to sensitive species. This may result, for example, in behavioural changes or barrier effects hampering the migration of fish or marine mammals. Because power cables in use outside the North Sea and the Irish Sea are to date only found in coastal areas, most of the OSPAR maritime area may not be affected. The expected future increase in submarine power cables will intensify the effects of electromagnetic fields and the heat unless appropriate mitigation measures are applied. There is concern that cables associated with the large number of planned offshore wind farms may, for example, disrupt the migration of sensitive anadromous fish species on their route into the rivers where they reproduce. The significance of such changes and related impacts especially on migrating species are unknown but potentially high.

The significance of impacts on the overall quality status of the OSPAR region from operational power cables is difficult to assess as field studies are few. Bearing in mind the low number and the relatively small spatial extent of cables, the impact on the overall quality status of the OSPAR region is expected to be low. However, if migration of electromagnetic-sensitive species is affected, the environmental impact will not be restricted to the close vicinity of the cables. The same would be the case if

[1] For example, the NorNed cable consists of 270 km two-core cable (bundled) and 2 x 310 km stretches of single-core cable. (www.statnett.no)

increased sediment temperature results in major changes of benthic communities. Additional extensive field research is needed to understand the significance of such effects.

5. What do we do next?

Even though cables are not covered by the EIA Directive, it is recommended that the Contracting Party responsible should assess the environmental impacts of newly planned submarine cables, especially power cables within the OSPAR maritime area through the EIA process. This assessment should take into consideration the site specific biotic and abiotic features of the cable route. Based on the results of the EIA appropriate mitigation measures should be identified and applied. In general, as a basic prerequisite, a route survey should be carried out to circumvent habitats of conservation interest (for example, boulder fields, seagrass meadows) and in order to provide an adequate description of impacts on the seabed and benthos, including forecasts of possible future impacts (for example, BSH, 2008).

OSPAR Guidance on environmental considerations for the placement and operation of submarine cables should be developed. This should include guidance on appropriate mitigation techniques including routeing (location), bundling and placement of the cables. The purpose of the guidance will be to assist OSPAR Contracting Parties, developers, consultants, regulators or any other party interested in the identification and consideration of the environmental effects of the placement and operation of sub-sea cables. Relevant recommendations of the International Committee for Cable Protection (ICPC) should be taken into account when developing the OSPAR Guidance.

A sound assessment of the environmental impact of cables has to be based on a comprehensive overview of cables in the OSPAR maritime area. In particular, information on existing or planned power cables should be gathered from OSPAR Contracting Parties. Such information should include specification with respect to cable design and capacity, location etc. In addition, new scientific findings on the environmental effects of submarine power cables should be made available.

Gaps in knowledge concerning the operational effects of submarine cables have to be addressed. *In-situ* measurements of the electromagnetic fields (including induced fields) emitted by operating cables should be carried out, taking into account various operational and environmental variables, including burial depth. In order to better understand the effects of electromagnetic fields on fish and marine mammals, information on their specific sensitivities is required. This requirement includes necessary field studies on behavioural changes and on potential disturbance of migration routes of marine species. With respect to heat dissipation in various sediments, monitoring is required to verify the predicted temperature increases. Potential changes in species composition of the benthic fauna due to a temperature rise should also be analysed by respective investigations along the cable routes.

6. Conclusion

Even though sub-sea cables have been in use since the middle of the 19th century, environmental concerns associated with their placement and operation are only recent. One main reason for the increased awareness is the rapid development of offshore wind farms in the last decade and the related increase of the use of submarine power cables.

The approval of new sub-sea cables should follow a licensing procedure and include the preparation of an EIA. The EIA should describe the environmental impacts of installing, operating and removing the cable and develop or propose adequate technical or organisational mitigation measures to manage these impacts.

The placement of both power and telecommunication cables may temporarily lead to impacts such as increased turbidity, noise, disturbance, habitat loss, habitat damage and in certain cases to long-term habitat change due to introduction of artificial substrate. The environmental impacts are generally limited to the near proximity of the cable routes and only in the case of alteration of the habitat are they long-term. However, appropriate mitigation measures are available and should be applied:

- avoiding sensitive habitats/areas;
- scheduling laying activities to certain times of the year to avoid disturbance of sensitive species, for example, marine mammals or resting/feeding (sea) birds;
- avoidance of heavily contaminated areas in order to prevent the re-mobilisation of contaminants from sediments.

Depending on their technical design, the transmission of electric power through these cables may generate electromagnetic fields strong enough to disturb the behaviour and migration of species sensitive to electromagnetic fields, for example, fish and marine mammals. In addition, loss of energy in the form of heat will occur, raising the temperature of the inhabited sea bottom and potentially affecting benthic species and processes.

The environmental impact of electromagnetic fields and thermal radiation on the population or ecosystem level is uncertain. Nevertheless, there is sufficient evidence that significant effects cannot be excluded. Suitable mitigation measures are available and should be applied following the precautionary principle when commissioning new cables. These include:

- application of cable types suitable to reduce the emission of magnetic fields, such as three-phase AC-cables, bipolar HVDC transmission systems;
- use of adequate shielding to minimise the emission of directly generated electric fields;
- burial of the cables to reduce exposure of sensitive species to electromagnetic fields by increasing the physical distance of the animals to the cable;
- an appropriate trenching depth to limit the rise in sediment temperature to prevent macrozoobenthic fauna from harm and benthic communities and processes from changes.

A coherent marine transmission grid should be promoted to reduce the number of anticipated power cables, amongst others linking various individual offshore wind farms together by using sub-sea cables with a high transmission capacity.

Both power and telecommunication cables should be removed once they are out of operation to allow for a recovery of the sea bottom.

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OSPAR's vision is of a clean, healthy and biologically diverse North-East Atlantic used sustainably

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內政部海岸管理審議會第 78 會議簽到簿

時　間：113 年 6 月 21（星期五）上午 9 時 30 分

地　點：國家公園署 B1 第一會議室

主　席：劉主任委員世芳（主任委員及副主任委員均未能出席時，由出席委員互推一人代理主席）

董建宏代

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