出國報告(出國類別:出席 國際會議)

出席 2015 年 OECD 「海洋經濟之未來」第 4 次「指導小組會議」會議報告

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摘　要

經濟合作與發展組織（Organization for Economic Co-operation and Development OECD）之「海洋經濟之未來」（The Future of the Ocean Economy）計畫，是屬於 OECD「國際未來計畫」（International Futures Programmes, IFP）的一部分。「海洋經濟」是在 2007-2008 年間發生之全球經濟衰退事件後，才開始逐漸興起之議題，目前相關概念及定義亦仍在發展中。由於海洋相關產業是個新興發展之領域，對全球之經濟希望能帶來新的動力與助益。「海洋經濟之未來」計畫之目的係為了對從現在起至 2030 年間的海洋經濟進行一個全球性的前瞻評估，並特別聚焦於新興海基活動的發展潛力。OECD 也希望能在找出其中之利基，使得從現在起至 2030 年間能夠使海洋經濟及相關產業有良好之發展，並擴大就業市場，提升就業率等。

本次指導小組（Steering Group, SG）會議於今（2015）年 6 月 16 日上午於 OECD 巴黎總部第 7 會議室舉行，為期一日，由 OECD IFP 資深顧問 Barrie Stevens 主持。由議程觀之，本計畫所關注之海洋經濟包括航運、漁業、海洋礦產、造船業、海洋養殖、海洋旅遊、海域空間規劃等方面。由會議內容觀之，OECD 之策略主要是先針對海洋經濟之定義與範疇加以確定，找出具發展潛力之相關產業，再思考要如何推動及促進該等產業之未來發展，最後找出相關指標以評估這些產業之發展情況。

事實上，這些產業在我國均已存在，故我國不論在政策層面或實務經驗上，均有實力與基礎可與其他國家進行交流，並參與 OCED 之相關計畫，除可深化我國在 OECD 之參與程度外，亦有機會藉此發展我國海洋經濟相關產業。由於 OECD 未來應該會將這樣的策略提交至大會通過，由所有會員國共同執行。因此，若我國在策略形成之際即能適當發揮影響力，使整個海洋經濟發展策略能納入我國之相關考量，未來也能與 OECD 其他會員國一同執行上述策略，則連帶將使我國的海洋經濟相關產業能與其他國家進行合作，創造更大的市場與利基。

由與會人士之組成觀之，除了議題報告者是學者外，在場各國的與會人士只有本人是學者身分，其他均是政府官員。顯示其他國家在看待此一議題時，仍然是由政府機關

主導為主要實踐。因此，建議仍應由國內主管機關派官員與會為宜，方能長期與 OECD 及其他國家代表間建立穩定之聯絡與關係。如果礙於其他因素，還是需由學者出席本計畫相關會議，則主管機關與該學者間需建立某種程度之長期合作與授權關係，方便該學者能深入相關議題之研究，以及在會議中之相關發言。

雖然我國是第一次參與 SG 會議，但獲得秘書處及其他與會人士高度讚賞，實屬不易。然而，本人認為我方之表現仍有很大的進步空間，特別是本人自接受經濟部國際貿易局邀請至成行之時間過短，在缺乏相關資料及準備下，表現只能說平平。希望如果下次 SG 會議我方如仍要與會，應可儘早決定與會人士，並提供相關資料以利其準備，相信在有充份準備下，就能於會中與秘書處及其他與會人士有更深入之互動。

出席 2015 年 OECD 「海洋經濟之未來」

第 4 次「指導小組會議」會議報告

目次

壹、 出國目的 1

貳、 過 程 3

參、 心得及建議 12

肆、 附件 13

出席 2015 年 OECD 「海洋經濟之未來」第 4 次「指導小組會議」

出國報告內文

壹、 出國目的

經濟合作與發展組織（Organization for Economic Co-operation and Development OECD）之「海洋經濟之未來」（The Future of the Ocean Economy）計畫，是屬於 OECD「國際未來計畫」（International Futures Programmes, IFP）的一部分。IFP 是 OCED 的一個前瞻性的研究團隊，自 1990 年起已經為該組織提供了策略性及長期性之思考，以及組織內部不同單位在水平層級之協調工作。IFP 所舉辦的各項活動，均為決策者提供一個良好的平台，使其可以自由地討論並面對其對未來願景及關切，瞭解其他人之觀點，並可進行模擬性之對話。在這樣的方式下，IFP 也利用了許多決策工具，包括水平掃瞄、趨勢分析及情結建構等，使決策者對於所討論的議題能有更好的瞭解。

從「海洋經濟之未來」計畫書之內容觀之（如附件一所示），「海洋經濟之未來」計畫之目的係為了對從現在起至 2030 年間的海洋經濟進行一個全球性的前瞻評估，並特別聚焦於新興海基活動的發展潛力。為了實際操作之目的，本計畫分為「已建立之海洋活動」及「新興海基活動」兩大部分，將探討海洋經濟之成長前景，以及其創造就業機會之潛力等。其中，重點將置於對新興海基產業部分，瞭解其未來發展時所面臨之風險與不確定性、科技上所需之創新發明、投資需求、環境意涵、對海洋生態系之衝擊、對綠色成長之貢獻、在規劃與規範上之意涵、與在以負責任及永續之方式下管理海洋時最適合促進其長期前景之政策選項等。這些產業包括：

- 離岸風力、潮汐及波浪能源；
- 深海及其他極端位置之離岸油氣開採；
- 深海床上金屬與礦物之開採；
- 海洋養殖；

- 海洋生物技術；
- 海洋相關之旅遊與休閒活動；及
- 海洋監測、控制與監視（monitoring, control and surveillance, MCS）。

整個計畫之總預算預計為 55 萬歐元。

在 2013 年所舉行之「海洋經濟之未來」「利害相關方會議」（Stakeholder Meeting）中，與會代表決議將設立一個「指導小組」（Steering Group, SG），用以提供該計畫在執行時之策略指導方針及財務支持，小組成員則由資助該計畫之機構與組織之代表所組成。第一次 SG 會議於 2013 年 10 月 28 日舉行，迄今已召開過 3 此，本次為 SG 第 4 次會議，預計在今（2015）年 12 月於 OECD 巴黎總部將會舉行最後一次之 SG 會議。

我國於今（2015）年開始參與「海洋經濟之未來」計畫之進行，並參與其下之各項會議，包括本次 SG 會議在內。身為一個海洋國家，海洋經濟之發展事實上亦影響我國未來之相關權益，故實不應缺席此一由已開發國家所主導、建構自即日起至 2030 年之全球海洋經濟發展藍圖之計畫。由於前 3 次 SG 會議我方均未參加，故本次 SG 會議事實上是我國首次參與負責「海洋經濟之未來」計畫之策略指導的高層會議，故重要性不言可喻。

由於我國資助「海洋經濟之未來」計畫所需之經費，故在 SG 會議內被列為是正式參與方而非觀察員身分，在組織地位上也與其他資助國家相同，亦是一項重要的參與國際組織成果。

貳、 過 程

本次出國行程主要係出席為期一日之 2015 年 OECD 「海洋經濟之未來」第 4 次 SG 會議。我國出席代表除本人外，駐法國代表處經濟組廖秘書健鈞除在各種行政事務及聯繫 OECD 人員上大力協助外，並與本人一起全程參與本次 SG 會議。

本人於 OECD 總部外留影

本次 SG 會議於 6 月 16 日上午於 OECD 巴黎總部第 7 會議室舉行，由 OECD IFP 資深顧問 Barrie Stevens 主持。會議一開始，S 主席即簡短向與會人員介紹本次會議之目的，並請所有參與會議的人員先行自我介紹，特別指出我國是第一次參與 SG 會議，除表熱烈歡迎之外，亦希望我國能在會議中提供寶貴之意見。本人在自我介紹時，表示本人的專長其實並不專精於經濟學方面，而是在海洋政策與海洋法。然而，由於海洋經濟亦是海洋政策中所需考慮之領域之一，故相信本人應可從海洋法政之觀點，適時提供此計畫在策略規劃及履行上的一些建議。經濟組廖秘書健鈞則表示我國是第一年參與此計畫，深感榮幸，也希望未來能與 OECD 秘書處及所有計畫參與方間有更密切之合作。本次會議與會人員名單如附件二所示。

隨後，S 主席介紹今日之議程（如附件三所示），並詢問在場與會人員是否有其他

意見。OECD 資深漁業政策分析專家 Lae Hyung Hong 表示，其因為行程關係，是否可將議程 6「海洋養殖」的部分提早到午餐前處理，原本已獲主席與在場與會人士之通過，然，議程 5「深海採礦研討會之報告」之報告人 Mark Hannington 表示，其亦需於午餐時離開。在 Lae Hyung Hong 資深漁業政策分析專家表示其彈性下，主席最後裁示，議程 5「深海採礦研討會之報告」將於上午進行，而議程 6「海洋養殖草案報告」則於午餐後進行，至於原本之議程 3「海事安全研討會重點報告」及議程 4「海域空間規劃及海洋監控研討會重點報告」，則順延至議程 6 之後。

與會人士自我介紹

議程 1 秘書處歡迎與會者並進行簡介

在計畫進程簡報部分，秘書處報告本計畫是自 2014 年開始，預計於 2016 年結束。本次是 SG 之第 4 次會議，在計畫結束前只剩 3 個會議尚未舉行，包括於今（2015）年 6 月 24 日至 25 日於瑞典哥特堡（Gothenburg, Sweden）所舉行之「2030 年前發展海洋旅遊之挑戰與機會經濟研討會」（Economy Workshop on Challenges and Opportunities related to the Development of Marine Tourism to 2030），今（2015）年 9 月 29 日至 30 日將於西班牙畢爾包（Bilbao, Spain）所舉行之「海洋生物科技長期潛力研討會」（Workshop on The Long-term

Potential of Marine Biotechnology），以及第 5 次（也是最後一次）SG 會議。此外，本計畫亦與其他組織有所互動，包括國際海事組織、聯合國糧農組織之漁業委員會等。與會人員問到，目前本計畫與聯合國糧農組織之漁業委員會互動情況為何？秘書處表示目前與該委員會之互動良好，也派員參與該委員會之會議，並進行互動與討論。

主席補充報告表示，「海洋經濟」是在 2007-2008 年間發生之全球經濟衰退事件後，才開始逐漸興起之議題，目前相關概念及定義亦仍在發展中。由於海洋相關產業是個新興發展之領域，對全球之經濟希望能帶來新的動力與助益。因此，OECD 也希望能在找出其中之利基，使得從現在起至 2030 年間能夠使海洋經濟及相關產業有良好之發展，並擴大就業市場，提升就業率等。至於本計畫各個領域之近期發展，則會在下面的議程中逐項討論。

議程 2 模型建構進展及資料庫介紹

本議程為此計畫最重要的部分，即為海洋經濟及資料蒐集等建立模型，並透過模型來預測相關潛力及未來發展等相關結果。為此，OECD 秘書處特別準備了一份關於此模型發展之報告（如附件四所示），供此議程討論之用。

第四次 SG 會議會中討論情況（一）

該報告一開始即表列過去對全球主要國家在海洋經濟產值之相關研究，可以看出海洋經濟之產值約佔各該國家 GDP 之比值均不到 10%，顯示海洋經濟在這些國家仍有許多發展空間。然而，目前對海洋經濟仍未有共同之定義，因此，本計畫建議引用南韓學者 Park 在 2014 年之定義：「海洋經濟之定義為發生在海洋、自海洋獲得產出及提供海洋貨品與服務之經濟活動」。然而，此一定義引起在場許多與會人士之疑問，特別是為何一定要用這位 Park 的定義？並質疑一個組織之研究如果採用特定人士之定義，事實上並不妥適？秘書處允諾會再予以研究。

此外，本報告書對海洋經濟之範疇（scope）分為航運、港埠、海洋旅遊、漁業、離岸油氣、再生能源、海床採礦、船舶建造與修護、海洋生物科技等部門（sectors），每個部門下又分為數個類別（categories），在每個類別內再挑選出適當之數值作為該類別之指標，最後並註明這些數值之可能來源（譬如來自國家的統計局或是相關國際組織）。本人發言表示，這樣的部門分類似乎有些問題，因為船舶建造與修護本應屬於航運的一部分，將之獨立出來似乎有些奇怪，且航運與漁業均涉及船舶建造與修護（商船及漁船），如此一來即不容易將資料予以區別，且對某些國家而言（譬如我國在內），船舶建造與修護資料之主管機關就不知道應是交通部（航港局）或是農委會（漁業署），建議上述分類可再予重新調整。此外，離岸油氣、再生能源及海床採礦等部門，事實上均屬於 1982 年聯合國海洋法公約下的海洋非生物資源，且在國家管理上這些項目多由一個單一機關所管理，故建議可以將這些項目列在同一個部門之下。

隨後，有與會人士反應何為海岸防衛（coastal defense）？在定義上是指軍事需求還是防災設施？另有與會人士反應在取得資料時，歐盟與法國對這些資料之管理可能會對資料之取得造成問題，特別是資料之保密規範及智慧財產權等部分。另外，環境之負面衝擊並未列入這些部門或類別中，亦應加以列入考量。

主席最後回應，感謝與會人士所提出的各項建議，會再予以詳加考慮，特別在定義與範疇方面。主席亦表示，本部分最希望釐清的就是海洋經濟的定義，以及所利用的指標是否真的可被測量，會在年底的會議中將修正過的內容再呈現給大家。

議程 5 深海採礦研討會之報告

本議題 Mark Hannington 針對早先所舉行之深海採礦研討會之內容進行簡介，提到目前深海採礦主要分為錳核（manganese nodules）、海床硫礦物（seafloor massive sulphide, SMS）及含鈷地殼（cobalt-rich crusts）等三種礦物之開採，而這些礦物目前有超過 70% 是在國家所管轄之專屬經濟海域內，只有不到 5%是在國家管轄權外之「區域」（the Area）。目前主要面臨的問題是風險太高，且市場未來性不佳，使得有意願開採的國家或企業卻步。

報告最後建議，負責「區域」內採礦管理之國際海床管理局（International Seabed Authority, ISA）應針對全球的洋底進行一個研究計畫，瞭解上述礦物之分布情況，減低有意願開採國家或企業在投資上的風險，以利深海採礦之未來發展。本人發言表示，就本人所知短期內此一建議並不可行，因 ISA 一開始在設立之初即是將所有的深海採礦風險由開採國家或企業全部承擔，甚至其組織內部中根本就沒有可以進行研究之單位。另外，ISA 也要求欲申請在「區域」中採礦的國家需負責進行海底研究與調查，並將結果提交 ISA，甚至連 ISA 下的採礦單位「企業部」（Enterprise）都不見得有實際的採礦能力，而是轉而委由採礦國家或企業協助開採。在 ISA 沒有法律授權、相對應組織架構及能力下，這個建議恐難實現。主席對此意見表示感謝，並理解上述之問題所在，也希望與會人士能夠持續針對此一議題提供建議。

此議題結束後，主席宣布本日上午議題到此結束。

議程 6 海洋養殖草案報告

午餐過後繼續本日議程之進行。「海洋養殖草案」係由 Torger Reve 進行報告（該員為挪威某大學管理學院之教授）。原本以為報告內容應涉及海洋養殖實務面之討論，包括漁業生物學、餌料營養學、漁業管理、環境影響等內容，然或許是因為報告者是企業管理之背景，其報告之內容多是企業管理之層面，並非真的切入海洋養殖之內容。在報告完畢後，幾乎所有與會人士均表示此議題最大的考量應為對環境之影響，特別是過剩餌料所造成的海洋環境污染，以及因密集養殖所產生的魚類疾病問題，故包括愛爾蘭、

丹麥及瑞點等國事實上是禁止海洋養殖之發展的，只能發展岸上的陸地養殖。

報告者則回應，過去的思維多將海洋養殖設定在沿岸地區，因為水淺、空間狹窄而有海洋環境污染之後果。但他的研究是將海洋養殖移至開放的洋區，包括沿海國的專屬經濟海域或是公海上，就不會有這樣的問題。此一回答則引來更多與會人士之發問，包括目前相關的國際海洋或漁業法並沒有辦法處理沿海國在其專屬經濟海域內核發海洋養殖執照的問題，而超過目前海洋漁業法律體制等。最後，亦有與會人士建議應該在研究中加入海洋養殖對國家 GDP 及就業率之考量，以及利用海域空間規劃之概念及技術劃設海洋養殖之專用海域等。

第四次 SG 會議會中討論情況（二）

本人原欲發言表示，從漁業生物學及營養學的角度觀之，海洋養殖並非完全沒有限制，特別是因為目前進行海洋養殖之魚種，仍需以魚類蛋白為餌料，無法完全改用植物性蛋白（如大豆蛋白）。如此一來，人們就必須捕撈海洋中的其他魚種（特別是沙丁魚或鯷魚等小型魚種）成為海洋養殖所需之餌料。在今日海洋漁業資源多已枯竭之現況下，推廣海洋養殖恐使得海洋漁業資源枯竭之狀態更為雪上加霜。另一方面，餌料之換肉率最高約只有 10%（即餵養 10 公斤之餌料只能使養殖魚類獲得 1 公斤之重量）。換

言之，近 90%之餌料會因此浪費掉。因此，建議只少量進行海洋養殖，而將大多數的小型魚種直接供人類食用，以減低在營養轉換時之消耗。

惟受限於時間因素，再加上幾乎所有與會人士都一面倒地不支持的情況下，本人最後並未對此進行發言。

議程 3 海事安全研討會重點報告

礙於時間關係，本議題只由主席進行很簡短之報告，主要是針對先前 5 月時在韓國所舉辦的「海事安全研討會」之會議成果進行重點報告，包括在 2030 年前驅動海事運輸發展之重要因素、改變中的風險及範疇、驅動全球性海事安全產業發展之重要因子、電子導航系統之創新與數位化、船舶衛星追蹤系統等議題，歷時約 5 分鐘。在沒有任何與會代表發言下，主席隨即裁示進入下一議程。

議程 4 海域空間規劃及海洋監控研討會重點報告

與前一個議程相同，本議題礙於時間因素，也只由主席將先前所舉辦之「海域空間規劃及海洋監控研討會」之會議成果進行很簡短的報告，包括目前海域空間規劃之全球進展、運用在海域空間規劃之經濟工具、支持海域空間規劃之資料發展及技術基礎設施、海域空間規劃治理之創新、港埠議題、策略性環境影響評估等議題。

議程 7 迄今之計畫

在議程 7.1「主要報告之更新，包括時間表」中，主席首先報告當本計畫結束時，將會提交一份報告。該報告中會將不同的內容以不同章節安排的方式進行呈現，目前暫訂的主要章節名稱為前言、全球內涵、海洋環境、海洋經濟之定義與範疇、預測至 2030 年之海洋經濟、海洋經濟發展之趨勢與不確定性、傳統與新興海洋經濟間之相關性與潛在衝突、及為新興海洋產業規劃政策方向等。

在時間表上，預計在暑假過後的 9 月完成資料庫建立及假想情境之設計；11 月初會將報告初稿發送給本會議之參與人士，並最遲於 2 週內完成內部之建議。預計在 12 月初最後一次 SG 會議舉辦後，即完成本報告之最終版本，並於明（2016）年 4 月舉辦研

討會，正式發表此一報告。與會人士提到，本報告是否會以英語以外的其他語言呈現？主席則表示受限於時間、經費與人力等因素，本報告只會以英文版本之方式加以呈現。

在議程 7.2 中，主席則是簡短介紹即將於瑞典哥特堡所舉行之「2030 年前發展海洋旅遊之挑戰與機會經濟研討會」及 9 月 29 日至 30 日將於西班牙畢爾包所舉行之「海洋生物科技長期潛力研討會」之暫訂議程，希望有興趣之國家都能參加。

議程 7.3 中，主席介紹在 OECD 中有關海洋經濟之下一階段工作，並提到本計畫雖然將於明年結束，但應該會有包括多部門間之續期計畫持續針對海洋經濟議題進行研究。主席提到續期計畫中的一些可能議題，包括持續改進 OECD 在海洋經濟方面之資料庫、在 OECD 建立海洋經濟學家之國際網絡、討論生態系服務在海洋經濟上之價值、氣候變遷對海洋經濟之影響、海域空間規劃之進階發展及北極議題等。本人隨即發言表示，可以理解主席所提的其他議題在海洋經濟發展之重要性，但好奇北極議題在本計畫中應如何進行？因目前北極相關議題係由北極理事會所主導，OECD 在此議題中所扮演的角色為何，又應如何與北極理事會間進行互動？主席則表示，目前這個議題是他個人覺得有興趣者，也是認為可以做的方面，但他目前仍沒有想法，希望本人或其他與會人士能在這個議題上提供寶貴之建議。

議程 7.4 中主席介紹了即將召開的 OECD 科技政策次委員會部長級會議，預計於今（2015）年 10 月底於南韓舉行。然因我國並非此一次委員會之會員，亦無法參與此一會議，故對我國影響與實質意義不大。

最後，主席宣布本次會議到此結束，並感謝所有與會人士之參與，特別是我國大老遠飛至此地與會。本次會議於下午 4:40 分圓滿結束。

會外事項

會議結束後，本人與廖秘書健鈞留下與主席及秘書處人員談話。秘書處人員十分感激我方在會中之高度參與，並提供許多寶貴意見。本人則向其表示，除了海洋養殖部分外，能發言的部分我方均已提供看法。由於是第一次參與，有些議題之掌握度還沒有那麼好，未來如果有機會繼續參與，則應可有更深入之想法。至於沒有發言的海洋養殖部

分並非沒有想法，而是受限於時間及在場氛圍才沒有發言，且本人對擴大海洋養殖之作法，是持反對態度的。秘書處人員對本人之回答似乎出乎其意料之外，並詢問本人所持之反對理由為何。本人即將前述所列出之理由告知秘書處人員，除獲其高度讚賞與同意，並要求本人將書面資料提供給他們，以便將本人意見納入會議報告中，獲本人允諾。

參、 心得及建議

一、 由議程觀之，本計畫所關注之海洋經濟包括航運、漁業、海洋礦產、造船業、海洋養殖、海洋旅遊等方面。事實上，這些產業在我國均已存在，故我國不論在政策層面或實務經驗上，均有實力與基礎可與其他國家進行交流，並參與OCED之相關計畫，除可深化我國在OECD之參與程度外，亦有機會藉此發展我國海洋經濟相關產業。

二、 由會議內容觀之，OECD之策略主要是先針對海洋經濟之定義與範疇加以確定，找出具發展潛力之相關產業，再思考要如何推動及促進該等產業之未來發展，最後找出相關指標以評估這些產業之發展情況。由於OECD未來應該會將這樣的策略提交至大會通過，由所有會員國共同執行。因此，若我國在策略形成之際即能適當發揮影響力，使整個海洋經濟發展策略能納入我國之相關考量，未來也能與OECD其他會員國一同執行上述策略，則連帶將使我國的海洋經濟相關產業能與其他國家進行合作，創造更大的市場與利基。

三、 由與會人士之組成觀之，除了議題報告者是學者外，在場的其他國家與會人士只有本人是學者身分，其他均是政府官員。顯示其他國家在看待此一議題時，仍然是由政府機關主導為主要實踐。因此，建議仍應由國內主管機關派官員與會為宜，方能長期與OECD及其他國家代表間建立穩定之聯絡與關係。如果礙於其他因素，還是需由學者出席本計畫相關會議，則主管機關與該學者間需建立某種程度之長期合作與授權關係，方便該學者能深入相關議題之研究，以及在會議中之相關發言。

四、 雖然我國是第一次參與SG會議，但獲得秘書處及其他與會人士高度讚賞，實屬不易。然而，本人認為我方之表現仍有很大的進步空間，特別是本人自接受經濟部國際貿易局邀請至成行之時間過短，在缺乏相關資料及準備下，表現只能說平平。希望如果下次SG會議我方如仍要與會，應可儘早決定與會人士，並提供相關資料以利其準備，相信在有充份準備下，就能於會中與秘書處及其他與會人士有更深入之互動。

附件一

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

ORGANISATION DE COOPÉRATION ET DE DÉVELOPPEMENT ÉCONOMIQUES

DIRECTORATE FOR SCIENCE, TECHNOLOGY AND INDUSTRY

OECD International Futures Programme

Proposal for a project on

THE FUTURE OF THE OCEAN ECONOMY

Exploring the prospects for emerging ocean industries to 2030

December 2013

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The Project in Brief

1. **Aim:** Conduct a forward-looking assessment of the ocean economy to 2030 and beyond, with particular emphasis on the development potential of emerging ocean-based industries**.**

2. **Scope:** For practical purposes, the project divides the ocean economy into established marine activities and emerging activities. Established marine activities encompass shipping and shipbuilding, capture fisheries, traditional maritime and coastal tourism, and port facilities and handling. Emerging ocean-based industries include: Off-shore wind, tidal and wave energy, oil and gas extraction in deep-sea and other extreme locations; marine aquaculture; marine biotechnology; sea-bed mining for metals and minerals; ocean-related tourism and leisure activities; and ocean monitoring, control and surveillance.

3. **Key issues:** The ocean economy's long-term outlook and future contribution to growth and jobs. Particular attention will be devoted to emerging ocean-based activities, with respect to: risks and uncertainties surrounding future development; required progress/breakthroughs in science and technology; investment needs; environmental impacts; potential contribution to green growth; sectoral interdependencies, and potential synergies and negative externalities; implications for ocean management, planning and regulation; and the policy options most suited to boost their long-term development prospects and their contribution to growth and employment, while managing the ocean in responsible, sustainable ways.

4. **Management of the project:** Design, co-ordination and implementation of the project will be conducted by the OECD's International Futures Programme in the Directorate for Science, Technology and Industry, in co-operation with other relevant specialised OECD directorates, departments and agencies. Background papers to support the main modules of the project will be produced by OECD specialists and external experts. Strategic guidance and financial support will be provided by a Steering Group consisting of representatives of the institutions and organisations sponsoring the project.

5. **Workshops:** The project will be supported by special workshops that may be co-organised and co-hosted with institutions involved in the project.

6. **Funding:** The project will be financed by voluntary contributions from governments, agencies, research institutions, foundations and corporations. The budget for the project is estimated at 550 000 Euros. Resources to be supplemented by secondments of experts from participating organisations, and by financial and logistical support provided through institutions co-hosting the planned workshops.

7. **Outputs:** A series of briefs derived from each of the modules and the workshops associated with them; a final synthesis report; an international symposium and other events to highlight the findings of the project.

8. **Duration of the project:** 18-24 months.

9. **Provisional timetable:** Work began in summer 2013. The first Steering Group meeting was held on 28 October 2013, the second is scheduled for 16 May 2014, the third will be held on 12 December 2014 and the final Steering Group meeting on 25 May 2015. Reports on the respective modules would start to come on-stream as of first quarter 2014. The final synthesis report would be produced first half of 2015, and the final symposium could be held either June or September of 2015.

1. Aim and scope of the project:

The objective is to conduct a global forward-looking assessment of the ocean economy to 2030, with special emphasis on the development potential of emerging ocean-based activities. For practical purposes, the project divides the ocean economy into established marine activities and emerging ocean-based activities.

Established marine activities encompass shipping and shipbuilding, capture fisheries, traditional maritime and coastal tourism, and port facilities and handling.

Emerging ocean-based industries include:

- Off-shore wind, tidal and wave energy
- Offshore extraction of oil and gas in deep-sea and other extreme locations;
- Sea-bed mining for metals and minerals;
- Marine aquaculture;
- Marine biotechnology;
- Ocean-related tourism and leisure activities;
- Ocean monitoring, control and surveillance.

The project will explore the growth prospects for the ocean economy and its potential for employment creation. Particular attention will be devoted to the emerging ocean-based industries: the risks and uncertainties surrounding their future development, the innovations required in science and technology, investment needs, environmental impacts, their potential contribution to green growth as well as their negative externalities, the implications for planning and regulation, and the policy options most suited to boost their long-term prospects while managing the ocean in responsible, sustainable ways.

2. Background and rationale:

The ocean and its resources are increasingly seen as indispensable in addressing the multiple challenges the planet is facing in the decades to come. By mid-century enough food, jobs, energy, raw materials and economic growth will be required to sustain a population of 9 billion people. The potential of the ocean to help meet those requirements is huge. But it is already under stress from over-exploitation, pollution, declining biodiversity and climate change. Hence, realizing the full potential of the ocean will demand responsible, sustainable approaches to its economic development. This is well exemplified in the eco-system based approach to the management of human activities. This is described, for example, by the EU's Marine Strategy Framework Directive as "applying an ecosystem-based approach to the management of human activities means ensuring that the collective pressure of such activities is kept within levels compatible with the achievement of good environmental status and that the capacity of marine ecosystems to respond to human-induced changes is not compromised, while enabling the sustainable use of marine goods and services by present and future generations."

Established maritime industries will be undergoing significant change in the coming decades. This is partly driven by global economic growth and increasing demand. In the shipping sector, for example, container traffic looks set to grow very fast, with volumes tripling by 2030. In capture fisheries, wild fish stocks are under great pressure – around a third of global fish stocks are over-exploited, depleted or recovering from depletion. In addition 57% of world stocks are considered fully exploited, which means that there is no room for further expansion in catch for these stocks. Overall, global production in capture fisheries is leveling off. And in tourism, ageing populations, rising incomes and relatively low transport costs will make coastal and ocean locations ever more attractive. Concurrently, developments in traditional maritime industries will also be shaped by climate change, as shifts in temperature, ocean acidity and rising sea levels affect movements of fish stocks, open up new trading routes, affect sea port structures, and create new tourist destinations and attractions, whilst destroying others.

At the same time, emerging ocean-based industries offer huge opportunities for addressing many of the big economic, social and environmental challenges facing humankind in the years ahead. These emerging ocean industries are developing and applying a range of science and technology innovations to exploit the ocean's resources more safely and sustainably, or to make the oceans cleaner and safer and to protect the richness of their resources. The activities differ considerably in their stage of development: some are relatively advanced while others are still in their infancy. To bring them on stream on a scale that would allow them to contribute in a meaningful way to global prosperity, human development, natural resource management and green growth, they will require considerable R&D effort, investment, and coherent policy support. Such efforts however need to be shaped and directed with a view to the future, which is why this project has its sights set on 2030 and beyond.

The project "The Future of the Ocean Economy" is forward-looking, cross-sectoral and multi-disciplinary. The OECD is particularly well placed to conduct such a study. It has a wide range of in-house expertise and networks related to the various user communities – specialised departments and agencies for science and technology, energy, fisheries, environment, marine biotechnology, shipbuilding and tourism, as well as capacity for long-term projections and foresight work. Extensive scoping of the theme has been carried out, including via a major international symposium held in July 2012 at the World Expo in Yeosu, Korea. Initial consultations have also been conducted with many countries in Europe, North America, Asia and the OECD Pacific region.

The project is designed to complement other international initiatives underway or planned elsewhere. These include the European Commission's "Europe 2020", "Horizon 2020" and DG Mare's "New Maritime Agenda", the World Bank's "Global Partnership for Oceans" and UNEP's work on ocean sustainability.

3. Planned structure of the project contents:

The design of the project is modular.

A first module (A) will assess the overall global outlook to 2030, and the current and future contribution of ocean-based activities to economic growth and employment. It will develop a baseline projection to 2030 for a set of variables including population growth, economic growth, climate and environment, and likely geopolitical developments, and use the projections as a unifying framework for estimating growth and employment in established ocean-based activities (i.e. shipping, capture fisheries, tourism…) and in the emerging sectors.

A second module (B) will explore the uncertainties, risks and drivers underlying the projected sectoral developments, whereby each of the emerging ocean-based activities will be the focus of a special study supported by in-depth expert workshops (B1-B6). In a third module (C), the interdependencies and interactions among ocean industries will be the focus of attention, endeavouring to better understand not only the potential synergies among sectors but also the likely negative externalities, conflicts and tensions. A fourth module (D) will present a forward-looking exploration of marine spatial planning to 2030, drawing in particular on the findings of the first three modules. A final module (E) will explore policy options for fostering the development of the emerging ocean industries and for realising their long-term potential for growth, employment, and the greening of the economy.

Future of the Ocean Economy: Project Structure and Suggested Timing

MODULE A

Assessing the current and future contribution of ocean-based activities to economic growth and employment:

- Baseline projection to 2030 for population, growth, climate change, environment, geopolitical developments, etc. by major regions
- Estimates of market growth and employment to 2030 for key maritime sectors (established and emerging industries) under baseline projection assumptions

MODULE B

Uncertainties and drivers determining the development of emerging ocean industries:

- Economic drivers
- Required progress in innovation – science, technology, logistics, etc.
- Required investment, funding, business models, skills
- Potential impact on marine environment
- Regulations

Workshops

- B1: ocean-based energy (wave, tidal, thermal conversion
- B2: off-shore oil & gas
- B2bis: Seabed mining
- B3: Marine aquaculture
- B4: Marine biotechnology
- B5: New forms of ocean tourism and leisure activity
- B6: Maritime monitoring, control and surveillance

MODULE C

Sectoral Interdependencies

- Reducing negative externalities, including on marine ecosystems
- Developing value-chain synergies

among the emerging ocean acitivites, as well as established ocean industries

MODULE D:

Long-term development of emerging ocean industries and the outlook for maritime spatial planning

- Overview of the challenges
- Current good/best practice (case studies)
- Options of the future

MODULE E

Charting a policy course for emerging ocean activities

Exploring and mapping policy options for the development of the emerging ocean industries and for realising their long-term potential for growth, employment, sustainable marine ecosystems and greening of the economy

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MODULE A (June 2013 – Sept 2015)
MODULE B (June 2013 – Sept 2015)
MODULE C (from Feb 2015 – Sept 2015)
MODULE D (from Feb 2015 – Sept 2015)
MODULE E (from Dec 2013 – Sept 2015)

Steering Group Meetings

28 Oct

16 May

12 Dec

29 May

June 2013	Dec 2013	Feb 2014	Mar 2014	May 2014	Sept 2014	Oct 2014	Nov 2014	Dec 2014	Jan 2015	Feb 2015	Mar 2015	April 2015	May 2015	June 2015	Sept 2015

Module A: Assessing the current and future contribution of ocean-based activities to economic growth and employment

The base-line projection for the global outlook to 2030 will not need to be constructed from scratch. Instead it will draw on recent work performed in the OECD Economics Department on medium- and long-term scenarios for growth and imbalances; on the OECD Environment Directorate's Environmental Outlook to 2050; and the IEA's work on Energy Technology Perspectives to 2050. The project will benefit from further OECD work on global scenarios (economy and environment) planned for the period 2013-14.

The ensuing global scenario will form the reference scenario framework for estimating business-as-usual trends (market growth, capacity, employment) to 2030 in established maritime industries such as shipping, capture fisheries and tourism, as well as in the emerging ocean industries outlined above.

Module B: Uncertainties and drivers determining the development of emerging ocean industries

This is the core of the project, which lies in the in-depth exploration of the different emerging ocean industries (B1-B6). The reference projections for these industries which are to be described in Module A will be based on business-as-usual assumptions concerning a number of key variables, including global demand, steady progress in S&T, funding availability, no major changes in policy etc. The purpose of Module B is to examine the uncertainties inherent in such assumptions and to consider the factors that would need to fall into place for each of the emerging ocean sectors to develop or at least approach their full potential, with due consideration to environmental and social factors. This turns the spotlight on economic drivers such as raw materials and commodity prices, requisite innovative breakthroughs in science and technology, the importance of anticipating impacts on the environment with a view to avoid or mitigate them, the need to secure adequate funding and devise appropriate business models, and so on. Each emerging ocean sector will be the object of a special report supported by an experts' workshop.

A more detailed description of the prospects and challenges facing these sectors as well as illustrations of the kind of issues to be explored is provided below:

B.1. Ocean-based energy

This project module will address some of the main uncertainties surrounding the long-term development of ocean-based energy, and identify and discuss some of the key advances that need to be made with a view to ensuring that the long-term potential of ocean-based energy can be more fully realised.

Ocean-based energy refers to all sources of energy that are obtained by either harnessing certain characteristics of ocean power (wave, tidal, thermal conversion, salinity gradient) or by utilising ocean space (offshore wind energy). The ocean is a rich source of potential energy resources, and with growing concern over climate change and increasing global interest in renewable energy, investment in ocean based energy is poised to grow over the next few decades.

The offshore wind energy industry is the most mature of the ocean based energy sources. Global installed capacity is currently only a little over 6 GW, but relatively conservative estimates (IEA, 2012a) suggest this could grow to 175 GW by 2035.

Installed onshore and offshore wind power capacity by region in the IEA New Policies Scenario (in GW)

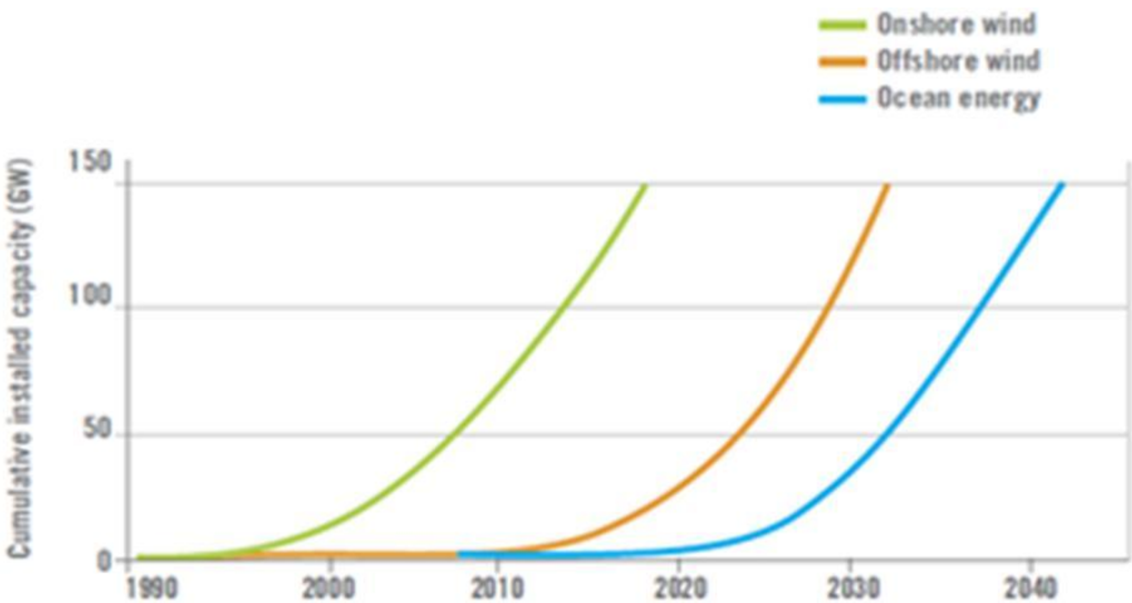
	Wind Onshore			Wind Offshore			Total Wind		
	2011	2020	2035	2011	2020	2035	2011	2020	2035
OECD	150	285	441	4	31	113	154	315	555
Americas	53	107	175	-	4	26	53	112	202
United States	47	90	143	-	3	18	47	93	161
Europe	91	161	231	4	24	72	95	184	304
Asia Oceania	6	16	34	0	3	14	6	19	49
Japan	3	8	16	0	2	9	3	9	25
Non-OECD	84	262	482	0	9	62	85	271	544
E. Europe/Eurasia	2	6	16	-	0	3	2	6	19
Asia	79	239	411	0	9	53	79	248	464
China	62	191	280	0	9	46	62	200	326
India	16	44	93	-	-	5	16	44	97
Middle East	0	2	21	-	-	2	0	2	23
Africa	1	4	15	-	-	1	1	4	16
Latin America	2	11	19	-	-	3	2	11	22
World	234	546	923	4	40	175	238	586	1 098
European Union	90	159	218	4	23	70	94	182	288

Source: IEA (2012a)

Nonetheless, the sector faces significant challenges, on the technological, regulatory and supply chain management fronts. Understanding of the requirements of wind technology in offshore conditions is still inadequate, and this has led to the spread of conservative design practices involving versions adopted from their onshore counterparts. Regulatory challenges extend to usage of maritime space, planning restrictions, competition from other ocean activities, and international boundary issues. Potential shortages of such essential ingredients as certain types of high-voltage sub-sea cables and off-shore construction vessels may also prove problematic for the future roll-out of offshore wind turbines, especially as sites move increasingly further from the shore and into deeper waters (IEA, 2012b).

The potential for ocean power is significant and widespread, though the technologies are at various stages of development.

Onshore, offshore and ocean energy projected growth



Source: European Ocean Energy Association (2010), *Oceans of energy - European Ocean Energy Roadmap 2010-2050*, European Wind Energy Association

Tidal barrages are furthest advanced, with France and Korea already with sizeable installed capacity. Tidal and ocean currents and wave power are still at the demonstration stage, with multiple MW-scale projects undergoing testing. Temperature and salinity gradient technologies remain at the research and development stage. The global market is not expected to scale up significantly in the medium term (IEA, 2012b). Over the longer-term however the potential is enormous. For that potential to be realised, and perhaps accelerated, challenges will need to be addressed and constraints overcome in numerous areas.

For example:

Science & Technology:

- As offshore wind energy moves increasingly offshore and into deeper waters, what are the key technological challenges that need to be addressed? What are the prospects for more rapid progress in such areas as, for example, the manufacture of turbines specifically for the offshore environment, low-cost deep-water foundation technology, the development of floating turbines, or the reduction of "cluster risk" to offshore wind farms from winter storms?

- What are the chief hurdles that need to be overcome in order for ocean power technologies to become significantly more cost-efficient, reliable, easy-to-maintain and environment-neutral?

- What progress can be expected in the medium-term future with respect to overcoming the challenge of connecting transformer stations to the shore by high-voltage cable, especially in deep water?

Management:

- How is the future development of ocean-based energy likely to impact other ocean and coastal users? Where are there potential synergies, where negative externalities?
- Where are bottlenecks likely to arise over the medium-to-long-term in the expansion of offshore wind energy? Will they be mainly upstream (e.g. sea-cable and construction equipment) or downstream (e.g. problems with connecting to mainland grids stemming from environmental concerns, skill shortages etc.)?
- How well is offshore wind energy production integrated into maritime spatial planning? What particular obstacles does its integration face?
- What is the potential for mapping techniques and decision support systems to better assess and identify favourable sites for offshore wind farms, but also other ocean-based energy facilities, thereby reducing potential conflicts between different uses and enhancing maritime spatial planning?

Regulation:

- What are the principal environmental challenges facing the development of the various types of ocean based energy?
- To what extent are national spatial restrictions on the siting of offshore wind farms impeding development of the sector, and how are such restrictions likely to evolve in the future as it becomes increasingly feasible to locate offshore wind turbines ever further from the coast line?
- Many ocean power technologies are still in the development stage. What environmental impediments might they face in the longer term as large-scale deployment becomes increasingly feasible?

Investment/financing:

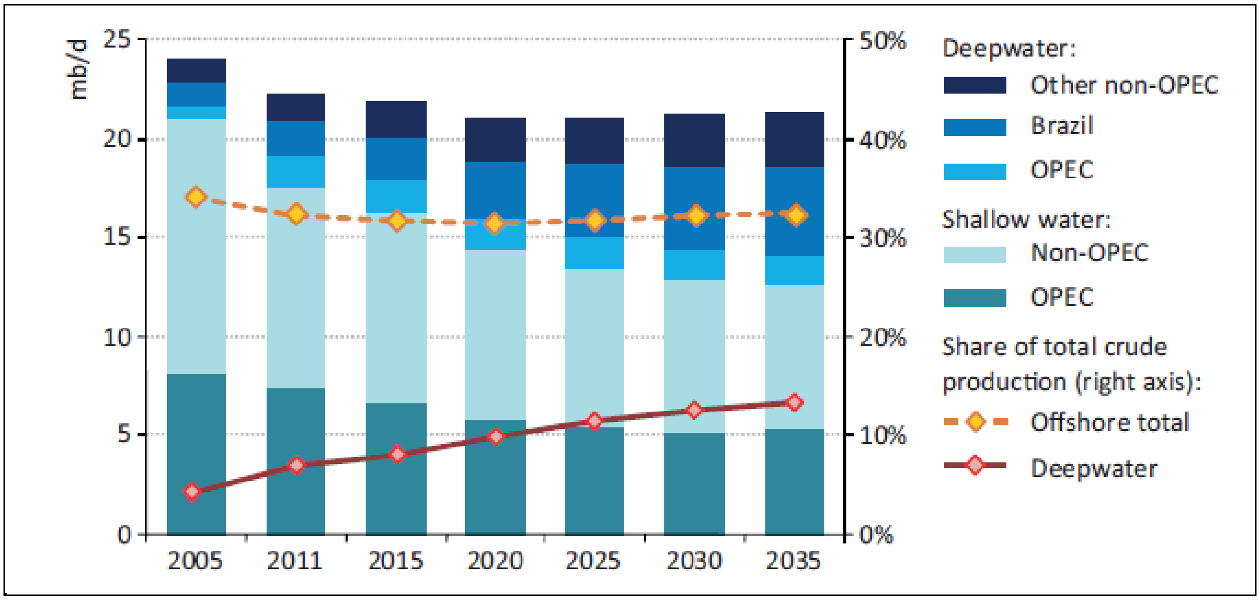
- Given the technical and commercial risks investors need to take into account, lack of funding could prove an important impediment to the future expansion of offshore wind energy. How likely is it that traditional long-term bank financing of offshore wind energy will improve in the medium term?
- Are new sources of financing (e.g. pension funds, non-utility corporate investors) sufficiently exploited?
- What are the sustainable business models of the future?

B.2. Offshore and deep-water extraction of marine mineral resources (oil & gas, metals, rare earths)

This project module will address some of the main uncertainties surrounding the long-term development of offshore mineral extraction, and identify and discuss some of the key advances that need to be made with a view to ensuring that the long-term potential of marine extraction activities can be more fully realised.

Oil will remain the dominant fuel in the energy mix through 2035, with demand projected to climb by almost 15% from its current level. This trend will be accompanied by a decline in production from the world's older oil fields, stimulating the search for new sources. Offshore oil and gas will figure strongly among those new sources.

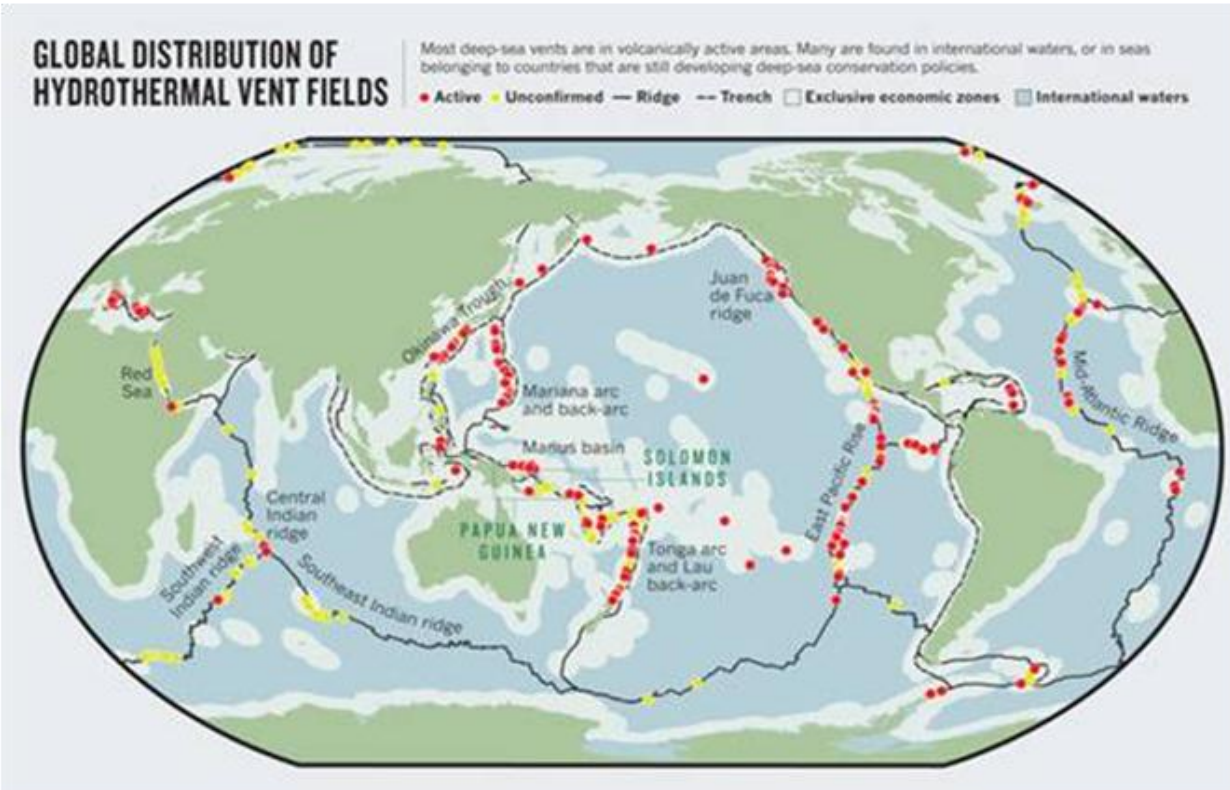
World offshore crude oil production by physiographical location and region in the New Policies Scenario



Sources: Rystad Energy AS; IEA analysis, World Energy Outlook 2012

Offshore crude oil is now the only growing segment of the industry and accounts for almost one third of gross oil production worldwide. As the depletion of shallow-water offshore hydrocarbon reserves continues, the focus is shifting increasingly towards exploration and exploitation of oil and gas reserves in deep (500- 1500 metres) and ultra deep (beyond 1500 metres) water. Indeed, almost half of remaining recoverable conventional oil is estimated to be in offshore fields, and a quarter of that in deep water (IEA, 2012a). Moreover, interest in the Arctic is growing. The USGS estimates that about 30% of the world's undiscovered gas and 13% of its undiscovered oil may be found there. While most of the drilling would be offshore in less than 500 metres of water, the conditions in the Arctic are extremely hostile and environmental safety is written large in such a pristine environment.

Although still very much at the exploration stage, interest in deep-sea mining for minerals, and especially metals, has picked up in recent years, largely because of rising demand and prices for such metals as copper, zinc, gold and silver, but also due to sovereignty considerations in the case of some rare earth elements. Given limitations on land-based mineral resources, interest in sea-bed exploitation is expected to be sustained over the long-term future. Commercial interest is particularly strong in polymetallic nodules and in seafloor massive sulphides (SMS) which are base-metal sulphur-rich mineral deposits that precipitate from the hydrothermal fluids as these interact with the cooler ambient sea water ay hydrothermal vent sites.



Source: Joyce & Soule

It is estimated that thousands of underwater sulphide systems exist, and that even if only half them are geographically viable, annual seafloor production would represent several billion tons of copper alone. Deposits of rare earth elements such as yttrium, dysprosium and terbium, many of them vital for the production of electric vehicles, ICT hardware and a whole raft of renewable energy technologies, are also to be found on or in the sea bed.

Deep water oil production, Arctic exploration and deep-sea mining all have in common that they raise enormous technological and regulatory challenges while also posing serious threats to the environment. Examples of key uncertainties, challenges and hurdles are set out below:

Science:

- Where are there still important gaps in the ocean sciences' and environmental sciences' understanding of the risks and potential impacts of liquid and hard mineral extraction on the marine environment? Where in particular do scientific research efforts need to be focussed?
- Differences in the occurrence and distribution of SMS deposits necessitate different systems of access for prospecting and exploration. How important is the lack of scientific information about non-active hydrothermal sites in this regard?

Technology:

- What technological enhancements are in the pipeline which could greatly facilitate the exploration and exploitation of oil and gas resources in hostile climes? What are the most significant technological challenges still to be resolved?
- The design and application of deep-sea mining technologies derive largely from the technologies used for the exploration of offshore oil and gas. In terms of lifting and transporting the products from the sea bed, however, new technologies will be required, not least because the disturbance to the sea floor and marine environment is of a different order. What are the prospects for workable technological solutions to such challenges, and what are the key obstacles?

Environment:

- How well developed are environmental assessment methods when it comes to understanding the potential effects of deep-water oil and gas extraction and seabed mining for minerals? Where does more progress need to be made in the underlying science and in the assessment processes?
- How well integrated into upstream assessments is geo-hazard analysis, i.e. the risk of sub-marine landslides, gas/liquid seepage, active faulting and earthquakes etc.?

Regulation:

- As oil and gas operations move further offshore into deep and ultra-deep waters as well as into the Arctic, what are the key regulatory issues that will need to be resolved?
- What improvements are still needed to national regulatory frameworks concerning the exploitation of seabed minerals within national jurisdictions? For example, how can developing countries' capacities to develop and enforce suitable environmental laws and regulations to oversee seafloor mining activities in their jurisdictions be rendered more effective?
- Given the potential of seabed resources and the likelihood in the medium-term of seabed mining operations starting up in international waters, is the current international regulatory framework (as encapsulated by the ISA) for prospecting, exploration and extraction of minerals in deep sea areas beyond national jurisdictions sufficiently robust? Where is greater clarity and where are improvements to the framework still required?

- How will the absence of progress in the above regulatory issues constrain the long-term development of deep-water oil and gas extraction and seabed mining for minerals?

Investment/Financing:

- As exploration and exploitation of liquid and hard minerals move into increasingly challenging environments, how will the risk landscape change for such capital intensive operations? What new risks for investors and operators will emerge? Which risks will intensify and for whom?
- Which existing financing models are likely to remain viable in the new risk landscape, and where are new tools and innovative instruments called for?

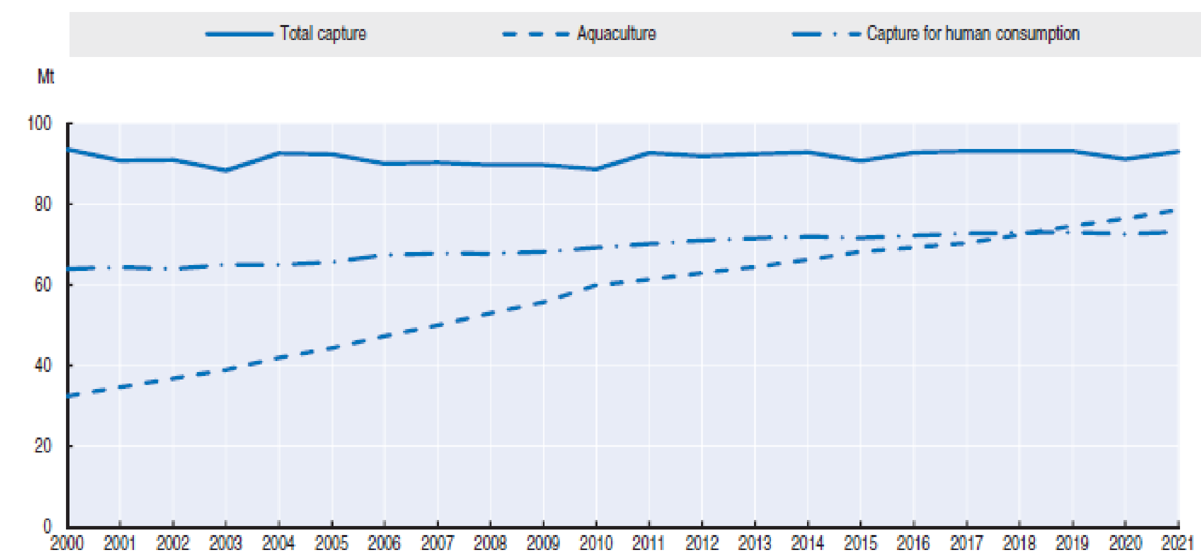
B.3. Marine aquaculture

This project module will address some of the main uncertainties surrounding the long-term development of marine aquaculture, and some of the key advances that need to be made with a view to mitigating the risks and loosening the constraints confronting future aquaculture development.

Worldwide demand for fish and fishery products is expected to surge in the coming years across all continents. However, capture fisheries production is set to remain rather static, so that most of the growth will need to come from aquaculture.

Figure 8.4. **Aquaculture overtakes capture fisheries for human consumption**

Fishery production in live weight equivalent



Source: OECD and FAO Secretariats.

StatLink http://dx.doi.org/10.1787/888932640217

Over the next decade aquaculture production is projected to expand by a third, reaching almost 80 Mt by 2021 (OECD/FAO, 2012). But the overall annual growth rate is likely to slow from 5.8% in the previous decade to 2.4% over the next ten years. However, global demand for seafood is expected to continue to rise over the following decades, raising concerns that production may fall well short of required levels and drive up prices as a consequence. Indeed, there are many constraints affecting the prospects of aquaculture production. These include the growing scarcity of suitable water, limited opportunities for sites for new operations along increasingly crowded, multiple-user coastal areas, limited carrying capacity of the environment for nutrients and pollution, and more stringent environmental regulations.

Most of the future expansion in aquaculture production capacity will probably occur in the ocean, with some of it moving increasingly off-shore to escape the constraints of coastal waters. Aquaculture is very dependent on a healthy and productive ecosystem. To ensure that the expanding aquaculture sector does not significantly aggravate environmental problems (degradation of coastal waters and marine habitats, endangered biodiversity due to escapees and lower resistance to economically costly fish diseases) and continues to expand strongly as a food source for the world's burgeoning population, a number of challenges will need to be addressed and obstacles. For example:

Science:

- What are the key risks in terms of fish disease and invasive species now and in future? What progress has already been made in the biosciences (e.g. vaccines versus antibiotics) and bio-security (e.g. biosensors) to reduce these risks? Which are the most important scientific hurdles still to be overcome and how are these currently being addressed?
- How mature is the science with respect to assessing the environmental and biological carrying capacity of sites? What are the key scientific challenges that need to be tackled?

Technology:

- What progress has been made to date in the search for substitutes for fishmeal and oil, for improved feeding systems, etc.? What are the principal technology challenges for the coming period?
- How feasible is open-ocean aquaculture, and what are the main technical hurdles that need to be overcome?
- How has R&D spending on aquaculture been holding up in recent years, and what are the prospects for the coming years?

Management:

- How is the future development of marine aquaculture likely to impact other ocean and coastal users? Where are there potential synergies, where negative externalities?
- How fast has progress been in marine aquaculture management practices around the world, and what is the outlook for improvement in the following domains:

- Multi-stakeholder/multi-user consultation
- Adoption/diffusion of good management practices
- Marine spatial planning for aquaculture

Regulation:

- What works well and what works less well in terms of regulatory tools? Where is progress most urgently needed? E.g. with respect to:
    - Environmental approvals
    - Discharge permits
    - Mandatory technical standards
    - Command-and-control v. incentive-based measures
- How will regulatory frameworks need to evolve over the long-term to cope with the changing aquaculture landscape?

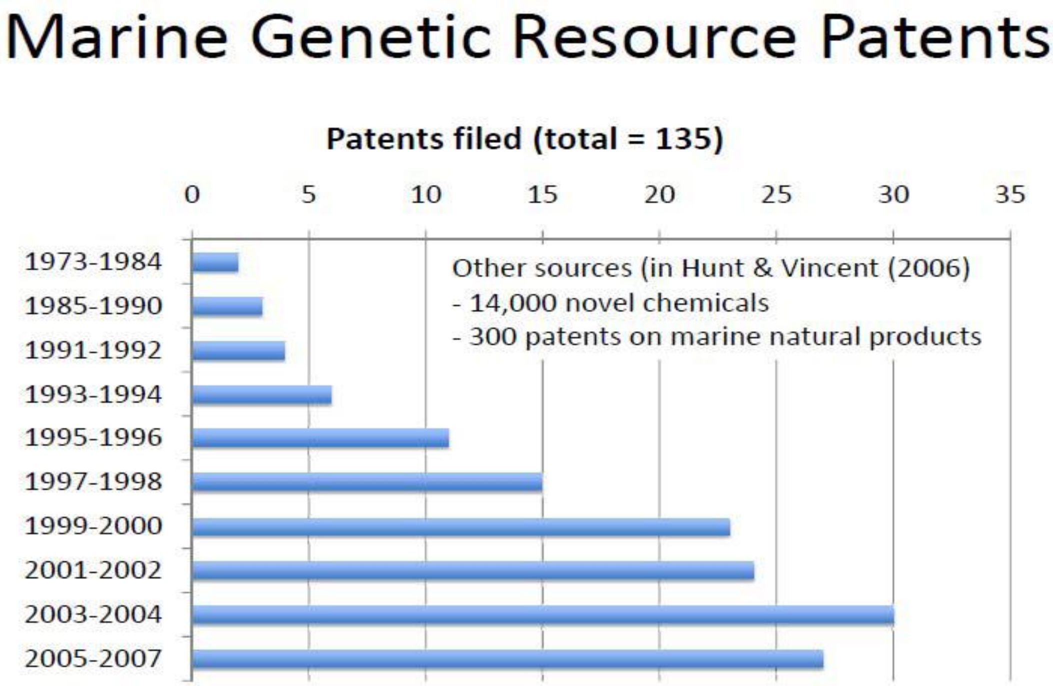
Investment, financing:

- How will the risks and uncertainties outlined above affect the flow of investment into the marine aquaculture business in the coming years?
- What are the most likely sources of future investments in marine aquaculture? Which business models are likely to be most successful?

B.4. Marine biotechnology

This project module will address some of the main uncertainties surrounding the long-term development of different strands of marine biotechnology, and identify and discuss some of the key advances that need to be made with a view to ensuring that the long-term potential of marine biotechnology can be more fully realised.

Marine biotechnology has the potential to address a raft of major global challenges such as sustainable food supplies, human health, energy security and environmental remediation, and to make a significant contribution to green growth in many industrial sectors. At the same time, marine bio-resources also provide a number of important ecosystem services for the planet and its inhabitants which must be maintained. Notwithstanding difficulties of definition, the global market for marine biotechnology products and processes is a significant and growing opportunity. It is currently estimated at around USD 2.8 billion and, on the basis of quite conservative assumptions, is projected to grow to around USD 4.6 billion by 2017.



(adapted from Leary et al. (2009) Marine Policy 33, 183-194)

On the health front, there has been increasing interest in marine microbes, particularly bacteria, with studies demonstrating that they are a rich source of potential drugs. Antimicrobial resistance has been identified by the WHO as one of the three greatest threats to human health, so finding new strains to develop drugs is high priority. The complex marine ecosystem with its large number of yet undiscovered microbial species presents a rich and largely untapped resource base. In 2011 there were over 36 marine derived drugs in clinical development, including 15 in the cancer field. One area in which marine biotechnology may make a critical contribution is the development of new antibiotics. Other promising areas include biomedical products such as anti-bacterial and anti-fungal properties, as well as nutraceuticals and cosmeceuticals.

Marine biotechnology has also displayed widespread commercial potential in industrial products and processes, and in the life sciences industry as a novel source of enzymes and polymers. It is providing a source of synthetic substitutes for many high-value chemicals derived from fossil raw materials, and is being extensively applied in environmental monitoring, bioremediation and prevention of bio-fouling. Despite these successes, limited knowledge of marine genetic diversity still constrains the potential development of industrial applications and innovations.

On the energy front, algal biofuels appear to offer promising prospects. According to the Marine Board of the European Science Foundation (2010) a theoretical production volume of 20 000 – 80 000 litres of oil per hectare per year can be achieved from microalgal culture, whereby only the lower end of the band seems to be achievable with the current technology. (This is nonetheless considerably higher than biofuel from terrestrial crops.) Cost-competitive, high volume algae biofuel production is still some way off and will require much more long-term research, development and demonstration. And even when the technologies have been developed, there is still the risk that limited global resource availability may hamper production (Energy Biosciences Institute, 2010).

Hence, in order for all three marine biotechnology strands to develop further, challenges will need to be addressed and constraints overcome. For example:

Science:

- How well are marine bioscience and marine biotechnology infrastructures performing? What are the main obstacles impeding their faster development over the period ahead?
- What are the prospects for the successful genomic modification of algal strains?
- What are the prospects for the development of a new algal chemistry that, over the long-term, would deliver multiple, profitable uses of all components of the algal biomass?

Technology:

- What technical improvements are needed to the marine biodiscovery pipeline to make marine derived compounds more acceptable to the pharmaceutical industry?
- Where do efforts need to be focussed in order to further improve growth conditions and extraction processes, with a view to making algal fuels commercially viable?
- What new concepts of marine biorefining are emerging which hold the promise for more efficient large-scale production of renewable energy products and processes?
- What are the technical hurdles to developing sustainable and economically viable production methods for functional product ingredients in the area of bioactives and structural compounds?

Management:

- How is the future development of marine biotechnology likely to impact other ocean and coastal activities? Where are there potential synergies?

Regulation:

- Given the difficulties pharmaceutical discovery faces in securing access to marine resources, property rights and intellectual property, what progress has been made to date in developing a workable regulatory framework for bio-prospecting activities? In particular, what are the implications of the implementation of the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention of Biological Diversity, as well as that of a potential regime to be put in place for marine genetic resources in areas beyond national jurisdiction?
- As the marine biotechnology landscape changes in the years ahead, what new regulatory challenges are likely to arise?

B.5. Ocean-related tourism and leisure activities

This project module will address some of the main drivers and uncertainties behind the long-term development of new ocean-related tourism and leisure activities, and identify and discuss some of the key issues and constraints (in particular the environmental and regulatory ones) that need to be tackled if these activities are to contribute fully to the ocean economy in the coming decades.

In many regions of the world, coastal and ocean-related tourism (including island-based tourism) has grown considerably in importance in recent decades. Its contribution to the national economy and national employment is significant, as is its value to local communities. Coastal communities in particular are expected to benefit from this growth through the creation of employment opportunities, rising incomes and revenues. Non-economic benefits may also be substantial – e.g. improvements in health and safety standards, quality of life, and growing national and international recognition and valorisation of their culture and natural environs, which in turn help leverage investment in environmental protection.

Despite a long history, cruise tourism remains a relatively small sector. However, in recent years, it has shown itself to be the fastest growing sector in the leisure travel industry, with the number and size of ships, passengers, ports and profits all on the rise. Between 1970 and the mid-2000s the number of people taking cruises increased 24-fold, and by 2011 some 16 million people were boarding ocean liners. Overall, average annual passenger growth rates are in the region of 7.5%, and passenger expenditures are estimated in the order of 18 billion USD a year. The industry is thought to be still a long way from maturity. Against a global background of rising incomes, ageing populations, growing leisure time, and the declining image of cruises as the preserve of the wealthy, the long-term prospects for ocean cruise tourism appear healthy. However, there are concerns that the cruise industry is already placing considerable strains on the environment (pollution, threats to biodiversity, intensive energy consumption) and in some cases on local communities (erosion of traditional lifestyles, competition for coastal space with other ocean-based industries). As UNEP (2009) indicates, the main conceptual challenge is to resolve the conflict between the benefits ocean tourism can bring to the national and local economies, its impact on the physical environment and the pressure it may exert on the social environment.

source: Arctic Marine Shipping Assessment (AMSA Executive Summary with Recommendations, 2009);

http://www.arctic.gov/publications/AMSA_2009_Report_2nd_print.pdf

That challenge stands to intensify in the future as the ocean cruise industry seeks not only steadily to expand its business in traditional waters but also in new destinations. Polar marine tourism (Arctic and Antarctica) is one such example. In the Arctic, it is expected that the number, size and variety of tourist vessels visiting the area, the range of locations and time spent in the region, will all grow in the coming years. On the positive side, there are clearly opportunities to raise local incomes, strengthen and enhance local marine infrastructures, and improve living standards of local communities. The concern, however, is that without taking the appropriate steps, the Arctic environment, community infrastructures, social institutions and cultural values will be increasingly vulnerable. Managing ocean tourism in the polar regions is likely to prove challenging, with the relevant nations enacting and enforcing numerous and differing laws and regulations governing marine operations and pollution, albeit on the basis of international law. Similarly, many countries with expedition cruise ships operating in both the Arctic and Antarctic are utilising self-imposed (and often unharmonised) guidelines to enhance marine operations and visitor safety, and provide environmental and cultural protection. This interplay of stakeholder interests, regulations and controls will require careful balancing if the polar regions are to see marine tourism expand in sustainable ways.

source: http://www.economist.com/blogs/gulliver/2012/05/underwater-hotels Dubai Discus Underwater Hotel

Looking a couple of decades ahead, there is the question not only of new destinations but also of new forms of ocean-related tourism. Underwater hotels and sea-floor/floating resorts already exist in places as far-flung as Florida, China, and Fiji, and many more are currently in the planning stage. Deep sea tourist expeditions are another such activity with significant potential. Several companies around the world already offer mid-range dives of between 500 and 1000 metres, and one specialist operator organises dives of up to 10 000 feet. Target venues range from famous shipwrecks to mid-Atlantic hydrothermal vents and other especially attractive deep-ocean eco-systems. With technological advances in submersible vehicles that can reach depths of 5 000 metres and offer increased underwater manoeuvrability, experts believe that the advent of deep-sea adventure tourism is within reach.

For the potential of these new or emerging ocean tourism activities to be realised, a number of challenges and constraints will need to be addressed. For example:

Science & technology:

- As traditional ocean cruise destinations expand, new destinations grow in popularity and new forms of ocean tourism emerge, what are the key S&T challenges that need to be addressed to ensure that the development of these activities is aligned to green growth objectives?
- In particular with respect to underwater ocean activities, what are the key scientific and technological hurdles that need to be overcome to promote their successful development?

Management:

- How is the projected expansion of ocean tourism and new forms of ocean recreation likely to impact other ocean and coastal users? What are the potential synergies, conflicts and/or negative externalities?

- To what extent will current models of marine spatial planning be able to cope with the expected surge in ocean tourist activity?

Regulation:

- What are the key environmental issues facing the expansion of ocean tourism in both established regions and new destinations?

- Given the complexities of regulating ocean tourist activities in environmentally sensitive areas (at both the national and international level), what examples of best practice are emerging? What role is there here for self-regulation by the industries involved?

Investment/financing:

- While financing does not seem to be a serious potential impediment for the future of the ocean cruise industry, even with respect to new destinations, the development of new types of ocean tourism infrastructure and activities clearly face bigger risks and greater difficulties in securing financial backing (e.g. underwater hotels). Where are the new sources of financing and economic instruments supporting stronger growth for such activities? What are the business models most likely to promote their successful development?

- How likely is it that investment in new forms of ocean tourism will be private-sector led? What role could there be for government?

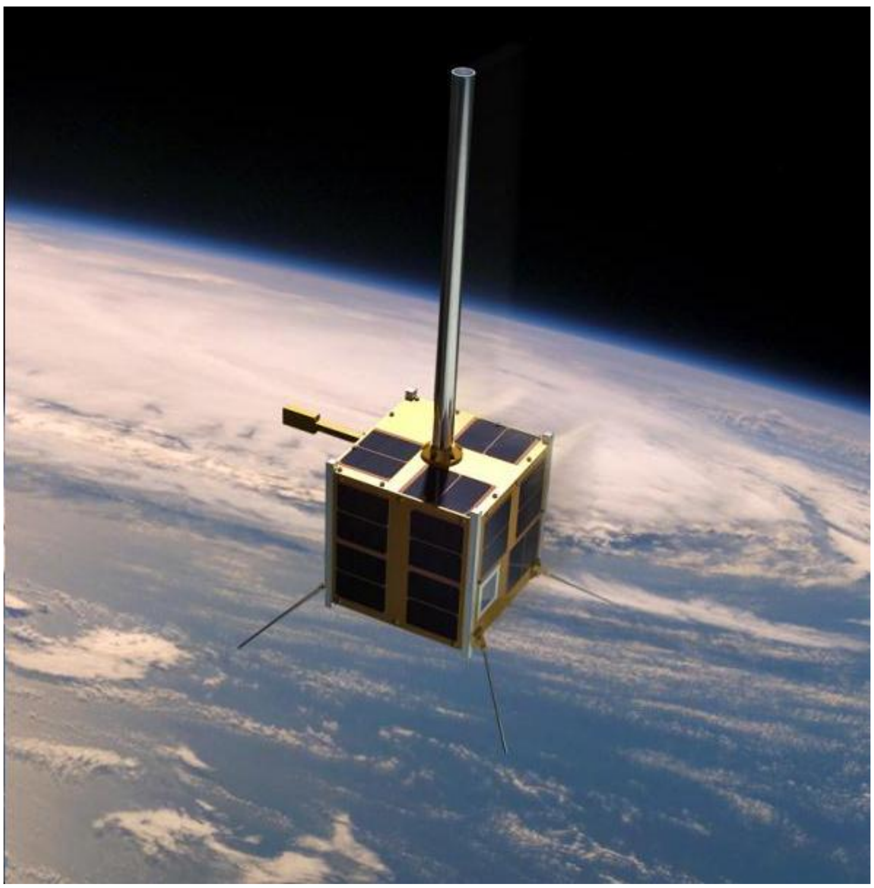
B.6. Ocean monitoring, control and surveillance (MCS)

This project module will address some of the main drivers, uncertainties and constraints surrounding the long-term development of the critical infrastructures required for ocean monitoring, control and surveillance, and will identify and discuss some of the key advances that need to be made to ensure its effective functioning in the future.

Ocean monitoring, control and surveillance is a tool to better understand the ocean environment, manage oceanic space, prevent unlawful activities, enforce maritime laws, implement ecosystem safeguards and ensure environmental protection. With the growth of the maritime sector and the emergence of new ocean-based activities, the coming years will see growing interest in ocean MCS and growing demand for its services.

Ocean monitoring is required for at least three purposes: (1) fundamental scientific understanding of the ocean, e.g. its properties and behaviour, its health, its role in climate change and how it is affected by climate change (e.g. acidification); (2) identification of ocean resources, be it food, energy, minerals or materials as well as support of its effective and efficient use – e.g. assessment of fish stocks, location of potential energy sources from gas hydrates, or identification of preferred sites for wind farms; (3) assessment of the impacts of ocean-based activities such as resource extraction, shipping and coastal tourism either to help minimise environmental and eco-system degradation or to ensure sustainable use, as well as support coastal and marine spatial planning to better organise competing uses. Control and surveillance are required to prevent unlawful activities such as piracy as well as illegal, undeclared and unreported fishing (IUU), to enforce maritime laws and agreements such as marine conservation zones; and ensure marine ecosystem protection measures are in place.

A raft of infrastructures is required to perform these tasks. The most important ones include ocean-going research- and marine-security vessels; satellite remote sensing, communications and global positioning; submersible and fixed platforms and systems; in-situ sensors; modelling and computational infrastructure as well as 'big data' storage and management. In other words, ocean monitoring, security and surveillance encompasses a mix of diverse sectoral infrastructures serving a variety of purposes.



source: AISSat-1 in orbit (Illustration: ESA/The Norwegian Space Centre)

Hence, the module will need to concentrate on a manageable number of activities. These are: satellite systems (Earth observation, global positioning, navigation and communications) for remote sensing, imaging, tracking and surveillance, especially in wide-area settings in the open seas; in-situ sensing; and modelling and data management & storage issues. Illustrative examples of the issues that will be pursued are:

Science and technology:

- Given the challenges that lie ahead for ocean MCS, most if not all critical infrastructure domains will need continual maintenance, upgrading and improvement. For example, in satellite technology: there is concern in many quarters that remote sensing capabilities and data continuity are declining, when in fact the existing polar-orbiting satellites need complementing with geostationary satellites providing better and more frequent coverage and real-time data during extreme weather events such as hurricanes or major oil spills. And for tracking ocean-going vessels, greater signalling accuracy is required – improvements which should come into effect in the next few years as more global positioning and AIS systems are put in place. What other improvements to the satellite infrastructure are considered essential for keeping abreast of the growing demands MCS? Where does faster progress need to be made in integrating the different scientific disciplines that space systems can leverage?
- In modelling and computational infrastructure, improvements are needed in integrating the deep ocean with the shelf seas for ecosystem-based management, including safety and environmental impacts for various industrial activities; and capabilities will need to be developed which permit the direct assimilation of many additional channels of remotely sensed and in-situ global array data. Where are the current constraints most acute and where is progress particularly urgent?
- With respect to in-situ sensors, the future is likely to require more multidisciplinary sensor packages with long endurance, stability, and range in different types of operating environments. What is the current state of play in this field and what scientific and technological breakthroughs are required to achieve significant improvements in in-situ sensing, not least in connection with remote sensing and satellite communications (e.g. broadband) capabilities?

Management:

- The scale of the challenge in ocean monitoring, security and surveillance is such that no single country has the capacity to master it alone. International collaboration in the development of scientific and technological infrastructure, but also in its use, is essential these days for scientific exploration, safeguarding ocean ecosystems, policing agreements, conservation zones etc. What are the main constraints on the further development of collaboration in the MCS infrastructures considered here?
- Equally, more effective integration of data generated in a wide range of disciplines will be required, and this across institutional and international borders. What examples of good/best practice are there in this respect? What are the chief hurdles to improved data sharing?
- An important complement to civil MCS of the oceans that remains to be more fully exploited is military surveillance facilities. As the worlds of commercial shipping and civil space applications demonstrate,

significant overall benefits can be derived from co-operation with the military authorities (e.g. securing shipping routes, reducing supply chain vulnerabilities, sharing of space-based meteorological tools and data). Looking ahead over the next couple of decades, what are the opportunities and what the constraints at the interface of civil and military infrastructure facilities in ocean monitoring, control and surveillance?

Investment/financing:

- As with any infrastructure, those for ocean monitoring, control and surveillance require research, development, implementation, maintenance, upgrading and renewal. What are the future pressures likely to come to bear on investment in infrastructure for MCS? What should the role of the state be and what the role of the corporate sector? How are the business models in space technologies, in-situ and remote sensing, and other MCS infrastructures set to change in the years to come?

Module C: Sectoral interdependencies

Emerging ocean industries are of course not developing in isolation. They interrelate and interact with one another and with established ocean activities in a myriad of different ways. Given that ocean space is limited, especially in coastal areas where many of these activities are unfolding, there is a risk that they may impede each other's operations and development over time. Examples of such negative externalities are numerous:

- Tidal barrages may disrupt migration routes of fish
- Off-shore wind farms may interfere with shipping lanes
- Oil spills from deep-water drilling operations can be very harmful to ecosystems, including fish stocks
- Deep-sea hydrothermal vents may not only be rich in SMS deposits but may also be biodiversity hotspots, so that sea-bed mining may then pose a risk to ecosystems and in turn to their exploitation (bio-prospecting).

On the other hand, interactions among the different industries may be quite beneficial. By way of illustration:

- Satellite remote sensing and earth observation can assist with the mapping of toxic algal blooms, the tracking of oil pollution or the identification of suitable sites for off-shore wind energy facilities
- Marine biotechnology can be an important source of products to combat bio-fouling on ships and marine structures, or stimulate natural habitats through bio-remediation
- Off-shore wind turbines may create suitable conditions for algae and attract fish species.

Such potential synergies but also the potential negative externalities need to be taken into account when considering both the future development pathways that emerging ocean industries may take in the years ahead, and the measures that might be put in place to reduce obstacles and amplify the benefits that might accrue. Interrelations of this nature are also an important part of maritime spatial planning, the subject of Module D.

Module D: The outlook for maritime spatial planning and its potential to promote the development of emerging ocean industries

Marine Spatial Planning (MSP) has the potential to transform the way that oceans are managed. It can help address conflict among multiple uses, improve management of ecosystems, create economies of scale and enhance efficiencies in the management of ocean space and the enforcement of agreements. That potential however is far from being realised yet.

MSP is a framework to support decision making in the use of marine resources and space – protecting marine and coastal biodiversity while at the same time addressing human needs along coasts, in near-shore environments and on open oceans. It is not a substitute for integrated marine coastal area management (although it often builds on its underlying principles), nor does it encompass a specific set of policies, nor is there a single model for MSP. Rather it is a planning framework that attempts to take into account the unique and dynamic spatial planning requirements of marine ecosystems to sustain the goods and services society needs.

The concept of marine spatial planning has been around for decades, but its implementation is far from being mainstream and, where it does exist, can rarely claim to be comprehensive. This is hardly surprising given the complexity of the processes involved: establishing planning authority, obtaining financial support, organising the process and stakeholder consultation, defining and analysing existing and future conditions, preparing and implementing/enforcing the plan, monitoring it and evaluating its performance.

As a result, MSP faces all kinds of challenges and limitations. Perhaps the greatest of these are technical and scientific. This applies especially to the difficulties experienced in data collection and use. The task of mapping environmental characteristics and species distribution, ecosystem goods and services, ecosystem vulnerabilities, the impacts of human activities and so on, often proves hugely problematic. The circumstances are further complicated these days in cases where traditional uses (shipping, fisheries etc.) come up against new and emerging economic activities such as off-shore wind farms, mining or deep-sea oil and gas drilling operations.

MSP also faces many institutional, environmental, social and economic barriers. These can be considerable at the local and national level, where most marine spatial planning is to be found. It also has great potential to improve the management of shared marine resources at the ecosystem level and at international level. Experience is rare however with systematic marine spatial planning on a trans-boundary scale or in areas outside of national jurisdictions.

The purpose of this module is to explore how the findings from the preceding three modules, notably as concerns the future development of newly emerging ocean activities, stand to influence marine spatial planning. It will cover aspects of governance; the use of monitoring, data analysis and scenario modelling; impact assessment; and issues surrounding collaboration across institutions, sectors, disciplines and communities.

Use will be made of case studies – regional, national and international - to illustrate good or promising practice.

Module E: Charting a policy course for emerging ocean-based industries

The final module will explore and map out policy options for the development of the emerging ocean industries in order to realise their long-term potential to 2030 and beyond to foster green growth, employment and innovation with due consideration given to environmental and social factors.

The focus will be on policy ideas targeted at loosening potential constraints on and maximising opportunities in: scientific and technological advances; availability of investment, suitable business models and skills; assessment of environmental impacts; marine spatial planning; collaboration across institutions, disciplines and communities; and international co-operation in all of the above.

4. Management of the project

Design, co-ordination and implementation of the project will be carried out by the OECD's International Futures Programme in the Directorate for Science, Technology and Industry, in co-operation with other relevant specialised OECD Directorates and Agencies.

The project modules will be supported both by background papers produced by OECD specialists and external experts, and by expert workshops on individual emerging ocean industries.

Strategic guidance, technical advice and financial support will be provided by a Steering Group consisting of representatives of the institutions and organisations sponsoring the project.

The special workshops may be co-organised and co-hosted with institutions and organisations supporting the project.

5. Funding

The project will be financed by voluntary contributions from governments, agencies, research institutions, foundations and corporations.

The budget for the project is estimated at 550 000 Euros, supplemented by secondments of experts from participating organisations (to be determined).

6. Outputs

A series of briefs derived from each of the modules and the workshops associated with them; a final synthesis report; an international symposium and other events to highlight the findings of the project.

7. Project duration

18 months to 2 years

8. Provisional timetable

Work began in summer 2013. The first Steering Group meeting was held on 28 October 2013, the second is scheduled for 16 May 2014, the third will be held on 12 December 2014 and the final Steering Group meeting on 25 May 2015. Reports on the respective modules would start to come on-stream as of first quarter 2014. The final synthesis report would be produced first half of 2015, and the final symposium could be held either June or September of 2015.

www.oecd.org/sti/futures

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4th Steering Group Meeting

The Future of the Ocean Economy:
Exploring the prospects for emerging ocean industries to 2030

OECD Headquarters, Room CC7

Paris, 16 June 2015

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4th Meeting of the Steering Group

The Future of the Ocean Economy:
Exploring the prospects for emerging ocean industries to 2030

OECD Headquarters, Room CC7
Paris, 16 June 2015

Chair: Barrie Stevens
OECD International Futures Programme

Draft Agenda

09.45 **Arrival**

10.00 **1. Introduction and Welcome by the Secretariat:** Brief project progress report, objectives of the meeting, review of the agenda, brief round table introductions by participants

10.30 **2. Presentation of the progress on modelling work and the database**
Presentation by the Secretariat, followed by discussion

11.00 **3. Presentation of the key points of the workshop on Maritime Safety**
Presentation by the Secretariat, followed by discussions

11.15 **Coffee break**

11.45 **4. Presentation of the key points of the workshop on Maritime Spatial Planning and Ocean monitoring**
Presentation by the Secretariat, followed by discussions

12.00 **5. Presentation of the workshop on Deep-Sea Mining**
Presentation by the Mark Hannington, followed by discussions

12.30 **6. Presentation of the draft report on Marine Aquaculture**
Presentation by Torger Reve, followed by discussions

12.45 **Lunch (Restaurant des Nations)**

14.15 **7. Project progress to date:**
- 7.1 Update on Main Report, including timetable
- 7.2 Next workshops (Marine Tourism, Marine Biotechnology)
- 7.3 Next phase of work on the ocean economy at the OECD
- 7.4 Upcoming CSTP (Committee for Science and Technology Policy) Ministerial in Korea

16.30 **8. Next steps and concluding remarks by Chair**

17.00 **Close of meeting**

The Future of the Ocean Economy:

Exploring the prospects for emerging ocean industries to 2030

Report on the Module
"Economic modelling and data collection"

OECD Headquarters, Conference Center, Room CC7

Paris, 16 June 2015

DSTI/STP International Futures Programme

This paper is a draft for discussion at the Second Meeting of the Steering Group and is not to be circulated please.

NOTE: THIS DRAFT IS NOT TO BE CITED.

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Table of Contents

Introduction ... 4

Definitions and scope of the Ocean Economy ... 6

Methodology ... 7

Database ... 11

Limitations ... 14

Tentative schedule ... 14

References ... 15

Introduction

The purpose of this paper is to report on progress in collecting data about ocean-based economic activities with the objective to conduct modelling work for future growth projections for the ocean economy by 2030, a key module of the Future of the Ocean Economy project.

This work is important for several reasons. First, long-term growth forecasts for the ocean economy are few and far between. There have been attempts to estimate the value of the national ocean economy but these reports only consider current figures and in most cases focus on one nation only (Figure 1). There have been very few attempts to estimate global value and they refer mostly to secondary data. This leads to the second important aspect of this work. Worldwide there is no data base that collects and combines data on global and national maritime activities in a comprehensive manner. Third, this work attempts to create definitions for both the sectors and the scope of the Ocean Economy. There is still no standard definition of the "Ocean Economy", nor is there general agreement on its scope. Thus the results of different reports cannot easily be compared as different nations include somewhat different sectors. In many cases, the emerging ocean-based industries, such as ocean energy, marine biotechnology and seabed mining are not yet defined in national statistical accounts. However, the future value of the ocean-industry can only be estimated if there are current market figures.

Overview of previous studies valuing the ocean economy

Since the late 1990s a number of nations have produced ocean valuation studies: In the United Kingdom, Pugh and Skinner (2002) and Pugh (2008) examined marine related activities; Australia produced two studies as part of its National Ocean Policy, with Allen (2004) examining the economic contribution of marine based industries to the economy; France developed a national study (Kalaydijan et. al., 2009) in response to the European Commission which began work on an all embracing maritime policy; and in 2006 New Zealand conducted a study to see how the marine environment is utilized to generate economic activity. Additionally, the US National Ocean Economics Program released the State of the U.S. Ocean and Coastal Economy in June 2009.

Fig. 1: The value of the Ocean Economy by country / region

Country	Author	Date of study	Date of data	$ Ocean sectors GDP/GVA	% of GDP/ GVA	Employment
Europe	EU COM	2011	2011	€ 495 bln	-	5.6 mln
Worldwide	Hoegh-Guldberg, O et al.	2015	2011-2014	US$2.5 trillion	3.2% GDP	-
USA	J. T. Kildow et. al.	2009	2004	US $ 138bn	1.2% GDP	2,323,904
UK	David Pugh	2008	2005-2006	GB Pounds 46bn	4.2% GDP	890,416
Canada	Gardner Pinfold	2009	2006	CA $17.7 bn	1.2% GDP	171,340
France	Regis Kalaydjian et al.	2009	2007	Euro 28 bn	1.4% GDP	484,548
Germany	Federal Ministry for Economic Affairs and Energy	2011	2008	Euro 2944,7 ml*	-	26,590*
Australia	Allen Consulting Group	2004	1996-2003	Au$ 26.7 bn	3.6% GVA	253,130
New Zealand	Statistics NZ	2006	1997-2002	NZ $ 3.3 bn	2.9% GDP	21,000
Ireland	Karyn Morrissey et. al.	2010	2007	Euro 1.44 bn	1,0% GDP	17.041
China	CMIEN	2012	2011	CNY 4,557 bn	9.6% GDP	34,200,000
Japan	NRI	2009	2005	JPY 7,863 bn	1,6% GDP	981,234
South Korea	K. H. Hwang et. al.	2011	2008	KRW 13,435 bn	4.9% GDP	919,314

Source: Individual report by country and region

Note: The German study focuses only on maritime technology and ocean engineering.

However, it is difficult to compare the ocean economy among countries because the definition, classification standard and scope differ from country to country. In addition, data on the ocean economy continue to be widely dispersed and are far from homogenous.

Definitions and scope of the Ocean Economy

Internationally agreed definitions for statistical terminology on ocean-based activities do not yet exist.

We suggest the definition introduced by Park (2014): *"The ocean economy is defined as the economic activities that take place in the ocean, receive outputs from the ocean, and provide goods and services to the ocean. In other words, the ocean can be defined as the economic activities that directly or indirectly take place in the ocean, use the ocean's input, and put the goods and services into the ocean's activities. "*

In addition, the scope of the ocean economy differs considerably by country. The number of categories ranges from 6 sectors (in the case of the USA) to 33 categories (in the case of Japan). This results in different classifications and categories among countries. Also, some industries may be excluded from the ocean economy in one country and not in another.

We take up the suggestion of Park (2014) and suggest the following scope and definitions for existing and emerging ocean-based activities:

- **Shipping** – the economic activity related to the transportation of freight and passengers through the ocean. However, it doesn't include the building and repair of vessels.
- **Ports** – the economic activity related to operations and management, such as storing, loading and unloading activities. Port development and construction are also included in this sector, measuring the investment and maintenance in ports.
- **Marine tourism** – the economic activity related to new forms and destinations of ocean-related tourism and leisure activities. This includes the established cruise industry but with new destinations, such as to the Arctic and Antarctic. We also include new forms of tourism, such as underwater tourism.
- **Fisheries –** consists of the economic activity related to the production and processing of seafood. The scope of fisheries can be categorized by *capture* or aquaculture.
- **Offshore oil & gas** – the economic activity related to the exploration and production of offshore oil and gas, and includes the operation and maintenance of equipment related to this activity.
- **Renewable energy** – the economic activity related to the production of offshore wind and ocean renewable energy, such as tidal energy, wave energy, osmotic energy, and OTEC.
- **Seabed mining** – the economic activity related to the production of minerals and metals from the seabed (in the deep sea) and diamonds in estuary waters.
- **Ship building and repair** – the economic activity related to the building, repair, and maintenance of ships, boats, offshore platforms, and offshore supply vessels.
- **Marine biotechnology** – economic activity which is related to the use of living organisms as precursors for the development of medication, cosmetics, technology and energy biofuels, as well as other fields requiring bio products.

Methodology

In estimating the economic contribution of marine industries to the global economy today and by 2030, it has been necessary to identify a range of measurements that aim to help address the following questions:

- What is the direct value-added contribution of the selected maritime industry to the global GDP - today and by 2030?
- What is the number of direct jobs created in the maritime industry and for the whole ocean economy - today and by 2030?

Obtaining a measure of employment creation and economic activity is complex. There are a number of different measures, which can account for industry impacts, including production, gross value of production, gross value of revenue, value, value added, turnover and volume.

The selected key indicators for the purpose of this work and economic analysis are:

- Gross Output and/or Revenues
- Gross Domestic Product (GDP)
- Employment

Following data collection on these indicators, three different models were developed to estimate the value-added contribution of the ocean economy to GDP.

Model 1: Ratio-based method

The first model is an aggregated ratio-based model. The projection of the ocean economy is based on a projection of the percentage of ocean economy of the world GDP. It comprises a calculation of the ratio of the ocean economy to world GDP for the past years and extrapolates this ratio until 2030. This is what we call the business-as-usual scenario. It is a simple extrapolation of past growth dynamics. Alternatively, experts can be consulted to construct more sophisticated scenarios. The development of the world GDP is based on OECD long-term growth models (Duval et.al. 2009). Finally the size of the ocean economy in 2030 is based on that previous calculated ratio – however, projected until 2030.

The main assumption about the projection is that past data determine the ratio of the ocean economy to the global GDP – in the past and future. One weakness of this approach lies precisely in this assumption: As emerging ocean-based activities, such as Seabed Mining, Ocean Energy (e.g. tidal, wave, osmotic energy and OTEC) and Marine Biotechnology are not included in past figures, the extrapolation of the ratio might not be valid. However, considering different scenarios about the ratio partially offsets this weakness. A second weakness of this approach is that it does not take into consideration the specific dynamics of each sector. Last but not least, the model doesn't consider capital, labour and productivity developments – unless further assumptions are made. Consequently, this model is limited for making policy recommendations.

Nevertheless, this first model can be easily used as a benchmark for the total value of the ocean economy in the future. The plausibility of the different assumptions can be guaranteed by comparing top-down and bottom-up approaches. In sum, even though this intuitive approach does not contain detailed projections, it provides an indication of the quantitative range of possible outcomes for the ratio. In other words, it provides a good basis for conducting plausibility checks for the other models and estimates.

Model 2: Multi-sector projection approach

Model 2 increases the complexity by creating projections for each different sector. This is done with the help of a multi-sector model to construct predictions for the ocean economy for 2030. In a benchmark model a reference framework is developed. It includes multiple ocean-based industries without putting them into relation with one another. In a further extension, technology spill-over effects from one industry to another that create positive externalities, are included in a third model.

Such an approach has several advantages compared to the first model. First, the multi-sector model allows one to take into consideration specifications of each sector which in turn permits more precise and realistic projections based on expert knowledge and empirical evidence. Second, this approach allows greater flexibility in the construction of scenarios. In other words, assumptions about different future paths of each ocean-based industry allow for a more comprehensive set of possible future states of the world in 2030 compared to model 1. Last but not least, the segregated approach allows one to model interdependencies between the different ocean industries. In this vein, we focus on two (partially overlapping) types of interdependencies: intermediate products and technological spill-overs. This is motivated by the major role of technological progress that is crucial for economic growth.

Nevertheless, this approach also implies increased complexity and data intensity in comparison to model 1. Moreover, at the current stage it is not decided how the variety of scenarios for each maritime industry can be combined. For example, developing two contrasting scenarios for each industry already results in 1024 scenarios in total ($2^{10} = 1024$). One solution to solve this problem would be to consider quantiles[1] of the distribution of the projected values.

Model 2.0: Benchmark framework

In a benchmark model, a reference framework is developed. It includes multiple ocean-based industries without putting them into relation with each other. Each sectoral projection is based on a Cobb-Douglas production function. This includes constructing projections of sector-specific parameters, such as physical capital, effective labour input and total factor productivity for each industry. These projections are based on past data and qualitative arguments about their future developments. Further, these projections will be in the

[1] Quantiles are statistics that describe various subdivisions of a frequency distribution into equal proportions.

framework of previous qualitative scenarios for the global setting in 2030[2]. Already this simplified benchmark model considers possible separate future growth paths of each maritime industry. In a final step, all sector-specific output projections are aggregated in one total ocean economy figure.

Model 2.1: Intermediate products

In a first extension of the benchmark model we include intermediate products. An intermediate product is a product (or service) that needs further processing before its ultimate consumption and / or being used as an input for a further product. In other words, products or services that are developed in one sector and consequently used in another sector are incorporated in this first extension of the model. The assumption is that the growth path of a sector and its technological progress has a strong impact on the growth path of the sector that finally uses this final good. For example, the growth and technological progress in shipbuilding increases freight capacities of container ships.

For this model it is crucial to outline which industries use final and intermediate goods. For example, if one industry (e.g. marine equipment) produces an output for another ocean industry (e.g. offshore oil & gas), this should be considered as a production factor in the production function of the industry that uses the output as a final good for its operations. This is then to be computed with real world data. The main implicit assumption is that there is no stock of intermediate goods. Thus, the full output of the intermediate sectors is completely used as input for the production of final goods in one period.

Model 2.2: Technology spill over

A third model - which is a second extension of the benchmark model - includes positive technological spill-over effects from one industry to another. Technological progress is identified in the literature as the most important factor of growth and productivity. In the ratio-based model, the benchmark model of model 2, and the first extension including intermediate products, technological progress is incorporated via the total factor productivity (TFP) of each of the sectors. However, in this second extension, we increase the complexity of the model by introducing technology spill-over effects. That happens when knowledge is spread due to research & development activities in companies or governments. Typical channels for technology spill-overs are imports of technology goods, migration and foreign direct investment (Eaton and Kortum, 2002). The productivity in the different sectors and countries is influenced by the productivity of other sectors and countries. For example, the technological developments in the offshore oil & gas sector allow drilling activities in great water depths, which enhances the technological prospects of deep sea mining. These relationships should be incorporated in the scenario analysis. Based on the approach of Coe and Helpman (1995), we make a regression of the productivity in a country/sector on its own

[2] Outlines of these scenarios were developed with Steering Group Members of the Future of the Ocean Economy in a workshop in September 2014.

R&D activities and spill-overs. We differentiate between cross-country same-sector spill-overs (CCSSS) and same-country cross-sector spill-overs (SCCSS). CCSSS are technology spill-overs within the same industry in different countries. Similarly, SCCSS are spill-overs between different sectors in one country.

Model 3: A regression to the mean method

The third and last approach is to project the maritime economy based on regression analysis. In this model, we make a regression of growth figures of the maritime economy within one country and use the estimates to predict the future growth of the ocean economy. This third approach is based on the study of Summers and Pritchett (2014).

There are three main assumptions behind the model. First, the industries' growth is structurally stable. Second, past growth explains future growth, e.g. past growth values determine future growth. Third, the future growth pattern depends linearly on past values and income.

This approach also has three disadvantages. First, the model should be understood as an ad hoc approach for initial predictions rather than a benchmark for structural scenarios, since there is a structural disadvantage to this model in that it does not follow from economic theory. Another disadvantage with this approach is that future projections are based on past data. In other words, speculations and scenarios about positive external shocks (e.g. technological productivity changes) cannot explicitly be included in this model. Another disadvantage is that the model is based on a linearity assumption. It is therefore not flexible enough to incorporate non-linear trends.

Nevertheless, the regression approach also has several advantages. First, it seems to work well for GDP growth forecasts. Second, it allows for confidence bounds, thereby permitting the construction of best-case and worst-case scenarios that are neutral and independent of individual scenario construction. It also allows one to verify the plausibility of the produced prediction by predicting past growth.

Regarding the benefits and limitations of this model, it is used as a tool to conduct plausibility checks for the more complex structural models, such as model 2.

Database

A wide diversity of organisations provide economic data on ocean-based activities. They include public organisations (e.g. European Commission), international organisations (e.g. OECD), industry associations (e.g. Shipbuilding Association Europe), consulting firms (e.g. Douglas Westwood), banks (e.g. Deutsche Bank) and research institutions.

Below is a list of the key components of our data collection as of May 2015.

Sectors	Categories		Data source
Shipbuilding & Repair & Equipment manufacturing	Ship & boat building	• Global vessel price and values in $ (2008-2014) • New order of producer countries (2012-2017) • Global investments in new buildings in $ • Deliveries and production levels by country and region IN GT and DWT (2011-2014) • Projected demand in the future (2015-2022) • Order book by countries and regions (2000-2013) • World fleet age by distribution by vessel type (1980-2014) • National ownership by nation (2014) • Average demolition (2009-2014) • Value-added of building of ships and boats	CESA Market monitoring report, UNCTAD, Koshipa, IHS Fairplay, BTM Consult, Clarkson Research, Eurostat, OECD, SEA Europe, Douglas Westwood
	Offshore platform & offshore supply vessel building	• Global total supply vessel production (1970-2014) • Global supply vessel demand projection (2013-2025)	Douglas Westwood
	Marine equipment manufacturing	• Global demand for marine supplies in $ (Average between 2013-2017) • Production marine supplies in Europe (Average between 2006-2010)	EU COM, Ecorys
Shipping	Freight transportation	• Global volume by cargo in tonnes and tonnes/mile (1970-2013) • Container volume in TEU (2002-2013) • Freight rates in $/tonnes (2011-2013) and in $/TEU (2002-2013) • …	UNCTAD, OECD STAN, Lloyds, Eurostat, Dewrey Research,
Ports		• Container throughput (globally and selected ports)	UNCTAD, Lloyds, Individual port websites, Eurostat

		in TEU (2008-2011) • Port charges = Terminal handling charges (in 2015) (of 50 major ports) • Port infrastructure investment (1995-2011) • Port infrastructure maintenance (1995-2011) • …	
Fisheries	Catches	• Catches / landings in tonnes (OECD countries: 1995-2013), (World regions: 2000-2012), (Europe: 2004-2013), (Overseas: 2002-2011) • Future catches projections (2015-2023) • Employment in OECD countries (1999-2013) • Future price projections (until 2023) • ..	OECD, FAO, Eurostat
	Aquaculture	• Production in tonnes (Global total: 2000-2011), (OECD countries: 1995-2013), (Developing countries : 1990-2012) • Global production in tonnes forecast (2014-2023) • Global production total value in $ (2000-2012) • ..	OECD, FAO, Eurostat
	Combined production	• Global fish production in tonnes and EUR (1995-2012) • Projected total global fish production in tonnes (2012-2024) • Gross-value add of total global production in EUR (2004-2011) • Future price projections for fish (2015-2024) • Employment for selected OECD countries (2000-1011)	OECD, FAO, Eurostat
Offshore Oil & Gas		• Global total offshore exploration & production (2009-2020)	Douglas Westwood, Deutsche Bank
Renewable Energy		• Offshore wind capacity installed in Europe in MW (2013-2022) • Offshore wind electricity production in Europe and selected regions in MW (2011-2020) • Offshore wind investments in EUR (selected regions) • Current global capacity	GWEC, EWEA, BTM Consult, IEA

		installed by country • Projected installed capacity in GW in selected regions (2020, 2030) • Employment globally and selected regions (2020, 2030) • Global total investment needed in $ (2011-2050) • …	
Marine Mining		• Operation & Capital costs of the first worldwide deep-sea mining site • Market prices for metals per tonne (2013/2014 values) • Estimates for worldwide underwater mineral and metal resources (2014 estimate)	Nautilus Company, London Stock Exchange, Eurostat
Marine biotechnology		• Financial performance of European companies (2013) • Revenues & R& D spending on EU-level and national scale (2011-2012) • Number of employees in Europe (2011-2012) • …	EU COM
Marine Tourism		• Total global passengers (globally, regions, nations, Europe) • Average port calls per passenger (2009, 2013) • Average expenditures per passenger per port call in $ (for North & Central America) (in 2013) • Total global total employment (globally and regionally) (in 2013) • …	BREA, Deloitte, CAGR

Limitations

Nevertheless, it is difficult to obtain relevant data since only very few data are published and accessible by the public. Not every nation collects and reports detailed data on maritime-activities. Sometimes double-counting can be an issue when adding national accounts: one sector's output can be another sector's input (for examples, fish harvesting output can be an input for fish processing).

However, by building up a database and by calculating the output/revenue by ourselves, we hope to be able to address at least some of these problems.

At the current state of the work, the data series as currently constructed need continuous expansion to better reflect the realities of a complex and dynamic economic system coupled with equally complex and dynamic marine ecosystems.

Tentative schedule

- June:
  - Components of the ocean economy, definitions, scope, other methodologies/ approaches, indicators
- July/August:·
  - Gaps in the data base must be filled as far as possible
  - Quantitative scenarios and projections for each industry
  - Conclude and summaries different quantitative projections
- September/October:
  - WORKING PAPER: (1) Economic models, (2) Results of calculations and projections
- November:·
  - First final draft of entire report

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