國際海洋資訊

International Ocean Information

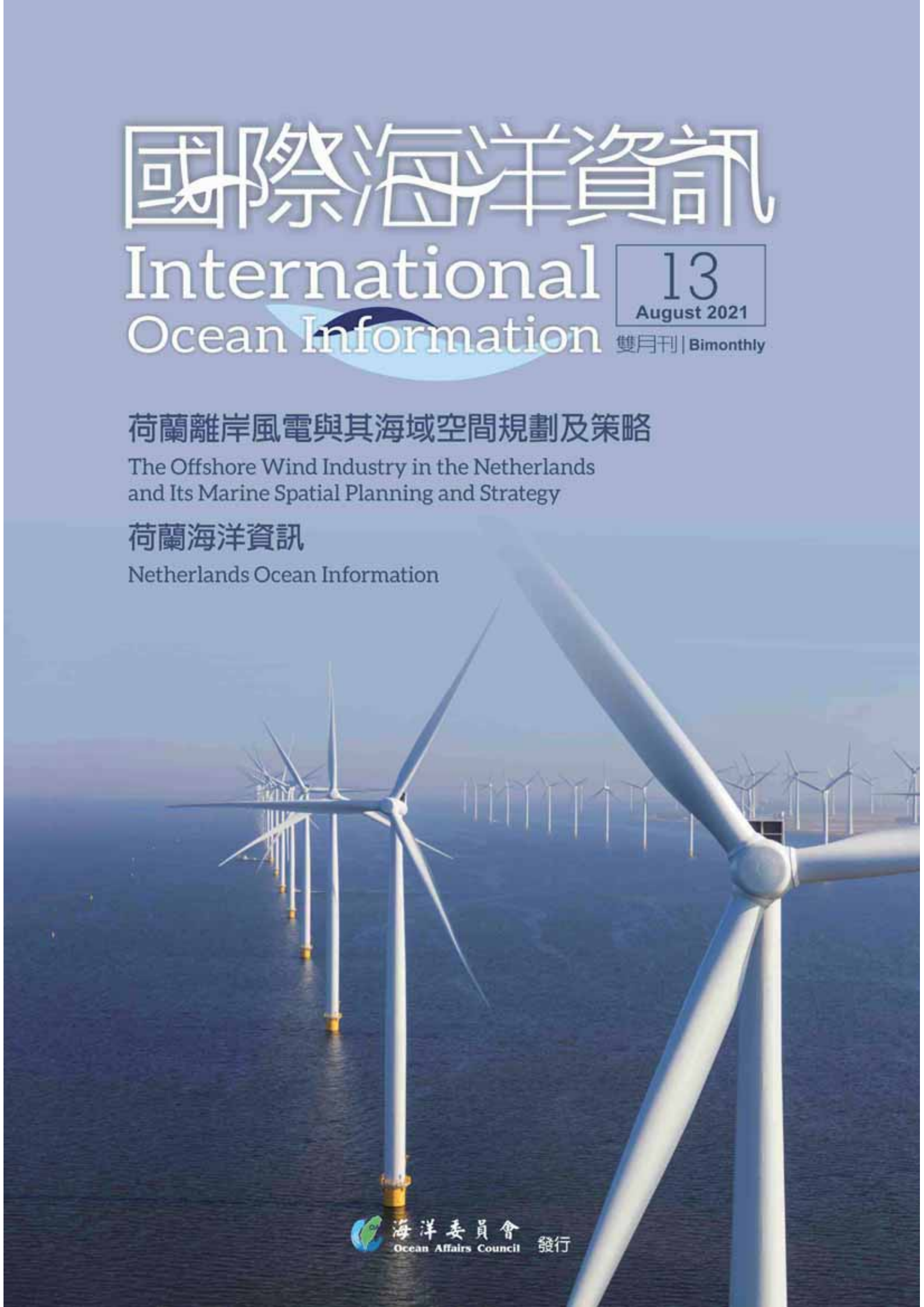
13
August 2021
雙月刊 | Bimonthly

荷蘭離岸風電與其海域空間規劃及策略

The Offshore Wind Industry in the Netherlands and Its Marine Spatial Planning and Strategy

荷蘭海洋資訊

Netherlands Ocean Information



海洋委員會 Ocean Affairs Council 發行

國際海洋資訊 13 August 2021 雙月刊 | Bimonthly
International Ocean Information

目錄 Contents

關注海洋環境 共探增能減廢的荷心經驗

主任委員：李仲威

海洋環境的變化，是全球都應該關注的焦點，聯合國今年（2021）發布第2期世界海洋評估報告，除了全面記錄海洋環境的生態、經濟和社會面向等資訊，更提醒我們應妥善管理海洋，利用創新科技、知識整合與能量建置等方法，來確保海洋的永續發展。本期除在「國際議題」專欄解讀此份報告，也向讀者介紹荷蘭的海洋治理與科技發展，如「組織焦點」分析荷蘭基礎設施暨水資源管理部（Ministry of Infrastructure and Water Management, Ministry of I&W）在海上運輸與港口、水資源管理以及帆船與小船方面的政策規劃；「產業動態」介紹荷蘭的循環經濟政策與減廢技術，還有當地企業利用海洋廢棄物回收再製成地毯、沙發和滑板，提升海廢效益；「資訊新知」則聚焦荷蘭海事研究所（Maritime Research Institute Netherlands, MARIN）研發具能源中心、生活空間、海上農場和海上運輸物流等多功能的Space@Sea大型浮動島。

而我國在積極發展離岸風電的此刻，更期望藉由荷蘭經驗提供我方參考，「專題報導」邀請荷蘭企業署撰文（荷蘭在台辦事處提供），分享荷蘭政府在能源轉型路上為降低離岸風電開發風險，所制定的10步驟政策辦法，除為專案開發商創造有利的市場和投標條件，也展現政府的主導作用；「法規制度」則探討荷蘭物理環境顧問委員會（Physical Environment Consultative Council, OFL）在利害關係人協商方面的協調角色，並達成《北海協議》（North Sea Agreement, NSA）凝聚多方共識。荷蘭在離岸風電開發方面的經驗分享，可做為我國進行海域利用協商作法之參考。

圖說／北海的離岸風電人工島概念圖
圖片來源／Tennet
https://www.tennet.eu/company/news-and-press/footage/footage-tennet/

荷蘭離岸風電與其海域空間規劃及策略

撰文／Henk van Elburg、Kees Mokveld（荷蘭企業署）
中文翻譯／萬象翻譯股份有限公司
本文由荷蘭在台辦事處提供（英文）
關鍵字／離岸風電產業、海域空間規劃、荷蘭

荷蘭能源轉型正如火如荼地展開，而離岸風電是政府和民間企業達成氣候雄心的基石。荷蘭在海域營運有著悠久的歷史、嶄新的政策推動和持續不斷地創新，使其在國際離岸風電產業方面相當知名。荷蘭致力於達成《巴黎協定》並在「2030年願景」明確提出2030年離岸風電目標為11.5GW。荷蘭政府預先指定風電場域與招標制度相結合，為開發商創造了一個清晰可見的願景。政府負責場址研究和連接離岸電網，為開發商降低風險，並增強投資者信心。

荷蘭2013年以前離岸風電的缺點在於：專案開發商獨自負責選址、調查和許可流程，在申請補貼之前面臨著高昂的成本和風險。因此到2017年為止，在80項初步申請中，荷蘭北海經濟區（Dutch Economic Zone of the North Sea）實際建造完成的離岸風場只有4個，總計裝置容量不足1GW。

相較之下，現今的政策辦法藉由規範離岸風場建設的條件，即確切場址、穩定的招標計畫、同意書、電網併網、必要時的營運補助金，荷蘭政府幫助降低投標前的投資風險、融資以及社會成本。

現今的政策辦法可用10個步驟詳加解釋，展現政府如何發揮主導作用。

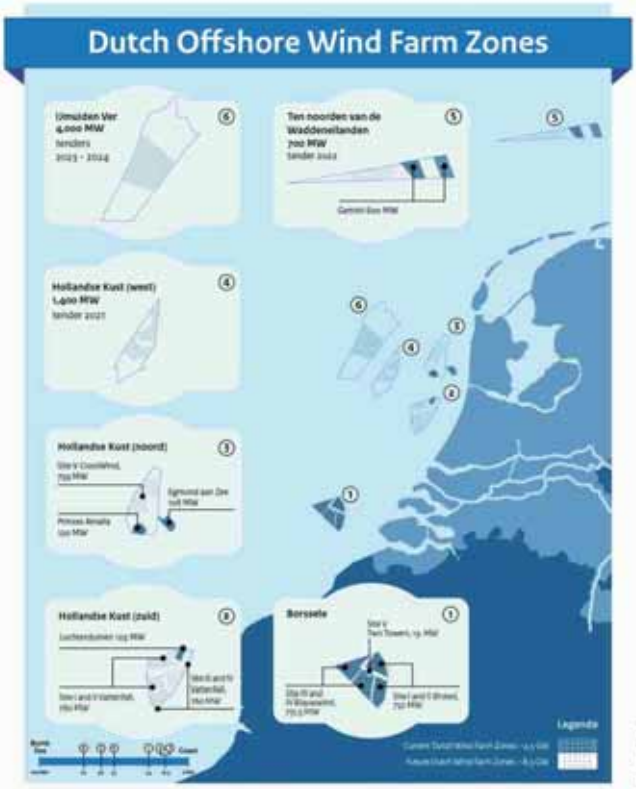
圖1／荷蘭於北海領海（經濟區）的離岸風場開發區域
圖片提供／荷蘭企業署

步驟1：指定風電場域

荷蘭針對離岸風電制度立法，始於早期場域規劃。藉由「國家水資源計畫」（以《水資源法案》〔Water Act〕為基礎），經濟事務暨氣候政策部（Ministry of Economic Affairs and Climate Policy, Ministry of EZK）以及基礎設施暨水資源管理部（Ministry of Infrastructure and Water Management, Ministry of I&W）在荷蘭北海領海分配了未來離岸風場的開發區域，每個區域可以包含一或多個風場場址。

步驟2：制定離岸風場招標藍圖（推行計畫）

離岸風場藍圖中規範了開發風場之區域、個別場址的預計發電容量以及安裝和運作招標年份的詳細推行順序。



2015年，在與風電業密切磋商之下，荷蘭通過了《離岸風電法》並且公布了第1次招標藍圖（2015～2023），旨在2023年前新增3.5GW的離岸風電總容量。

在第一份藍圖成功推動招標的鼓舞下，政府於2018年發布了另一份藍圖（2023～2030），宣布在2030年底前再開發7GW離岸風電。

圖2／2030年離岸風場藍圖
圖片提供／荷蘭企業署

步驟3：展開研究

在議會批准藍圖後，未來的離岸風場場址將接受全面的環境影響評估（Environmental Impact Assessment, EIA），由經濟事務暨氣候政策部和基礎設施暨水資源管理部發布選定風場場址（見步驟5）。步驟3將進行一系列場址研究。

對場址進行分析，必要時處理風場對於周遭經濟、社會和生態造成的影響，場址選定依法受到經濟事務暨氣候政策部及基礎設施暨水資源管理部委託進行的EIA規範。EIA的結果將在場址選定時（步驟5）公布，供大眾檢視（和申訴），之後將不可撤銷。

同時，政府亦進行一系列實地研究（土壤、風力及水力），例如氣象和海洋調查、土壤調查、生態土壤調查、考古調查和未爆彈調查。與EIA的模式相似，這些實地資料研究的結果將提供給專案開發商，供其前端工程設計（FEED）研究在招標流程中提交競爭性投標（另見步驟6）。

因此，專案開發商（許可申請人）不需自行進行EIA與場址研究。這些調查的相關費用由國家負擔並經過官方認證。

步驟4：安裝電網併網

荷蘭國家輸電系統營運商TenneT依法受託負責風場與陸上電網的併網連接。由於離岸電網的規劃和安裝通常需要8至10年的時間，因此，需儘早做出是否安裝該電網的決策。

與專案開發商個別安裝電網併網相比，選擇TenneT作為離岸電網系統營運商具有明顯的優勢。TenneT的電網運作模式簡化了電網波動補償、流量管理和供需平衡，同時，一體化電網運作模式亦可使電力系統中的分配任務和責任歸屬更為明確。

為了創造節省成本的規模經濟，設計了標準化交流變電站（每個容量為700MW），使用2條220kV輸出電纜將風場連接到國家電網。一旦380kV的海底電纜可用，將可減少目前所需的電纜數量。

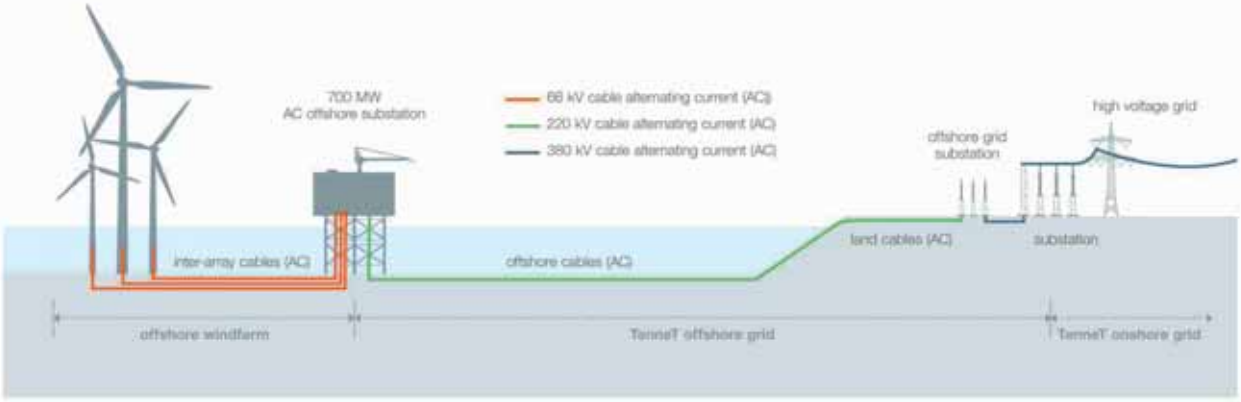


圖3／如果到陸上連接點的距離相對較短，且提供的容量相對有限，則可以配置交流（AC）離岸電網
圖片提供／荷蘭企業署

對於遠離海岸的離岸風場，便需要直流變電站。其連接的輸電容量約為2GW，藉由2條525kV電纜連接陸上變電站，將成為離岸電網的一部分。

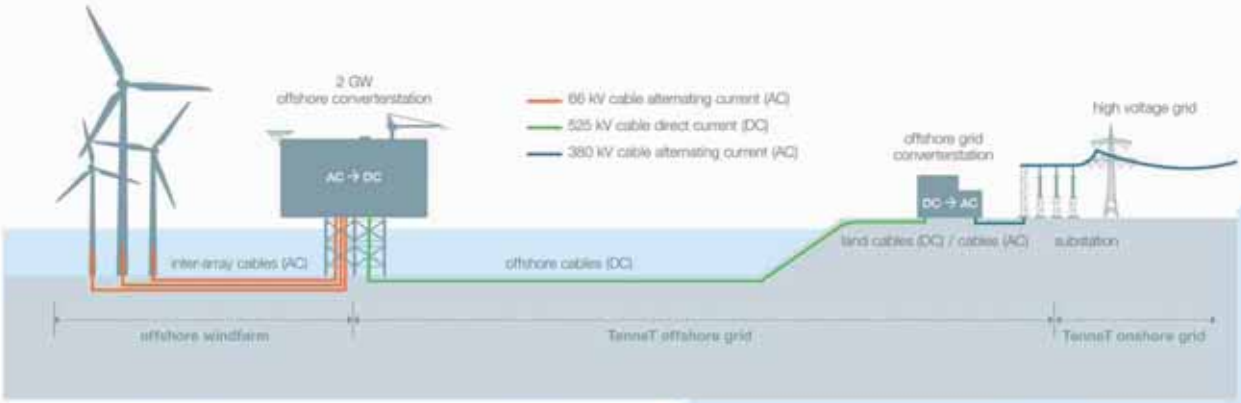


圖4／鑑於距離陸上連接點相對較遠（70公里）且需要連接的容量較大（約4GW），IJmuiden Ver風場區將採用直流技術（HVDC）連接
圖片提供／荷蘭企業署

將風力發電機連接到變電站的內陣列（場內）電纜仍由專案開發商負責。風力發電機將藉由66kV場內電纜連接到TenneT平臺，使荷蘭離岸風場成為世界上第1個採用66kV而非33kV電壓連接的風場。

政府藉由發展架構提供指引來規劃離岸電網的公共投資。本架構概述了離岸電網的設計和建造及其主要功能和技術要求。它也規定出TenneT作為離岸輸電系統營運商的任務，並制定場址開發的順序、現場連接試俥的時間表。在發展架構的基礎上，TenneT制定了一個兩年一次的投資計畫，列出了預定的投資、績效目標、期限和產能擴張計畫。這項投資計畫需要得到荷蘭消費者與市場管理局（Authority for Consumers & Markets, ACM）的核准。

TenneT和離岸風場營運商簽署了一份達成協議以及一份連接和傳輸協議。協議中規定了風場有關併聯電網的條款和條件，涉及併聯電網和變電站的基本設計與技術規範，以及TenneT與風場開發商之間的作業安排和資訊交流等。如果離岸電網有延遲或無法使用的狀況，TenneT依法承諾賠償風場所有者延遲或錯過的（補貼）電力銷售收入和間接損害。

步驟5：合意一作出風場選址決策

在初步分配風電場域（步驟1）、藍圖規劃（步驟2）、EIA評估（步驟3）和離岸電網決策（步驟4）之後，政府現在準備公布風場「選址決策」。風場選址決策是荷蘭《離岸風電法》的基石。只有核發許可後，才能建造離岸風場。因此，風場選址決策決定了風場的位置以及風場的建設和營運條件，同時亦考慮了風場的周遭生態和後續退役等問題。這些條件可能與風力發電機（最小功率、葉尖最高速和最低速）和場內電纜（禁止設於風場邊界外）有關。選址決策仍為風場設計保有一些彈性。開發商有機會在自然和環境架構內選擇最新的技術創新，以盡可能低的成本營運風場。

步驟6：舉辦招標

風場選址決策定案不可撤銷後，政府便開始進行招標。招標結束後，經濟事務暨氣候政策部部長將在13週內宣布得標人，此任命期限可再延長13週。得標決議可由參與招標競爭者提出異議和申訴，異議必須在得標之日起6週內提出，後續申訴可在反對決議之日起6週內提出。

現行的立法招標架構劃分了3種可供將來使用的可選招標模式：最低補貼招標、最佳可行性（+財務）招標和最高拍賣價格招標。

《海上風能法》正在進行部分法條修訂，目的是：一、在（零補貼）招標模式中創造更多選擇；二、納入氫氣等其他再生能源；三、將許可的有效期限從30年延長至40年。預計議會將在2021年核准。

步驟7：核發許可

得標後，政府將立即核發風場建設、營運和拆除許可。有了許可，得標開發商可以立即開始建置風場。許可規定，風場必須在4年（最晚5年）內建成，建成後的有效期限最長為40年。

步驟8：監督風場相關準備

一旦獲得許可，風場開發商必須遵守與申請一起提交的風場建設和營運計畫。如步驟5所述，許可對創新保持開放彈性，因此允許與風場開發或營運相關的部分許可變更。生產裝置重大變更的例子有生產裝置的風力發電機數量、位置、輪轂高度、風力發電機類型和基座類型。風場開發商能夠使用最新的技術，並透過創新降低成本。

步驟9：監督風場之建置

公共工程和水管理總局（Rijkswaterstaat, RWS）負責監督風場的規劃、建設和營運。每個階段的監督活動各不相同。規劃階段主要包括評估許可持有人擬備的工作計畫。在施工階段，藉由荷蘭海岸巡防隊（Netherlands Coastguard）和國家礦業監理局（State Supervision of Mines, SSM）的船隻和航空器進行檢查。

步驟10：監督風場運作

風場運作產生了電力。在運作階段，RWS監督運作管理和維護活動，最長40年後，該風場將退役並拆除。許可在此期限後不再有效。

結論

可以肯定的是，這10個步驟的導入，證明荷蘭是離岸風電開發中「改變遊戲規則的參與者」。這10個步驟有助於降低離岸風電開發的風險，降低開發商的成本。再加上每年將1GW離岸風電發電容量加入電網的藍圖目標，開發商信心因而大增，帶來零補貼投標和電價歷史新低。截至2030年，預計裝置總容量可達到11.5GW。

荷蘭政府的政策架構證明了政府為公私部門指引作業流程、設定步調的重要性，由其擬定開發速度、風場最大容量、規劃和分區、場址調查和電網併網等。藉由規範風場建設的所有條件，荷蘭政府降低了專案開發風險、融資以及（最後但並非最不重要的）社會成本。

如今，荷蘭在成本效益較高的離岸風電開發和安裝領域處於領先地位。近年來，國際社會越來越關注荷蘭對離岸風電的作法、招標制度和選址上的研究。北海風場的建置，創造了全球對離岸風電的信心。

瞭解海洋：聯合國2021年發布第2期世界海洋評估報告

撰文／陳璋玲（國立成功大學海洋科技與事務研究所教授）
關鍵字／海洋環境、評估、社經面向

依據聯合國大會於2003年和2004年分別通過的案號57/141和58/240決議案，聯合國決定建立一個定期性的評估程序，作為海洋環境的全球報告與評估，且包括的面向包括社會經濟層面。此定期性評估程序的目的在評估全球海洋環境狀態、海洋提供的服務，以及影響海洋狀態的人類活動。第1期的世界海洋評估報告（簡稱評估報告）已於2015年完成，此評估報告建立了海洋環境的基準資料（baseline），並指出海洋許多部分已受到嚴重損害，若未能及時解決，將產生破壞性的循環，使海洋無法再提供人類依賴海洋所獲致的利益。此評估報告發表後，接續啓動2017～2020年第2期的評估程序，並於2021年發表第2期的世界海洋評估報告[1]。此評估報告是建立在第1期評估報告的基準上，並進一步評估海洋環境的改變和趨勢。

圖1／海洋保護區可減緩人類使用海洋造成的衝擊（攝於美國海峽群島國家公園）
圖片提供／陳璋玲

內容架構

第2期世界海洋評估報告計有28章，分兩大冊。第1冊包含第1章至第7章，計570頁；第2冊包含第8章至第28章，計520頁。內容非常多元豐富，主要內容包括海洋環境趨勢、各項人類活動對海洋環境的影響，以及管理措施的進展等，全面地記錄海洋環境的生態、經濟和社會面向等資訊。本評估報告亦和聯合國2015年通過之永續發展目標（Sustainable Development Goals, SDGs）的目標14：「保育及永續利用海洋與海洋資源，以確保永續發展」予以適當連結。

第1冊的內容重點在評估方法、影響海洋環境變化的驅動力（drivers）、海洋物理和化學狀態的趨勢以及海洋生物多樣性的趨勢。第2冊內容則是關切人類在海洋的各項活動（如漁業、養殖、海底採礦等）和所造成問題（如營養鹽排放、液體和大氣排放、固體廢棄物排放、海岸侵蝕等）的變化或趨勢、活動帶來的環境和社經衝擊，以及知識和／或能量建置落後的問題。此外，第2冊亦檢視管理措施的進展（例如海洋空間規劃），並於最後一章檢視海洋提供的整體效益。

評估報告各章的標題如下：

第1冊

第1章：整體摘要

第2章：評估方法

第3章：瞭解海洋的科學面向

第4章：影響海洋環境的驅動力

第5章：海洋物理和化學狀態的趨勢

第6章：海洋生物多樣性的趨勢。此章分7個子章，分別為浮游生物（浮游植物、浮游動物、微生物和病毒）、海洋無脊椎動物、魚類、海洋哺乳類、海洋爬蟲類、海鳥、海洋植物和大型海藻。

第7章：海洋棲地多樣性的趨勢。此章分17個子章，分別為潮間帶；生物礁和沙質、泥質和岩岸質地；環礁和島嶼瀉湖；熱帶和亞熱帶珊瑚礁；冷水珊瑚；河口和三角洲；海草床；紅樹林；鹽沼；大陸棚和海底峽谷；高緯度覆冰區域；海底山和尖頂；深淵平原；大洋；海洋脊、高原和海溝；海底熱泉和冷泉；馬尾藻海。

第2冊

第8章：和海洋相關之人類社會狀態的趨勢。此章分2個子章，包括為海岸社區和海洋產業，以及受海洋影響的人類健康。

第9章：源自於氣候和大氣變化的壓力

第10章：營養鹽排入海洋環境的變化

第11章：來自陸地（包括透過地下水）、船舶和外海設備的液體和大氣排入海洋環境的變化

第12章：固體廢棄物排入海洋環境和分布的變化

第13章：海岸侵蝕和堆積的變化

第14章：海岸和海洋基礎設施的變化

第15章：漁業捕撈和野生海洋無脊椎動物捕獲的變化

第16章：養殖的變化

第17章：海草採收和使用的變化

第18章：海底採礦的變化

第19章：碳氫化合物探勘和萃取的變化

第20章：人為噪音在海洋環境的趨勢

第21章：海洋再生能源的發展

第22章：外來侵入種

第23章：海洋基因資源探測和使用的發展

第24章：海洋水合物—一個可能新興的議題

第25章：累積性影響

第26章：海洋空間規劃的發展

第27章：管理手段的發展

第28章：海洋之於人類整體利益瞭解的進展

摘要重點

由於評估的報告內容非常龐大，本段呈現報告的摘要重點如下：

- 自第一期評估報告發表以來，用以緩和或減少人類活動的壓力，以及因應壓力對海洋衝擊的措施已有改善，方法之一為擴充與實施海洋環境保育的管理架構（如海洋保護區的設立、污染和漁業管理）。然而，許多壓力仍持續破壞海洋（如紅樹林、珊瑚等重要棲息地），包括不永續的漁業行為（如非法、未報告及不受規範漁撈）、外來種入侵、海洋酸化、大量營養鹽和有毒物質排入海洋（如塑膠、塑膠微粒、人為噪音），以及管理不善的海岸開發和自然資源開採。

- 有關壓力對海洋環境影響和累積性影響的量化評估仍缺乏。從糧食安全、物質提供、人類健康和福祉、海岸安全，以及關鍵生態系統服務的維護等角度來看，若未能達成海岸和海洋資源使用的整合性管理，將增加人類從海洋獲致利益的風險。

- 改善海洋使用管理可確保永續，此需要能量建置、海洋科技創新、跨領域觀測系統整合，以及海洋知識和科技的整合性管理、規劃、取得和交換。

- COVID-19疫情對於人類在海洋的活動有很大的影響，但疫情之於人類和海洋互動的整體意涵仍尚待評估。

- 驅動力具有和社會、人口和經濟發展相關的特徵，包括生活型態的改變，以及相關的消費和生產型態，這些皆對海洋產生壓力。驅動力和壓力的關係是複雜且變動的，已確認的驅動力包括人口成長、經濟活動、科技進步、治理結構改變、地緣政治不穩定，以及氣候變遷。

- 缺乏合適的廢污水處理，以及持續來自於製造業、養殖、旅遊、漁業和航運等污染物的排放對海洋施予壓力。此對糧食安全和海洋生物多樣性造成負面衝擊。海洋垃圾更是一個問題，它的存在除了帶來環境和經濟傷害外，更可透過長距離傳送污染物和外來種生物。

- 海洋生態系的主要威脅來自人類活動，例如漁業、養殖、航運、砂礦採取、石油和天然氣開採、再生能源設施興建、海岸基礎設施，以及污染（包括溫室氣體排放）。許多保護海洋生態系統的海洋管理架構是部門導向，因此容易造成跨部門之間對海洋環境保護存有不同的目標。管理工具可

以是以區域為基礎，或不以區域為基礎，前者如海洋保護區和漁場關閉；後者如全球氣體排放控制、漁獲和努力量控制，以及漁獲技術限制等等。目前管理手段逐漸從部門式管理朝向多元面向關聯的管理方式，包括生態、社會、經濟和文化等面向。此外，文化資訊也成為管理架構的重要一環，存在於以社區為基礎的管理方式，而且有助保存海洋環境的文化面向。

- 瞭解海洋有助於永續管理。感應器和自動觀測平臺相關科技和工程的創新，允許在更小尺度的空間和時間上來進行海洋資訊的收集，同時可在偏遠地區觀測資料。具有成本效益和使用者方便特性的感應器和行動裝置，公民參與的增加，以及非研究船舶上裝設感應器，皆大大擴大海洋觀測資料的收集。這些創新科技發展增進我們對海洋物理、生物、地質和化學系統，以及海洋因應氣候變遷如何改變的瞭解，同時也提升全球和區域尺度的海洋模擬能力。

- 海嘯、暴潮、瘋狗浪、氣旋、颶風、海岸溢淹、侵蝕、海洋熱浪和藻華等事件，加上有毒物質的影響和過度營養物質排放，對於糧食安全可能造成威脅，且也阻礙經濟永續發展。

- 海洋的動物蛋白質（大部分來自漁業）占人類消費的動物蛋白質的17%，其支撐12%人類的生計。但值得注意的是，養殖對於糧食安全的貢獻度正快速增加中，且成長的潛力大於捕撈業。漁業本身是海洋環境的壓力因子，而養殖規模的擴大更增加對海洋生態系的壓力，或帶來新的壓力，尤其在海岸地區。

- 海洋支持許多經濟活動，包括海底採礦、外海碳氫化合物開採、觀光遊憩、海洋基因資源、海洋再生能源等。所有海洋產業皆高度依賴科技，如此海洋產業始能安全運作且減少對海洋環境的危害。有關海洋基因資源部分，這領域的大部分開發工作僅在少數國家進行，因此能量建置仍是一個議題。為永續發展藍色經濟，有必要在許多國家規劃和建置相關的海洋基因資源開發技術。

- 《聯合國海洋法公約》（United Nations Convention on the Law of the Sea, UNCLOS）在經濟和社會發展需求，以及保育和永續管理海洋資源的必要性之間建立一個細膩的平衡。除了公約的兩個執行協定外（第11部分協定〔Agreement Relating to the Implementation of Part XI of the UNCLOS, 1994 Part XI Agreement〕和跨界魚種協定〔Agreement for the Implementation of the Provisions of the UNCLOS relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, 1995 Fish Stocks Agreement〕），許多全球性和區域性的法規文件亦補充公約，且涵蓋海洋使用的許多面向，例如屬全球性文件的《防止船舶污染國際公約》（International Convention for the Prevention of Pollution from Ships, MARPOL）；另一個是屬區域性文件的《中西太平洋高度洄游魚種保育和管理公約》（Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean）。然而，有些國家因為缺乏財務、技術和人力資源，因此無法善盡國家義務並有效執行這些法律文件。尤其許多開發中島嶼和低度發展國家缺乏知識和技術人力資源以進行海洋管理，而且其管理轄屬大面積海域資源的能力通常非常有限。

●評估報告內容詳細完整，各章節內容均和聯合國永續發展目標的目標14（保育及永續利用海洋與海洋資源，以確保永續發展）及其所屬的各子目標有所關聯。例如，子目標14.1「潔淨海洋」和評估報告第10章、第11章、第12章及第20章有關。子目標14.2「保護和恢復生態系」和第6章及第7章有關。子目標14.3「減少海水酸化」和第5章、第9章、第10章和第13章有關。目標14則反應在最後一章—第28章。

●報告亦針對聯合國永續發展目標14的各子目標列出對應的機制作為，例如子目標14.1對應的機制包括改善廢污水管理；都市永續化發展和減少都市對環境的衝擊；改善科學、科技和創新科技的使用；提升知識分享、科技轉移，以及能量建置。

表1／永續發展目標14子目標

子目標14.1	2025年以前，避免和減少各類海洋污染，尤其是陸源性的海洋垃圾和營養鹽污染。
子目標14.2	2020年以前，以永續方式管理和保護海洋和海岸生態系，包括加強生態系韌性和採取行動致力恢復生態系。
子目標14.3	減少和解決海洋酸化的影響，包括透過各層級的科學合作。

圖2／養殖快速成長對海洋／海岸生態系帶來壓力
圖片提供／陳璋玲

圖3／廢棄物丟入海洋破壞海洋環境
圖片提供／陳璋玲

圖4／海洋支持許多經濟活動—觀光遊憩
圖片提供／陳璋玲

結語

第1期評估報告於2015年發表後，第2期評估報告接續於2021年發表。2021年的報告進一步提供最新的全球海洋環境狀況、變化和趨勢，內容完整，包含大尺度的海洋環境趨勢、人類各項活動對海洋環境的影響、管理措施的進展，以及海洋提供予人類整體利益的相關資訊。報告內容亦和聯合國2015年通過之永續發展目標的目標14和其下各項子目標予以適當連結，並列出達成該等目標的有關機制作為。

參考資料

[1] United Nations (2021). The Second World Ocean Assessment (WOA II).

荷蘭海廢處理對策

撰文／顏寧（澄洋環境顧問執行長）
關鍵字／荷蘭、循環經濟、海洋廢棄物、升級再造（Upcycling）

荷蘭，一個面積比臺灣稍稍大些、人口又少一些，一樣有著潮溼多雨氣候的歐洲國家。跟臺灣相似的是，在可貴的土地上，發展了花卉和蔬果的精緻農業。臺灣有護國神山台積電供應全球晶片，荷蘭則擁有許多穩坐全球市場的品牌，例如殼牌汽油、家電霸主菲利普，以及食品工業巨頭聯合利華。在面對海洋廢棄物的問題上，荷蘭不像臺灣，針對海洋廢棄物提出行動方案，從源頭管理的減塑政策以及加強清理下手。荷蘭提出的是一個更宏觀的視角：的確，海洋廢棄物威脅了海洋中的生物與水體環境，如果，根本不會產生廢棄物呢？

荷蘭的循環經濟政策

在步入荷蘭的政策之前，讓我們先回顧目前人類的生活方式。我們生活起居的一切，絕大部分都是線性經濟的產物。上游廠商生產原物料，經過加工、設計、生產、配送到市場上，我們消費、使用、使用後丟棄，再去購買新的物品。當人們開始有回收的觀念後，有些材料能重新回到製造端。可惜的是，在現在的體系之下，並非所有的東西都能回收。舉例來說，多數的家電產品是複合材質，像吹風機就包含ABS（丙烯腈-丁二烯-苯乙烯共聚合物）外殼，PP（聚丙烯）吹嘴，金屬線圈，陶瓷隔熱板和PVC（聚氯乙烯）塑膠線材包裹的電線，除非一一拆解，否則沒有回收廠願意收。另外，即使有些材質理論上可以回收，例如PS（聚苯乙烯），如果量太少或市場價值較低，即使能回收，也會因為沒有價值而被當成一般垃圾處理。

相對於目前僅聚焦在物品的回收，荷蘭政府想解決的，是減少物品成為廢棄物的機會。要達成這個目標，除了再次使用物品，還可以透過產品設計、修理、翻新、重新組裝與材料重塑等方式（例如將無毒的工業廢料窯燒為建築鋪面材料，或是用植物的剩餘材料例如稻梗轉化為食品容器），以延長物品的生命週期。荷蘭政府的目標，是用封閉循環（closed-loop）的經濟模式取代現有的線性經濟，在2030年減少一半的原物料使用，在2050年達到完全循環經濟[1]。

這個遠大的目標面對重重挑戰。在生產端上，需開創聚焦在封閉循環的設計和生產上；甚至開發自然資源的永續使用，以減少材料的耗損。在消費端，則需要消費者有意識的消費和使用產品，降低產品廢棄的量。廢棄物的品質和總量是循環活動的指標，因此，也需要更多與更好的回收。而中央政府透過以下3個行動，加速民間與市場擁抱循環經濟。一是強化創新的網絡，串聯不同的部門與永續的新創團體；二是消除法律與規範的壁壘，包含修改法條、核發證照以及允許實驗的空間；三是透過採購和提升民眾認知，作為市場的支持[2]。

打掉重練更值錢：讓廢棄物重生的創新之路

過去我們習以為常的回收，許多都屬於降級回收（Downcycling），回收後的材料因為無法達到原本材料的強度或品質，使得回收後的價值下降而稱之。傳統上紙和塑膠回收，都屬於降級回收。例如紙回收後成為紙質較次等的報紙，或塑膠瓶回收製成花盆或相框。相對於降級回收，升級再造（Upcycling）是材料回收後賦予比原先更高的價值。

點石成金，有可能嗎？荷蘭證明永續實踐不是空口白話，2018年，85,000個循環經濟活動在荷蘭誕生，創造了42萬個就業機會[3]。為了持續鼓勵企業發展循環經濟，荷蘭基礎設施暨水資源管理部（Ministry of Infrastructure and Water Management, Ministry of I&W）在2019年與2020年匡列了4,000萬歐元資助循環經濟相關的計畫，而地方策略和永續發展目標也都提供企業在轉型期間的財務支援[4]。

在荷蘭政府政策和財政的雙雙支持下，許多企業將過去不再具有價值的廢棄物當作新的材料，經由回收再生成新產品，除了減少對原生材料或天然資源的依賴，也創造新的商業模式。全球模組地毯龍頭「英凡地毯」（Interface）注意到廢棄漁網成了環境的惡夢，而漁網和地毯的材料其實都是尼龍（Nylon）。因此，在菲律賓與喀麥隆推動「Net-Works」計畫，回收當地漁網再生為地毯紗線，不但為漁村人民創造額外收入，減少地毯使用新的石化原料，也降低廢棄漁網對野生動物的傷害。如今，英凡地毯58%的原料來自回收或生物來源，與1996年相比，英凡地毯已減少95%的碳排量，並致力於為更多的貧窮家庭帶來更好的收益。

圖1／英凡地毯（Interface）在漁村收購舊漁網
圖片來源／Net-Works

同樣專注在地毯的「Niaga」（英文的「再次again」倒過來寫），則在產品設計時就思考能再次使用，因此將回收納入生命週期。在Niaga每項商品上都附有一個標籤，教導消費者用歸還代替丟棄。如果消費者都能把可以回收的產品交給他們集中回收，才能一直保持材料循環使用。他們回收床墊和地毯，抽出尼龍或羊毛纖維，運用科技減少生產成本，以及能源與水的消耗。

打造長生不老的塑膠？這不是痴人說夢，而是Ioniqa的獨特技術。由於塑膠的物理特性，每次回收會打斷塑膠的高分子鏈，因此回收後的強度和韌性不如全新材料，必須加入新的塑膠原料來補強。但Ioniqa所研發的科技，能周而復始地將PET（聚對苯二甲酸乙二酯，寶特瓶的原料）重塑為高品質、透明、宛如原生的塑膠酯粒。PET聚合物廣泛用於瓶裝水和飲

料、包裝、機能服飾與地毯，每年全球使用量高達6,100萬噸，但有9成最終進到焚化爐、或亂丟在環境當中。Ioniqa期望扭轉PET材料的命運，創造有品質和價格競爭力的再生塑膠。

把垃圾變黃金的，還有家具製造商Van de Sant、滑板公司WasteBoards，與荷蘭肯亞跨國合作的Ocean Sole。Van de Sant將從陸地和海洋蒐集到的塑膠垃圾重新加工、鎔鑄，再塑型為沙發，成為商務旅館、會展活動與宴會上不可或缺的時尚配件。滑板公司WasteBoards與塑膠鯨魚基金會合作，後者帶著民眾與學童坐船遊覽阿姆斯特丹運河時，順手撈拾水道中的垃圾。超過1萬2,500人次的參與，已清出超過10萬個寶特瓶，與2,000多袋的塑膠垃圾。來自運河的垃圾上岸後再揀選，1,000個瓶蓋經過3小時的加熱鎔鑄，重生為一塊全新、擁有1,000個瓶蓋圖樣的滑板。

圖2／WasteBoards的滑板上可清楚看見每個瓶蓋的圖樣
圖片來源／WasteBoards

在荷蘭公司Nic&Mic的協助下，肯亞的Ocean Sole把淨灘撿到的拖鞋，透過藝術家的巧手與重新雕塑，變成各種尺寸、色彩繽紛的動物造型立體雕塑。2018年，75萬隻拖鞋，經過80位在地藝術家的打磨與重塑，再生為大大小小的藝術傑作。有的適合當成居家或辦公小物裝飾，也有像長頸鹿和獅子的真實尺寸巨大裝置。

史上最強募資一舉消滅海廢

除了以修復、重新組裝、回收重組等升級再造的方式來延長產品的生命週期，對於已進入環境中的廢棄物，荷蘭誕生了許多結合工程與科技的新創團隊，提出像是海洋吸塵器（The cleanup system）、泡泡牆（Bubble Barrier）、清淨河川（CLEAR RIVERS）等解決塑膠污染的方案，以下一一詳細介紹。

2013年，年僅18歲、因浮潛時看見海中垃圾而大感震撼的荷蘭青年柏楊．史拉特（Boyan Slat），為了消滅海洋的塑膠垃圾，創辦海洋清淨行動（The Ocean Cleanup），打造海洋吸塵器。雖然被喻為2015年最佳發明與海洋清淨科技的奇蹟，更一舉獲得超過4,000萬美元的資金；但實際出海後表現卻不如預期，甚至在任務結束前就在海上斷裂。團隊只得將系統拖回港，再做後續的評估和修正。

除了關注海洋垃圾，海洋吸塵器團隊深深瞭解光清理海洋垃圾，遠遠趕不及垃圾流入海洋的速度。根據團隊科學家最近發表的研究，估算全球1,000條以上的河流，將80%的河川垃圾帶往海洋[5]。因此，他們同步研發了河川攔截器（Interceptor）。使用壽命20年、100%太陽能發電與全自動的河川攔截器，如今已進駐印尼、馬來西亞、越南和多明尼加，也與泰國、宏都拉斯與美國舊金山簽署合約，希望能從污染熱區的河川下手解決海廢問題。

圖3／在多明尼加的河川攔截器
圖片來源／The Ocean Cleanup

同樣聚焦在河川垃圾的，還有在阿姆斯特丹運河登場的泡泡牆。泡泡牆的原理是先在水道底部鋪設一條鑽有細孔的管子，用壓縮機打入空氣，便可製造出一道泡泡帷幕。這道帷幕可以產生向上的水流，像是一道隱形的攔截索，藉而引導漂浮在運河表面的塑膠垃圾。他們在運河的對角裝設泡泡牆，水流就能推動塑膠垃圾流向河道兩側，進而流入收集裝置裡。泡泡牆能24小時運作，增加水中溶氧又不會傷害到水中生物，對於船隻航行的安全無虞，作用範圍還可以遍及整個河面的寬度與深度，期待未來能應用到其他河川。

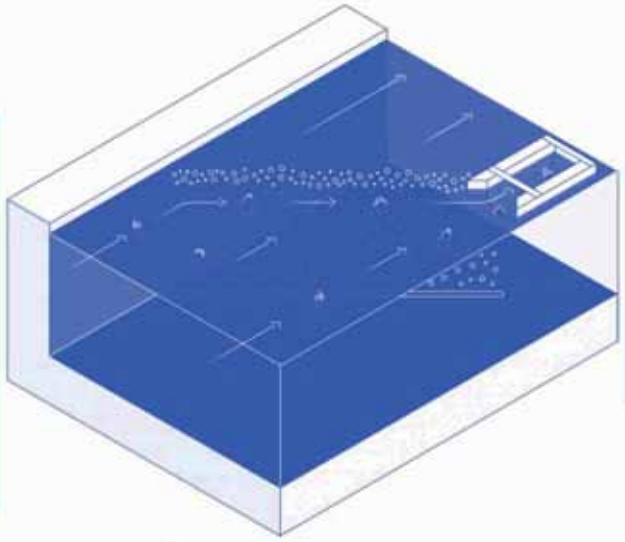


圖4／泡泡牆（Bubble Barrier）運作原理
圖片來源／The Great Bubble Barrier

跟前述所提的河川攔截器和泡泡牆相比，清淨河川則是提出整合垃圾攔截、清除、環境教育、提升民眾意識與回收再製的系統性解決方案。利用類似浮動碼頭裝置與攔截索來攔阻河面與碼頭垃圾，垃圾經過揀選分類後，可變成3D列印的材料，再製成浮島結構、現代風格的沙發與可作為建築營造的六邊形磚塊。浮島組成的水上公園，不但能讓植物生長，也能吸引鳥兒和魚類聚集棲息，為鹿特丹這樣的都會城市帶來些許綠意，更是直接向民眾展示成果的最佳例證。

圖5／CLEAR RIVERS運用回收塑膠垃圾製成浮島
圖片來源／CLEAR RIVERS

結語

從海廢問題反思材料的珍稀性與資源運用的效益，荷蘭政府正加速朝向完全循環經濟轉型，打破產品、材料和組成的界線，重新賦予高效能與高價值，打造持續發展的正向循環。如今荷蘭已有1,500個在產品設計、商業模式或科技的創新循環行動，像是塑膠回收作為家具或建築塑材，甚至將回收的垃圾變身為運河裡的浮島公園。荷蘭向世界證明，這樣的作法不但對環境有益，亦能提升經濟。從政策制定框架，並透過獎勵與法規鬆綁，讓荷蘭各種新創想法百花齊放。未來，更需讓公民與商業社群參與支持，讓荷蘭成為一個循環經濟的熱點，加速全球一同轉型，擁抱永續發展的未來。

參考資料

[1] The Ministry of Infrastructure and the Environment and the Ministry of Economic Affairs (2016). A Circular Economy in the Netherlands by 2050. The Ministry of Infrastructure and the Environment and the Ministry of Economic Affairs.
[2] Herman Huisman (2018). From waste management to circular economy: Circular scheme and policy of plastic management in the Netherlands. Oral presentation at the 5th SMM International Conference 2018 November 19-20, Taipei Changhua & Taichung, Taiwan.
[3] Trudy Rood and Maikel Kishna (2019). The Outline of Circular Economy. PBL Netherlands Environmental Assessment Agency, The Hague.
[4] Netherlands Enterprise Agency (2019) Rijksdienst voor Ondernemend Nederland https://www.rvo.nl/ (Jun. 20, 2021)
[5] Meijer, L. J., van Emmerik, T., van der Ent, R., Schmidt, C., & Lebreton, L. (2021). More than 1000 rivers account for 80% of global riverine plastic emissions into the ocean. Science Advances, 7(18), eaaz5803.

荷蘭基礎設施暨水資源管理部及海洋政策

編撰／鍾政棋（國立臺灣海洋大學航運管理學系暨研究所特聘教授及海洋觀光管理學程主任）
張晴婷、許照雋、羅豐毅（國立臺灣海洋大學航運管理研究所碩士生）
關鍵字／海上運輸、海洋政策、水資源管理

荷蘭的外向定位源於優異之海運歷史，因坐落於萊茵河口，獲通往歐洲門戶之美名。荷蘭海運發展，基礎設施暨水資源管理部功不可沒，該部主掌業務包含海上運輸與港口、水資源管理、帆船與小船。荷蘭水路運輸網絡相當完善，海上運輸與港口業務目標，為確保海運安全及港口永續性。荷蘭有領土低於海平面及河水氾濫問題，因此透過水資源管理進行防洪，並確保水資源充足供應。我國土地面積狹小，經濟以外貿為主，針對海運事業有許多發展條件與荷蘭雷同，藉認識荷蘭海洋政策，提供或可借鑑之處。

圖1／The Ocean Cleanup的海洋吸塵器
圖片來源／Netherland Oceancleanup

荷蘭的基礎設施暨水資源管理部

荷蘭基礎設施暨水資源管理部（Ministry of Infrastructure and Water Management, Ministry of I&W）致力於創造有效率的鐵路、公路、水道及航空交通網路，以有效的水資源管理因應水患，及改善空氣與水資源品質[1]。此部門有交通總局、民航與海事總局、水土事務總局、環境與國際事務總局負責制定政策。另執行政策的公共工程和水管理總局（Rijkswaterstaat, RWS），監管法定合規的人類環境與運輸監察局、荷蘭環境評估局與皇家氣象局亦隸屬此部門[2]。

一、海上運輸與港口 [3]

因國土狹小缺乏天然資源，荷蘭超過一半進出口貨透過海運，可見海運對其經貿之重要性。荷蘭基礎設施暨水資源管理部致力於維持海運與港口安全，及規劃未來發展，近年持續推動港口永續措施以降低船舶造成之污染。相關單位與業務介紹如下。

（一）相關單位：含民航與海事總局、交通總局、環境與國際事務總局、水土事務總局、人類環境與運輸監察局。

（二）業務範圍：主要的5大業務綜整如表1所示。

表1／海上運輸與港口的業務綜整

業務項目	業務內容
國際海運協議	為讓重要的海事主題受國際關注，荷蘭於下列國際組織擁有發言權：國際海事組織（IMO）、國際勞工組織（ILO）、歐洲海事安全局（EMSA）及歐盟理事會航運工作小組成員
提升港口競爭力	● 強化海港經貿：荷蘭海港在貨物裝卸方面須具吸引力以面對其他大型海港之競爭，如德國漢堡港 ● 鹿特丹主港開發：擴建港口以保持競爭力，同時改善萊茵河口地區宜居性 ● 改善港口易達性：加深並維護海上通道、改善並擴建與腹地運輸聯繫、加強與周邊地區知識型產業與製造業間之協作
海事安全及保安	● 防止恐怖主義：將國際船舶與港口設施保安規章（ISPS Code）與歐盟規章第2004/725號保安要求，納入2004年航運法令及港口保安法案 ● 打擊海盜：荷蘭於2010年成為《亞洲反海盜區域合作協定》締約國 ● 海事安全：簽定國際海上安全協議，確保提供良好的海事教育及培訓
海運永續性	● 對抗船舶排放有害影響：自2015年起於北海船舶低硫燃油含硫量不得超過0.1%；不得在海上排放廢棄物；歐洲港內有義務卸交廢棄物並付廢棄物處理費 ● 壓艙水：IMO採用《壓艙水管理公約》為防止壓艙水中的潛在有害水生生物及病原體擴散之國際公約 ● 公正且安全處分船舶：僅滿足嚴格環境與工作條件要求的船舶回收公司得處分船舶
智能航運	智能航運指船舶得較大程度的自主航行，含船上科技、港口及水道設計，有下列優點： ● 更具競爭力：獲得更精準之航行數據，使船舶能更有效利用水道，降低運輸成本，提高內河航運競爭力 ● 航行更安全：智能航運可降低人為疏失造成事故之可能性，使船上及沿岸水道工作更安全且易於管理 ● 更具永續性：智能航運科技可節省燃料使航行具永續性，如運用更精確之環境數據調整船速以減少燃料消耗

資料來源／Government of Netherlands (2021) [3]

二、海上運輸與港口政策 [4]

基礎設施暨水資源管理部提出《2015～2025年荷蘭海商策略》，將海洋政策區分7個面向；其中海上運輸與港口政策涵蓋4個面向。

（一）貿易面：具吸引力之船舶註冊地

荷蘭擁有優異商業環境及有利的船舶噸位稅制，為船舶設籍潛在偏好地。為吸引遠洋船入籍，組織更有效率的註冊及發證，使行政作業品質可與其他重要航運註冊國家相當，亦追求更富彈性之付款制度。

（二）可及性：產業鏈優化與航海服務

政府與產業竭力實現無縫物流運輸網及海運整合，由政府提供航海相關服務，致力於近洋航運發展。藉優化提供歐洲國家近洋航運機會，減少海運行政負擔，使海運環境更友善，並改善船舶、港口及腹地交通聯繫。

（三）安全與環境：適切的監管架構

政府與產業力圖現代化及適切國際監管架構，使航運與港口發展更安全、環境更友善且永續發展。政府將實施新法案，努力建立完善政策、實施及執法。政策包含環境安全相關課題，如限制船舶排放有害污染、規範船舶處分。

（四）交流面：構建海運知識計畫

海運策略的適當執行及監管，須具備特定專業知識，政府不僅建立海港知識之議程，亦考慮海運

策略的知識議題，與整體海運產業聚落交流專業知識。

我國船隊國輪比例近年皆無明顯成長，依2020年聯合國UNCTAD統計，我國輪比例僅14.14%，荷蘭國輪占58.72%[5]；吾人可參考荷蘭船舶設籍制度以提升國輪比率。由海關資料，我國進出口貨幾乎全仰賴海運[6]，可學習荷蘭增加港口及腹地聯繫以克服土地面積狹小問題，加強港口設施以提升港口可及性及競爭力。政府可透過與海運群體交流，更加瞭解並重視海運產業之發展。

圖2／鹿特丹港
圖片來源／Port of Rotterdam [7]

三、水資源管理

荷蘭有一半以上領土及三分之二經濟活動位於易生洪災且有淹沒風險之地區，使須面對水資源管理之安全，尤指防洪及堤壩維護[8]。荷蘭水資源部門在全球享有聲譽，藉由政府、專業機構、產業界、非政府組織專家之合作，為全球面臨最大挑戰帶來永續性解決方案[9]。相關單位與業務範圍介紹如下。

（一）相關單位：水資源管理組織單位及負責事項，如表2所示。

表2／參與水資源管理的組織單位及其負責事項

歐洲等級	
歐盟： 水資源、洪水及環境的立法與規章	國際流域委員會：跨境水資源管理
國家等級	
荷蘭基礎設施暨水資源管理部： 國家等級水資源、空間規劃、防洪	公共工程和水管理總局： 主要水資源系統的運行及維護
省份等級	
省份： 整合空間及環境規劃、監管區域水務局 地下水規則、其他區域政策之協調	
分水嶺等級	**直轄市等級**
地區水務委員會： 區域水資源系統的運行及管理、防洪、 水質及水量、廢水運輸及處理	直轄市： 當地空間規劃、污水收集及 廢水運輸、城市排水、雨水收集

資料來源／Organisation for Economic Co-operation and Development (2014) [8]

由表2可知，荷蘭當局高度重視水資源管理，且各單位職責明確。國際上遵守歐盟及國際流域委員會相關法規；國內則由荷蘭基礎設施暨水資源管理部及RWS共同規劃防洪與水資源系統政策，各省份及地區水務委員會僅規劃其範圍內水資源管理措施。

（二）業務範圍：由RWS與地區水務委員會負責全國水資源充分供應，使國家免受洪水侵害；其業務範圍[10]，如表3所示。

表3／公共工程和水管理總局與地區水務委員會的業務範圍

單位	掌管區域	業務範圍
公共工程和水管理總局	主要水域：如海洋及河川	●替政府發出洪水及暴雨警報 ●維護堤防、水壩 ●深化洪氾區及修建次要管道
地區水務委員會	區域水域：如水道及運河	●確保水質 ●防洪、確保農民有足夠水資源 ●廢水淨化

資料來源／整理自Government of Netherlands (2021) [10]

由表3可知，荷蘭水資源管理部門劃分為中央及地方。中央以國家整體安全及建設為目標，地區負責當地水資源管理。

四、水資源管理政策 [9]

（一）《2016～2021年國家水資源計畫》

●擬定荷蘭洪水風險管理及淡水供應政策。

●確定洪氾區策略，如萊茵河默茲三角洲及沿海地區。

●檢視荷蘭空間規劃中容納水資源的最佳方式及其成本。

（二）《水務管理協議》

為2011年荷蘭中央及各省、市政府，地區水務委員會及自來水公司簽訂之協議，規定至2020年止，政府提供總資金7.5億歐元之高水位保護計畫，用於水資源系統及水資源供應鏈。此計畫針對不符安全標準，但尚未含在其他計畫的水壩和堤壩，加強防洪以保護海洋並防止河流水位過高。

（三）《重視水資源倡議》

2016年4月聯合國與世界銀行召集水資源問題高階小組，倡導以全面協作開發及管理水資源，改善水資源與排污設施服務。配合《聯合國重視水資源原則》，荷蘭於2019年正式啓動《重視水資源倡議》，在政策、實踐、財務及行為面對水資源價值進行系統性改革，並鼓勵他人效法。

臺灣亦常面臨豪雨及颱風造成洪水之潛在威脅，每年洪氾皆造成防洪及排水設施毀損。或可參考荷蘭，增加政府與產業界或學界之合作，尋找最適合臺灣環境之解決方案。

帆船與小船[11]

荷蘭政府對水上運具制定航行許可與註冊規定，概分4部分：

一、遊艇執照之取得：欲駕駛船長25～40公尺遊艇，須參加考試方可取得大型遊艇執照，而該船不可作商業用途。大型遊艇執照II適用所有內陸水道航行，亦是內陸及沿海水域遊艇操作國際適任證書。

二、快艇、水上摩托車或小型噴射快艇之註冊：皆須在荷蘭註冊方能在內陸水域航行，證書僅在荷蘭內陸水域有效。若欲航行至國外，須先確認該國是否接受荷蘭證書。

三、快艇或遊樂艇小型許可證之取得：欲駕駛20公尺以下且時速超過20公里之快艇，或15～25公尺長遊樂艇，須經荷蘭駕駛證管理局考試通過，方能獲得小型許可證。

四、向Kadaster申請船舶註冊：在Kadaster公共登記簿完成船舶註冊；此適用於船屋、帆船及其他遊艇。完成註冊後Kadaster會將註冊號碼固定於船上以保護船舶免遭盜竊。

我國2020年《國家海洋政策白皮書》指出，政府擬定推廣海洋觀光政策[12]。荷蘭係水上活動著名之觀光勝地。由上述可見其對各式海上運具規定詳盡，含領證條件、船舶註冊及不同水域航行規範。有關海洋觀光發展，荷蘭有非常多值得我國借鏡之處。

參考資料

[1] Government of Netherlands, Ministry of Infrastructure and Water Management Search
https://www.government.nl/ministries/ministry-of-infrastructure-and-water-management (May 31, 2021)
[2] Government of Netherlands, Organisation
https://www.government.nl/ministries/ministry-of-infrastructure-and-water-management/organisation (May 31, 2021)
[3] Government of Netherlands, Maritime Transport and Seaports
https://www.government.nl/topics/maritime-transport-and-seaports (May 31, 2021)
[4] Ministry of Infrastructure and the Environment, The Dutch Maritime Strategy 2015-2025
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwje_I_rxfbwAhXvw4sBHWMmDhcQFjAHegQIBRAF&url=https%3A%2F%2Fwww.rand.org%2Fcontent%2Fdam%2Frand%2Fpubs%2Ftechnical_reports%2F2010%2FRAND_TR690.pdf&usg=AOvVaw0od-jQEG2ECshgJ1ATp5Np (May 31, 2021)
[5] UNCTAD, Review of Maritime Transport 2020
https://unctad.org/system/files/official-document/rmt2020_en.pdf (May 31, 2021)
[6] Taiwan Customs Administration CPT Single Window, Statistics Database Query
https://portal.sw.nat.gov.tw/APGA/GA11_LIST (May 31, 2021)
[7] https://www.portofrotterdam.com/nl/nieuws-en-persberichten/breakbulk-europe-in-2022-naar-rotterdam
[8] OECD, Water Governance in the Netherlands: Fit for the Future?, 2014.06.
https://doi.org/10.1787/9789264102637-en (May 31, 2021)
[9] Government of Netherlands, Water Management
https://www.government.nl/topics/water-management (May 31, 2021)
[10] Government of Netherlands, Water Management in The Netherlands
https://www.government.nl/topics/water-management/water-management-in-the-netherlands (May 31, 2021)
[11] Government of Netherlands, Sailing and Boating
https://www.government.nl/topics/sailing-and-boating (May 31, 2021)
[12] Ocean Affairs Council, 2020 National Ocean Policy White Paper
https://www.oac.gov.tw/ch/home.jsp?id=232&parentpath=0,2

Space@Sea浮動島之水槽測試與展示

撰文／許文陽（工業技術研究院綠能與環境研究所研究員）
彭珩筑（工業技術研究院綠能與環境研究所助理研究員）
關鍵字／浮動島、水槽測試、荷蘭海事研究所

根據統計[1]，全球大多數人口生活在近岸沿海區域。然而海平面因全球暖化而逐漸上升，可知在不久的將來，有限的濱海土地利用將面臨重新分配或大幅改變等挑戰議題。因此，研究學者對於開發海域空間的可能性愈來愈感興趣。在此同時，海域開發正快速的從傳統離岸油氣產業轉向再生能源、水產養殖、海運樞紐、旅遊、機場和城市等應用[2]。歷史上從陸地轉型至海上的開發行為，通常利用離岸平臺或填海造陸等方式達成，而滿足多目標利用的浮動島概念雖曾經被提及，但至今仍未有具體成果展示。事實上，大型浮動島仍存在許多技術挑戰，例如由大量浮動模組構成島嶼，彼此間交互作用十分複雜。有鑑於此，歐盟在Horizon 2020啓動一項名為Space@Sea的研究計畫，在2017年11月委由17個聯盟單位共同執行，包括：Maritime Research Institute Netherlands、DeltaSync、DST、Nemos、Delft University of Technology、Mocean Offshore、TU Hamburg Harburg、Bluewater、University of Rostock、Gicon-Grossmann、Wageningen University & Research、University Duisburg-Essen、TU Graz、Waterstudio、Icepronav與Val Fou and GeoSea。其宗旨為開發標準化的浮動模組，並構築具低生態衝擊、永續環境與經濟可行的大型浮動島嶼。本文章將針對Space@Sea於荷蘭海事研究所（Maritime Research Institute Netherlands, MARIN）水槽所進行的測試，介紹浮動島水工模型實驗與展示成果。

浮動島水槽實驗範疇

Space@Sea計畫亦採用模組概念，整體架構如圖1。共分為4個群集，分別為階層1～5的技術／非技術類群集（商業模式／技術挑戰／環境影響）、階層6～9的應用情境群集、階層10的模組整合與展示群集，以及階層11～12的管理、行銷、執行與開發群集。其中，浮動島4個應用情境，分別為能源中心、生活空間、水產養殖與海上運輸物流，其簡介如下。

- 能源中心（Energyhub@Sea，圖1階層6）的設計包含利用浮動模組間的相對運動來產生再生能源，以及透過浮動模組創造海上再生能源開發空間（例如太陽能、風力等）。此工作項目將以開發波浪能源轉換器為目標，並評估削減後的波浪能量對於內側浮動模組的運動響應。此外，再生能源儲存與電力傳輸等服務也是評估項目。

- 生活空間（Living@Sea，圖1階層7）的理念主要為離岸工作者提供一生活空間，同時亦將吸引人民居住在海上。類似的需求已出現在離岸再生能源運維作業，由於將技術人員分別調遣至不同的海

上任務所費不貲，因此創造了海上旅館需求。此計畫初期的服務對象為技術人員，後續將逐漸擴展到家庭住宅以及更大的建築群及城市。

- 水產養殖（Farming@Sea，圖1階層8）將開發以水產養殖為主的農業組件，目標除了維持浮動島自給自足之外，也將開發提升水產養殖和生質能源產量技術。此外，在離岸更遠的地方進行水產養殖也將變得更可行。

- 海上運輸與物流（Transport&Logistics@Sea，圖1階層9）將開發離岸樞紐組件，以解決日益增加的航運量，但部分港口已無法擴增空間的困境。對於康斯坦察、巴塞隆納或直布羅陀等擴展空間有限的城市港口，離岸樞紐站將是唯一的擴增機會。另外，對於漢堡和安特衛普此類的港口，離岸物流樞紐將提供擴大港口吞吐量的可能性，同時能降低大型船舶在狹窄河流中之航行量。

為進一步評估浮動島整合上述4大應用模組時的水動力響應特性，以及達成示範成效，MARIN在該機構內的離岸水池（Offshore Basin）進行1：60的縮尺實驗。該實驗由數個次系統組成，包含73個浮島模組、260個連結器模組、46條繫纜以及一艘停泊於浮動島的貨櫃輪。實驗項目標包含重量配比與氣象環境（包含100年重現期極端條件）的率定實驗，以及繫纜回復力與自由衰減測試等靜態荷載實驗，其結果可檢視部分水動力特性並提供數值模擬校驗。

圖1／Space@Sea計畫架構與各階層子計畫
圖片來源／Flikkema M. and Waals O. [2]

另外，在耐海性測試中，量測項目包含各位置的流速、波高、模組與貨櫃輪的6軸運動、繫纜繩與連結器的6軸荷載，以及波能轉換器運動與上浪（green water）對甲板的影響。浮動島實驗配置如圖2所示。值得注意的是，為了降低實驗的總變因，必需使每個獨立浮動模組的變因降到最低（例如質量、重心位置與吃水深等），因此在實驗過程中，各模組上方未承載任何上層結構，僅有在公開展示時才將上層建築物配置上去。

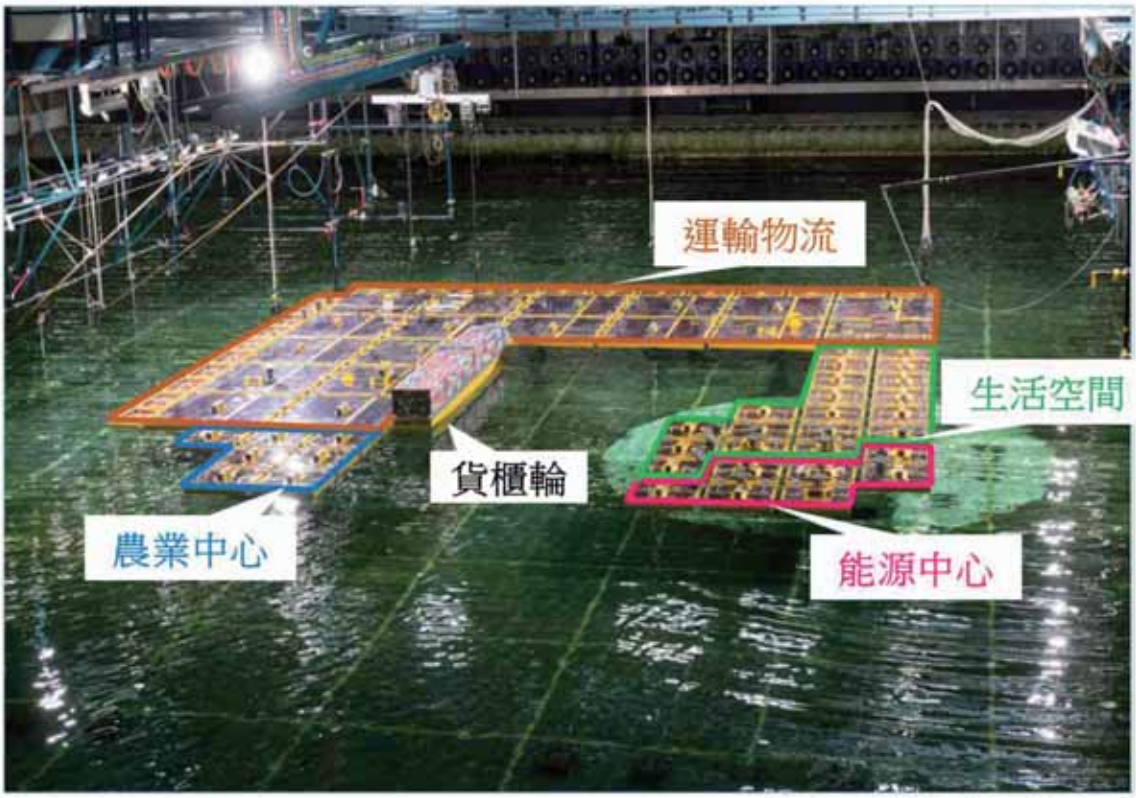


圖2／浮動島於荷蘭MARIN水槽進行實驗測試照片。其中，粉紅為能源中心（階層6）、綠色為生活空間（階層7）、藍色為農業中心（階層8）與橘色為運輸物流（階層9）

圖片來源／https://spaceatsea-project.eu/images/d10.4_part1.pdf

實驗設備與模組介紹

本節將分別介紹MARIN實驗水槽、浮動模組、連結器、繫纜與停靠船舶。

一、實驗水槽

MARIN造波水槽尺寸為46公尺*36公尺，並具有可移動的地板（尺寸36.35公尺*31.6公尺），可用於調節局部測試水深。水槽最大測試水深為10.2公尺，此外在水槽中央配有一深坑，最大深度達30公尺。造流設備由6層獨立循環流道構成，可產生涵蓋水深10.2公尺的均勻流場。造波系統則由大約200個獨立擺動襟翼組成，可獨立控制擺動周程和衝程，藉此產生單方向不規則波、具方向傳播的不規則波，以及波浪和湧浪等組合。

二、浮動模組

該浮動島嶼由3種不同類型模組組成，原尺寸分別為45公尺*45公尺以及95公尺*95公尺的正方形模組，以及26.58公尺*45公尺的波能轉換器（Wave Energy Converter, WEC）模組。正方形模組高度皆為11公尺（如圖3a），吃水8公尺深；WEC模組其高度為4公尺，吃水2公尺深（如圖3b）。正方形模組縮尺模型底部和側面由木頭製成並塗成黃色，以增強照片和影片中的可見性。上層封蓋由透明壓克力材質製造，以便能夠在測試過程中目視檢測洩漏。此外，模組內部利用木製加勁肋版來防止模組變形，根據扭轉測試，模組對角線的平均變形量僅為0.157mm／kg。

三、連結器

在Space@Sea其他子項目中，已經完成分析不同的連接器設計。針對水槽測試，MARIN選擇「Graz-connector」進行測試，其完整設計與特性可參考其報告[3]。該連結器由防舷材組成，並透過預張力繫纜來維持防舷材預壓縮特性，如圖3a所示。在水槽實驗中，連結繫纜將透過合適的彈簧進行模擬。

四、繫纜

懸鏈式（catenary）繫纜設計來自Space@Sea的第3項子計畫，該繫纜適用於約100公尺的水深環境。原尺寸繫纜長度為436公尺，重量達798公斤／公尺。水槽測試採用直徑32㎜不銹鋼鍊以及重量為50kg的重力式錨碇塊（如圖3c），荷載感測器則安裝於部分的繫纜卸扣位置。

五、停靠船舶

為了研究繫泊船隻與浮動島的交互作用，MARIN採用既有的M10128貨櫃輪船模（如圖3d），模擬船舶透過兩組連結器繫泊停靠於碼頭時，分析船隻動態與連結器受力。

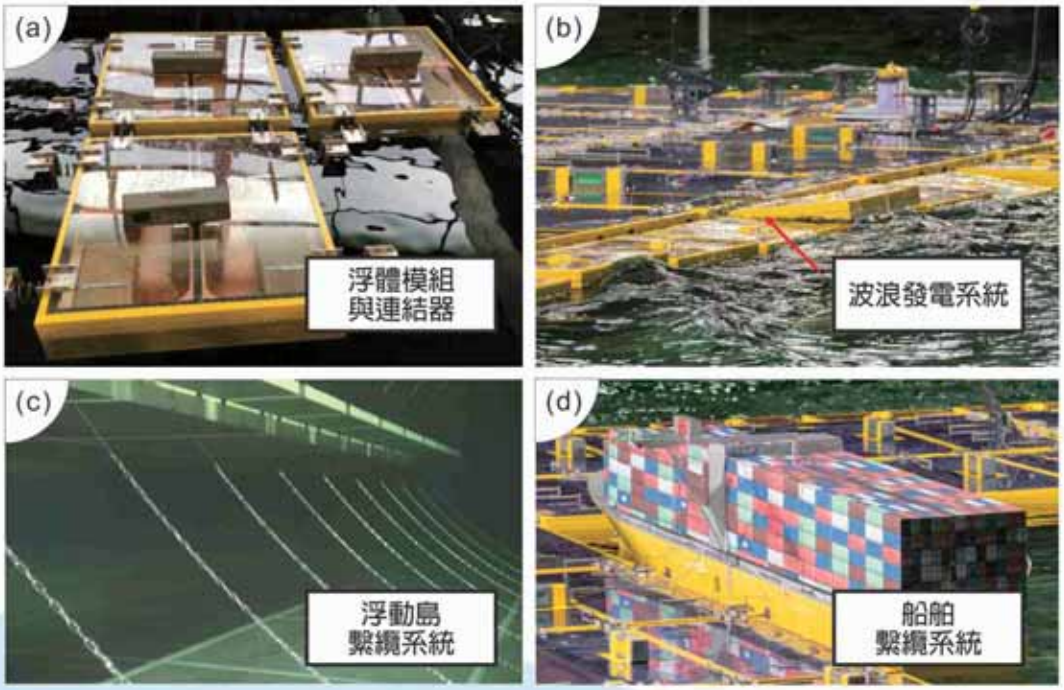


圖3／(a)方形浮動模組與連結器；(b)波浪發電系統模組；(c)浮動島繫纜系統；(d)船舶繫纜系統
圖片來源／https://spaceatsea-project.eu/images/d10.4_part1.pdf

實驗成果

整體而言，由數個方形模組組成浮動島嶼的運動行為與原先預測模擬結果並無太大的差異。重要實驗成果摘錄如下：

在靜態荷載測試實驗中，繫纜張力與浮動島位移的反應曲線結果顯示，實驗與模擬結果一致，代表繫纜模型縮尺與實驗安裝配置符合原尺寸要求。自由衰減實驗結果顯示浮動島存在典型的拍頻特徵

（beating pattern），該機制是由於多個共振模態彼此接近，因此造成自由衰減後期呈現震盪現象。縱移（surge）、橫移（sway）與偏擺（yaw）的自然頻率落在155秒到180秒。

在單純海流作用下，浮動島吃水與姿態呈現穩定。而在波浪作用下，縱移、橫移與偏擺皆屬於低頻運動響應，幾乎無波浪或更高頻率造成的運動響應。每個浮動模組的可能最大（most probable maximum, MPM）俯仰角度亦被記錄，結果顯示迎浪面的模組可減低波浪繞射效應，受遮蔽內的側模組因此相對穩定。

在連結器部分，防舷材在波浪與海流作用下始終保持在被壓縮狀態，代表設計的繫纜預張力是足夠的。此外，在比較不同波浪入射角度時，斜向入射為225度時，防舷材所承受的剪力最大。此外，在所有測試條件下繫纜最大張力皆小於材料破斷力，整體安全係數大於2。

在暴風條件下，波能轉換器模組的上浪現象十分顯著，並且部分水體溢淹至後方模組，如圖3b所示。未來需進一步考量波能轉換器運作時，評估上浪衝擊力與溢淹水量，新增適當的屏障設施。停靠船舶的部分，由於該泊位處在浮動島嶼的遮蔽內港，水位與貨櫃輪的姿態呈現相當靜穩。

結論

Space@Sea計畫旨在開發一種標準化且具有成本效益，同時能將生態影響降至最低的模組化島嶼，在海上提供永續且合乎成本的工作、生存空間。整體而言，模組化的浮動島概念在經過水槽測試後，各模組與整體的水動力響應與數值計算大致符合，證明模組化技術是可行的。MARIN在2020年10月公開展示。Space@Sea模組化浮島的外觀[4]，包含各模組上層的結構模型（例如起重機、貨櫃碼頭、太陽光電、風力機、住宅房屋等），來演示4種不同應用情境。未來該計畫將持續解決實驗過程所揭露的技術問題，例如上浪現象的保護工法、從經濟與技術層面來找最佳化模組幾何與不同水深下的繫纜方案等。

參考資料

[1] Geography MYP, Dot Map Showing Population Distribution 2015 (Jun. 5, 2021)
http://www.bbc.co.uk/staticarchive/e4ff248622e19fa303d72e259e0d6201b8ceea9e.gif
[2] Flikkema M. and Waals O. (2019), Space@Sea the Floating Solution, Front. Mar. Sci. 6:553. doi: 10.3389/fmars.2019.00553
[3] Breuls M., Blumer S., Jacob N. and Blümel B. (2020), Detail Design Report- Deliverable 4.4," Space@Sea Project
[4] Otto W. and Hüsken C. (2020), Results from Demonstration at Wave Tank.
https://spaceatsea-project.eu/images/d10.4_part5.pdf

北海協議之初探：荷蘭經驗對臺灣的啓示

撰文／曹立運（工業技術研究院綠能與環境研究所副管理師）
黃柏誠（工業技術研究院綠能與環境研究所副研究員）
關鍵字／荷蘭、北海協議、利害關係人、離岸風電、協商機制

行政院分別於2012年及2017年核定「千架海陸風力機計畫」[1]及「風力發電4年推動計畫」，採「先陸域後離岸」及「先示範、次潛力、後區塊」3階段策略，循序漸進推動離岸風電發展[2]。目前我國在離岸風電發展上已取得階段性成果：第1階段海洋示範案（128MW）已於2019年商轉，且台電示範案（109.2MW）亦將於2021年商轉[3]。第2階段則透過遴選及競價作業共核配9家開發商、14座風場（共5.5GW），預計陸續於2025年前商轉[3]。我國政府刻正研擬第3階段區塊開發相關草案，規劃於2026年至2035年間，每年釋出1GW以上開發量[4]，然因涉及生態、飛安、國防、漁業、航安等競合問題，導致凝聚共識之路崎嶇難行，故本文將介紹荷蘭協調離岸風電利害關係人之經驗－《北海協議》（North Sea Agreement, NSA），以期提供我國進行海域利用協商作法之參考。

圖1／位於Afsluitdijk大堤北荷蘭省終點旁的Buitenhaven漁港，港外為淺海濕地瓦登海（Waddenzee），向外即連結北海
圖片提供／黃柏誠

NSA推動背景與挑戰

位於西北歐的北海，不僅是重要的生態系統，也是豐沛食物的關鍵來源，更是航運、遊憩、軍事訓練及能源開採等海域活動之舞臺。有鑑於氣候變遷已對該海域生態環境產生顯著影響，荷蘭政府正依《巴黎協定》減碳目標，力推再生能源以取代化石能源，並試圖在環境影響與有效空間利用間取得平衡，NSA即是權衡荷蘭政府與利害關係人利益後之初步成果。

NSA聚焦在生態轉型（The nature transition）、食物轉型（The food transition）、能源轉型（The energy transition）等3大挑戰及其交互影響，期能擬定具整合性之長期海洋發展政策。有關生態轉型，係依歐盟海洋策略架構指引[5]，在進行海域用地劃分時，應考量特定活動對海域生態之影響。至於食物轉型，北海使用情形將影響漁業永續發展可行性，使荷蘭海洋漁業面臨產業轉型壓力。在能源轉型方面，荷蘭政府於2019年公告之國家氣候協議（National Climate Agreement）中，將北海視為再生能源重點推動區域[6]，倘欲於生態系統及各種用海目的間取得平衡，勢必將調整海域空間規劃及能源技術選擇[7]。

展開對話：OFL的角色、利害關係人協商機制

荷蘭自古以來即與水爭地，進而從治水組織衍伸出具長期規劃，並以取得共識為導向的社會型態。如今，荷蘭政府透過設置委員會及規劃單位協助公部門執行前瞻性研究及活動，以建構出能有效整合利害關係人協商意見的治理模式[8]。在北海議題方面，主要權責機關是基礎設施暨水資源管理部（Ministry of Infrastructure and Water Management, Ministry of I&W），該部與相關部會於2019年洽物理環境顧問委員會（Physical Environment Consultative Council, OFL）主導並展開北海對談（North Sea Dialogue）[7][9]。OFL的任務即藉由設計合作及治理模式，提供政府與民間利害關係人交流互動平臺，OFL每年根據政府及社會所提議題建立工作計畫，並涵蓋能源、氣候、農業與水安全等議題[10]。

有關北海對談利害關係人協商機制，OFL掌握利害關係人名單後，便召開連續6天的對談啓動會議，再於後續一年半期間每三周安排兩場會議，其中一場會議聚焦特定議題，並邀請專家學者與會，另一場則讓更多參與者提出各自立場及想法。隨後，OFL透過為期兩周之全民線上調查及一場實體會議，蒐集公民意見。最後，OFL舉辦為期2天的全體大會，除了納入利害關係人外，亦一併提出上開公民意見，俾利達成協議共識[9]。

表1／北海對談參與者

領域	組織	是否於2020/6/19簽署最終協議
能源	荷蘭油氣探勘協會（NOGEPA）	○
	荷蘭風能協會（EWEA）	○
	荷蘭能源管理（EBN）	○
	TenneT電網公司	○
漁業	荷蘭漁民協會（Visserbond）	X
	荷蘭漁業協會（VisNed）	X
環境保育	荷蘭國際鳥盟（Dutch Birdlife International）	○
	自然與環境基金會（Nature & Environment Foundation）	○
	北海基金會（North Sea Foundation）	○
	世界自然基金會荷蘭分會（World Wide Fund for Nature Netherlands）	○
公部門	農業、自然及食物品質部（Ministry of LNV）	○
	經濟事務暨氣候政策部（Ministry of EZK）	○
	基礎設施暨水資源管理部（Ministry of I&W）	○

資料來源／de Koning et al. (2021)

NSA主要共識

OFL邀集荷蘭政府及利害關係人共同討論協商所促成之NSA，針對制度、議題、財務、技術、研究、執行等面向，業已達成數項極富意義、可行性及遠見之共識，重點整理如下[7]：

圖2／NSA主要共識架構
圖片來源／曹立運製

一、治理（Governance）

荷蘭政府及利害關係人均認同透過NSA作為逐步推動後續正式政策或於既有國際法架構下法制化之初步方向，並同意沿用OFL建立之協商機制，以北海協商會議（North Sea Consultation）作為未來協商及推動平臺，故可將治理視為衆多共識之基礎。

二、轉型基金（Transition Fund）

在考量生態、食物及能源轉型相關規劃之需求後，建置轉型基金便成為必要採取之共識，具體包

含基金申請資格（正／負面表列）、建置時程、監督作為、金額比例等方面之要求，以作為獨立於既有預算或經費以外之補償及緩解措施或其他財務支出來源。

三、多元使用（Multifunctional Usages）

荷蘭政府及利害關係人認同北海係屬共同利益，欲在有限海洋空間內達到最大效益之資源利用，容許無排他性之空間競合，亦即多元使用，應屬最佳解方，遂提出考量既存使用目的（包含漁業、養殖、國防、採砂、飛安、海纜管線、油氣平臺、科學研究、海域活動監測、離岸風電選址等）及未來共存可能性之「區域通行證」（Areas Passport）規劃。

結論

NSA起初是由OFL作為協調角色，邀集相關政府機關及利害關係人對談，以凝聚共識，其中關鍵共識莫過於「未來北海治理模式將沿用OFL協商機制」、「NSA僅作為正式政策及法制化之初步方向」、「轉型基金具有建置必要性」及「容許海域空間多元使用以有效解決空間競合問題」。荷蘭OFL協商機制顯然為達成NSA之重要推手，雖然我國海洋委員會已於2018年成立，惟就海域空間規劃議題扮演協調功能尚在發展中，如欲由第三方學術／研究機構擔任協調者，即可參考OFL執行模式，權衡利害關係人利益並透過系統性協商進行意見共識凝聚，方有利於加速未來離岸能源相關政策之推動。

參考資料

[1] 曾君儒（2015），〈捕風捉綠電—千架風力機蓄勢待發〉，《能源報導》
https://energymagazine.itri.org.tw/Cont.aspx?CatID=19&ContID=2617（2021年6月13日）

[2] 經濟部能源局（2017年8月），〈風力發電四年推動計畫（核定本）〉
https://www.moeaboe.gov.tw/ECW/populace/content/wHandMenuFile.ashx?file_id=4107（2021年6月13日）

[3] 風力發電單一服務窗口（2019年12月27日），〈大事記〉
https://www.twtpo.org.tw/history.aspx（2021年6月13日）

[4] 經濟部（2021年5月11日），〈離岸風電區塊開發招商容量每年提高至1.5GW 導入產業關聯彈性機制〉
https://www.moea.gov.tw/MNS/populace/news/News.aspx?kind=1&menu_id=40&news_id=94366（2021年6月13日）

[5] EUR-Lex (n.d.), Directive 2008/56/EC of the European Parliament and of The Council
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008L0056 (Jun. 10, 2021)

[6] Government of The Netherlands (Jun. 28, 2019), Climate Agreement
https://www.government.nl/documents/reports/2019/06/28/climate-agreement (Jun. 10, 2021)

[7] Noordzeeloket (n.d.), North Sea Agreement.
https://www.noordzeeloket.nl/en/policy/north-sea-agreement/ (Jun. 10, 2021)

[8] European Environmental Agency (Oct. 11, 2011), BLOSSOM – Bridging long-term scenario and strategy analysis: organisation and methods.
https://www.eea.europa.eu/publications/blossom (Jun. 10, 2021)

[9] de Koning, S., Steins, N., & van Hoof, L. (2021). "Balancing Sustainability Transitions through State-Led Participatory Processes: The Case of the Dutch North Sea Agreement", Sustainability, 13(4): 2297.

[10] Physical Environment Consultative Council (n.d.), About the Physical Environment Consultative Council.
https://www.overlegorgaanfysiekeleefomgeving.nl/english/default.aspx (Jun. 10, 2021)

Pay Attention to the Marine Environment and Learn from the Netherlands' Experiences in Increasing Energy Capacity and Reducing Waste

Translated by Linguitronics

Minister of the Ocean Affairs Council: Chung-Wei Lee

The changes taking place in the marine environment deserve global attention. The United Nations (UN) released the second World Ocean Assessment this year (2021). In addition to documenting the ecological, economic, and social aspects of the marine environment in a comprehensive manner, the Assessment also reminded us to manage the oceans properly and utilize measures such as innovative technology, knowledge integration, and building our energy capacity to ensure sustainable marine development. In addition to providing an analysis of the Assessment in our "International Issues" column, this issue also introduces ocean governance and technology development in the Netherlands. In "Organization Focus", we analyze the Dutch Ministry of Infrastructure and Water Management's policy planning related to marine transportation, the management of water resources and piers, and sailing and small boats. In "Industry Dynamics" we introduce the circular economy policies and waste-reduction technology in the Netherlands. We also cover stories of local businesses turning recycled marine debris into carpets, sofas, and skateboards, thereby enhancing the value of marine debris. In "Latest News", we focus on the multi-functional Space@Sea large-sized floating island that is an energy hub, living space, and farm on the sea as well as serving as a logistics center at sea. It was developed by the Maritime Research Institute Netherlands (MARIN).

At a time when Taiwan is actively developing offshore wind power, we hope to learn from the Netherlands' experiences. We invited the Netherlands Enterprise Agency (RVO) to write an article (provided by the Netherlands Office Taipei) for the "Special Report" section. The RVO share the ten-step policy measures enacted to reduce risks related to offshore wind power development during energy transformation. In addition to creating a favorable market and bidding criteria for project developers, the measures also demonstrated the leading role of the Dutch government. In "Regulatory Systems", we discuss the coordinating role that the Physical Environment Consultative Council (OFL) played in stakeholder negotiations in order to reach a consensus in the North Sea Agreement (NSA). The Netherlands' experiences in offshore wind power development can serve as a reference for Taiwan's negotiation methods regarding the use of Taiwan's offshore regions.

Concept image of an artificial offshore wind power island in the North Sea
Source/ Tennet
https://www.tennet.eu/company/news-and-press/footage/footage-tennet/

The Offshore Wind Industry in the Netherlands and Its Marine Spatial Planning and Strategy

Henk van Elburg, Kees Mokveld (RVO.nl)
Keywords: offshore wind industry, marine spatial planning, Netherlands

The Dutch energy transition is in full swing and offshore wind is a cornerstone of the climate ambitions of both the government and the private sector. Because of a strong history in maritime operations, an innovative rollout policy and continuous innovation, the Dutch has also become a renowned player in the international offshore wind business. The Netherlands are committed to the Paris Climate Change Agreement. The Dutch government has presented a clear 11.5 GW pipeline of offshore wind projects until 2030 and is now discussing the post 2030 outlook. The Dutch government pre-designated wind farm zones combine with a tender-permit system creating a clear outlook for developers. The government also takes responsibility for the site studies and offshore grid connection, de-risking plans for developers and increasing investor confidence.

Today's regulatory and tender framework for offshore wind tackles the disadvantages of the previous policy approach until 2013, in which project developers alone were responsible for the site selection, investigations and permitting process and faced high cost and risk perceptions before they could apply for subsidies. As a result, out of 80 initial applications, only four offshore wind farms were actually built in the Dutch Economic Zone of the North Sea until 2017, with a total installed capacity of less than 1 GW.

The current policy approach in contrast is much more proactive: by regulating conditions for the construction of the wind farms - i.e. exact locations, steady tender plans, consents, grid connections, operating grants if necessary - the Dutch government helps to reduce pre-bid investment risks, financing and - last but not least - societal costs.

The current policy approach can best be explained in 10 steps, showing a leading role for the government and by creating favourable market and tender conditions for project developers.

Step 1. Designating The Wind Farm Areas

The Dutch legislative offshore wind framework starts with early spatial planning. Through the National Water Plan, which finds its legal base in the Water Act, the Ministry of Economic Affairs and Climate Policy and the Ministry of Infrastructure and Water Management allocate the areas for future offshore wind farm development in the Dutch territory of the North Sea. Each area can include one or more wind farm sites. The development of offshore wind farms will be restricted to these areas, and permits will not be awarded for wind farms outside these areas.

Step 2. Drawing Up Offshore Wind Farm Tender Roadmaps (roll out plans)

The specific roll-out sequence in which the wind farm area's and included sites will be developed, the projected generation capacity of the individual sites and the year of tendering for installation and operation, are scheduled in the Offshore Wind Energy Roadmap.

The Offshore Wind Energy Act, in which the Roadmap is legally based, was introduced in 2015 in close consultation with the wind energy sector. The purpose of this law is to guarantee optimal efficiency in the use of marine space and to provide a decade-long pipeline of tenders as an assurance for project developers. Two offshore wind farm Roadmaps have been issued by the government so far.

As stated in the National Energy Agreement (2013), the Dutch government published in 2015 a first Tender Roadmap (2015-2023), aiming at adding a total of 3.5 GW offshore wind power capacity in 2023. The Roadmap announced the release of five offshore windfarms, all to be tendered between 2016 and 2019 and the last one expected to be in operation in 2023.

Encouraged by the successful rollout of tenders in the first roadmap, the government released another Roadmap (2023-2030) in 2018, announcing an additional 7 GW offshore wind development before the end of 2030. This roadmap schedules the release of wind farm to be tendered between 2021 and 2026 and the last one to be in operation in 2030. The Roadmap 2023-2030 includes the zones Hollandse Kust (west), Ten Noorden van de Waddeneilanden and IJmuiden Ver.

Step 3. Conducting Studies

Following the parliamentary approval of the roadmap, the foreseeable offshore wind farm sites will be subject to a comprehensive environmental impact assessment, leading to a ministerial wind farm site decision (to be explained in step 5). A series of geo-physical site studies will be executed in step 3.

To analyse and - if necessary - deal with the economic, social and ecological impacts of the wind farm(s), the site decisions are legally subject to an environmental impact assessment (EIA), commissioned by the Ministry of Economic Affairs and Climate Policy and the Ministry of Infrastructure and Environment. The EIA results will be published in the site decision (step 5), available for public inspection (and appeal), after which it becomes irrevocable.

Apart from the EIA, the government also conducts a series of local site studies (soil- wind- and water). Examples are the meteorological and oceanographic survey, the soil survey, the ecological soil survey, the archaeological survey and UXO surveys. Similar to the EIA, the outcomes of these site data studies will be made available for project developers for their FEED studies to submit competitive bids in the tendering procedure (see also step 6).

Project developers (permit applicants) therefore do not have to make an environmental impact assessment and perform the site studies of their own. The costs in relation to these surveys are for the account of the State and will not be borne by the competing project developers. The Netherlands Enterprise Agency (RVO) will commission and publish the site data packages. All studies and investigations are officially certified or quality approved.

Step 4. Installing The Grid Connection

The Dutch national electricity Transmission System Operator TenneT is legally appointed to be responsible for the connection of the wind farms to the onshore electricity grid. As the planning and installation of this offshore grid network generally takes 8 to 10 years (depending on the distance, technique and permit procedures and subject to EIA), this grid installation decision is taken as early as possible in the process. The permit for TenneT is made publicly available for inspection (and appeal) by all parties, after which it becomes irrevocable.

The choice for TenneT to be the offshore grid system operator has clear advantages over individual grid connections installed by project developers. The advantages are mainly financial and related to economies of scale following standardization in substation design, purchasing, maintenance and knowledge development. Grid operation by TenneT also simplifies compensating grid fluctuations, flow management, and balancing supply and demand, whilst integral grid operation also leads to a clear distribution of tasks and responsibilities in the electricity system.

To create the cost-saving economies of scale, standardized AC-substations (with a capacity of 700 MW each) have been designed to connect the wind farms to the national grid, using two 220kV export cables. As soon as 380kV subsea cables become available, this will be applied to further reduce the amount of required cables.

For offshore wind farm further away from the coast, DC-substations are needed. The connected transmission capacity is approximately 2 GW and an onshore converter station via two 525kV cables will be part of the offshore grid.

The inter-array (infield) cables, which connect the wind turbines to the substation remain the responsibility of the project developer. The wind turbines will be connected to the TenneT platform through 66kV infield cables, making the Dutch offshore wind parks the first in the world to be connected by a voltage level of 66kV instead of 33kV.

To plan the public investments in the offshore grid, the government provides guidance through a development framework. This framework outlines the design and construction of the offshore grid and its main functional and technical requirements. It also stipulates the tasks of TenneT as offshore transmission system operator, provides the sequence of the development of the sites and sets the timetable for commissioning of the connection for the sites. On the basis of the development framework, TenneT draws up a bi-yearly investment plan setting out the envisaged investments, performance targets, deadlines and plans for capacity expansion. The investment plan needs approval from the Dutch regulator, the Authority for Consumers & Markets.

TenneT and the offshore wind farm operators sign a realization agreement as well as a connection & transmission agreement. The agreements set out the terms and conditions regarding the development of the connection for the wind park, addressing aspects such as the basic design and technical specifications of the connection and the substation as well as operational arrangements and the exchange of information between TenneT and the wind park developer. In case of a delay or unavailability of the offshore grid, TenneT is legally committed to compensating the wind park owner for postponed or missed (subsidy) revenues from electricity sales and consequential damages.

Step 5. Consenting: Taking The Wind Farm Site Decision

Following the initial assignment of wind farm areas (step 1), the Roadmap planning (step 2), EIA-assessment (step 3) and offshore grid decision (step 4), the government is now ready to publish the wind farm 'Site Decision'. The wind farm site decision is the cornerstone of the Dutch Offshore Wind Energy Act. Offshore windfarms can only be built after a permit, based on the site decision, has been issued. A wind farm site decision is therefore the necessary consent required to build a wind farm and specifies the location for the wind farm and the conditions under which it may be constructed and operated, taking issues into considerations such as ecology and decommissioning of the windfarm. These conditions can be related to wind turbines (minimum power, maximum tip high & minimum tip low) and infield cables (prohibited outside wind farm site boundaries). The site decision however leaves some

flexibility for the design of the wind farm. This means that project developers have the opportunity to choose the latest technical innovations - within the natural and environmental framework – to realise and operate the windfarm at the lowest possible costs.

The site decision is subject to public consultation and possibly appeal. At the end of the consultation phase, the Wind Farm Site Decision becomes irrevocable in case there are no further appeals.

Step 6. Organising The Tender

As the Wind Farm Site Decision has become irrevocable, the government starts the tender. All tenders kick-off with a Ministerial Order, including tender rules for the relevant offshore wind sites. Examples are the timing of the tender, the deadline for commencement of operation, the maximum tender amount and base electricity price, the minimum and maximum capacity of the wind park and tender eligibility criteria, and criteria for ranking the bids. After the tender closure, the Minister of Economic Affairs and Climate Policy will appoint the winner within 13 weeks, a period which may be extended by another 13 weeks. The award decision is subject to objection and appeal proceedings by competing tender participants. Objections must be filed within six weeks of the date of the tender award. Subsequent appeals can be filed within six weeks of the date of the decision on the objection.

The current legislative tender framework distinguishes three optional tender models to select for future use: the tender for lowest subsidy bid, tender for best feasibility (+ financial) offer and tender for highest auction price.

The Law 'Windenergy at Sea' is currently subject to some legal changes with the purpose to 1. create more choice in (zero-subsidy) tender models, 2. include other sources of renewable energy such as hydrogen and 3. extend the duration of the permit from 30 to 40 years. Parliamentary approval is expected in the course of 2021.

Step 7. Granting The Permit

Immediately after winning the tender, the government grants the permit for the construction, operation and the removal of the wind farm. With this permit, the winning developer can immediately start constructing the wind farm. The permit states that the wind farm must be constructed within four (eventually five years) and is valid for a maximum of 40 years.

Step 8. Monitoring Wind Farm Preparation

Once granted the permit, the wind farm developer must comply with its plan for the construction and operation of the wind park as submitted together with the application. As stated in step 5, the permit remains flexible for innovation and therefore allows for certain permit changes in relation to the development or operation of the wind park. Examples of so-called essential changes to the production installations are the number of turbines of the production installation, the positioning of the turbines, the hub height, type of turbine and type of foundation. A request for an exemption must be accompanied by an explanation of the effect of the change on the aspects set out above, as well as by an amended wind energy yield calculation (if applicable). Any deviation from the original plan requires an exemption granted by the Minister of Economic Affairs and Climate Policy. This way the wind park developers are enabled to use the most up-to-date technology and pursue cost reductions through innovation.

Step 9. Monitoring Wind Farm Construction

The Directorate-General for Public Works and Water Management (Rijkswaterstaat, RWS) monitors the planning, construction, and operation of wind farms. The monitoring activities vary per phase. The planning phase mainly includes the assessment of the work plans drawn up by the permit holder. During the construction phase, inspections are performed via ships and aircraft of the Netherlands Coastguard and the State Supervision of Mines.

Step 10. Monitoring Wind Farm Operation

The wind farm operation results in the generation of electricity. During the operational phase, RWS monitors the operations management and maintenance activities. After a maximum of 40 years, the wind farm will be decommissioned and removed. The permit is no longer valid after that period.

Conclusion

It is safe to conclude that the introduction of this 10-step approach is proved to be a 'game changer' for the development of offshore wind in the Netherlands. The 10 steps approach helps to de-risk the development of the offshore wind farms and lower the cost for the developers. Together with a roadmap aiming at connecting each year 1 GW of offshore wind capacity to the grid, the confidence of developers grew which resulted in zero subsidy bids and record low prices. While there was only little activity in offshore wind under the previous policy up to 2013 (resulting in approx. 1 GW capacity in total), under the current policy approach a total of 3.5 GW was successfully tendered between 2016 and 2019 and an additional 7 GW offshore wind farm capacity in now being scheduled, leading into a total 11.5 GW installed offshore wind capacity in 2030.

It proves the importance of a public-private process guided by the government setting parameters for the pace at which the proposed new capacity will be developed, the maximum capacity of the wind farms; planning and zoning; site investigations and last but not least the grid connection. By regulating all conditions for the construction of the wind farms the Dutch government reduces project risk, financing and – last but not least - societal costs.

Today, the Netherlands is a front-runner in cost efficient offshore wind development and installation. International attention for the Dutch approach to offshore wind energy, the tender system and location studies, has increased in recent years. The construction of wind farms in the North Sea has created confidence in offshore wind energy worldwide.

Understanding the Ocean: The Second Ocean World Assessment

Chung-Ling Chen (Professor, Institute of Ocean Technology and Marine Affairs, National Cheng Kung University)

Keywords: Marine environment, evaluation, socioeconomic aspects

In its resolutions 57/141 and 58/240, the General Assembly of the United Nations decided to establish a regular process for global reporting and assessment of the state of the marine environment, including socioeconomic aspects. The aim of the regular process is to provide an evaluation of the state of the global ocean, the services that it provides and the human activities that influence its state. The first World Ocean Assessment was completed in 2015, establishing a baseline and pointed out many parts of the ocean has been seriously degraded and that, if the problems that it described were not addressed, they would produce a destructive cycle of degradation in which the ocean could no longer provide many of the benefits on which humans rely. Following the first Assessment, the second cycle of the regular process for the period of 2017-2020 was launched. The second Ocean World Assessment was issued in 2021, which builds on the baseline established by the first Assessment and further extends to evaluate the changes and trends of the marine environment.

Marine Protected Areas can alleviate impacts of human uses to the marine environment (photo taken at Channel Islands National Park)
Image by Chung-Ling Chen

The structure of the Second Ocean World Assessment

The Second Ocean World Assessment (hereafter the Assessment) consists of 28 chapters, which are assigned in two volumes. The chapters from Chapter 1 through Chapter 7 are collected in Volume I with a total of 570 pages. The remaining chapters from Chapter 8 through Chapter 28 are compiled in Volume II with a total of 520 pages. The content it contains is very enormous and diverse, mainly including the trends of the marine environment, the impacts of various human activities on the marine environment, and development of management approaches. It comprehensively documents the information regarding ecological, economic and social aspects of the marine environment. A linkage was adequately made between the Sustainable Development Goal 14: Conserve and sustainable use the oceans, seas and marine resources, which was adopted by the United Nations in 2015.

Volume I focuses on the approaches to the assessment, scientific understanding of the ocean, drivers of change in the marine environment and trends in the physical, chemical, biological states. Volume II takes care of the trends of, or changes in various human activities at sea (e.g., capture fisheries, aquaculture, seabed mining) and the associated problems (e.g., nutrient inputs, liquid and atmospheric inputs, inputs of solid waste, coastal erosion), the environmental and socioeconomical impacts of human activities, and the key remaining gaps in knowledge and capacity-building. In addition, it examines the developments of management approaches (e.g., marine spatial planning) as well as in the overall benefits from the ocean to humans in the last chapter.

The title of each chapter of the Assessment is presented as follows.

Volume I

Chapter 1: Overall summary
Chapter 2: Approaches to the assessment
Chapter 3: Scientific understanding of the ocean
Chapter 4: Drivers
Chapter 5: Trends in the physical and chemical state of the ocean
Chapter 6: Trends in the biodiversity of the main taxa of marine biota. A total of seven subchapters are under Chapter 6, including plankton (phytoplankton, zooplankton, microbes and viruses), marine invertebrates, fishes, marine mammals, marine reptiles, seabirds, marine plants and macroalgae.
Chapter 7: Trends in the state of biodiversity in marine habitats. A total of 17 subchapters are under Chapter 7, including intertidal zone; biogenic reefs and sandy, muddy and rocky shore substrates; atoll and island lagoons; tropical and subtropical coral reefs; cold water corals; estuaries and deltas; seagrass meadows; mangroves; salt marshes; continental slopes and submarine canyons; high-altitude ice; seamounts and pinnacles; abyssal plains; open ocean; ridges; plateau and trenches; hydrothermal vents and cold seeps; Sargasso Sea.

Volume II

Chapter 8: Trends in the state of human society in relation to the ocean. Two subchapters are under Chapter 8, including coastal communities and maritime industries, and human health as affected by the ocean.
Chapter 9: Pressures from changes in climate and atmosphere
Chapter 10: Changes in nutrient inputs to the marine environment
Chapter 11: Changes in liquid and atmospheric inputs to the marine environment from land (including through groundwater), ships and offshore installations
Chapter 12: Changes in inputs and distribution of solid waste, other than dredged material, in the marine environment

Chapter 13: Changes in erosion and sedimentation
Chapter 14: Changes in coastal and marine infrastructure
Chapter 15: Changes in capture fisheries and harvesting of wild marine invertebrates
Chapter 16: Changes in aquaculture
Chapter 17: Changes in seaweed harvesting and use
Chapter 18: Changes in seabed mining
Chapter 19: Changes in hydrocarbon exploration and extraction
Chapter 20: Trends in inputs of anthropogenic noise into the marine environment
Chapter 21: Developments in renewable energy sources
Chapter 22: Invasive species
Chapter 23: Developments in the exploration for and use of marine genetic resources
Chapter 24: Marine hydrates – a potentially emerging issue
Chapter 25: Cumulative effects
Chapter 26: Developments in marine spatial planning
Chapter 27: Developments in management approaches
Chapter 28: Developments in the understanding of overall benefits from the ocean to humans

Keynote points

Due to the enormous amount of information contained in the Assessment, this section presents the keynote points as follows.

- Some measures for mitigating or reducing pressures and their associated impacts on the ocean have improved since the first Assessment was issued. One of measures is the expansion and implementation of management frameworks for conserving the marine environment, including the establishment of marine protected areas and improved management of fisheries and pollutions. However, many pressures from human activities continue to degrade the ocean (e.g., mangroves and coral reefs), including unsustainable fishing (e.g., illegal, unreported and unregulated fishing), the introduction of invasive species, ocean acidification, excessive inputs of nutrients and hazardous substances (e.g., plastics, microplastics and anthropogenic noise) and ill-managed coastal development and extraction of natural resources.
- There continues to be a lack of quantification of the impacts of pressure and their cumulative effect effects. A failure to achieve the integrated management of human uses of coasts and the ocean is increasing risks to the benefits that people draw from the ocean, in terms of food safety and security, material provision, human health and well-being, coastal safety and the maintenance of key ecosystem services.
- Improving the management of human uses of the ocean can ensure sustainability. It requires capacity-building; innovations in marine technology; the integration of multidisciplinary observation systems; integrated management, planning and improved access to, and exchange of, ocean knowledge and technologies.
- The coronavirus disease (COVID-19) pandemic is having a major effect on many human activities carried out in the ocean. The full implications of the pandemic on human interactions with ocean are yet to be fully assessed.
- Drivers are characterized as social, demographic and economic developments in societies, including changes in lifestyles and associated consumption and production patterns. They apply pressures to the ocean. Relationships between drivers and pressures are complex and dynamic. The drivers identified are: population growth, economic activity, technological advances, changing governance structures, geopolitical instability, and climate change.

- The lack of appropriate wastewater treatment and the release of pollutants from the manufacturing industry, agriculture, tourism, fisheries and shipping continue to put pressure on the ocean. They pose a negative impact on food safety and security and marine biodiversity. Marine litter is a further problem, given that, in addition to the environmental and economic damages caused by its presence, it can carry pollutants and non-indigenous species over long distances.
- The main threats to marine ecosystems come from human activities, such as fishing, aquaculture, shipping, sand and mineral extraction, oil and gas exploitation, the building of renewable energy infrastructure, coastal infrastructure development and pollution, including the release of greenhouse gases. Many management frameworks for protecting marine ecosystems have a sectoral focus and can therefore have differing objectives for the protection of the marine environment across sectors. Management tools can be area-based (such as marine protected areas and fishery closures) or non-areas-based (such as global emission controls, catch and effort controls, and technical restrictions). They are increasing moving away from being focused on sectoral use towards the ones caring for diverse links between ecological, social, economic and cultural aspects. In addition, cultural information is becoming an integral part of management frameworks, both in the context of community-based management and for safeguarding the cultural dimension of the marine environment.
- Understanding the ocean facilitates sustainable management. Innovations in technology and engineering related to sensors and autonomous observation platforms have allowed for ocean data collection at finer temporal and spatial resolutions and expanded those observations into remote areas. Cost-effective and user-friendly sensors and mobile applications, the enhanced participation of citizens, and the deployment of sensors on non-scientific ships, all facilitate the expanded collection of ocean observations. Such developments have increased understanding of physical and biogeochemical systems in the ocean and how the ocean is changing in response to climate change, as well as enhanced ocean modelling capabilities at the global and regional scales.
- A wide range of events including tsunamis, storm surges, rogue waves, cyclones, hurricanes and typhoons, erosion, marine heatwaves and harmful algal blooms, together with various effects of hazardous substances and excessive nutrients, have the potential to threaten food security and hamper sustainable economic development.
- Animal protein from the seas, which is largely derived from wild fisheries, provides about 17 percent of all animal protein consumed by humans and supports 12 percent of human livelihoods. However, the contribution of aquaculture to food security is growing rapidly and has greater potential for growth than capture fisheries. Fishing is by itself a stressor on the marine environment, and the expansion of aquaculture brings new or increased pressures on marine ecosystems, in particular coastal areas.
- The ocean supports a wide range of economic activities, including seabed mining, extraction of offshore hydrocarbons, maritime transport, tourism and recreation, marine genetic resources, marine renewable energy, etc. All maritime industries are highly dependent on technology to operate safely and reduce damage to the marine environment. With regard to marine genetic resources, capacity-building remains an issue, as most work in this field is carried out in a small number of countries. There is therefore a need to build skills relating to the development of marine genetic resources in many countries in order to develop their blue economy sustainably.
- The United Nations Convention on the Law of the Sea (hereafter the Convention) establishes a delicate balance between the need for economic and social development through the use of the ocean and its resources and the need to conserve and manage those resources in a sustainable manager. In addition to its two implementing agreements (Agreement Relating to the Implementation of Part XI of the UN Convention on the Law of the Sea [1994 Part XI Agreement]; and Agreement for the Implementation

of the Provisions of the UN Convention on the Law of the Sea relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks [1995 Fish Stocks Agreement].), the Convention is supplemented by numerous global and regional legal instruments, covering many aspects of ocean use. One example at the global scale is the International Convention for the Prevention of Pollution from Ships (MARPOL). The other example at the regional scale is the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean. However, due to a lack of financial, technological and human resources, some countries fail to fulfill a State's obligations by effectively implementing these instruments. In particular, many small island developing States and least developed countries lack access to the detailed knowledge and skilled human resources needed for ocean management, and resources for managing the large marine areas under their jurisdiction are often limited.

- The Assessment specifies the links between the chapters and the Sustainable Development Goal 14 (Conserve and sustainably use the oceans, seas and marine resources for sustainable development) and its associated targets. As an illustration, Target 14.1 pertaining to cleaning up the ocean corresponds to Chapter 10, 11, 12 and 20. Target 14.2 pertaining to protecting and restoring marine ecosystems corresponds to Chapter 6 and 7. Target 14.3 pertaining to reducing ocean acidification corresponds to Chapter 5, 9. 10, and 13. The SDG 14 is reflected in the last chapter – Chapter 28.
- The Assessment lists a wide range of mechanisms associated with SDG 14 targets. For example, the mechanisms corresponding to Target 14.1 are improved wastewater management; sustainable urbanization and reduction in the environmental impact of cities; improved access to science, technology and innovation; enhanced knowledge-sharing and transfer of technology and capacity-building.

Table 1/ Sustainable Development Goal 14 associated targets

Target 14.1	By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.
Target 14.2	By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans.
Target 14.3	Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels.

Conclusion

Following the publication of the First Ocean World Assessment in 2015, the Second Assessment was published in 2021. The second Assessment further provides the updated information on the state, changes and trends of the marine environment at the global scale. The content it contains is comprehensive, particularly covering the impacts of human activities on the marine environment, developments of management approaches and the information relating to the overall benefits derived from the ocean. It also adequately links with the SDG 14 and the associated targets and further lists the mechanisms in achieving these targets.

References

[1] United Nations (2021). The Second World Ocean Assessment (WOA II).

Management Policy of Marine Debris in the Netherlands

Ning Yen (CEO of IndigoWaters)
Translated by Linguitronics
Keywords: the Netherlands, circular economy, marine debris, upcycling

The Netherlands is a European country with a slightly larger area and a slightly smaller population than Taiwan. It is also humid and rainy, much like Taiwan. Furthermore, similar to Taiwan, its land is scarce, which led to the development of high-value added agriculture such as flowers, fruits and vegetables. TSMC is known as one of Taiwan's major economic drivers, and it supplies electronic chips all over the world. The Netherlands, on the other hand, is home to several global brands such as the oil and gas company Royal Dutch Shell, Philips, one of the largest household electronics companies in the world, and the food conglomerate Unilever. However, when it comes to addressing marine debris issues, the Netherlands has adopted a strategy that differs from Taiwan. We focus on marine debris itself and propose actionable solutions to reduce plastic from the source, while also putting more effort in cleaning up waste. The Netherlands, on the other hand, proposed its policy from a macro prospective: Indeed, marine debris is a threat to sea creatures and the marine environment. But what if what people produce don't end up as waste all at?

Circular Economy in the Netherlands

Before looking into the Netherlands' policy, let us first recap humanity's current way of life. Almost everything that is associated with our way of life are products of a linear economy. Upstream factories produce raw materials, and through processing, designing, manufacturing and delivery, the product becomes available on the market. We then consume, use and dispose them of them before buying a new product. After people learned about recycling and started doing it, some materials then began to cycle back into the manufacturing process. Unfortunately, under the current system, not all things can be recycled. For example, most household products use compound materials. Take a hair dryer for example, it consists of an ABS outer shell, a PP mouthpiece, metal coils, ceramic heat shields and electric wires wrapped in PVC plastic. Unless they are all dismantled, no recycling plant would accept them. Moreover, though some materials can be recycled theoretically, such as PS, if they only come in a small amount or have a low market value, then it will be disposed of as common trash despite being a recyclable material, because recycling them is not economically worthwhile.

In contrast to solely focusing on recycling, the Dutch government wants to reduce the chances of items becoming waste. To achieve this goal, in addition to reusing a product, it is also possible to extend the life cycle of a product through product design, repair, renovation, reassembly, and reconstruction of materials (such as kiln-burning non-toxic industrial waste into paving materials for constructions, or transforming leftover plant material into food containers). The goal of the Dutch government is to replace the current linear economy with closed-loop economy. By 2030, it aims to reduce the amount of raw materials used by half, and attain a circular economy by 2050 [1].

This ambitious goal is confronted with many challenges. On the production side, the Dutch need to be pioneers in the design and manufacturing of closed-loop products; they even have to develop new sustainable uses of natural resources to reduce material consumption. On the consumption side, consumers need to be more aware of the products they buy and use to reduce the amount of waste generated. The total amount and quality of waste are indicators of circular economic activities. Hence, people need to recycle more and recycled items must be better processed. The central government greatly encourages its people and businesses to embrace the circular economy through the following three actionable solutions. First, strengthening the network of innovation by connecting different departments with sustainable startup groups. Second, tearing down the barriers from laws and regulations, including law amendments, license issuance and permitting room for experiments. Third, gaining market support through procurement and enhancing public awareness [2].

It is more valuable to completely dismantle and reuse: The innovative path to recycling waste

The type of recycling that we are familiar with is known as downcycling. The strength and quality of recycled materials cannot be on par with the original materials, leading to a downgrade of value after recycling. The conventional recycling of paper and plastic are all downcycling. For example, paper is recycled into newspapers of lower paper quality, or recycled plastic bottles are made into flower pots or photo frames. In contrast to downcycling, upcycling is adding value to materials after they are recycled.

Is it possible to turn stone into gold? The Dutch have proven that they're not all talk and no action when it comes to realizing sustainability. In 2018, 85,000 circular economic activities were created in the Netherlands, creating 420,000 job opportunities [3]. To continuously incentivize businesses, the Dutch Ministry of Infrastructure and Water Management set aside 40 million euros to fund circular economy projects in 2019 and 2020. Municipal strategies and the Sustainable Development Goals also led to financial support for businesses in this period of transformation [4].

Figure 1/ Interface buying old fishing nets from fishermen
Source/ Net-Works

Through the dual support of government policies and fiscal policies in the Netherlands, many businesses now view waste as new materials instead of the useless things they used to consider them, and will turn them into new products through recycling. This not only reduced dependency on raw materials and natural resources, but also created new business models. The global leader in carpets and modular flooring, Interface Inc., noticed that abandoned fishing nets are hazardous for the environment. They also noticed that both fishing nets and carpets are made of nylon. Therefore, the company launched the Net-Works program in the Philippines and the Republic of Cameroon, recycling local fishing nets into yarn for carpets. This not only created revenue for the fishermen, but also reduced the usage of petrochemical materials in making carpets. Furthermore, the program reduced the harm abandoned fishing nets have on wild animals. Now, 58% of the materials used to make Interface carpets comes from recycled or biological sources. Compared to 1996, Interface has reduced its carbon emissions by 95%, and is dedicated to bring more benefits for poor families.

Another company that also produces carpets is called Niaga (the word "again" in reverse), incorporating the concept of reusing materials in product designs and adding recycling into the product's life cycle. Every item from Niaga comes with a tag instructing consumers to return it instead of throwing it away. If all consumers can return recyclable products back to the company for collective recycling, the materials can then be reused continually. Niaga recycles bed mattresses and carpets by extracting the nylon or woolen fibers and utilizing technology to reduce production costs and the consumption of energy and water.

Creating plastic that lasts forever? This is not a fantasy, it is actually a unique technology by Ioniqa. Due to the physical properties of plastics, every time we recycle, the polymer chains in the plastic are broken. This results in less strength and toughness after each recycle and forces us to add new plastic materials as reinforcement. The technology that Ioniqa developed can repeatedly remake PET (polyethylene terephthalate, or the material used to make plastic bottles) into high quality, transparent, good-as-new plastic ester pellets. PET polymer is widely used in water and beverage bottles, packaging, functional clothing and carpets. We use up to 61 million tons worldwide annually, but 90% of them end up in incinerators or as environmental litter. Ioniqa wants to change the fate of PET polymer and created recycled plastic with quality and price competitiveness.

Figure 2/ Bottle cap patterns are clearly visible on a WasteBoards skateboard
Source/ WasteBoards

Other companies are also involved in the quest to turn trash into gold, including furniture manufacturer Van de Sant, skateboard company WasteBoards, and Dutch-Kenyan firm Ocean Sole. Van de Sant reprocesses, melts and reshapes plastic waste from land and the ocean into sofas. These furniture go on to become key fashionable items in business hotels, exhibitions, and banquets. The skate board company WasteBoards collaborated with the Plastic Whale Foundation, which guides people and children to pick up trash from the waterways when touring on boats in the canals of Amsterdam. More than 12,500 people have participated, and they have cleaned up more than 100,000 plastic bottles, as well as enough plastic waste to fill more than 2,000 plastic bags. The trash from the canals then undergo a selection process to pick out the useful items; 1,000 plastic bottle caps can go through 3 hours of heating and melting to be made into a brand new skateboard, with the patterns of the 1,000 bottle caps upon it.

With the help of a Dutch company called Nic & Mic, Kenya's Ocean Sole turns slippers picked up during beach cleaning into 3D animal sculptures with vibrant colors and different sizes through the skilled hands of artists. In 2018, 750,000 slippers were sculpted and transformed into artistic masterpieces of different sizes by 80 local artists. Some are suitable for home or office decorations, while others are large pieces of installation art, such as life-size giraffes and lions.

The most ambitious fundraising event in history to eliminate marine debris once and for all

It's not just repairing, reassembling, and recycling materials to extend a product's life cycle. For waste

that is already littering the environment, the Dutch incubated many startup teams that combined engineering and technology. The solutions they proposed to solve plastic pollution issues include ocean cleanup system, Bubble Barriers, and CLEAR RIVERS. Detailed descriptions for the solutions are as follows.

In 2013, a young Dutchman named Boyan Slat (who was 18 at the time) was deeply shaken after witnessing marine debris while snorkeling. He launched an NGO "The Ocean Cleanup" to eliminate ocean plastic waste and created the cleanup system. It was hailed as the best invention of 2015, a miracle in ocean cleanup technology, and even received more than 40 million USD in funds. However, the performance of the system wasn't up to expectations, some even split apart in the sea before they had completed their mission. The team could only drag the system back to the port for assessment and correction.

In addition to cleaning marine debris, the Ocean Clean Up team knew all too well that the speed of cleaning up marine debris is far slower than the speed of waste being dumped into the ocean. According to the team's scientists' latest research, approximately more than 1,000 rivers across the globe flush 80% of river debris into the ocean [5]. Hence, they also developed the River Interceptor. The River Interceptor has a life span of 20 years, is 100% powered by solar energy, and is fully automated. It is now used in Indonesia, Malaysia, Vietnam, and the Dominican Republic. The team also signed contracts with Thailand, Honduras and the United States, hoping to stem marine debris issues by solving river debris issues.

Figure 3/ An Interceptor on a river in the Dominican Republic
Source/ The Ocean Cleanup

Figure 4/ Operation principles of a Bubble Barrier
Source/ The Great Bubble Barrier

Another innovation that also focused on river debris is the Bubble Barrier in the canals of Amsterdam. The principle of a Bubble Barrier is to first lay a pipe drilled with small holes at the bottom of the canal. Then a compressor is used to blow air into it, creating a barrier of bubbles. This barrier can create an upward current like an invisible interceptor, pushing plastic waste up to the surface of the canal. The team installed Bubble Barriers at opposite corners of a canal, which allows the current to push plastic waste to the banks on either side and right into collection devices. The Bubble Barrier can run all day long, increasing dissolved oxygen in the water without harming aquatic creatures. It is also very safe for boats to cruise through, and its scope can cover the whole breadth and depth of the river. We hope that this technology can be applied to other rivers as well.

Compared to the abovementioned River Interceptor and Bubble Barrier, CLEAR RIVERS proposes a systemic solution that combines trash intercepting, cleaning, environmental education, improving public awareness, and recycling. CLEAR RIVERS uses devices that are likened to floating piers and intercepting cables to collect trash in rivers and around piers. The trash is then sorted and can be made into 3D printing filaments as well as remade into dock structures, modern-styled sofas, and hexagon bricks used in constructions. A water park that consists of floating islands can not only allow plants to grow, it can also attract birds and fish to inhabit there. This brings greenery to a metropolitan city like Rotterdam, and it is also the best example of directly showcasing to the public the results of cleaning marine debris.

Figure 5/ Floating islands made with recycled plastic waste from CLEAR RIVERS
Source/ CLEAR RIVERS

Conclusion

The issue of marine debris has inspired a great deal of self-reflection on the use of rare materials and the benefits of reusing resources. As a result, the Dutch government is swiftly transforming the country into a circular economy. This has blurred the lines between products, materials, and components by adding value and enhancing performance. The Dutch government is creating a virtuous cycle of sustainable development. The Netherlands now has 1,500 innovative circular economic initiatives in product design, business models, and technology, such as recycling plastic and turning them into furniture or construction materials, and even transforming recycled waste into floating island parks on the canal. The Netherlands has proven to the world that these measures are not only beneficial for the environment but also for the economy. Policies are used to establish the basic frameworks, and through incentives and easing regulations, the Netherlands are flourishing with all kinds of innovative ideas. In the future, more people and businesses need to support this cause and transform the Netherlands into a model for a circular economy, thereby accelerating global transformation and embracing sustainable development.

References

[1] The Ministry of Infrastructure and the Environment and the Ministry of Economic Affairs (2016). A Circular Economy in the Netherlands by 2050. The Ministry of Infrastructure and the Environment and the Ministry of Economic Affairs.
[2] Herman Huisman (2018). From waste management to circular economy: Circular scheme and policy of plastic management in the Netherlands. Oral presentation at the 5th SMM International Conference 2018 November 19-20, Taipei Changhua & Taichung, Taiwan.
[3] Trudy Rood and Maikel Kishna (2019). The Outline of Circular Economy. PBL Netherlands Environmental Assessment Agency, The Hague.
[4] Netherlands Enterprise Agency (2019), Rijksdienst voor Ondernemend Nederland https://www.rvo.nl/ (Jun. 20, 2021)
[5] Meijer, L. J., van Emmerik, T., van der Ent, R., Schmidt, C., & Lebreton, L. (2021). More than 1000 rivers account for 80% of global riverine plastic emissions into the ocean. Science Advances, 7(18), eaaz5803.

The Ministry of Infrastructure and Water Management and Marine Policies in the Netherlands

Compiled by Cheng-Chi Chung (Distinguished Professor, Dept. of Shipping and Transportation Management, and Chairman of Bachelor Degree Program in Ocean Tourism Management, National Taiwan Ocean University, Taiwan), and Ching-Ting Chang, Chao-Chun Hsu, and Fen-Yi Lou (Master Degree Student, Dept. of Shipping and Transportation Management, National Taiwan Ocean University, Taiwan)

Keywords: Maritime transportion, Marine policy, Water management

The outward orientation of the Netherlands stems from its distinguished maritime history with its location at the mouth of the Rhine River, which has earned its name as "the Gateway to Europe." The Ministry of Infrastructure and Water Management (Ministry of I&W) has been instrumental in the development of maritime transportation in the Netherlands. Its main business includes maritime transportation and seaports, water management, and sailing and boating. The Dutch water transportation is well-connected between ports and the inland waterways, and the main objectives of maritime transportation and seaports are to ensure the safety of maritime transportation and to maintain the sustainability of ports. The Netherlands also has problems with territories below sea level or of river flooding. Therefore, water management services are required for flood control and ensuring adequate water supply. As for Taiwan's maritime industry, there are many development conditions similar to those of the Netherlands, such as limited land area and the externally oriented economy. Taiwan may use the experience of the Netherlands for reference by understanding the Dutch maritime policies. The Ministry of I&W and marine policy in the Netherlands are introduced in the article.

Ministry of Infrastructure and Water Management in the Netherlands

The Ministry of I&W in the Netherlands is committed to creating an efficient transportation network by railways, highways, waterways and airways, as well as effective water management to combat flooding and improve air and water quality [1]. There are four Directorates-General responsible for policy-making, including Directorate-General for Mobility, Directorate-General for Aviation and Maritime Affairs, Directorate-General for Water and Soil Affairs, and Directorate-General for the Environment and International Affairs. Additionally, there are the Rijkswaterstaat (RWS) for policy implementation, Human Environment and Transport Inspectorate (ILT) for statutory compliance, and the Netherlands Environmental Assessment Agency (PBL) and Royal Dutch Meteorological Institute (KNMI) are also the agencies under the Ministry [2].

I. Maritime Transportation and Seaports [3]

As a small country that has almost no natural resources, more than half of imports and exports in the Netherlands are transported by sea, which shows the importance of maritime transportation and ports to its economic development. Hence, the Ministry of I&W is committed to maintaining the safety of maritime transportation and ports along with planning for future development. In addition, the Dutch government continues to promote port sustainability measures to reduce pollution from ships. The related departments and subject scope of maritime transportation and seaports are introduced as follows.

i. Related Departments: The related departments under the Ministry of I&W include Directorate-General for Aviation and Maritime Affairs, Directorate-General for Mobility, Directorate-General for the Environment and International Affairs, Directorate-General for Water and Soil Affairs, and ILT .

ii. Subject Scope: The five main subjects are shown in Table 1.

Table 1/ The Subjects of Maritime Transportation and Seaports

Subject	Subject Description
International Maritime Agreements	Maritime issues are considered as an important facet for the Netherlands, having a voice in international organizations can attract attention from other countries. Therefore, the Netherlands has representatives in the following international organizations: International Maritime Organization (IMO); International Labour Organisation (ILO); European Maritime Safety Agency (EMSA); Working Party on Shipping of the Council of the European Union.
Enhancing Port Competitiveness	• Strengthening Seaport Trade: The main competition Dutch seaports face comes from other large seaports e.g. the port of Hamburg, German. Thus, the seaports must be attractive in cargo handling. • Rotterdam Mainport Development: Expanding Rotterdam to remain competitive. At the same time, the liveability of the Rhine Estuary region must be improved. • Improving Port Accessibility: Deepening and maintaining the depth of sea lanes, improving and expanding transport links with the hinterland, strengthening collaboration with knowledge-based industries and manufacturing industries in neighboring regions.
Maritime Safety and Security	• Preventing Terrorism: The Dutch government has incorporated the International Ship and Port Facility Security Code (ISPS Code) and Regulation (EC) No. 2004/725 security requirements into Schepenbesluit 2004 (Shipping Decree) and Havenbeveiligingswet (Port Security Act) for protection of maritime transportation and seaports against terrorism. • Combating Piracy: The Netherlands has become a party to the Regional Cooperation Agreement on Anti-Piracy in Asia (ReCAAP) in 2010. • Maritime Safety: The Dutch government has signed international maritime safety agreements and ensured to provide better maritime education and training.
Maritime Sustainability	• Combating the Harmful Effects of Ship Emissions: The content of low sulphur fuel oil shall not exceed 0.1% in the North Sea area since 2015. Ships shall not discharge waste at sea. In European ports, ships are obliged to turn over their waste and pay a waste treatment fee. • Ballast Water: Ballast Water Management Convention (BWM Convention) is an international convention adopted by the IMO in order to help prevent the spread of potentially harmful aquatic organisms and pathogens in ships' ballast water. • Fair and Safe Disposal of Ships: Only ship recycling companies that fulfill strict environmental and working conditions are allowed to dispose of ships.
Smart Shipping	Smart shipping refers to a greater degree of autonomy in navigation for ships, including on-board technologies, ports, and waterway design, with the following three advantages: • More Competitive: By obtaining more accurate navigational data, ships can utilize waterways more productively, reduce transport costs, and improve the competitiveness of inland shipping. • Safer Sailing: Smart shipping can reduce the possibility of accidents caused by human error, making work on ships and coastal waterways safer and easier to manage. • More Sustainable: With Smart Shipping technologies, ships can save bunkers for more sustainable sailing, such as using more precise environmental data to allow ships to adjust their speed to reduce bunker consumption.

Source/ Government of Netherlands (2021) [3]

II. Maritime transportion and seaports policies [4]

The "Dutch Maritime Strategy 2015~2025" proposed by the Ministry of I&W divides the maritime policy into 7 directions, of which the maritime transport and port policy covers the following 4 directions.

i. Trade: An Attractive Shipping Register

The Netherlands has an excellent business environment and a favorable tonnage tax scheme, making it a potential location for ship registration. The government organizes more efficient registration and certification for seagoing ships, so that the quality is comparable to that of other important maritime registers, including faster registration and certification procedures. A more flexible payment system is also provided.

ii. Accessibility: Chain Optimization and Nautical Services

The government and industry will continue to pursue seamless logistics and transportation network, as well as the integration of maritime transportation. The Dutch government provides navigation-related services and is committed to the development of offshore shipping. The government hopes to

reduce the administrative burden of maritime transportation by optimizing the opportunities for offshore shipping between European countries, make the shipping environment friendlier, and improve the transportation links between ships, ports and hinterland.

iii. Safety and the Environment: Adequate Regulatory Framework

The government and industry are striving for a modern and appropriate international regulatory framework for safer, more environmentally friendly and sustainable development of shipping and ports in the Netherlands. The government will make efforts to implement new legislation promptly and establish a sound policy, implementation and enforcement chain. This policy covers environmental safety-related issues, such as restricting harmful ship emissions and regulating the safe disposal of ships.

iv. Communication: Establishing a Knowledge Program in Shipping

The proper execution and monitoring of maritime strategies require specific expertise. The Dutch government has not only established an agenda for seaport knowledge, but also pondered knowledge issues related to maritime strategies, and exchanged relevant knowledge with the overall maritime community.

In recent years, the proportion of national ships in the Taiwan fleet has not increased. According to statistics from UNCTAD in 2020, the proportion of national ships in Taiwan is only 14.14%, while in Dutch is 58.72% [5]. We can learn from the Netherlands and adjust our ship registration system in order to increase the proportion of national ships. In addition, it can be seen from customs statistics that almost all of Taiwan's imports and exports rely on shipping industry [6]. We can follow the Dutch policy, such as increasing the connection between the port and the hinterland to overcome the problem of limited land area, and maintaining or strengthening port facilities to enhance port accessibility and competitiveness. After all, the government can communicate with the maritime community more frequently to better understand and pay more attention to the development of maritime industry.

III. Water Management

More than half of the Dutch territory and two-thirds of economic activities are located in areas prone to flooding and at risk of inundation. These factors forced the Netherlands to face the safety of water management, especially in flood control and dam maintenance [7]. The Dutch water sector has a global reputation. The cooperation of experts from the government, expert institutes, industry and NGOs brings sustainable solutions to the world's greatest challenges [8]. The related departments and subject scope of water management are introduced as follows.

i. Related Departments: The responsibilities of related departments in water management are shown in Table 2.

Table 2/ The Responsibilities of Related Departments in Water Management

European level	
European Union: Legislation and regulation for water, floods and the environment	International River Basin Commissions: Cross-border water management
National level	
Ministry of Infrastructure and Water Management: Water, spatial planning and flood protection at national level	Rijkswaterstaat: Operation and maintenance of main water system
Provincial level	
Provinces: Integrated spatial and environmental planning, supervision of Regional Water Authorities (RWAs), groundwater regulation, and co-ordination with other regional policy areas	
Watershed level	**Municipal level**
District water boards: Operation and management of regional water systems, flood defense, water quality and water quantity, and wastewater transport and treatment	Municipalities: Local spatial planning, sewage collection and wastewater transport, urban drainage, and stormwater collection

Source/ Organisation for Economic Co-operation and Development (2014) [7]

As shown in Table 2, the Dutch authorities attach great importance to water management, and the responsibility of each unit is clearly defined. Internationally, it complies with European Union water legislation and international basin committee's legislation. Nationally, the Ministry of I&W of the Netherlands and RWS jointly plan the flood control and water system policies. The provincial and district water boards plan the water management measures within their areas.

ii. Subject Scope: RWS and the district water boards are in charged with water management in the Netherlands. They are responsible for ensuring a sufficient supply of water and protecting the country against floods [9]. The subject scope of them is shown in Table 3.

Table 3/ The Subject Scope of Water Management Departments

Department	Area	Responsible Description
Rijkswaterstaat	Major waters, such as the sea and the rivers	• Issue flood and rainstorm warnings for the government • Maintain dikes and dams • Deepen the floodplain and build secondary channels
District water boards	Regional waters, such as waterways and canals	• Ensure water quality • Prevent flooding and ensure that farmers have sufficient water resources • Responsible for wastewater purification

Source/ Government of Netherlands (2021) [9]

As shown in Table 3, the Ministry of I&W of the Netherlands are divided into central and local departments. RWS aims at overall national security and construction, while the district water boards is responsible for the management of local water resources.

IV. Water Management policies [8]

i. National Water Plan 2016~2021

- Draft policies for Dutch's flood risk management and freshwater supply.
- Identify strategies for flood-prone areas, such as the Rhine-Meuse delta and the coastal area.
- Review the optimal way to accommodate water in spatial planning in the Netherlands, and its costs.

ii. Administrative Agreement on Water Affairs (Bestuursakkoord Water)

The Dutch central government, provincial authorities, municipalities, district water boards and water companies signed an agreement on Water Affairs (Bestuursakkoord Water) in 2011. This agreement stipulates a total funding of 750 million euros for the High-Water Protection Program (HWPP) until 2020 for water systems and water supply chains. The HWPP targets dams and dikes that do not meet safety standards, yet have not been included in other programs, for enhanced flood protection to preserve the ocean and prevent high water levels in rivers.

iii. Value Water Initiative

In April 2016, the United Nations and the World Bank convened a High-Level Panel on Water (HLPW) to advocate for a holistic and collaborative approach to the development and management of water resources with improved water and sanitation-related services. In 2019, the Netherlands launched the Valuing Water Initiative (VWI). The initiative demonstrates the implementation of the United Nations Valuing Water Principles, with the aims of systemically reforming the way water is valued in policy, practice, finance and behavior, and encouraging others to follow suit.

Taiwan also faces the potential threat of flooding caused by heavy rains and typhoons, which will cause damage to flood protection and drainage facilities every year. Refer to the Netherlands, we can promote cooperation between the government and experts from industry or academia to find the most suitable solutions for Taiwan.

Sailing and boating [10]

The Dutch government regulates sailing permits and registration regulations for watercrafts, such as sailboats and boats. There are four main sections:

I. **Obtaining a yacht license:** If you want to sail a yacht with a hull length of 25 to 40 meters, you need to take an exam to obtain a yacht license. This license does not allow commercial use of the ship. Groot Pleziervaartbewijs II is valid for navigation in all inland waterways and is the International Certificate of Competence for yachts in inland and coastal waters.

II. **Registration of speedboats, water scooters or jet skis:** Speedboats, water scooters, and jet skis must be registered in the Netherlands before sailing in inland waters. The registration certificate is only valid in Dutch inland waters. If you wish to sail abroad, you shall check whether the country accepts the Dutch registration certificate.

III. **Obtaining a small license for speedboats or pleasure boats:** A small license is required if you want to sail a speedboat under 20 meters and over 20 km/hour, or a pleasure boat 15 to 25 meters long. You must pass the exam of CBR (Central Bureau Rijvaardigheidsbewijzen) to obtain this license.

IV. **Application to Kadaster for registration of boats:** The registration of a boat can be done in the public registry of Kadaster. This applies to houseboats, sailboats and other yachts. After registration, Kadaster will affix a registration number, also known as a brand mark, to the boat. This branding can protect the boat from theft.

Taiwan's 2020 National Ocean Policy White Paper states that the government is formulating policies to promote ocean tourism [11]. Water sports is one of the fun activities to do when visiting the Netherlands. We can learn from Dutch's detailed legislation on watercrafts, including certification requirements, ship registration and navigation regulations in different waters. Regarding the development of ocean tourism, Taiwan still has a lot to learn from the Netherlands.

References

[1] Government of Netherlands, Ministry of Infrastructure and Water Management Search
https://www.government.nl/ministries/ministry-of-infrastructure-and-water-management (May 31, 2021).
[2] Government of Netherlands, Organisation
https://www.government.nl/ministries/ministry-of-infrastructure-and-water-management/organisation (May 31, 2021).
[3] Government of Netherlands, Maritime Transport and Seaports
https://www.government.nl/topics/maritime-transport-and-seaports (May 31, 2021).
[4] Ministry of Infrastructure and the Environment, The Dutch Maritime Strategy 2015-2025
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwje_I_rxfbwAhXvw4sBHWMmDhcQFjAHegQIBRAF&url=https%3A%2F%2Fwww.rand.org%2Fcontent%2Fdam%2Frand%2Fpubs%2Ftechnical_reports%2F2010%2FRAND_TR690.pdf&usg=AOvVaw0od-jQEG2ECshgJ1ATp5Np (May 31, 2021).
[5] UNCTAD, Review of Maritime Transport 2020
https://unctad.org/system/files/official-document/rmt2020_en.pdf (May 31, 2021)
[6] Taiwan Customs Administration CPT Single Window, Statistics Database Query
https://portal.sw.nat.gov.tw/APGA/GA11_LIST (May 31, 2021)
[7] OECD, Water Governance in the Netherlands: Fit for the Future?, 2014.06.
https://doi.org/10.1787/9789264102637-en (May 31, 2021).
[8] Government of Netherlands, Water Management
https://www.government.nl/topics/water-management (May 31, 2021).
[9] Government of Netherlands, Water Management in The Netherlands
https://www.government.nl/topics/water-management/water-management-in-the-netherlands (May 31, 2021).
[10] Government of Netherlands, Sailing and Boating
https://www.government.nl/topics/sailing-and-boating (May 31, 2021).
[11] Ocean Affairs Council, 2020 National Ocean Policy White Paper
https://www.oac.gov.tw/ch/home.jsp?id=232&parentpath=0,2

Tank Testing and Demonstration of Space@Sea Floating Island

Wen-Yang Hsu (Research Fellow, ITRI Green Energy and Environment Research Laboratories)
Heng-Chu Peng (Assistant Research Fellow, ITRI Green Energy and Environment Research Laboratories)
Translated by Linguitronics
Keywords: floating island, tank testing, Maritime Research Institute Netherlands

Statistics [1] show that the majority of the world population resides in inshore coastal areas. However, as sea levels rise with global warming, in the near future, the limited amount of littoral land will have to be redistributed or drastically altered in how it's used. Hence, researchers are becoming increasingly interested in the possibility of the development of ocean space. In addition, offshore development is quickly shifting from the conventional offshore oil and gas industry to applications such as renewable energy, aquaculture, transportation hubs, tourism, airports, and cities [2]. Historically, development activities that have transitioned from land to sea were usually achieved through the use of offshore platforms or artificially created land. Although the concept of a floating island that fulfills multiple purposes has been proposed, so far there has not been any examples with tangible results. In fact, many technical barriers for large floating islands still exist. For example, when large numbers of floating modules are joined to form an island, the interactions between them can be very complicated. In light of this, the European Union commenced the research project named Space@Sea in the Horizon 2020 research program in November 2017, appointing 17 collaborating partners. These partners include: Maritime Research Institute Netherlands, DeltaSync, DST, Nemos, Delft University of Technology, Mocean Offshore, TU Hamburg Harburg, Bluewater, University of Rostock, Gicon-Grossmann, Wageningen University & Research, University Duisburg-Essen, TU Graz, Waterstudio, Icepronav, Val Fou and GeoSea. The goal of the project is to develop standardized floating modules and build affordable large floating islands that are environmentally sustainable and have a low ecological impact. This article will introduce the floating island hydraulic model experiments conducted by Space@Sea in the tank at the Maritime Research Institute Netherlands (MARIN), and describe the results of the experiments.

Scope of Floating Island Tank Tests

The Space@Sea project also uses a modular concept. The overall structure is shown in Figure 1. There are 4 clusters: the technical/non-technical cluster (business model, technical challenges and environmental effects) in WP 1-5, the application scenario cluster in WP 6-9, the module integration and demonstration cluster, WP 10, and the cluster that deals with management, dissemination and implementation in WP 11-12. Among them, the four application scenarios for floating islands include Energyhub@Sea, Living@Sea, Farming@Sea, and Transport&Logistics@Sea. They are each introduced below.

- The design of the Energyhub@Sea component (WP 6 of Figure 1) includes the use of the relative motion between floating modules to produce renewable energy. It also utilizes the floating

modules to create developmental space for renewable energy sources such as solar power and wind power. The goal of this work item is the development of a wave energy converter and to evaluate the motion response that weakened wave energy would have on inner floating modules. Additionally, services such as the storage of renewable energy and electric power transmission are evaluation items as well.

- The philosophy of Living@Sea (WP 7 of Figure 1) is that jobs at sea will also attract people to live at sea. Similar needs have already appeared in the maintenance work of offshore renewable energy industries. Due to the high cost of sending technicians to complete missions at sea, the demand for hotel space at sea has emerged. The early stages of the project will aim at housing technicians, but it will gradually expand to include family residences and eventually larger building complexes and cities.

- Farming@Sea (WP 8 of Figure 1) will develop agriculture components that specialize in aquaculture. The goal is not only to maintain the self-sustainability of the floating island, but also to develop technology that promotes the production of aquaculture and biomass energy. Furthermore, aquaculture further away from the shore will become more feasible.

- Transport&Logistics@Sea (WP 9 of Figure 1) will develop offshore hub components. This is to solve the issue of some harbors no longer having the capacity for expansion despite the constantly rising volume of maritime transport. For harbor cities with limited expansion space such as Constanta, Barcelona, and Gibraltar, having offshore hub stations is their only opportunity to grow. Moreover, for ports like Hamburg and Antwerp, offshore logistics hubs provide the possibility to increase port throughput, while also reducing the necessity of having large vessels navigate through narrow rivers.

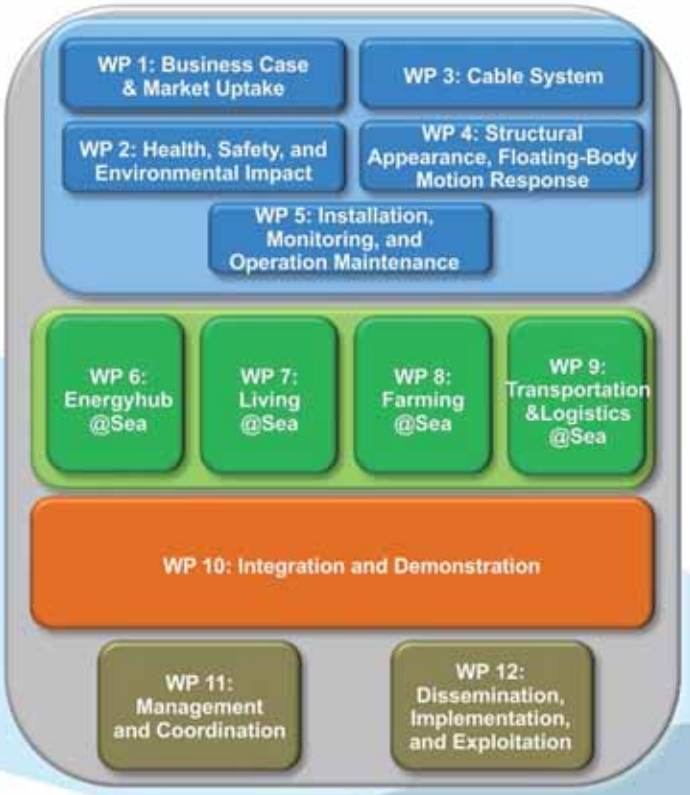


Figure 1/ Project Framework of Space@Sea and its subprojects at each WP
Source/ Flikkema M. and Waals O. [2]

In order to further evaluate the hydraulic response characteristics when the floating island integrates the 4 application modules mentioned above and to demonstrate the results, in the Offshore Basin within their facility, MARIN conducted testing on a 1:60 scale. These tests consisted of multiple subsystems, including 73 floating island modules, 260 connector modules, 46 cables, and one berthed cargo ship. Test items included calibration testing of weight proportion and climate environment (including extreme conditions of the 100-year recurrence interval), and static load tests such as cable restoring force and free decay testing. The results can be used to examine some of its hydraulic characteristic and provide data for simulation calibration.

In addition, in the seakeeping quality test, measurement items included the flow speed at each position, wave height, the 6-axis motion of the modules and the cargo ship, the 6-axis load of the cables and connectors, and the effects the wave energy convertor and green water had on the deck. The floating island testing layout is shown in Figure 2. It's worth noting that in order to reduce the total variance, the variance of each individual module had to be minimized (for example, the mass, center of gravity, and the draft). Hence, during the testing, none of the modules had structures mounted above; only during public display will these structures be set up.

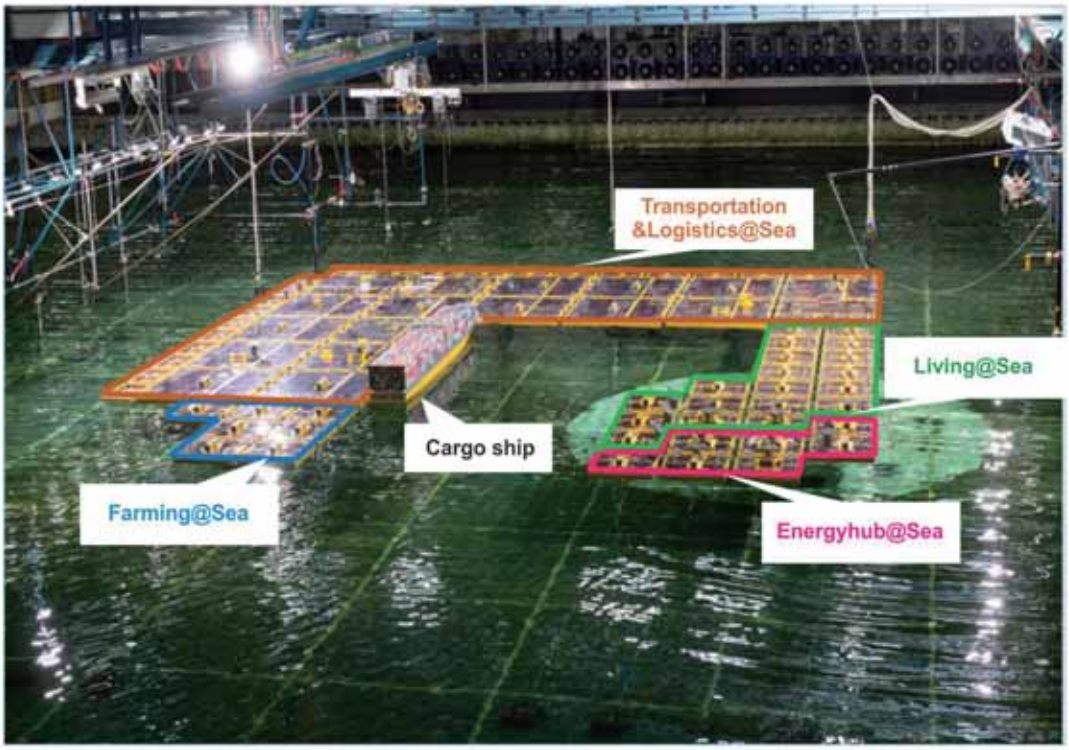


Figure 2/ Photo of floating island tank testing in Holland MARIN. The pink part is the energy center (level 6), the green part is living space (level 7), the blue part is the agriculture center (level 8), and the orange part is transportation and logistics (level 9)
Source/ https://spaceatsea-project.eu/images/d10.4_part1.pdf

Experiment Equipment and Module Introduction

In this section, the MARIN testing tank, floating modules, connector, cable system, and berthed ship will be introduced in turn.

I. Testing Tank
The MARIN wave generating basin (46 x 36 m) has a movable floor (36.35 x 31.6 m) that allows partial adjustment of the depth. The maximum depth is 10.2 m; in addition, there is a well in the center of the basin that can reach a maximum of 30 m. The current generator comprises six individual circulation channels and can generate an even flow field up to the depth of 10.2 m. The wave generator is made up of 200 individual flaps. By individually controlling its frequency and stroke, it can generate long-crested irregular waves, directional propagating irregular waves, and combinations of waves and surges.

II. Floating Modules
The floating island is made up of three different types of modules, including square modules with original sizes of 45 x 45 m and 95 x 95 m, and a wave energy converter (WEC) module with the original size of 26.58 x 45 m. The height of the square modules are all 11 m (shown in Figure 3a), with a draft of 8

m. The height of the WEC modules is 4 m and the draft is 2 m (shown in Figure 3b). The bottom and sides of the downscaled square module model are colored yellow, in order to enhance their visibility in photos and videos. The upper cover is made with a transparent acrylic material to allow visual examination of leakage during the testing process. Additionally, torsion testing showed that, by using wooden slab stiffeners on the inner sides of the module to avoid module deformation, the average deformation of the diagonal measurement of the module was only 0.157 mm/kg.

III. Connectors

Other subprojects of Space@Sea have already analyzed different connector designs. For the tank testing, MARIN chose to use the "Graz-connector". For its complete design and characteristics, refer to [3]. The connector is made of fender and, as shown in Figure 3a, through the tension of the cables, pre-compression of the fender can be maintained. In the tank testing, appropriate springs are used to simulate the effects of the connecting cables.

IV. Cables

The catenary cable design is from the third subproject of Space@Sea. It is suitable for environments with depths of about 100 m. The original length of the cable is 436 m and it weighs 798 kg/m. The gravity anchor blocks used in the tank testing have stainless steel chains with a diameter of 32 mm and weight of 50 kg (as shown in Figure 3c). Load sensors were installed at some of the shackles of the cables.

V. Berthed ship

To study the interactions between the berthed ship and the floating island, MARIN used the existing M10128 cargo ship model (shown in Figure 3d) to simulate the ship being berthed using two sets of connectors, and analyzed the ship motion and capacity of the connectors.

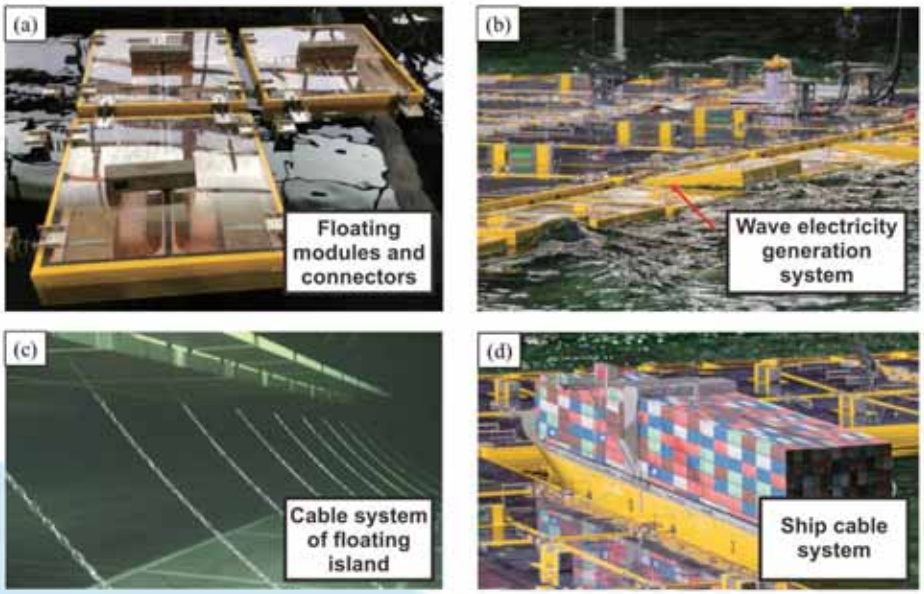


Figure 3/ (a) Square floating modules and connectors; (b) Wave electricity generation system module; (c) Cable system of floating island; (d) Ship cable system
Source/ https://spaceatsea-project.eu/images/d10.4_part1.pdf

Results

Overall, the motion behavior of the floating island that comprised multiple square modules did not differ much from that of the original predicted simulation. Excerpts of important experiment results are as follows:

The results of cable tension and the reaction curve of floating island displacement from the static load testing corresponded with the simulation, which means that the scale of the cables and testing installation layout meet the requirements of the original size. The results of the free decay testing show that the floating island displays a typical beating pattern. This mechanism results from multiple similar modes of resonance, which is responsible for the oscillation phenomenon during late stages of the free decay. The natural frequency of the surge, sway, and yaw were between 155 s and 180 s.

When under the effect of a single current, the floating island exhibited stable draft and motion. When under the effect of wave action, all surge, sway, and yaw motion responses were at low frequencies; almost no motion responses were generated by waves or higher frequencies. The most probable maximum (MPM) angle of pitch of each floating module was recorded. These results show that modules facing the waves can reduce the wave diffraction effect, resulting in relatively stable side modules.

As for the connectors, since the fenders were able to be maintained in a compressed state throughout the effects of the current and waves, the designated pretension of the cables were sufficient. Additionally, when comparing incident angles, an incident angle at 225 degrees generated the greatest shear force on the fenders. Also, the maximum tension on the cables under all testing conditions were below the fracture strength of the material. The overall safety factor was greater than two.

Under storm condition, significant green water effects occurred on the wave energy convertor module, and some of the water body overflowed to the rear modules, as shown in Figure 3b. In the future, further evaluation of the green water impact force, overflowing volume, and installation of appropriate barriers during the operation of the wave energy convertor would be necessary. For the berthed ship, since the berth unit was within the shielded inner port of the floating island, the water level and the cargo ship appeared to be rather stable.

Conclusions

The aim of the Space@Sea project is to develop a standardized and cost-efficient modularized island that has minimal ecological impact and provides sustainable affordable space for living and working. Overall, after tank testing the concept of the modularized floating island, the hydraulic response of the overall structure and each module corresponded with the calculated data, proving that the modularized technology is feasible. When MARIN displayed the Space@Sea modularized floating island in October 2020 [4], it included upper layer structure models on each module (such as cranes, cargo harbors, photovoltaics, wind power generators, and residential houses), to demonstrate the four different application scenarios. In the future, the project will continue to solve technical issues that were revealed during the testing process, such as protection methods against the green water effect, optimization of the module geometry in terms of economy and technology, and cable schemes at different depths.

References

[1] Geography MYP, Dot Map Showing Population Distribution 2015 (Jun. 5, 2021) http://www.bbc.co.uk/staticarchive/e4ff248622e19fa303d72e259e0d6201b8ceea9e.gif
[2] Flikkema M. and Waals O. (2019), Space@Sea the Floating Solution, Front. Mar. Sci. 6:553. doi: 10.3389/fmars.2019.00553
[3] Breuls M., Blumer S., Jacob N. and Blümel B. (2020), Detail Design Report- Deliverable 4.4," Space@Sea Project
[4] Otto W. and Hüsken C. (2020), Results from Demonstration at Wave Tank. https://spaceatsea-project.eu/images/d10.4_part5.pdf

A Peek into the North Sea Agreement: Taiwan Gains Insights from the Netherlands' Experiences

Li-Yun Tsao (Vice Manager of the Green Energy and Environment Research Laboratories at the Industrial Technology Research Institute)
Po-Cheng Huang (Vice Research Fellow of the Green Energy and Environment Research Laboratories at the Industrial Technology Research Institute)
Translated by Linguitronics
Keywords: The Netherlands, North Sea Agreement, stakeholders, offshore wind power, negotiation mechanism

The Executive Yuan promulgated the "Thousand Wind Turbines Project" [1] and the "Four-year Wind Power Promotion Plan" in 2012 and 2017 respectively. The Executive Yuan implemented the "First Onshore then Offshore Plan" and the three-phase strategy "Demonstration Incentive Program, Zones of Potential, and Zonal Development" to promote offshore wind power gradually [2]. Some results have successfully been accomplished. In the first phase, the offshore demonstration project (128MW) first started commercial operations 2019, while the Taiwan Power Company demonstration project (109.2MW) also started commercial operations in 2021 [3]. In the second phase, 9 developers and 14 wind farms (a total of 5.5GW) were licensed through capability review and bidding process and are scheduled to start commercial operations before 2025 [3]. The Taiwan government is now drafting the third phase, zonal development. We plan to generate at least 1GW annually from 2026 to 2035 [4]. However, due to complex spatial competition among different issues such as ecology, aviation safety, national defense, fishery, and marine safety, the path to reaching a consensus is filled with obstacles. Therefore, this article will introduce the experiences of stakeholders in the Netherlands' negotiation for offshore wind power—the North Sea Agreement (NSA)—hoping to serve as a reference for our own negotiations in the use of offshore regions.

Figure 1/ Buitenhaven fishing port is situated near the Afsluitdijk dam, which is at the end of the province of North Holland. Around the port is a shallow wetland, Waddenzee, which connects to the North Sea
Image by Po-Cheng Huang

The Background and Challenges of the NSA

The North Sea, which is in north western Europe, is not only an important ecological system but also a crucial source for a variety of foods. Furthermore, it is also where shipping, recreation, military training and energy mining take place. As climate change has already caused significant impacts on marine ecology, the Dutch government aims to replace fossil fuel with renewable energy in accordance with the Paris Climate Agreement on reducing carbon emissions. The government also strives to strike a balance between environmental impacts and effective implementation. The NSA is the initial result of weighing the interests between the Dutch government and other stakeholders.

The NSA focuses on three cohesive challenges—nature transition, food transition and energy transition. The goal of the NSA is to draft a comprehensive long-term ocean development policy. In terms of nature transition, according to the European Union's Marine Strategy Framework Directive [5]; when dividing sea areas, the impact of the activity on marine ecology should be considered. As for food transition, economic activities on the North Sea will have an impact on the sustainable development feasibility of the fishery industry, which leads to pressure on the Dutch to transform their fishery industry. Lastly, for energy transition, the Dutch government announced the National Climate Agreement in 2019, listing the North Sea as a pivotal area for promoting renewable energy [6]. To strike a balance between the ecological system and different economic activities at sea, the choice made to strike a balance between marine ecological plans and energy technology must be adjusted [7].

Initiating a Dialogue: The Role of OFL and Stakeholder Negotiation Mechanism

Throughout history, the Netherlands has fought with the sea for land. Their social systems were derived from long-term planning and consensus, which were evolved from the country's water governance experience. Currently, the Dutch government assists the public sector in implementing forward-looking research and activities by setting up committees and planning agency, hoping to establish a governance model that can effectively integrate different stakeholder's opinions [8]. With regards to the North Sea issue, the main responsible authority is the Ministry of Infrastructure and Water Management (Ministry of I&W). The Ministry of I&W and related departments consulted with the Physical Environment Consultative Council (OFL) in 2019 to lead and initiate the North Sea Dialogue [7][9]. The mission of the OFL is to provide an interactive stakeholder platform for the government and people through designing a collaboration and governance model. The OFL establishes a working plan according to the issues raised by the government and society annually. Issues raised include energy, climate, agriculture and water security [10].

Regarding the negotiation mechanism of North Sea stakeholders, OFL hosts a dialogue meeting for six consecutive days after having a list of stakeholders. It will then arrange two meetings every three weeks for 18 months. One meeting will focus on specific issues and invite experts and scholars while the other meeting will allow more participants to share their positions and views. After this, the OFL will hold an online survey and an offline meeting for all citizens that lasts for two weeks to collect public opinion. Lastly, OFL will hold a two-day general meeting. In addition to stakeholders, the Council will also present public opinion to reach a consensus [9].

Table 1/ Participants at the North Sea Dialogue

Sector	Organization	Signed the final agreement before 2020/6/19
Energy	Netherlands Oil and Gas Exploration and Production Association (NOGEPA)	○
	European Wind Energy Association (EWEA)	○
	The European Business and Innovation Centre Network (EBN)	○
	TenneT, an electricity transmission system company	○
Fishery	Visserbond	X
	VisNed	X
Environmental Protection	Dutch Birdlife International	○
	Nature & Environment Foundation	○
	North Sea Foundation	○
	World Wildlife Fund - Netherlands	○
Public Sector	Ministry of Agriculture, Nature and Food Quality (LNV)	○
	Ministry of Economic Affairs and Climate Policy (Ministry of EZK)	○
	Ministry of Infrastructure and Water Management (Ministry of I&W)	○

Source/ de Koning et al. (2021)

Key Consensus in the NSA

The OFL invited the Dutch government and stakeholders to discuss and negotiate together, which resulted in the NSA. All parties have reached extremely meaningful, feasible and visionary consensus in spheres such as regulation, issues, finance, technology, research, and implementation. The key points are as follows [7]:

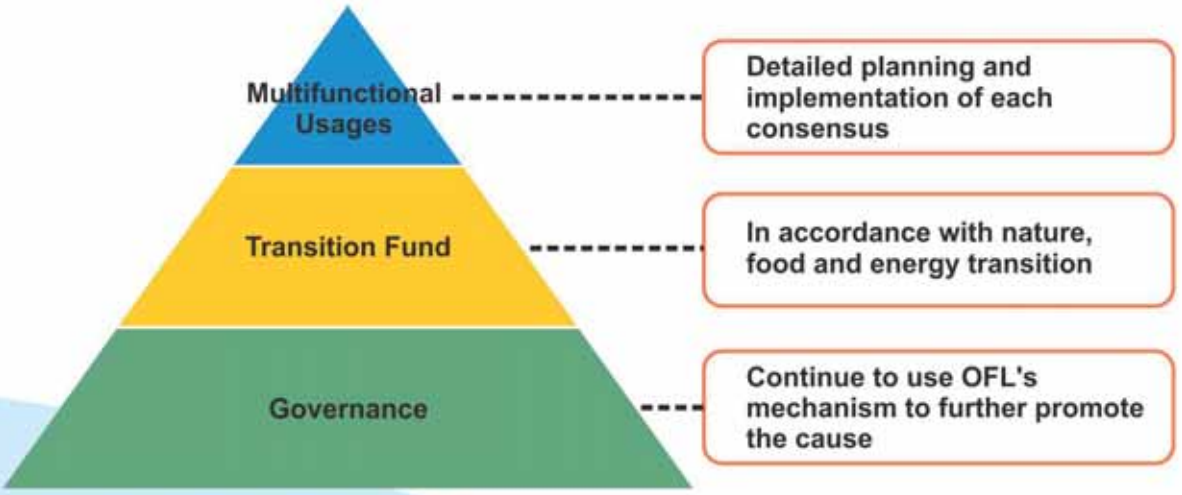


Figure 2/ Key Consensus Framework in the NSA
Image by Li-Yun Tsao

I. Governance

The Dutch government and stakeholders agreed that the NSA will be adopted for the initial steps taken to gradually promote future formal policies or the legalization under the existing international law framework. All agreed to adopt the negotiation mechanism established by the OFL. With the North Sea Consultation as a means for future negotiations and promotion platform, it will allow governance to be the foundation for consensus.

II. Transition Fund

Taking the requirements of nature, food and energy transition plans into consideration, establishing a transition fund became a crucial consensus. Details include fund application criteria (criteria that applies and do not apply), establishment schedule, monitoring governance, sum proportion etc. The fund will pay for compensation and serve as a buffer that is independent from other financial source and existing budgets.

III. Multifunctional Usages

The Dutch government and related stakeholders all agree that the North Sea is an area of common interest. They all hope to maximize the benefits of using the resources within the limited ocean space. All allow for non-exclusive competition and collaboration, and will accept diversity and find the best solutions. The Dutch government and related stakeholders propose to make plans based on the specific purposes of using resources (including fishery, aquaculture, national defense, sand mining, aviation safety, sea bed cables, oil and gas, scientific research, sea activity monitoring, and offshore wind power area selection) as well as the possibilities of future coexistence via the Areas Passport plan.

Conclusions

The OFL was initially the coordinating factor of the NSA, bringing related government departments and stakeholders into dialogues to reach consensus. The crucial points of their consensus are: "the governance model of the North Sea will follow the OFL negotiation mechanism in the future", "the NSA is just the initiating phase towards formal policies and legitimization", "establishment of the transition fund is necessary" and "diverse usage of the sea area has solved collaboration and competition issues". The Dutch OFL negotiation mechanism has evidently become an important driving force for achieving the NSA. Taiwan's Ocean Affairs Council was established in 2018, but has yet to become a coordinator in sea area planning issues. If we want third party academic or research institutions to serve as the negotiator, we can refer to the OFL model. Weighing the interests of stakeholders and reaching a consensus through systematic negotiation are beneficial to accelerating offshore energy policies.

References

[1] 曾君儒（2015），〈捕風捉綠電—干架風力機蓄勢待發〉，《能源報導》
https://energymagazine.itri.org.tw/Cont.aspx?CatID=19&ContID=2617（2021年6月13日）
[2] 經濟部能源局（2017年8月），〈風力發電四年推動計畫（核定本）〉
https://www.moeaboe.gov.tw/ECW/populace/content/wHandMenuFile.ashx?file_id=4107（2021年6月13日）
[3] 風力發電單一服務窗口（2019年12月27日），〈大事記〉
https://www.twtpo.org.tw/history.aspx（2021年6月13日）
[4] 經濟部（2021年5月11日），〈離岸風電區塊開發招商容量每年提高至1.5GW 導入產業關聯彈性機制〉
https://www.moea.gov.tw/MNS/populace/news/News.aspx?kind=1&menu_id=40&news_id=94366（2021年6月13日）
[5] EUR-Lex (n.d.), Directive 2008/56/EC of the European Parliament and of The Council
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008L0056 (Jun. 10, 2021)
[6] Government of The Netherlands (Jun. 28, 2019), Climate Agreement
https://www.government.nl/documents/reports/2019/06/28/climate-agreement (Jun. 10, 2021)
[7] Noordzeeloket (n.d.), North Sea Agreement.
https://www.noordzeeloket.nl/en/policy/north-sea-agreement/ (Jun. 10, 2021)
[8] European Environmental Agency (Oct. 11, 2011), BLOSSOM – Bridging long-term scenario and strategy analysis: organisation and methods.
https://www.eea.europa.eu/publications/blossom (Jun. 10, 2021)
[9] de Koning, S., Steins, N., & van Hoof, L. (2021). "Balancing Sustainability Transitions through State-Led Participatory Processes: The Case of the Dutch North Sea Agreement", Sustainability, 13(4): 2297.
[10] Physical Environment Consultative Council (n.d.), About the Physical Environment Consultative Council.
https://www.overlegorgaanfysiekeleefomgeving.nl/english/default.aspx (Jun. 10, 2021)

國際海洋資訊

13
August 2021
雙月刊 | Bimonthly

International Ocean Information

發行：海洋委員會

地址：806610高雄市前鎮區成功二路25號4樓

電話：(07)3381810

E-mail：master@oac.gov.tw

網址：https://www.oac.gov.tw/

執行：財團法人台灣經濟研究院

地址：104222臺北市中山區德惠街16-8號7樓

電話：(02)2586-5000分機888

傳真：(02)2595-7131

網址：http://www.tier.org.tw/

發 行 人：李仲威

副發行人：蔡清標、周美伍

總 編 輯：劉國列

編輯委員：黃向文、邱永芳、謝亞杰、沈建中、許啓業、王茂城、黃世偉、陳裕興、林麗英、陳致延、賴依雯

編輯顧問：李賢華、楊清喬

執行主編：鍾嘉雯、陳璋玲

執行編輯：黃釋緯、洪承豐、李茗家、謝惠子

美編設計：不賴的廣告

電話：(02)2783-0978

傳真：(02)2783-3033

Published by Ocean Affairs Council

Address：4F., No. 25, Chenggong 2nd Road, Qianzhen District, Kaohsiung City 806610, Taiwan

Telephone：(07)3381810

E-mail：master@oac.gov.tw

Website：https://www.oac.gov.tw/

Executive：Taiwan Institute of Economic Research

Address：7F., No. 16-8, Dehuei St., Jhongshan District, Taipei City 104222, Taiwan

Telephone：(02)2586-5000 Ext.888

Fax：(02)2595-7131

Website：http://www.tier.org.tw/

Publisher：Chung-Wei Lee

Associate Publisher：Ching-Piao Tsai, Mei-Wu Chou

Editor-in-Chief：Kuo-Lieh Liu

Editorial Board：Hsiang-Wen Huang, Yung-Fang Chiu, Ya-Chieh Hsieh, Chien-Chung Shen, Chad C.Y. Hsu, Mao-Chen Wang, Shin-Wei Huang, Yu-Hsing Chen, Li-Ying Lin, Chih-Yen Chen, Yi-Wen Lai

Reviewer：Hsien-Hua Lee, Ching-Chiao Yang

Managing Editor：Chia-Wen Chung, Chung-Ling Chen

Executive Editor：Shi-Wei Huang, Cheng-Li Hung, Ming-Chia Lee, Hui-Tzu Hsieh

Designed by Pride Advertising Agency Ltd.

Telephone：(02)2783-0978

Fax：(02)2783-3033

讀者意見回饋，請來電(02)2586-5000分機888或E-mail至d11743@tier.org.tw

國際海洋資訊

13
August 2021
雙月刊 | Bimonthly

International Ocean Information

封面：荷蘭北海離岸風場
封底：荷蘭賀河旁的風車村（Zaanse Schans）

中華民國110年8月出版（每雙月出版）
中華民國108年8月創刊
ISSN 2706-638X （紙本）
ISSN 2706-6398 （電子）
中華郵政高雄雜字第236號執照登記為雜誌交寄
高雄郵局許可證 高雄字第2084號
著作權所有未經同意不得轉載

線上全文

海洋委員會 Ocean Affairs Council 發行

台灣經濟研究院 Taiwan Institute of Economic Research 編印

贈閱