出國報告書（出國類別：雙邊會議）

赴美出席「氣候變遷調適夥伴合作」會議

服務機關：行政院環境保護署

姓名職稱：簡慧貞 參事兼執行秘書

派赴國家：美國

出國期間：民國 **105** 年 **4** 月 **9** 日至 **4** 月 **19** 日

摘要

本次出國行程主要是係延續過去兩年（民國 103 及 104 年）推動氣候變遷調適夥伴倡議的成果，赴美出席「氣候變遷調適夥伴合作」會議，與美國環保署（United States Environmental Protection Agency, USEPA）、美國國家海洋暨大氣總署（National Oceanic and Atmospheric Administration, NOAA）氣候計畫辦公室（Climate Program Office, CPO）等單位舉辦雙邊會議，進行氣候變遷調適業務交流，分享臺美雙方氣候變遷合作成果；我方並分享在「泛太平洋氣候變遷調適夥伴」的實質推動成效，並介紹我國通過的溫室氣體減量及管理法，就調適業務規範及我國國家調適政策綱領目前進度提出說明。美方並肯定我方在推動泛太平洋氣候調適夥伴計畫所做的努力，建議我國可參加亞太調適網絡（Asia Pacific Adaptation Network, APAN）及韓國舉辦城市清淨空氣夥伴（Cities Clean Air Partnership, CCAP）會議，希望透過臺美雙方氣候變遷調適領域之相關業務交流，共同發展與執行合作方案/計畫，提供面對氣候變遷的最佳實務與作法，精進我國氣候變遷調適能力，共同提升亞洲區域夥伴氣候變遷調適的能力。

在本次行程中亦安排拜會世界銀行（World Bank），雙方就氣候減緩方面進行意見交換，並就世界銀行於西元 2010 年建立之「市場準備夥伴計畫」（Partnership for Market Readiness, PMR）進行交流，探討我國以技術夥伴加入之可行性；另與美國麻省理工學院（ Massachusetts Institute of Technology, MIT）氣候合作實驗室（Climate CoLab）洽談後續雙方合作事務，開展氣候變遷調適活動，促進亞太地區氣候變遷調適夥伴關係及開創氣候新發想。參訪美國氣候中心（Climate Central），了解氣候科普資訊及前瞻作法，對於我國氣候變遷調適宣傳和提升知識的認知交換經驗，對於推動本署氣候變遷調適業務與國際接軌之契機，極有助益。

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壹、 背景說明及目的

為展現積極推動區域性國際環境合作之意願，於西元 2014（下同）年提倡泛太平洋氣候變遷調適夥伴（Pan Pacific Adaptation on Climate Change, PPACC），促進泛太平洋地區小島國家與低度開發國家間氣候變遷調適合作關係，建立調適夥伴網絡，於 2014、2015 年與美國環保署透過國際環境夥伴（International Environmental Partnership, IEP，以下簡稱 IEP）計畫共同辦理兩次泛太平洋氣候變遷調適國際研討會，與美國環保署（United States Environmental Protection Agency, USEPA ，以下簡稱 USEPA）、美國海洋暨大氣總署（National Oceanic and Atmospheric Administration, NOAA，以下簡稱 NOAA）、美國美國麻省理工學院（Massachusetts Institute of Technology, MIT ，以下簡稱 MIT）氣候合作實驗室（Climate CoLab）、太平洋島國、東北亞、東南亞、南亞等國外專家和政府官員，共同擘劃具體的氣候夥伴合作模式與平臺。

延續兩年氣候變遷調適夥伴倡議的成果，本次行程主要安排與美國環保署、美國 NOAA 氣候計畫辦公室（Climate Program Office, CPO）舉辦雙邊會議，談後續合作發展細節，開展氣候變遷調適事務合作事宜，以及與美國 MIT 氣候合作實驗室（Climate CoLab），談後續合作事務細節，開展氣候變遷調適活動，促進亞太地區氣候變遷調適夥伴關係及開創氣候新發想。另外，參訪氣候中心（Climate Central），了解氣候科普資訊及前瞻作法，有助於加強氣候變遷調適宣傳和提升知識的認知。藉由參與本行程參訪及交流，了解國際對氣候變遷及相關風險資訊之應用與作法，掌握美國國家因應氣候變遷現況、氣候變遷調適資訊和前瞻作法，了解美國氣候變遷調適策略及推動現況，有助益精進我國因應氣候變遷的調適能力與經驗，並且更進一步提升臺灣與美國雙方氣候變遷調適事務及國際合作關係，以建立氣候變遷調適夥伴合作平臺，共同促進亞太地區氣候變遷夥伴關係，對於推動本署氣候變遷調適業務與國際接軌之契機，極有助益。

另外，在氣候減緩方面，則將就世界銀行（World Bank）於 2010 年建立之「市場準備夥伴計畫」（Partnership for Market Readiness, PMR，以下簡稱 PMR）做交流，討論我國以技術夥伴加入之可行性，透過技術交流和創新合作創造低碳環境，強化與國際連結。

貳、 交流過程及內容

一、出國行程

本次出國行程是安排與 USEPA、NOAA、MIT 氣候合作實驗室（Climate CoLab）、氣候中心（Climate Central）等單位，對於氣候變遷調適相關業務進行交流，並洽談後續合作發展細節，開展氣候變遷調適業務，相關行程如下表所示。

表 1 本次行程

日期	地點	工作內容
4 月 9 日（六） 4 月 10 日（日）	桃園→華盛頓特區	啟程。
4 月 11 日（一）	華盛頓特區	1. 與 National Oceanic and Atmospheric Administration （NOAA）氣候計畫辦公室舉辦雙邊會議，就 Climate Resilience Toolkit（CRT）回復力/韌性工具部分，學習氣候工具包使用方法及評估技術等細節。
4 月 12 日（二）	華盛頓特區	1. 與美國環保署舉辦雙邊會議，了解美國環保署對 Climate Resilience Toolkit （CRT）回復力/韌性工具之推動現況和區域性碳交易市場議題交流，學習韌性和推動碳市場之運作方式。 2. 拜會美國環保署國際事務辦公室代理助理署長西田（Jane Nishida）女士，分享歷次氣候變遷調適國際研討會成果，並邀請參加研討會以分享韌性城市案例。
4 月 13 日（三）	華盛頓特區	1. 上午 10:00am，與世界銀行（World Bank）針對韌性城市與 Partnership for Market Readiness（PMR）議題進行雙邊會談。 2. 下午拜訪駐美國台北經濟文化代表處（TECRO）公使。
4 月 14 日（四）	普林斯頓、波士頓	前往美國氣候中心（Climate Central）就氣候變遷及群眾溝通議題進行討論，了解其在氣候變遷宣傳的角色。

日期	地點	工作內容
4 月 15 日（五）	波士頓、紐約	與美國麻省理工學院（MIT）亞洲氣候競賽活動後續作業事宜。
4 月 16 日（六）	華盛頓特區	會議紀錄彙整 & 工作討論。
4 月 17 日（日）	紐約	前往紐約機場。
4 月 18 日（一） 4 月 19 日（二）	紐約	搭機返臺。

二、本次出國交流概述及成果

本次行程主要是赴美出席「氣候變遷調適夥伴合作」會議，並與 USEPA、OSTP 副主任、NOAA、MIT 氣候合作實驗室（Climate CoLab）、美國氣候中心（Climate Central）等單位進行氣候變遷調適業務交流，以及世界銀行（World Bank）進行氣候變遷減緩業務交流，分享過去兩年推動氣候變遷調適夥伴成果及未來規劃，以及瞭解美國對於氣候變遷的研究和資訊的應用與國際資訊交流互動的方式，掌握美國國家因應氣候變遷現況、氣候變遷調適資訊和前瞻作法，瞭解美國氣候變遷調適策略及推動現況，以增進我國因應氣候變遷的調適能力與經驗。

與 NOAA 會談，則由其氣候計畫辦公室（CPO）主任 Dr. Wayne Higgins 與我方主談，分享過去兩年臺美氣候變遷合作成果（如附件一），近年藉由舉辦國際研討會，凝聚氣候夥伴共識，已具初步合作共識，並於法國巴黎氣候會議 COP21 期間共同宣布推動夥伴關係，與成員國家建立良好互動，對於推動「泛太平洋氣候變遷調適夥伴」有相當的實質成效；另我國已於 104 年 7 月 1 日公布溫室氣體減量及管理法（以下簡稱溫管法），本次會議亦就調適業務規範及我國國家調適政策綱領進行分享，而 Dr. Higgins 非常肯定臺美在氣候變遷領域過去兩年的成效，尤其臺灣在推動泛太平洋區域合作的努力，美方將持續支持與合作，尤其美國在氣候變遷領域上，為跨領域的整合發展，非常樂意與臺灣深化發展關係，建議可先在臺美 IEP 架構下進行合作計畫。

與美國環保署代理助理署長西田（Jane Nishida）女士與進行會談，在本次會談中分享過去兩年臺美雙方藉由國際環境夥伴計畫（IEP）對於氣候變遷合作成果，透過國際研討會與成員國家建立良好互動，凝聚氣候夥伴共識，

期能促成合作計畫及協議的產生，另雙方並就我國國家調適政策推動情形進行交流。USEPA Nishida 女士非常肯定我國在推動泛太平洋氣候調適夥伴的計畫，願意與我國分享有關國家調適計畫之制定與執行經驗，建議我方可嘗試參與美日亞太調適網絡(Asia Pacific Adaptation Network, APAN)合作計畫、斯里蘭卡舉辦的氣候調適國際會議及城市清淨空氣夥伴（Cities Clean Air Partnership, CCAP）會議，彰顯於 IEP 下達成的貢獻，擴展國際合作事務，增加國際能見度。而對於與 NOAA 在 IEP 之架構下進行合作，後續可另外安排時間討論。

在美國世界銀行交流方面，本次行程中安排與 PMR 經理會面，雙方就氣候變遷與碳市場領域進行交流，分享國際重要資訊。

MIT 氣候合作實驗室（Climate CoLab）會談，雙方就後續合作細節進行討論，將調整亞太氣候合作競賽方式。而美國氣候中心（Climate Central）拜會中，雙方就未來合作機制進行初步討論，並邀請美國氣候中心參加泛太平洋氣候變遷調適國際研討會，建立合作共識，尋求合作之可行性。

參、 雙邊交流紀要

一、 美國國家海洋暨大氣總署（**NOAA**）

(一) 組織介紹

美國國家海洋暨大氣總署（National Oceanic and Atmospheric Administration, NOAA）是隸屬於美國商務部的科技部門，主要關注地球的大氣和海洋變化，提供對災害天氣的預警，提供海圖和空圖，管理對海洋和沿海資源的利用和保護，研究如何改善對環境的瞭解和防護，其組織架構圖如圖 1 所示。NOAA 設立氣候計畫辦公室（Climate Program Office, CPO）發展和維持全球實地氣候觀測系統，從海洋底部到大氣層頂部監測地球氣候變化，而並產生的數據和知識為全球性氣候訊息，目前 CPO 辦公室主任為 Dr. Wayne Higgins，其組織架構如圖 2 所示，分為五個主要部門，辦公室人員共 66 位，而主要目標如下所述：

1. 合作夥伴（Partnership）：促進夥伴關係，建立在雙方的優勢及興趣，發展 CPO 工作的價值及影響。
2. 整合氣候研究（Integrated Climate Research）：實現充分整合研究計畫以發展氣候科普、監測、模擬和預測，以及其影響實現有效的決策。
3. 人物與文化（People & culture）：賦予人們和自身在組織的角色具備技能及能力因應不斷改變的需求及條件。
4. 商業模式（Business processes）：採用 CPO 公共建設、管理範例和商業模式，維持高執行力並提供企劃、產品及服務。

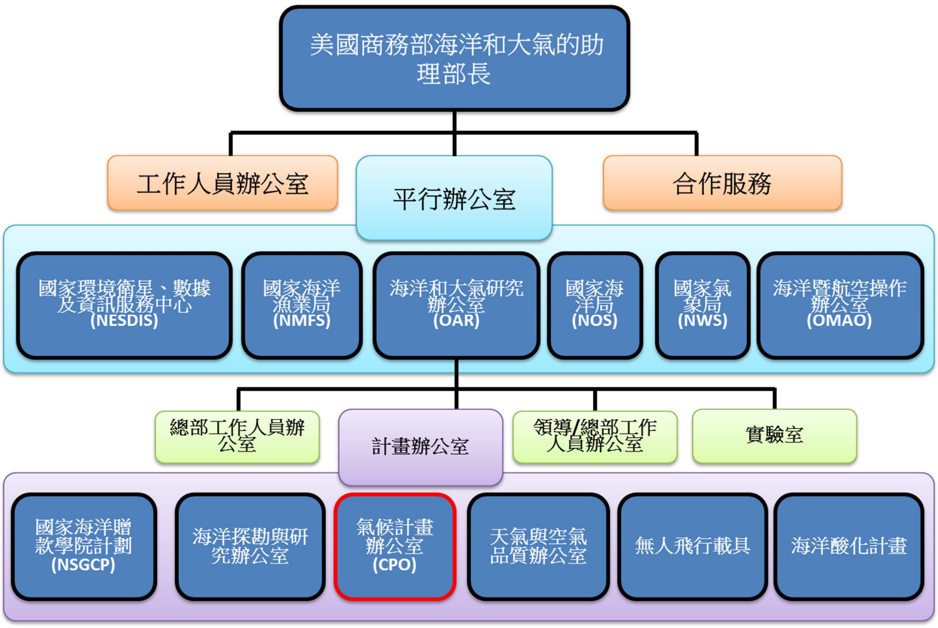


圖 1. National Oceanic and Atmospheric Administration（NOAA）組織架構

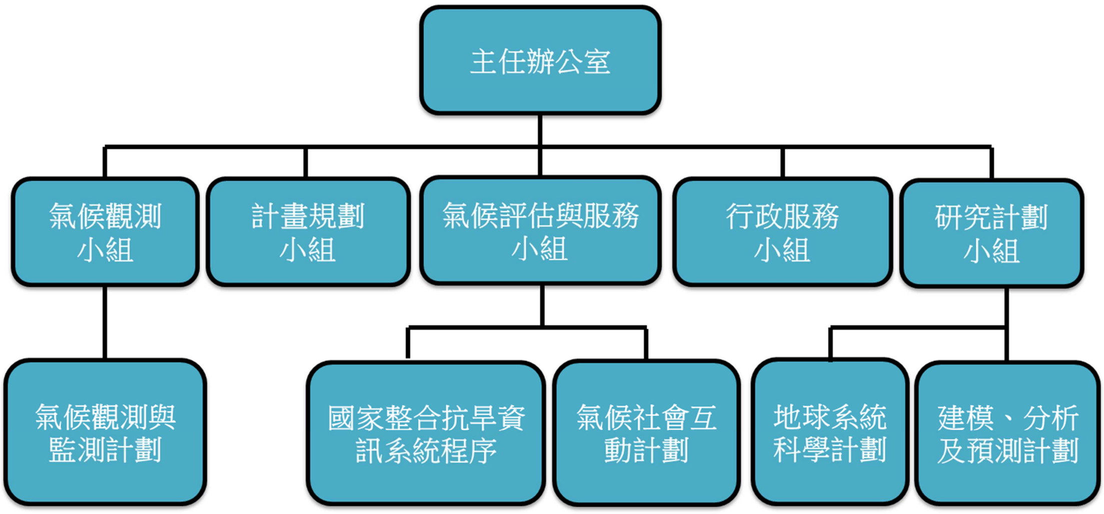


圖 2. National Oceanic and Atmospheric Administration（NOAA）
氣候計畫辦公室（Climate Program Office）組織架構

(二) 會談重點成果

1. 本次會談係延續過去兩年民國 103 及 104 年辦理氣候變遷調適夥伴的推動成果，洽談未來可能之合作計畫，其中針對氣候變遷調適業務，NOAA 表達高度合作意願，除派人參與我國泛太平洋氣候調適會議外，期望未來能有積極合作的計畫，本次會議主要討論重點為討論過去兩年的成效，擬定未來三年的工作計畫。（會議之英文共同結論初稿如附件三）

2. 會議首先由 NOAA 的氣候計畫辦公室（Climate Program Office, CPO）主任 Dr. Wayne Higgins 與我方進行雙邊會談，雙方將以氣候變遷韌性工具包（Climate Resilient Toolkits）、氣候變遷與健康、海岸韌性等三項議題進行合作交流，後續並將由美方各領域專家與我方專家分別會談。

3. 我方針對過去兩年臺美氣候變遷合作議題上進行成果說明，過去 2 年來共有 13 個國家參與我方舉辦的 2 次國際研討會，並於法國巴黎氣候會議 COP21 期間辦理宣傳活動，與成員國家建立良好互動關係，對於推動「泛太平洋氣候變遷調適夥伴」有實質的成效。另我國於民國 104 年 7 月 1 日公布溫管法，就我國調適政策推動現況進行分享，希望可以將美國已發展的評估工具進行交流。另由於島嶼國家所面臨的氣候變遷衝擊與大陸型國家有諸多差異。冀能透過雙方調適領域合作，如人員訓練、資訊交流及共同執行合作方案/計畫，提供彼此面對氣候變遷的最佳實務經驗與作法，進一步共同提升亞洲區域夥伴氣候變遷調適的能力。（簡報如附件一）

4. Dr. Wayne Higgins 非常肯定臺美在氣候變遷領域過去兩年的成效，尤其我國在推動泛太平洋區域合作的努力，美方將持續支持與合作。而美國在氣候變遷領域上，為跨領域的整合發展，而 NOAA 配合美國商業部，主要負責科學與政策工具的支援，也期待未來先在 IEP 架構下進行合作計畫，期望能持續推動與我國在氣候變遷相關議題之合作關係。

5. Dr. Wayne Higgins 提出可派美方專家團隊到臺灣，與本署就後續之推動計畫評估與規劃，並洽商本署規劃於十月舉辦的氣候變遷調適國際研討會。此外，雙方也可透過視訊會議等方式，擴大美方專家與我方商議的內容。

6. 美方分享由美國白宮科學顧問及環保署長在 4 月 4 日於白宮發布的「美國氣候變遷對人類健康的衝擊科學評估報告」(The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment)。其中 USEPA 主要任務是支援報告撰寫與分工，並統籌美國國家氣候調適團隊 (United States Global Change Research Program, USGCRP)，而 NOAA 則統整科學與評估報告內容。這份評估報告計有 13 個部會共同進行，獲得國際高度迴響，是近年度針對民眾因應氣候變遷健康及國家政策調適的政策藍圖典範之一。

7. 我方由本署代表及衛福部駐美組長盧道揚醫師，分享我國環境衝擊與疾病近期相關議題，如二氧化碳大量排放造成的細懸浮微粒 $PM_{2.5}$ 空氣污染，以及高溫導致傳播加速的登革熱疫情。另分享我國在氣候變遷與健康政策遇到的挑戰，如公共意識的提升與公眾觀點的促發、醫學或學術研究資料的傳遞與公開，以及政府間的跨部會合作。

8. NOAA 分享如何在的政府部會間凝聚共識，以及公眾認知到氣候變遷與健康之間的重要關係，在氣候變遷與健康議題的國際合作經驗，NOAA 協助印度、澳洲與英國等預測高溫工作，並以印度和南亞國家關注高溫為例，其表示這些國家透過國內研究機構進行跨國合作，累積多年的溫度觀測資料、進行氣候預報，其合作模式可提供我國參考。

(三) 交流照片：

圖 3. 與 National Oceanic and Atmospheric Administration (NOAA) 氣候計畫辦公室 (Climate Program Office) 進行雙邊會議

圖 4. 與 National Oceanic and Atmospheric Administration（NOAA）
氣候計畫辦公室人員合影-1

圖 5. 與 National Oceanic and Atmospheric Administration（NOAA）
氣候計畫辦公室人員合影-2

圖 6. 與 National Oceanic and Atmospheric Administration（NOAA）
氣候計畫辦公室人員合影-3

二、 美國環保署國際事務辦公室代理助理署長 **Jane Nishida** 女士

(一) 組織介紹

美國國家環境保護署（United States Environmental Protection Agency, USEPA）是美國聯邦政府的一個獨立行政機構，主要負責維護自然環境和保護人類健康不受環境危害影響。USEPA 由美國總統尼克森提議設立，在獲國會批准後於 1970 年 12 月 2 日成立並開始運行。在環保署成立之前，聯邦政府沒有組織機構可以共同合協地對付危害人體健康及破壞環境的污染物問題。環保署署長由美國總統認命，直接向美國白宮問責。USEPA 不在內閣之列，但於內閣各部門同級，現任署長為吉娜·麥肯錫（Gina McCarthy）。EPA 現有大約 18,000 名全職雇員，其組織架構（如圖 3 所示）包括華盛頓總署、10 個區域分署、和超過 17 個研究實驗所。USEPA 的具體職責包括，根據國會頒布的環境法律制定和執行環境法規，從事或贊助環境研究及環保項目，加強環境教育以培養公眾的環保意識和責任感。

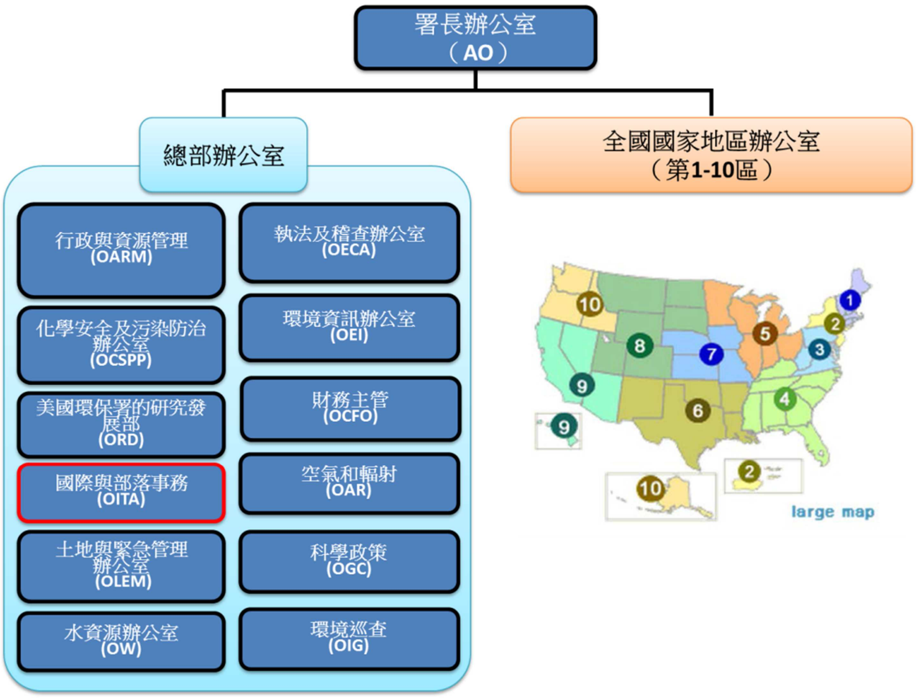


圖 7. 美國環保署（United States Environmental Protection Agency）組織架構

(二) 會談重點成果

1. 我方分享我國國家調適計畫與制定範疇（簡報如附件五），其涵蓋層面包含災難預防、水資源使用、公共建設、國土規劃、能源供應、至農業

與健康議題。另 2015 年我國溫管法通過，業正式確立環保署成為國家調適及減緩計畫之主責機關。USEPA 日前公告的「氣候變遷與健康報告」，將可做為我國施政規劃之重要參考依據。

2. USEPA 願意與我國分享有關國家調適計畫之制定與執行經驗。為提高執行效益，建議可就我國與美國國家調適計畫之內涵及差異出發，並可透過視訊或電話會議方式，持續進行討論會晤。

3. USEPA 於 2016 年 3 月與日本代表探討美日雙方在亞太調適網絡（Asia Pacific Adaptation Network, APAN）所扮演的角色。其中，USEPA 主要與日本交換實務應用層面資訊及相關計畫議題，其中包括 20 個高度發展城市領航計畫（20 Developed City Pilot Program）、亞洲空氣清淨計畫（Clean Air Asia），與其他城市級之計畫。建議本署可嘗試參與上述計畫。

4. Nishida 代理助理署長非常肯定雙方在推動泛太平洋氣候調適夥伴的計畫，並建議我國參加今年十月參與由聯合國環境規劃署（UNEP）支持的亞太調適網絡（Asia Pacific Adaptation Network, APAN）於斯里蘭卡舉辦的氣候調適會議，其屬大型國際會議，由亞洲開發銀行所支持，涵蓋地區包含了大部分亞太國家，建議我方可努力加入 APAN 組織，擴展國際合作事務。

5. Nishida 代理助理署長並表示今年 8 月將在韓國釜山舉辦清淨空氣（Cities Clean Air Partnership, CCAP）會議，有鑑於我方和韓國大學的良好關係，建議屆時我國應彰顯於 IEP 下達成的貢獻，創造共同利益，並可考量強化在氣候變遷調適議題上，尤其是中央政府與地方政府的合作面向。

6. 我方表示，NOAA 專家預計於 6 月底來臺展開為期一周的工作會議，雙方將就建置氣候韌性工具、健康衛生、海岸調適及國家調適計畫等議題進行深度討論。就此議題 USEPA 表示，可視工作範圍及其介入的程度，再評估後續是否再簽署新的協議，未來雙方可再擇期討論。

(四) 交流照片：

圖 8. 與美國環保署國際事務辦公室代理助理署長 Jane Nishida 女士合影

圖 9. 與美國環保署會談現況-1

圖 10. 與美國環保署會談現況-2

三、 世界銀行（**World Bank**）

(一) 組織介紹

世界銀行為發展中國家資本項目提供貸款的聯合國系統國際金融機構，主要由兩個機構組成：國際復興開發銀行(The International Bank for Reconstruction and Development, IBRD)與國際開發協會(International Development Association, IDA)，成員超過 100 個國家，而世界銀行的官方目標為消除貧困。

在氣候變遷議題上，世界銀行提供財務、政策與技術上的支援，針對衛生、供水、能源、工業、貿易、農林、災害管理等，協助開發中國家緩解或適應氣候變遷的劇烈影響，包括創新的財務融資（氣候投資基金、森林碳夥伴基金）和優惠、綠能技術開發與政策建議，而且網站上可找到相關支援計劃與研究報告，以及全球各國經濟發展和碳排放的指標圖表數據。

近年來由於氣候變遷，各國對於溫室氣體減緩開始有積極的作為，各國開始紛紛思考尋找最具成本效益的方式，藉以解決目前全球所共同面臨的困境，其中透過市場機制方式可被視為最創新且具成本效益的方式，不僅可以有效減緩溫室氣體的排放，也可提升資金的流動。

1. 「市場準備夥伴計畫」（Partnership for Market Readiness, PMR）背景介紹

世界銀行在 2010 年 12 月建立了已提供資金和技術協助的 PMR，來支持和推廣碳市場機制；其透過資金的援助、技術協助，幫助已開發國家和開發中國家建立起合作的橋梁，提供包含排放交易機制、碳稅、新額度機制等能力建構的援助，透過技術交流和創新合作創造低碳環境。

PMR 主要的四個核心目標為：

(1) 對於準備就緒的市場提供補助資金：如市場機制下的溫室氣體登錄、量測、報告和查證系統，數據收集與管理工具，和監管架構等。

(2) 試行和測試創新的市場工具，如國內排放交易機制或新的抵換額度機制。

(3) 提供技術討論與知識創造平台。

(4) 分享經驗教育與最佳做法。PMR 的目標是幫助國家事先準備以施行市場為基礎的政策措施，雖然並非所有國家已決定其採行之政策

措施，但預備夥伴國家在 PMR 協助下可以增進其市場預備的能力建置，不論預備夥伴國家最終是否施行以市場為基礎的政策措施，參與市場預備夥伴是有益無害。

2. PMR 技術工作計畫（PMR Technical Work Program）

履行參與國提出市場預備計畫，以作為發展市場預備的能力，以及設計市場機制的手段，包含試點的計畫，透過市場預備計畫的過程，履行參與國可以界定出在技術及制度能力上的落差與需求，PMR 技術工作計畫著重於履行參與國所共同需求並提供完整性的協助，此計畫之設計在於經驗知識分享，加強實際應用及建置可行的國家機制。技術工作計畫包含下列範疇：設施層級的溫室氣體可量測、可報告及可查驗（Measuring, Report and Verification, MRV）數據管理、註冊與追蹤工具、基線的設立、抵換標準、碳價的模型建置。PMR 技術工作計畫是由三個工作小組組成，分別為

(1) 基線團隊（Baselines Working Group）：設立目的是為促進市場機制的發展，專注於額度機制的額度基線設立。

(2) MRV 團隊（MRV Working Group）：由 PMR 參與國家以及對推薦給 PMR 秘書處的專家所組成，主要工作範疇為提 PMR 供秘書處 MRV 相關工作上的建議，提供 PMR 知識的意見與回饋。

(3) 抵換團隊（Offsets Working Group）：由 PMR 的成員國、抵換標準設立組織以及 PMR 的專家團隊所組成，目的在為對抵換計畫的設計、發展與實行等基本要素需要進一步了解的履行參與國建立一個知識與資訊交流平台，透過次平台可以發表、學習與討論其他抵換計畫的經驗，以達到在抵換計畫的設計於實行上更可靠、一致與全面性的成果。

(二) 會談重點成果

1. 我國希望能和市場預備夥伴（PMR）進行技術方面的交流合作，PMR 對我國在減量上取的進展表示祝賀，也表示希望能知道更多有關實際減量、轉型至清淨能源的措施與作法。

2. PMR 目前共協助 17 個國家進行減緩的準備工作，項下共有三個計畫：國家、技術、政策工作，但由於資源有限，目前沒有加入新國家的規劃，建議可以與 PMR 資助的的國家合作，參與會議並進行

技術交流。

3. 我方分享我國在去年提出之 INDC（如附件六），在能源需求面主要策略以提高能源使用效率為優先，而在能源需求面則以優化調整能源組合為核心策略，惟為達成減碳目標，市場工具亦是相當重要的一環。

4. 為順利達成減量目標，環保署希冀藉由國際會議交流，精進國家相關政策執行，如 MRV 制度與碳交易市場之相互發展。鑑此，除持續積極參與相關會議外，亦藉由交流會舉辦，交換重要經驗。

5. 世界銀行代表表示，我國業於 2015 年完成氣候變遷專法立法工作，為完成減量目標，碳定價為重要的政策工具之一，為提供政府與民間企業建立雙方之溝通平台，以執行相關減碳政策，聯合國氣候高峰會已建置 CPLC（Carbon Pricing Leadership Coalition）平台，以利各機構共同探討，建議我方可以積極爭取參與該組織。

6. 碳價仰賴碳市場的連結，與政策工具亦有相當之關聯，因為我國的碳交易市場相對是個小型市場，較不具有流動性，因此未來勢必將與其他市場進行連結，未來若可連結到其他的碳交易市場，將有助於提升國內碳交易流動性，並確保價格的穩定性。連結其他碳交易市場亦可以提供具有減碳責任的公司有更多選擇，可以降低減碳的成本(有較大彈性取得成本較低的選擇)。

(三)　交流照片：

圖 11. 與世界銀行 Partnership for Market Readiness（PMR）會談現況-1

圖 12. 與世界銀行 Partnership for Market Readiness（PMR）會談現況-2

圖 13. 與世界銀行 Partnership for Market Readiness（PMR）合影

四、 MIT 氣候合作實驗室（Climate CoLab）

(一) 組織介紹

美國麻省理工學院氣候合作實驗室（MIT Climate CoLab，以下簡稱 MIT CC）為麻省理工學院程式研究與規劃部門（Department of Urban Studies and Planning，簡稱 DUSP）中的核心計畫之產物，MIT CC 利用知識達成深化公民參與、提高社會實踐程度、政策宣傳與資源共享，利用群眾智慧驅策達成創新目標，並提供實踐社會正義之舞台，實際達成低碳韌性城市建設。

MIT CC 成員來自複數群體，包含教師、校友、學者、公民組織、政府官員及其他不斷增長的合作夥伴，除此之外，透過在學學生加入團隊並成為重要的創新參與者，使 MIT 與公民組織間知識與資源的交流更為便利。其主要工作為與 MIT 的在學學生、教師與員工合作，並利用 MIT 之技術資源將下列願景與使命付諸實踐：

1. 行動：透過群眾參與及資源共享，發展實踐永續性的低碳韌性都市操作模型。
2. 想法：透過公民合作與共同創立理論等群眾參與、發展與社會革新等機制，孕育出關於永續低碳城市等相關知識，並培育相關計畫幹部擁有具備引領創新與處理問題的能力與技巧。

MIT CC 建置網路交流平臺，透過減碳或氣候變遷調適相關網路活動，讓參加者提出活動企劃案，並藉由網絡平臺讓世界各地不同的民眾進行討論及提出評論，於活動最後經由評審經過篩選後，再由專家與公眾評選，選出具可行性的企劃案，後續可與潛在的執行者合作，以達成具體實現企劃的目標。企劃案涉及的領域主要為能源、溫室氣體、碳管理、交通、建築、廢棄物、農業、氣候調適與公民參與等議題，不局限於硬體設施或政策機制的制定，也可以藉由宣導改善公眾對於能源使用之態度以達成減碳目標，而企劃案的實行範圍不限，也可以是單一城市、社區、或是國家、區域皆可。

(二) 會談重點成果

我國環保署與 MIT 已有合作意願，雙方將藉由 MIT CC 推展氣候變遷調適競賽方式進行合作，本次行程安排與 MIT CC 主要負責人 Ms. Laur Hesse Fisher 計畫經理進行會談，雙方就未來合作的計畫進行細部內容討論，國際環境夥伴計畫（IEP）計畫經理 Justin Harris 並以電話會議方式參與討論，對於亞太氣候合作競賽方式，將配合整體規劃進行調整。

(三)　交流照片：

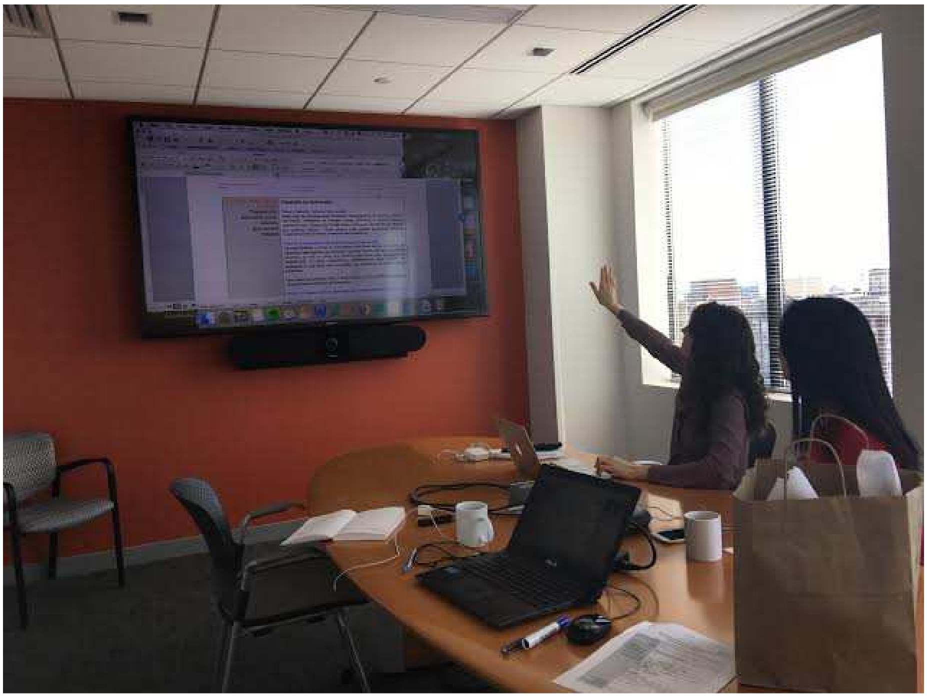


圖 14. 與美國 MIT Climate CoLab 計畫經理 Ms. Laur Fisher 會談現況

五、 美國氣候中心（**Climate Central**）

(一) 組織介紹

於 2005 年 10 月由耶魯森林與環境學校與上百名科家、政策規畫者、記者、商界代表、宗教與民間團體，所提出的倡議，並在 2008 年由 Flora 家族基金會與 11TH HOUR PROJECT 贊助下成立氣候中心（Climate Central）國際組織，係為公共慈善非營利機構，總部設立於紐澤西州。

Climate Central 由眾多科學家與記者組成，其主要任務在研究氣候變遷的科學事實，並向美國民眾與決策者提出報告，企圖由公民知識教育落實全民減碳，達成低碳城市之目標，並與國內外研究機構合作，交流研究成果與技術；另因群眾為落實低碳韌性城市之關鍵因素，故該機構並設立專門部門定期評估與檢討訊息傳播效率，提供永續與低碳排放技術分享平臺，借助專業科技達成永續低碳生活。

1. 核心價值

(1) 科學誠信：報告科學事實，即便是與主流有落差。

(2) 公眾傳達的重要性：盡可能廣泛傳遞科學事實給公眾，並支持公正公開的議題辯論，因為群眾為低碳韌性城市落實之關鍵。

(3) 溝通效率：尖端的科學與溝通的創新組合定義為方法特性，有效傳遞訊息與打動聽眾。

(4) 合作：在特定領域達到獨步全國，並將成果與技術分享給共同應對氣候變遷的夥伴。

(5) 不具黨派與立場：沒有任何政策規劃與法規確保無黨派立場。

2. 主要工作

(1) 研究：發布氣候變遷科學研究，但不局限於科學期刊，也提供資料的視覺化讓媒體與社會更直觀了解科學事實。

(2) 媒體與溝通：獨立新聞發布組織透過網站的每日專題報導或互動式圖卡影響公眾，涵蓋範圍有數位、印刷品與廣播。

(3) 社會科學研究：氣候變遷難以達成普遍理解，因此需要利用完整的社會科學研究，客觀評估宣傳效果以達最佳效率。

(4) 計畫主題：氣候變遷、能源、海平面上升、氣象。

(二) 會談重點成果

拜會美國氣候中心（Climate Central）雙方就初步合作機制進行討論，並將邀請美國氣候中心參加氣候變遷調適國際研討會，建立合作共識，尋求合作之可行性，以及建議可於聯合國舉行氣候大會 COP 會議期間，共同合作舉辦活動。

(三) 交流照片：

圖 15. 與美國氣候中心（Climate Central）人員合影。

肆、 心得與建議

(一) 美國 NOAA 提出六月將派專家來臺進行未來計畫評估會議和討論十月份氣候變遷調適國際研討會規劃內容，與我方專家進行互動，建議以氣候變遷調適韌性風險評估政策工具（resilient toolkits）、氣候變遷與健康、海岸韌性等三項議題，研擬未來會議規劃進行方向。

(二) 與美國 NOAA 未來可有一合作計畫，建議雙方先在 IEP 計畫下進行，研商合作規劃內容。

(三) 有關於 2016 年更好的空氣品質（Better Air Quality, BAQ）會議將於韓國釜山舉行，臺美雙方就納入溫室氣體減量及氣候調適等議題達成共識，並希望我方以夥伴形式參與會議及議題討論。本項任務預計四月底 USEPA 專家訪臺時進行討論。

(四) 我方與 NOAA 將於六月底訪臺，並規劃辦理範疇會議（scoping meeting），可邀請 USEPA 代表參加，共同就與 NOAA 合作推動項目、10 月之國際研討會議題、相關經費規劃等議題進行討論。USEPA 初步同意，並建議於會議與日期完成規劃後，再行討論。

(五) 參與國際組織 APAN 之途徑，建議我方可透過以 IEP 身分加入 APAN。

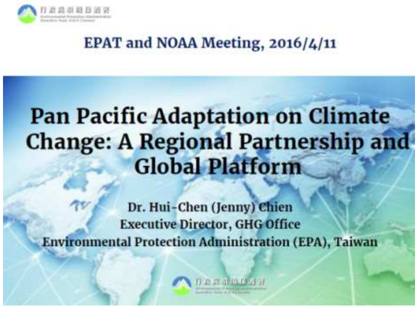
(六) 臺美雙方共同檢視兩國國家調適計畫之內容，建議於五月底與 USEPA 專家訪臺時，併入討論事項。

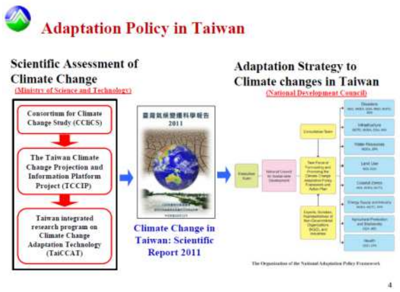
(七) 由於我國的碳市場暫處萌芽階段，為渡過此階段，PMR 可以協助我國減碳計畫，並提供其他國際減碳工具之服務，如果我方有意合作，PMR 可以派出專家提供技術上支援。

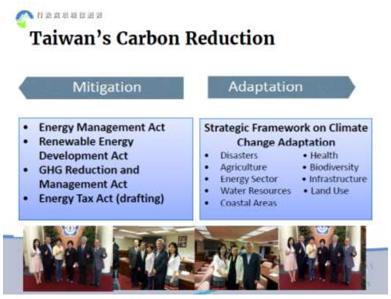
(八) 我國在溫管法規範之下，將進行每五年為一期的階段管制目標與策略，世界銀行在 Networked Carbon Market Initiative 計畫中，已完成設計碳定價的分析工具，其表示樂意提出本項工具的交流與分享，做為我分析碳定價與國內外抵換額度分析之用途。

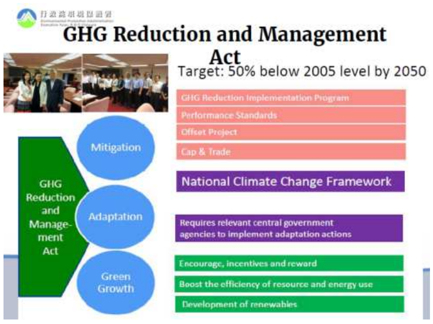
(九) 我代表邀請世界銀行參加今年下半年環保署舉辦之碳市場與碳定價國際研究會，其表達高度的肯定與意願，後續將持續就我國參加 PMR、碳定價工具與國際研討會等與其保持合作。

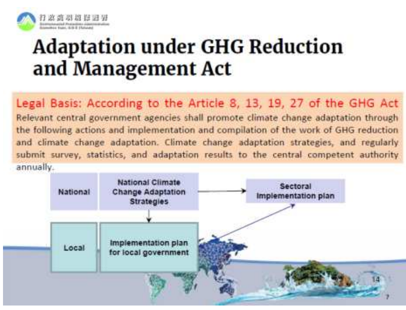
附件一、泛太平洋氣候變遷調適夥伴簡報

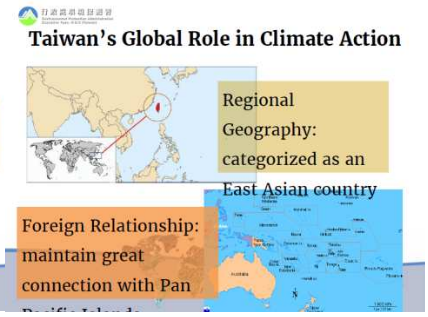




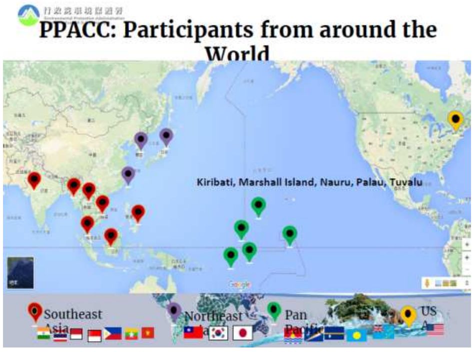


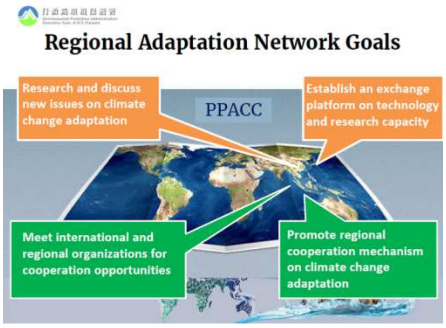







PPACC:
Extending from Bilateral to Partnership
CLIMATE PROGRAM OFFICE
USEPA
EPAT
Bilateral or multilateral projects
Partner nations
Partnership


PPACC: Participants from around the World
Kiribati, Marshall Island, Nauru, Palau, Tuvalu
Southeast Asia
Northeast Asia
Pan Pacific
US


Regional Adaptation Network Goals
Research and discuss new issues on climate change adaptation
PPACC
Establish an exchange platform on technology and research capacity
Meet international and regional organizations for cooperation opportunities
Promote regional cooperation mechanism on climate change adaptation


2. PPACC's Achievement during 2014 - 2016


2014: Technical Scoping Meeting with Climate Program Office, U.S. NOAA
Near Term: technical cooperation, knowledge Sharing Platforms
Next steps: Collaboration of U.S. Climate Resilience Toolkit.
Pan Pacific: Include presentation of the U.S. Climate Resilience Toolkit as part of a broader discussion of existing national and regional knowledge sharing platforms. If there is interest by the Partnership, focused areas of cooperation could be identified.
Coastal Resilience


2014: 1st PPACC Conference, Taipei
Focusing Attention on Climate Change and Pacific Island Nations
The 2014 Pan Pacific Partnership on Climate Change Adaptation, Taipei, Taiwan, 29 September to 2 October 2014
Citation: Wuebbles, D., W. Higgins, and H.C. Chien (2015), Focusing attention on climate change and Pacific island nations, Eos, 96, doi:10.1029/2015EO033665. Published on 3 August 2015.
https://eos.org/meeting-reports/focusing-attention-on-climate-change-and-pacific-island-nations

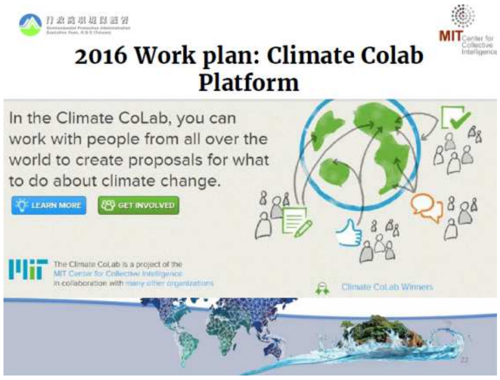

2015: 2nd PPACC Conference, Hanoi
Establish a platform for information sharing, experience exchanging, and tools developing on climate change adaptation.
Incubate bilateral and multilateral projects based on concrete objectives and collaborative tasks under the IEP structure.
Build up a more comprehensive partnership among the participants.

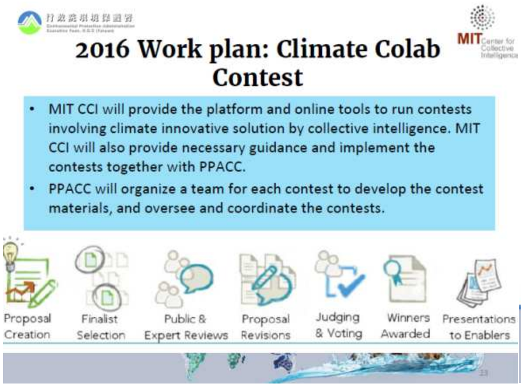

2015: Collaboration with MIT CCI to launch the Climate Colab Project
2015: Reunion in Paris-PPACC with COP21


PAN PACIFIC ADAPTATION ON CLIMATE CHANGE
2016: Collaboration with Korea University
PROACTIVE KU
BK21 PLUS ELEC
PAN PACIFIC ADAPTATION ON CLIMATE CHANGE
PPACC and BK21Plus ELEC here with agree to collaborate in Research and Education for Climate Change Adaptation in Pan Pacific and Mid-Latitude Region including "Model Development for Assessing Vulnerability of Forest and Agricultural Sectors to Climate Change" of MOTIVE (Model Of integrated Impact and Vulnerability Evaluation) project.

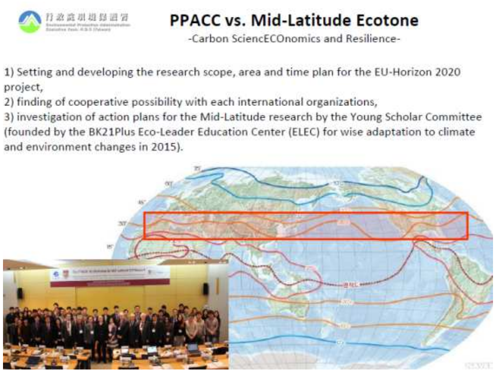

Achievements and Future work
2014-15
2016-17
Consensus building
Partnership platform
Regional adaptation network
Workshop and forum on Climate Change Adaptation
Multilateral consensus building meeting
Bilateral joint implementation projects
Construction and inception
International non-governmental organization (INGO)
Multilateral joint implementation projects
Adaptation Network on Climate Change
An exchange platform for climate information
20

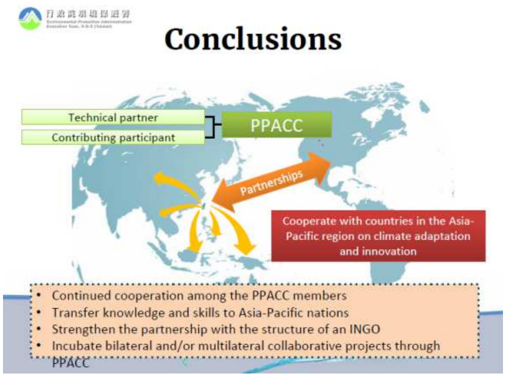

PPACC's Work plan of 2016

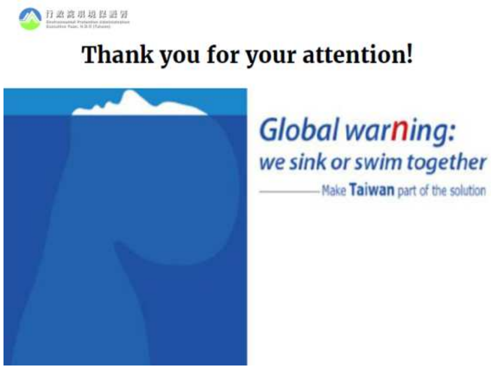

2016 Work plan: Climate Colab Platform
In the Climate CoLab, you can work with people from all over the world to create proposals for what to do about climate change.
LEARN MORE
GET INVOLVED
The Climate CoLab is a project of the MIT Center for Collective Intelligence in collaboration with many other organizations
Climate CoLab Winners
MIT Center for Collective Intelligence


2016 Work plan: Climate Colab Contest
MIT Center for Collective Intelligence
MIT CCI will provide the platform and online tools to run contests involving climate innovative solution by collective intelligence. MIT CCI will also provide necessary guidance and implement the contests together with PPACC.
PPACC will organize a team for each contest to develop the contest materials, and oversee and coordinate the contests.
Proposal Creation
Finalist Selection
Public & Expert Reviews
Proposal Revisions
Judging & Voting
Winners Awarded
Presentations to Enablers


2016 Work plan: 3rd PPACC Conference
Goal
Reunite with the participants of the previous conferences and making progress of the partnership.
Launch NOAA's climate change resilience toolkit training (progress/experience sharing) course.
Present the outcome of Climate Colab IEP project collaborated by MIT CCI and EPAT.
Incubate bilateral and multilateral projects based on concrete objectives and collaborative tasks under the IEP structure.


PPACC vs. Mid-Latitude Ecotone
-Carbon ScienECOnomics and Resilience-
1) Setting and developing the research scope, area and time plan for the EU-Horizon 2020 project,
2) finding of cooperative possibility with each international organizations,
3) investigation of action plans for the Mid-Latitude research by the Young Scholar Committee (founded by the BK21Plus Eco-Leader Education Center (ELEC) for wise adaptation to climate and environment changes in 2015).


Conclusions
Technical partner
Contributing participant
PPACC
Partnerships
Cooperate with countries in the Asia-Pacific region on climate adaptation and innovation
Continued cooperation among the PPACC members
Transfer knowledge and skills to Asia-Pacific nations
Strengthen the partnership with the structure of an INGO
Incubate bilateral and/or multilateral collaborative projects through PPACC


Thank you for your attention!
Global warning:
we sink or swim together
Make Taiwan part of the solution

附件二、**EOS** 科學論文

2019/4/25 Focusing Attention on Climate Change and Pacific Island Nations - Eos

Focusing Attention on Climate Change and Pacific Island Nations

The 2014 Pan Pacific Partnership on Climate Change Adaptation; Taipei, Taiwan, 29 September to 2 October 2014

Palau, seen here from above, risks being overrun as sea levels rise. Credit: LuXTonnerre, CC BY 2.0

By Donald Wuebbles, Wayne Higgins, and Hui-Chen Chien 3 August 2015

Many island nations across the Pacific Ocean face greater threats from climate changes and associated changes in sea level and ocean acidification than most mainland countries. These island nations have low elevation, long coastlines, and a critical dependence on the seas around them for their livelihoods. The United Nations Environment Programme (UNEP) named 2014 the "Small Island Developing States (SIDS) International Year

https://eos.org/meeting-reports/focusing-attention-on-climate-change-and-pacific-island-nations 1/3

Speakers also called on scientists to push harder for policy makers to include climate adaptation planning in decisions.

Speakers also called on scientists to push harder for policy makers to include climate adaptation planning in decisions. As part of this effort, the meeting participants concluded that a formal international environmental partnership should be established that would include representatives from the United States, the Southeast Asia nations, and Pacific island nations. Such a partnership could strengthen efforts, remove barriers, pursue sustainable development, and promote creativity. A strong international partnership is essential to support ambitious domestic action.

After the conference, 35 participants from 7 nations spent 2 days at a workshop, discussing the stresses of climate change. Workshop attendees discussed adaptation policies specifically for Pacific island nations. Participants reiterated the need for establishing an international platform for cooperative efforts to adapt to climate change together. To continue the efforts, a follow-up meeting to be held in Vietnam is planned for autumn 2015.

Acknowledgment

We give special thanks to Chi Ming Peng of WeatherRisk Inc. (Taipei, Taiwan) and S. K. Yang of the National Oceanic and Atmospheric Administration's Climate Prediction Center (College Park, Md.) for the outstanding contributions they made to organizing this meeting, as well as their contributions to this report.

—Donald Wuebbles, Department of Atmospheric Sciences, University of Illinois at Urbana-Champaign, Urbana; email: wuebbles@illinois.edu; Wayne Higgins, Climate Program Office, National Oceanic and Atmospheric Administration, Silver Spring, Md.; and Hui-Chen Chien, Environmental Protection Administration, Taipei, Taiwan

Citation: Wuebbles, D., W. Higgins, and H.-C. Chien (2015), Focusing attention on climate change and Pacific island nations, *Eos*, 96, doi:10.1029/2015EO033665. Published on 3 August 2015.

(http://www.un.org/en/events/islands2014/#&panel1-1)," raising international attention on these small island countries.

The United Nations Environment Programme has called on the international community to take action with island nations to prepare themselves for disasters that may come as climate changes.

"Raise Your Voice, Not the Sea Level" served as the theme for last year's World Environment Day (http://www.unep.org/wed/), during which UNEP called on the international community to take action with island nations to prepare themselves for disasters that may come as climate changes. To this end, the Environmental Protection Administration of Taiwan developed and led an international conference and workshop (https://sites.google.com/site/2014appiccaen/home).

Participants included scientists and policy makers from Taiwan, the United States, a number of the Pacific island nations, and Southeast Asia. The conference, held at National Taiwan University, drew more than 300 attendees. In addition, the presentations and panels were broadcast live to various universities and colleges in the region.

Conference goals included the following:

promoting public awareness and enhancing communication among decision makers, subject matter experts, and academia about policy making, adaptation strategies, tool development, and implementation pathways

identifying and prioritizing issues that span the Pacific, establishing public and private partnerships, and facilitating adaptation policies and the exchange of information on mitigation strategies

exploring the possibility of establishing a "Climate Change Adaptation Center" as a hub for research and education to promote usage of open and big climate data, as well as organizational networking

Many presentations focused on the need for adaptation policies. For instance, because of sea level rise and increases in extreme events, island countries and Southeast Asian nations confront the dilemma of adapting to changing conditions for survival, stimulating economic development, and/or meeting human needs. In some cases, such as those of the Republic of Palau and the Republic of Kiribati, the entire nation's existence (http://www.pri.org/stories/2014-01-03/climate-change-brings-new-wrinkle-life-palaus-islands-fear-sea) is threatened (http://www.theguardian.com/environment/2014/jul/01/kiribati-climate-change-fiji-vanua-levu). To better adapt to climate change, international cooperation is required to improve climate-related legislation, policy-making processes, human capabilities, education, technology, and financial support.

附件三、EPAT 與 NOAA 雙邊會議結論（英文版）

EPAT and NOAA Meeting

April 11, 2016

Meeting Summary Notes (DRAFT version, 4.12.2016)

Overall Summary

- Future areas of collaboration should be framed as supporting the implementation of Taiwan's Climate Change Adaptation Plan – for which EPAT has oversight.
- Taiwan can then highlight progress in these Taiwan-focused activities, with technical input from NOAA, in the broader context of the Pan-Pacific Adaptation on Climate Change conference.
- Outcomes from discussions over the summer can be used to inform the agenda of the October Conference in Thailand and an EPAT-NOAA work plan.
- In the near term, coordination will occur under the IEP umbrella. The need for additional agreements between EPAT-NOAA (via TECRO-AIT) can be explored later in the year.

Climate Resilience Toolkits

- **Summary.** A scoping meeting will take place in late June with the goal of understanding how 'climate resilience toolkits' and other platforms can be used to support implementation of Taiwan's National Climate Change Adaptation Plan. This Meeting/workshop will include sharing experiences of the developing the U.S. Climate Resilience Toolkit and understanding climate impacts and stakeholder needs – with the objective to develop a work plan on what is needed for creating and sustaining a Taiwan Climate Resilience Toolkit. This workplan can then be presented at the 3rd Conference of Pan Pacific Adaptation on Climate Change in October 2016, in Thailand.
- **Next Steps**
    - Identify dates of meeting (last 2 weeks of June) and location
    - Dr. Chien will identify EPAT leads for this activity
    - Meredith and Chi-Ming will speak to US EPA on including this activity under the IEP
    - Establish a core planning group that will draft the agenda and participant list
    - EPAT recommends the following:
        - 3 Days – for the Toolkit discussion, with possible case studies of Health and Coastal
        - 2 Days – to have a dialogue with core Pan Pacific countries to join (Korea, Thailand, Marshall Island….) to begin scoping future cooperation for the broader region

        - NOAA's input into this schedule: 5 days might be too long and not necessary, in particular when you consider travel distances. A two day meeting may be sufficient for the toolkit discussion. Meanwhile, the Health and Coastal groups – if present - would overlap with part of the toolkit discussion, but also meet separately for 1 or days for more in-depth conversations and planning. It may also be useful to have the expert consultations on heath and coastal first, to inform the tool kit discussion.

- **Technical Leads**
    - EPAT: will identify participants for this team
    - NOAA: Ned Gardiner (ned.gardiner@noaa.gov), David Herring (david.herring@noaa.gov)

Climate and Health

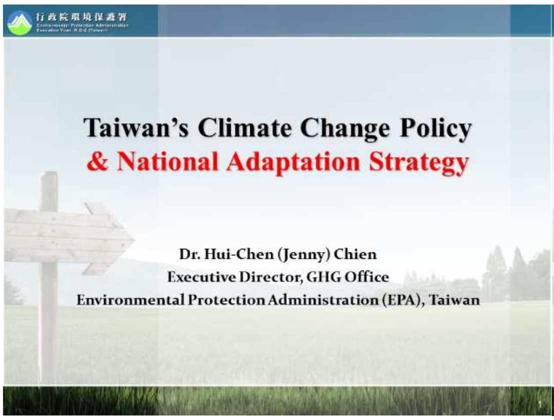
- **Summary**. Health is included as one of Taiwan's 8 focus areas in their National Climate change Adaptation Plan. Several areas of potential collaboration were discussed and includes (1) Infectious disease, (2) Air Quality, (3) Heat-Health Information Systems, (4) Data Analyses for a range of needs.
- **Next Steps.**
    - Dr. Chien will identify EPAT lead (s) for this activity, will inform NOAA of EPAT's priorities following her discussion with the Premier.
    - Potential inclusion of the topic for further refinement and collaboration as part of the June scoping meeting on toolkits.
    - NOAA will share information on the South Asia Regional Climate Outlook Forums and the upcoming focus on Health (in particular Heat-Health).
    - NOAA will facilitate discussion with the US Global Change Research Program Climate Change and Human Health Working Group.
- **Technical Leads**
    - EPAT: will identify
    - NOAA: Juli Trantj (juli.trtanj@noaa.gov), Hunter Jones (Hunter.jones@noaa.gov), Jesse Bell (jesse.bell@noaa.gov)

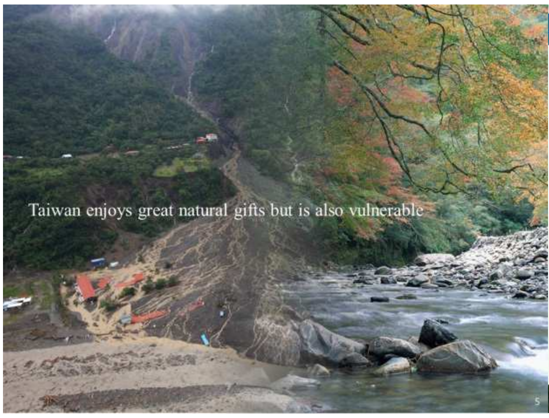
Coastal Resilience

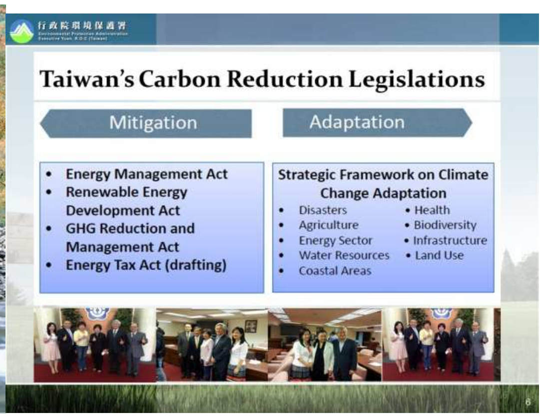
- **Summary**. The coastal zone is included as one of Taiwan's 8 focus areas in their National Climate Change Adaptation Plan. Several areas of interest were identified and include sharing examples of coastal zone protection to climate change, assessing climate change impacts in the coastal zone, and tools to inform adaptation practices such as flood inundation and erosion mapping.

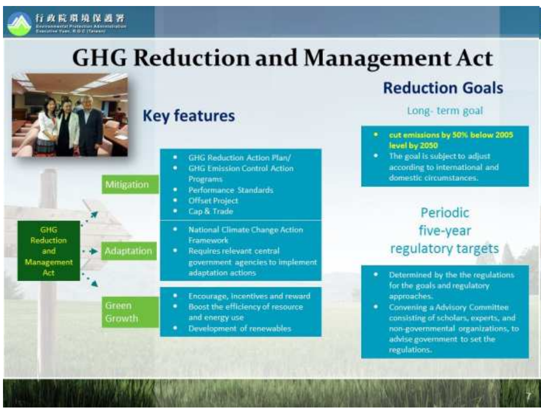
- **Next Steps**
  - Dr. Chien will identify EPAT lead(s) for this activity
  - Information sharing, including Taiwan's coastal zone assessment as well as information on work carried out in the US
  - A 'core team' of experts should be identified in Taiwan (EPAT lead) and the U.S. (NOAA lead) that reflect different but relevant disciplines.
  - This core team will address several issues that include assessing what existing information exists in Taiwan on climate impacts in the coastal zone, resources and capabilities, geographic focus, etc. Outcomes from these discussions will be used to clarify the focus and timeline of collaboration pertaining flood vulnerability analysis (exposure and sensitivity) ranging from tropical cyclones to sea level rise.
  - A summary of these discussions (e.g., the proposed work plan) will be presented at the October Pan Pacific Conference, with the potential of a side-workshop with on this topic with core Pan Pacific countries to begin scoping future cooperation for the broader region.
  - More discussion is needed on the linkage between the coastal resilience and the toolkit June meeting.
  - EPAT will contact Meredith if they are interested in activities related to oil spill response and restoration
- **Technical Leads**
  - EPAT: will identify participants for this team
  - NOAA: John Marra (John.marra@noaa.gov), Billy Sweet (william.sweet@noaa.gov), Doug Marcy (doug.marcy@noaa.gov), others as appropriate.

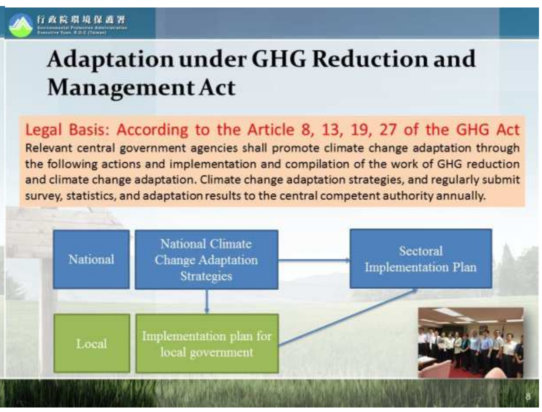
附件四、臺灣氣候變遷政策簡報

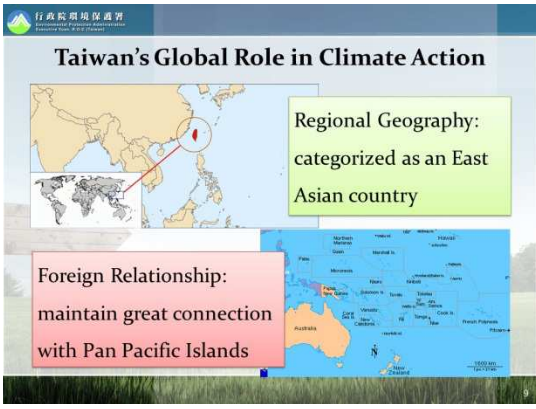


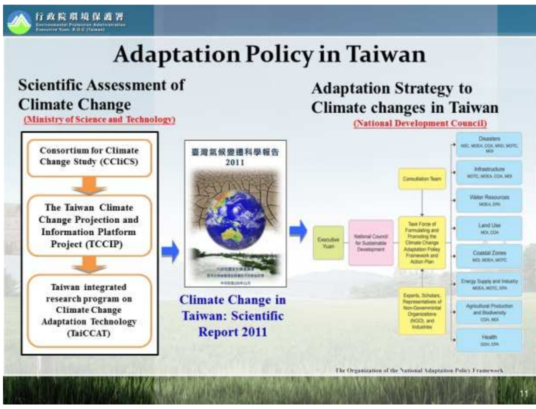


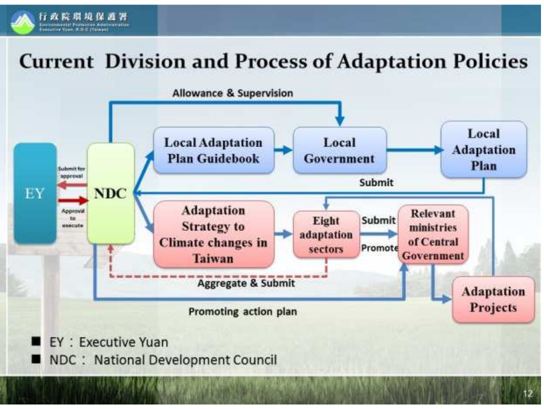


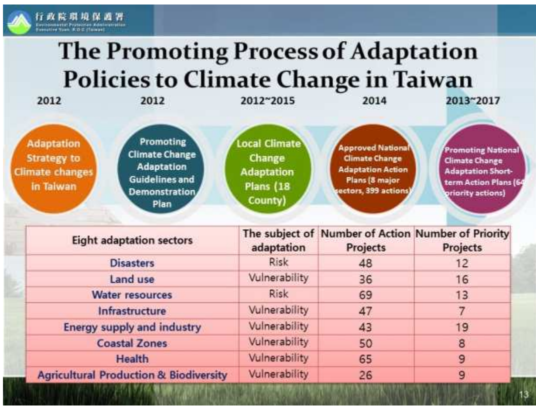




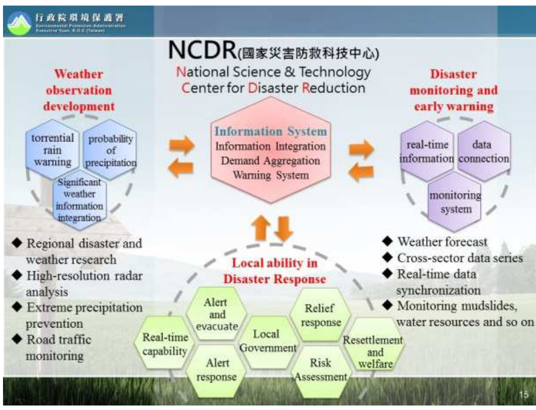


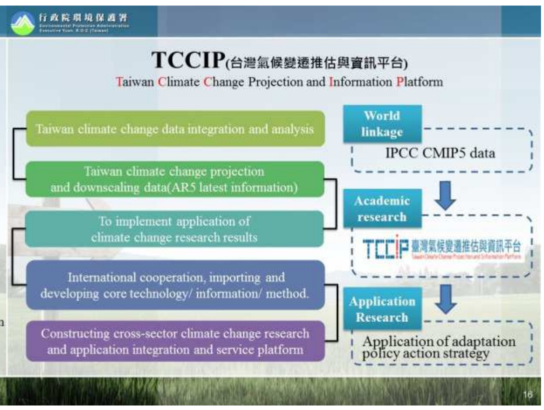


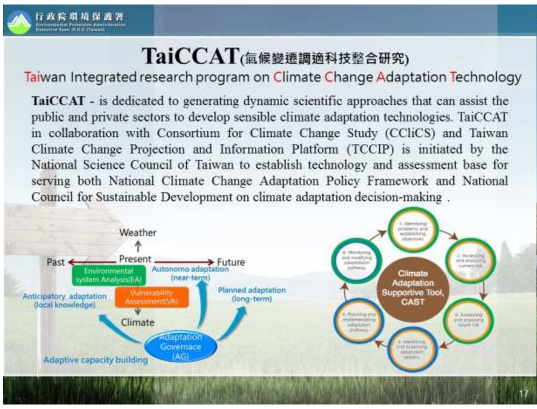




Eight adaptation sectors	The subject of adaptation	Number of Action Projects	Number of Priority Projects
Disasters	Risk	48	12
Land use	Vulnerability	36	16
Water resources	Risk	69	13
Infrastructure	Vulnerability	47	7
Energy supply and industry	Vulnerability	43	19
Coastal Zones	Vulnerability	50	8
Health	Vulnerability	65	9
Agricultural Production & Biodiversity	Vulnerability	26	9







TaiCCAT(氣候變遷調適科技整合研究)
Taiwan Integrated research program on Climate Change Adaptation Technology
TaiCCAT - is dedicated to generating dynamic scientific approaches that can assist the public and private sectors to develop sensible climate adaptation technologies. TaiCCAT in collaboration with Consortium for Climate Change Study (CCliCS) and Taiwan Climate Change Projection and Information Platform (TCCIP) is initiated by the National Science Council of Taiwan to establish technology and assessment base for serving both National Climate Change Adaptation Policy Framework and National Council for Sustainable Development on climate adaptation decision-making .
Weather
Past
Present
Future
Climate
Adaptation Governace (AG)
Adaptive capacity building
Climate Adaptation Supportive Tool, CAST
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Integrating
Adaptation Under GHG Act
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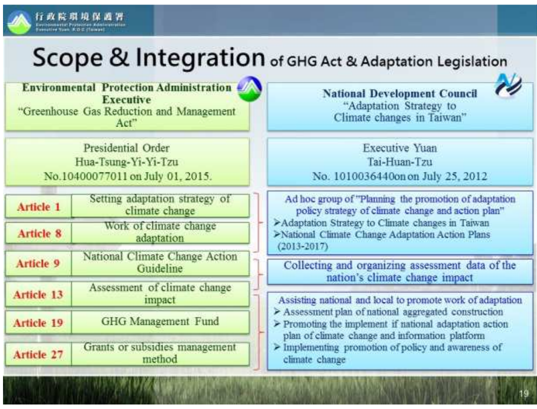

Scope & Integration of GHG Act & Adaptation Legislation
Environmental Protection Administration Executive
"Greenhouse Gas Reduction and Management Act"
Presidential Order
Hua-Tsung-Yi-Yi-Tzu
No.10400077011 on July 01, 2015.
Article 1 | Setting adaptation strategy of climate change
Article 8 | Work of climate change adaptation
Article 9 | National Climate Change Action Guideline
Article 13 | Assessment of climate change impact
Article 19 | GHG Management Fund
Article 27 | Grants or subsidies management method
National Development Council
"Adaptation Strategy to Climate changes in Taiwan"
Executive Yuan
Tai-Huan-Tzu
No. 1010036440on on July 25, 2012
Ad hoc group of "Planning the promotion of adaptation policy strategy of climate change and action plan"
➢Adaptation Strategy to Climate changes in Taiwan
➢National Climate Change Adaptation Action Plans (2013-2017)
Collecting and organizing assessment data of the nation's climate change impact
Assisting national and local to promote work of adaptation
➢ Assessment plan of national aggregated construction
➢ Promoting the implement if national adaptation action plan of climate change and information platform
➢ Implementing promotion of policy and awareness of climate change
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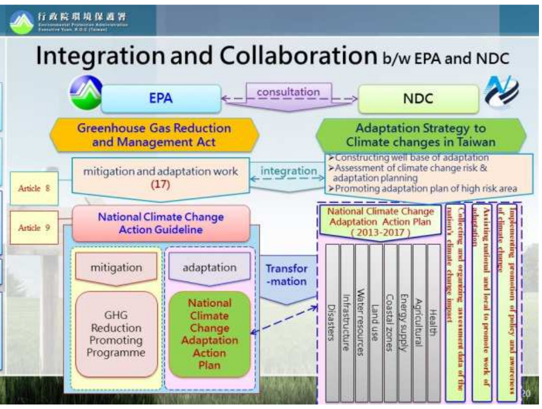

Integration and Collaboration b/w EPA and NDC
EPA
consultation
NDC
Greenhouse Gas Reduction and Management Act
Adaptation Strategy to Climate changes in Taiwan
mitigation and adaptation work (17)
integration
➢Constructing well base of adaptation
➢Assessment of climate change risk & adaptation planning
➢Promoting adaptation plan of high risk area
Article 8
Article 9
National Climate Change Action Guideline
mitigation
adaptation
Transfor -mation
GHG Reduction Promoting Programme
National Climate Change Adaptation Action Plan
National Climate Change Adaptation Action Plan (2013-2017)
Disasters
Infrastructure
Water resources
Land use
Coastal zones
Energy supply
Agricultural
Health
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Vision and
Long Term Strategy
on Adaptation
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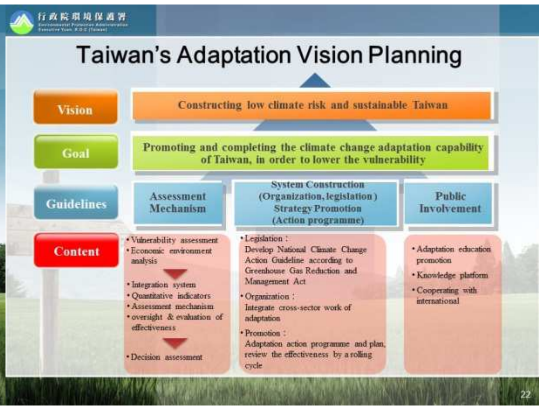
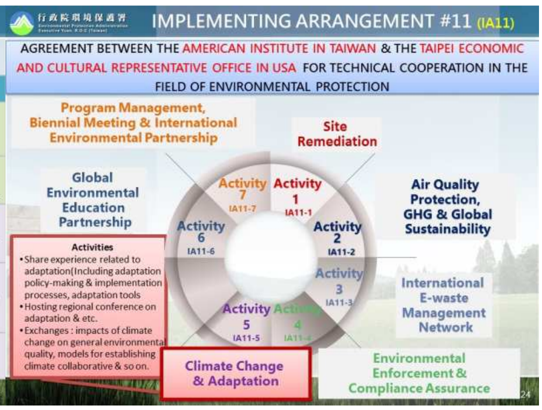


Taiwan's Adaptation Vision Planning
Vision
Constructing low climate risk and sustainable Taiwan
Goal
Promoting and completing the climate change adaptation capability of Taiwan, in order to lower the vulnerability
Guidelines
Assessment Mechanism
System Construction (Organization, legislation) Strategy Promotion (Action programme)
Public Involvement
Content
• Vulnerability assessment
• Economic environment analysis
• Integration system
• Quantitative indicators
• Assessment mechanism
• oversight & evaluation of effectiveness
• Decision assessment
• Legislation : Develop National Climate Change Action Guideline according to Greenhouse Gas Reduction and Management Act
• Organization : Integrate cross-sector work of adaptation
• Promotion : Adaptation action programme and plan, review the effectiveness by a rolling cycle
• Adaptation education promotion
• Knowledge platform
• Cooperating with international
22

Long Term Strategy and Roadmap
Short-term (Planning)
Medium-term (Launching)
Long-term (Developing)
Legislation Construction
➢ Policy transformation(NDC, EPA)
➢ Planning Action Strategy
➢ Planning Action Plan
➢ According to Article 9 of GHG management Act, review the action strategy once every five years
System Development
➢ Constructing infrastructure of adaptation policy
➢ Planning specific action plan of adaptation policy
➢ Quantifying 8 sectors' promotion goals of policy
➢ Reviewing the promotion effectiveness of policy
➢ Expanding balanced development of 8 sectors' adaptation policy
➢ Promoting policy effectiveness
Strategy Promotion
➢ Raising specific strategy action plan (national & local)
➢ Raising action plan planning and executive-related mechanism
➢ According to action strategy, implement the first-term of action plan
➢ Review the implementation of action plan
➢ According to action strategy, implement each-terms of action plan
➢ Review the implementation of action plan every year
Assessment Mechanism
➢ Constructing policy database (including economics, environment, energy)
➢ Constructing models of each adaptation sectors' policy impact assessment
➢ Building risk assessment monitoring mechanism
➢ Maintaining and uploading policy database
➢ Integrating each sectors policy assessment results
➢ Constructing decision mechanism responding to the uncertainty of climate change
Public Involvement
➢ Planning policy promotion website
➢ Collecting advices
➢ International cooperation
➢ Building knowledge and database platform
➢ Planning promotion of education randomly
➢ International cooperation
23



IMPLEMENTING ARRANGEMENT #11 (IA11)
AGREEMENT BETWEEN THE AMERICAN INSTITUTE IN TAIWAN & THE TAIPEI ECONOMIC AND CULTURAL REPRESENTATIVE OFFICE IN USA FOR TECHNICAL COOPERATION IN THE FIELD OF ENVIRONMENTAL PROTECTION
Program Management, Biennial Meeting & International Environmental Partnership
Site Remediation
Global Environmental Education Partnership
Air Quality Protection, GHG & Global Sustainability
Activity 7 IA11-7
Activity 1 IA11-1
Activity 6 IA11-6
Activity 2 IA11-2
Activity 3 IA11-3
Activity 5 IA11-5
International E-waste Management Network
Activities
• Share experience related to adaptation(Including adaptation policy-making & implementation processes, adaptation tools
• Hosting regional conference on adaptation & etc.
• Exchanges : impacts of climate change on general environmental quality, models for establishing climate collaborative & so on.
Climate Change & Adaptation
Environmental Enforcement & Compliance Assurance
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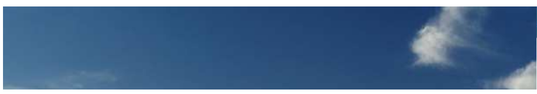
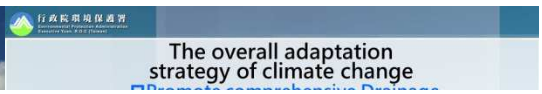
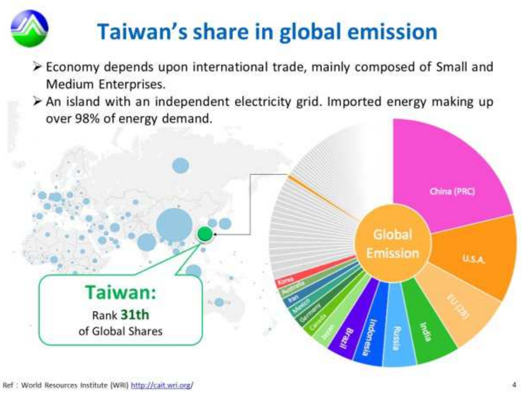
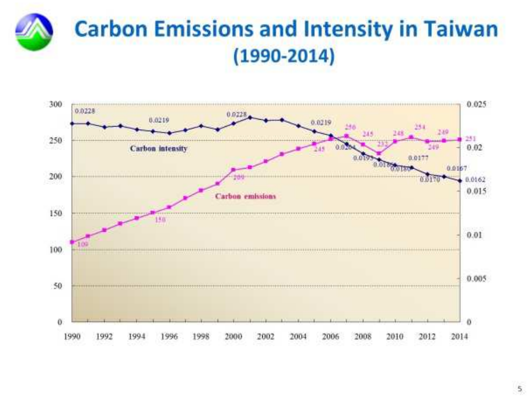


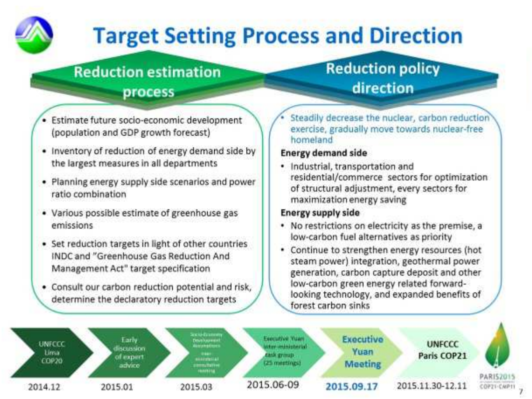


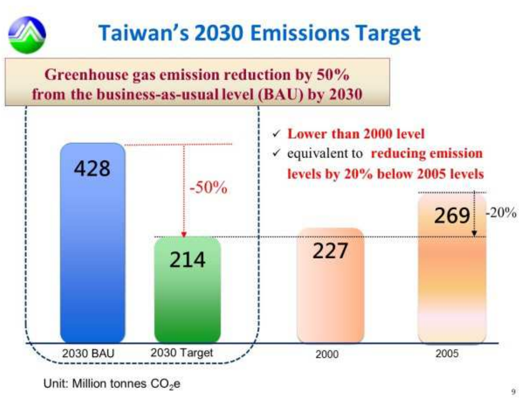
The overall adaptation strategy of climate change

附件五、臺灣 GHG 管制及碳市場簡報









Taiwan's 2030 Emissions Target

An economy-wide target to reduce its GHGs emissions by 50% from the business-as-usual level by 2030.

Emission Target	Greenhouse gas emission reduction (214 MtCO2eq) by 50% from the business-as-usual level (428 MtCO2eq) by 2030
Scope	Economy-wide
Gases covered	CO2, CH4, N2O, HFCs, PFCs, SF6, NF3
Sectors covered	Energy; Industrial processes and product use; Agriculture; Land-use, Land-use change and forestry; Waste
Assumptions and Methodological Approaches	2006 IPCC Guidelines for National Greenhouse Gas Inventories Global Warming Potential used in IPCC AR4
Credits from International Market Mechanisms	The emissions reduction target is committed to the domestic measures mostly. Future reduction potential can benefit from being involved in the international market mechanism.

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GHG Reduction & Management Act

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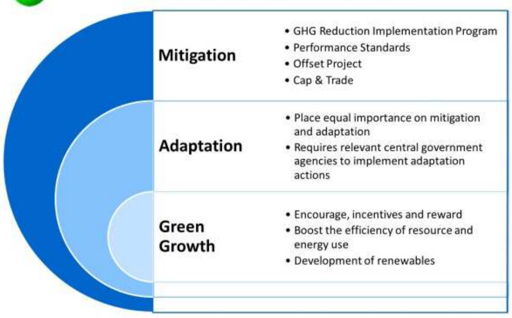
Key features of the GHG Act



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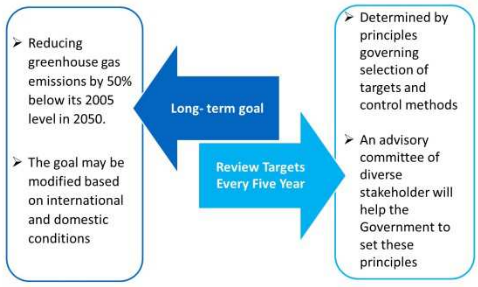
Emissions Reduction Targets



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Carbon Market Elements under GHG Act

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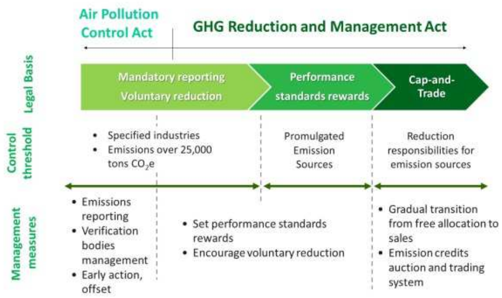
Reduction Strategy – Manage by phases



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Mandatory GHG Reporting

- In 2004, Taiwan EPA created the voluntary GHG reporting and inventory program, which became mandatory under the Air Pollution Control Act in 2013.

Mandatory Reporting

On December 2012, EPAT announced:
- "GHG Emissions Reporting Rule"
- "GHG Emissions Reporting - Designated Stationary Sources"
  - reporting subjects divided into 2 groups

GHG Reduction & Management Act

Passed in June 2015, the mandatory reporting rules will be incorporated into this Act.

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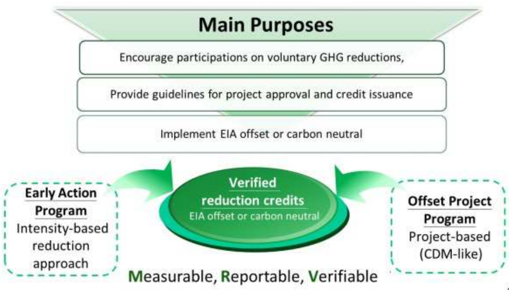
Voluntary Reduction Projects

10 September 2010: "Principles for Promoting GHG Early Action Project and Offset Project"



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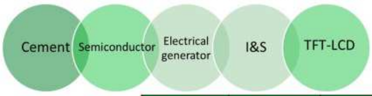
Early Action Credits

- Designated Emission Intensity values
- 5 Designated Emission Intensities released on June 30, 2011:



Emission intensity based on the product, scope, and installation types

Sector (process)	Product (variations)	Emissions Intensity
Iron & Steel (integrated, Elec.Arc, Rolling)	Billet, Carbon, H, Stainless, Hot Rolled Coiled Steel/Plate	0.14 ~ 2.17 tCO_2e/ t I&S product
Cement	Clinker	0.821 ~ 0.917 tCO_2e / tClinker
TFT-LCD	Glass Substrate (under 5th Gen.& above 5.5 Gen.)	0.031 ~ 0.308 tCO_2e / m^2Glass Substrate
Semi-Conductor	Wafer (< 6", 8", 12" & 12"DRAM)	0.426 ~ 1.894 $kgCO_2e/cm^2$Wafer
Electrical Generation	Steam Turbine Unit (coal, oil, NG)	0.355 ~ 0.882 tCO_2e/MWh
	Combined Cycle Unit (coal, oil, NG)	

- As of Mar 2016:
  - 200 Early Action applications submitted
  - 121 passed
  - 54 under review
  - 25 Withdrawn/rejected

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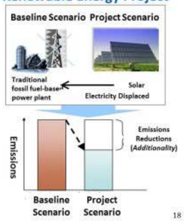
Domestic Offset Projects

- As of Mar 2016:
  - 38 applications submitted,
  - 10 registered.
  - 1 applications for issuance submitted

Renewable Energy Project



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Regulations Enforcement Timetable

Regulations in place → Relevant regulatory provisions within a few years' timeframe

Regulations related to registry, MRV, early action and offset crediting →

- National Climate Change Action Guideline
- GHG Reduction Action Plan
- First periodic regulatory goal
- Regulation of allocation

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Concluding Remarks

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Concluding Remarks

- Taiwan's legal framework is in place, and will develop programs and implementation rules under the GHG Reduction and Management Act, with inter-department and stakeholder consultation
- Under the GHG Act, we will proceed with setting the 5-yearly interim targets and decide how these will be turned into caps under the ETS in the future, as well as detailed rules for ETS design and operation in the future.
- Taiwan EPA has taken part in various World Bank PMR technical workshops and look forward to discussing potential ways for Taiwan to become a technical partner.
- Taiwan EPA is also very interested in the Networked Carbon Market initiative, and would like to participate in its ongoing activities, including developing methodologies for assessing "mitigation values".

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Global warning:
we sink or swim together
——Make **Taiwan** part of the solution

Thank you for your attention!

PARTNERSHIP FOR MARKET READINESS

AUGUST 2015

Crediting-Related Activities under the PMR

Status and Support for Implementation

WORLD BANK GROUP

Acknowledgments

This stocktaking study was prepared for the PMR Secretariat by Alyssa Gilbert, Noémie Klein, and Long Lam from Ecofys, and Michael Lazarus and Kevin Tempest from the Stockholm Environment Institute (SEI), with input and supervision from Alexandrina Platonova-Oquab (PMR Secretariat).

We would like to thank Neeta Hooda and Alexander Lotsch (Forest Carbon Partnership Facility [FCPF]), Marius Kaiser (Deutsche Gesellschaft für Internationale Zusammenarbeit [GIZ]), Clifford Polycarp (Green Climate Fund [GCF]), Hendrikje Reich (NAMA Facility), Josué Tanaka and Jan-Willem van de Ven (European Bank for Reconstruction and Development [EBRD]), and representatives from other ongoing funds and initiatives for their participation in the interviews and their insights.

We would also like to thank Adrien de Bassompierre, Marcos Castro, Pierre Guigon, Pauline Kennedy, Taisei Matsuki, and Xueman Wang (PMR Secretariat) for their comments and suggestions.

Please direct any questions about this study to the PMR Secretariat (**pmrsecretariat@worldbank.org**).

pmr | PARTNERSHIP FOR MARKET READINESS

August 2015

Crediting-Related Activities under the PMR

Status and Support for Implementation

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Cover design: Bill Pragluski, Critical Stages LLC.

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Abbreviations

CDM	Clean Development Mechanism
EEDP	Energy Efficiency Development Plan
EPC	Energy Performance Certificate
ETS	Emissions Trading Systems
EU	European Union
GHG	Greenhouse Gas
INDC	Intended Nationally Determined Contributions
LCC	Low Carbon City
MBI	Market-Based Instrument
MEF	Ministry of Economy and Finance
MRP	Market Readiness Proposal
NAMA	Nationally Appropriate Mitigation Action
NESDB	National Economic and Social Development Board
NMM	New Market-Based Mechanism
NMT	Nonmotorized Transport
NNRRG	National Network for Recycling of Refrigerant Gases
NPV	Net Present Value
PCCM	Politique du Changement Climatique au Maroc
PMR	Partnership for Market Readiness
RBB	Results-Based Budgeting
RBF	Results-Based Finance
SEI	Stockholm Environment Institute
UNFCCC	United Nations Framework Convention on Climate Change

Executive Summary

Policy analysts and decision-makers have long expressed interest in market-based mechanisms as tools to achieve greenhouse gas (GHG) emission reduction objectives in a cost-effective and accountable manner. Crediting instruments represent one such mechanism. By issuing transferable credits for verified emissions reductions, they can enable wider participation and greater cost-effectiveness in achieving mitigation goals.

Existing mechanisms such as the Clean Development Mechanism (CDM) have built extensive capacity, knowledge, and experience related to crediting. A number of developing countries are now considering the further development of crediting instruments in their own domestic contexts, as well as international markets. The design and operation of crediting instruments requires the establishment of numerous program elements, from quantification methods to data management and collection, and design and implementation processes that engage relevant stakeholders and are informed by timely and appropriate studies.

The Partnership for Market Readiness (PMR) is currently supporting eight countries in the development of crediting instruments: Colombia, Costa Rica, Mexico, Morocco, Peru, Thailand, Tunisia, and Vietnam. With this support, each country has drafted an extensive Market Readiness Proposal (MRP); they are at different stages, from final approval to early implementation. In light of the extensive planning efforts to date, and the ongoing evolution of both PMR and the broader carbon market, PMR commissioned the Stockholm Environment Institute (SEI) and Ecofys to undertake a study of crediting-related activities planned or being undertaken by the PMR's Implementing Country participants.

The objectives of this study are threefold: 1) to review and compare the PMR crediting-related activities presented in MRPs; 2) to assess whether and how these crediting-related activities can stimulate scaled-up mitigation by creating a domestic environment (technical, regulatory and institutional) that can support a range of climate policies; and 3) to identify opportunities for the PMR to provide further support. To achieve these objectives, the SEI/Ecofys team reviewed the MRPs, conducted a broader literature review, and interviewed numerous actors, from the PMR Secretariat to practitioners in the field of crediting and staff of programs that share the PMR's broader goal of enhancing readiness for low-carbon policy and investment.

This paper begins with an in depth look at the eight MRPs that currently focus on crediting, drawing out commonalities and differences in their approaches and activities. All have relied on thorough policy analysis as well as stakeholder engagement to inform instrument design, establish institutional and regulatory frameworks, and set up monitoring, reporting, and verification (MRV) systems. However, not surprisingly, national circumstances and priorities have driven important differences in sectors targeted, the role of domestic climate policies, and how demand risk is addressed.

While supporting the development of crediting instruments is an important part of the PMR's overall work program, the future of crediting has become increasingly uncertain, particularly with respect to the sources and scale of credit demand. Demand will be driven by the timing and ambition of future climate policies, the importance of markets in delivering these targets, and the ability to implement the relevant policies (supply and demand side) effectively. All such factors are currently in flux.

Given these uncertainties, the notion of minimizing regrets and maximizing benefits has become of greater interest for market readiness activities. Crediting-related activities that are being supported by the PMR also have the potential to support a broader range of climate policies than just crediting instruments. For example, the quantification approaches and MRV systems developed with PMR support could also prove invaluable for results-based financing. Mitigation potential assessments and stakeholder engagement efforts undertaken with the intent of supporting development of specific crediting instrument could also be relevant, and even build support for a broader emissions trading scheme or carbon tax. A range of crediting-related activities can thus create readiness for a host of climate actions, minimizing the risk of regrets and potentially providing multiple benefits.

In this study, we use these two criteria—minimizing regrets and maximizing benefits—to assess 15 types of crediting-related activities that are currently being supported in MRPs, and the extent to which they could contribute to creating readiness. We develop and apply a rubric for evaluating each activity and its contribution to the criteria, including its importance in supporting multiple climate policies. We find, for example, that countries with a clearer preference among instruments and willingness to commit to them (and in so doing, perhaps risk greater future regret) appear to have greater alignment with the maximizing benefits criterion. Five countries are setting up an institutional and regulatory framework, which scores high in our assessment of benefits, and also is a medium priority in terms of minimizing regrets. GHG data management and collection and registry development are also widely chosen as activities, and these offer a balance of minimizing regrets and delivering wider benefits and readiness.

While this paper provides a method for examining the relationship between specific crediting-related activities and the no-regrets concept, this analysis cannot in itself provide direction to the PMR or Implementing Countries on where and how to invest in future activities. Instead, it should be considered together with individual country contexts and aspirations, the future trajectory of the PMR, and synergies with other international and domestic initiatives.

The PMR should continue and perhaps even expand its support for a mix of activities that both support specific crediting instruments and bring wider benefits by paving the way for broader mitigation policies. This assessment has demonstrated that it is not possible to create a single approach that is optimal for all—the variety of factors involved in understanding which activities to choose is vast, and is based not only on different desired, and uncertain outcomes, but also on each country's starting point.

The PMR should consider more explicitly using the criteria described here: creating readiness while minimizing regrets, and maximizing benefits. In practical terms, this can help countries and the PMR to work together to limit over-investment in some activities that have highly uncertain returns. It also means more explicitly expanding the goals of PMR activities, to the extent possible within their terms of reference. Wider goals could support activities that serve multiple instruments, such as baseline and MRV activities that consider application for results-based finance or for regulatory systems.

The PMR has contributed unique value in recent years, even as the carbon market has weakened, because it has offered constructive dialogue and worked towards real action on the ground. This assessment demonstrates that there is merit in actively pursuing a full range of activities under the auspices of the PMR, provided that they are fit for purpose in each country and are assessed over time.

1. The Context for PMR Support for Crediting-Related Scaled-Up Mitigation Initiatives

1.1. The Role of Crediting Instruments

Policy analysts and decision-makers at the international, national, and sub-national levels have long expressed interest in market-based mechanisms as tools to achieve GHG emission reduction objectives in a cost-effective and accountable manner. The PMR was established with a focus on such market mechanisms, including two broad categories: *emissions trading systems* (ETS) and *crediting instruments*.

An ETS puts a cap on the total emission of a national or regional system and allows the participants flexibility in adhering to this cap. An ETS can be implemented as a stand-alone instrument—the demand for emissions reductions comes from within the capped system.

Crediting instruments can be project- or sector-based and provide credits for emissions reductions below an agreed baseline. A crediting instrument needs to be linked to an external source of demand.

Crediting instruments have been attractive to policy-makers for a number of reasons. They offer flexibility to meet emission targets or commitments by being a source of cost-effective emission reductions, and they support host countries transition to a low-carbon economy. They can also commoditize emission reductions independently from market demand through results-based finance (RBF), where credits earned are the proof of results.

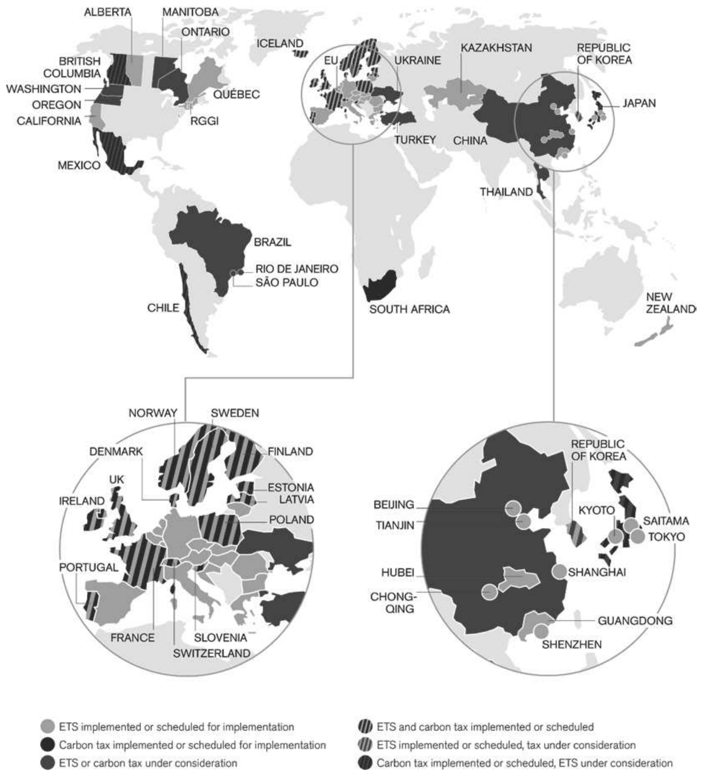
Creating Demand

The demand element is essential—without demand, a crediting instrument will not deliver. There are several ways to create (domestic or international) demand for credits.

- Compliance markets: countries or companies are obliged to comply with emission obligations set under e.g., an ETS, a carbon tax or other GHG compliance mechanisms. If the obligation scheme allows the use of credits, companies may be better off buying such credits than reducing emissions directly. Map 1 below shows that crediting instruments, ETS and carbon taxes often work in tandem, offering flexibility for compliance with emission reduction obligations.
- Voluntary markets: companies, institutions or end-users voluntarily want to "offset" their emissions (e.g., from industrial activities, or air travel) by buying credits from emission reductions elsewhere.
- Climate finance: finance to support mitigation can be granted through the purchase of carbon credits, which serve as "receipts" for emissions reductions under a RBF scheme.

Over time a wide range of instruments have been developed that put a price on carbon. These instruments include ETS and crediting but also carbon taxes, Nationally Appropriate Mitigation Actions (NAMAs) with a crediting element, and RBF. It is important that the PMR now considers its role in providing support to a wider set of policy outcomes than those initially envisaged, i.e., ETS and crediting.

Map 1. Existing, Emerging and Potential Regional, National and Subnational Carbon Pricing Instruments (ETS and Tax)



Source: © 2015 International Bank for Reconstruction and Development/ World Bank. This map was taken from *Carbon Pricing Watch 2015*, developed by the World Bank and Ecofys (World Bank. 2015. *Carbon Pricing Watch 2015*. Washington, DC: World Bank).

1.2. Crediting Can Play a Role in Climate Change Mitigation Policy Development

Countries can use crediting instruments in a number of ways to contribute to their wider climate change mitigation policy and strategy. For example, they can help to identify lower-cost mitigation actions, and build capacity and institutions to support these actions. This can in turn support the development of other

policy instruments, both market and non-market-based, from ETS and carbon tax systems to regulatory and incentive-based approaches to reducing GHG emissions.

The possible pathways from crediting instruments to an expanded suite of mitigation policies are many. The figures below show three conceivable pathways by which crediting instruments could serve as a stepping stone to more comprehensive mitigation policies.

In this first example, shown in figure 1, climate finance can support the implementation of a NAMA. Climate finance can be disbursed in the form of RBF, which in turn could evolve into a crediting instrument, possibly under a future United Nations Framework Convention on Climate Change (UNFCCC) Framework for Various Approaches (FVA) or New Market-based Mechanism (NMM), once there is sufficient international demand for carbon credits. Once the conditions are appropriate for domestic targets and demand to drive a domestic system, the market institutions and capacities established through the crediting system could help in launching a domestic ETS. The ETS could then replace, or continue to work in tandem with, the crediting approach.

In this second example, shown in figure 2, the CDM is the starting point. International demand is then replaced by domestic demand through a domestic project-based crediting system, which might then extend into sectoral coverage and evolve into a broad and flexible regulatory regime that achieves widespread reductions through multiple possible compliance strategies (market or non-market).

Figure 1. Potential Role (A) of Crediting in Climate Change Mitigation Policy Development

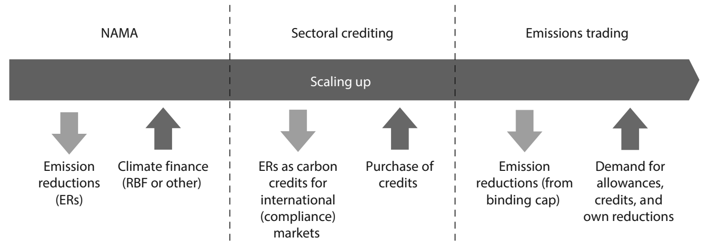
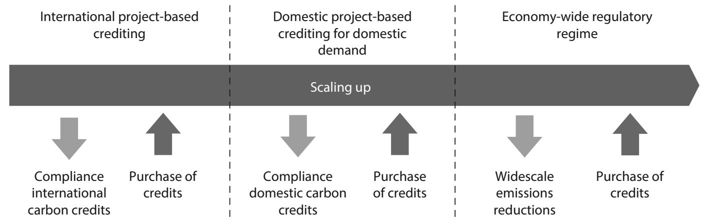


Figure 2. Potential Role (B) of Crediting in Climate Change Mitigation Policy Development



1.3. Factors Determining the Future of Crediting

The success of crediting instruments, now and in the future, relies on adequate demand for carbon credits, both in terms of volume and price. We identify three factors that will be crucial to future demand for credits:

1. **Levels of ambition in climate agreements:** The number of countries that take targets, whether these targets are binding, the stringency of these targets in relation to cost-effective GHG mitigation potential, and the timeline for achieving these targets will all affect future demand for credits. The expected Paris agreement this year has particular significance in this regard. The Intended Nationally Determined Contributions (INDCs) that countries have been asked to put forward this year will provide an indications of the magnitude of intended emissions reductions and the role of markets. At the national level, the ambition in the sectors with a target and the volume of the domestic voluntary market will influence the domestic demand.
2. **The role of crediting in future targets and the policies used to meet these targets:** Beyond the ambition of future targets, the critical question is whether credits will be viewed as a valid means to comply with targets, and if so, the extent to which there could be quantitative and qualitative restrictions on the use of carbon credits. This requires policy choices on the types of mitigation instruments. Some instruments, e.g., carbon tax and ETS, lend themselves better to the use of credits than, for instance, renewable energy or energy efficiency policies, where GHG emission reductions are not (yet) the sole or primary metric. The demand is also influenced by quantitative and qualitative restrictions on the acceptance of credits. For example, the European Union (EU) decision to limit the use of CERs for compliance, followed by a ban on international credits in phase 4 (from 2020 onwards), had a significant impact on demand.
3. **The ability to implement policies:** In practice the demand for credits will also be affected by countries' ability to implement policies such as ETS or carbon taxes that allow the use of credits as a means of compliance. Political preferences for the sources of credits and macro-economic conditions will also be important. Similarly, the supply of credits will depend on the ability of participants in the crediting instruments to generate credits that meet buyers' requirements. This aspect is of particular interests to the PMR, which aims to build readiness on the supply side and in domestic demand.

It is clear that the future of crediting—an important part of the PMR's work—is uncertain, particularly in terms of future demand. Still, crediting instruments have the potential to support the development of a wide range of climate policies, so there is merit in continuing to help develop them. With at least eight countries interested in doing this under the PMR's support program, it is important to understand what activities might be relevant, and how these can contribute to the wider mitigation agenda. These topics are examined in sections 2–4.

2. Features of Crediting-Related Activities in Eight PMR Countries

This section, draws lessons from crediting-related activities in eight PMR countries, looking at commonalities and differences in the countries' approaches, as well as some of the factors that account for them.

2.1. Key Features of Crediting Instruments Supported under the PMR

Crediting instruments such as Clean Development Mechanism (CDM) have helped build capacity and experience with market mechanisms specifically, and with the development, quantification, and monitoring of climate change mitigation activities more broadly. This experience has facilitated interest in exploring and pursuing various crediting approaches, which has led to the emergence of various crediting instruments at the domestic level. This evolution can be observed under the PMR, where 11 of the 17 current Implementing Countries are contemplating a crediting instrument, and undertaking, or planning to undertake, crediting-related activities.

This study focuses on the eight countries where crediting is the principal market-based instrument put forward under the PMR. The three others are developing domestic credit markets as a compliance option for a carbon tax or emissions trading systems (ETS), and are not explored here.[1]

Table 1 lists the types of instruments, sectors of focus, and expected sources of credit demand for each of these countries. The analysis presented is based on the review of the Market Readiness Proposals (MRPs) prepared by the eight countries and interviews with country focal points within the PMR Secretariat.

Main Features

Figure 3 depicts the progress towards the implementation of the MRP and, where applicable, the crediting instrument(s) used in the selected eight countries.

For each country the main features of the crediting instruments under the PMR are examined and documented in full country profiles (see appendix B).[2]

These profiles provide an overview of the type of instrument(s) proposed, the lead institutions and the principal stakeholders, and the timeline for implementation. There is a brief discussion of the rationale behind the choice of instrument and sectors covered as well as the role of crediting in future targets. The source of demand is discussed and a timeline and roadmap to implementation is provided. The aggregated findings are captured in the following section.

[1] The CCER scheme in China and the offset component of the South African carbon tax are not covered. Mexico is covered through its NAMAs but the offset component of the carbon tax is not covered.
[2] The appendix B reflects the information collected and reviewed as of February 2015.

Table 1. Overview of Crediting Instruments in Eight PMR Implementing Countries

Country	Type of instrument(s)	Sectors covered	Sources of credit demand currently envisaged
Colombia	NAMAs with a crediting component Domestic offset scheme Possible permit scheme for vehicle importers	Urban transport	Domestic (for domestic offsets through fuel carbon levy; vehicle importer/ producer standard) International (NAMAs with crediting component)
Costa Rica	Project-based crediting instruments for multiple sectors with some voluntary domestic demand	1st Phase: power generation, agriculture, solid waste, transport, and sustainable construction	Domestic (entities committing to carbon neutrality); Some activities may be supported via (crediting) NAMAs
Mexico	NAMAs with a crediting component	Urban communities; urban transport; refrigeration	International Domestic (compliance with tax or ETS)
Morocco	Sectoral crediting	Electricity, cement, phosphates	International
Peru	NAMAs with a crediting component	Provisional scope: energy supply, housing, industry, waste and transport	International and possibly Domestic (under consideration)
Thailand	Project-based crediting	Municipalities and communities	Domestic (pooled funds; voluntary market)
Tunisia	Sectoral crediting	Electricity; cement	International
Vietnam	NAMA with a crediting component	Steel; solid waste	International

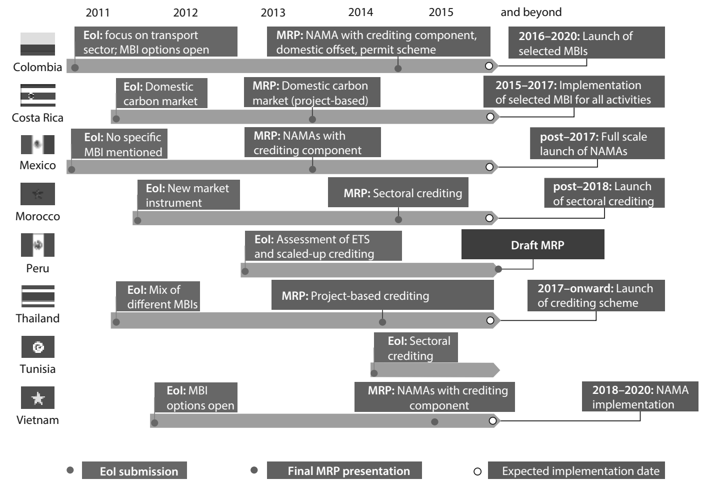
2.2. Summary of Commonalities and Divergences

The eight PMR countries display many commonalities in their approach to crediting instruments, but the design choices also reflect different national circumstances and considerations. The experiences and choices of the countries to date illustrate that there is no single preferred model, and show the extent to which countries can tailor the design to suit their institutional, economic and political contexts.

Based on the assessment of crediting-related activities in eight countries, we identify four differentiating elements:

- There is no general blueprint for the design of crediting instruments.
- The choice of sectors reflects national priorities.
- Countries use crediting in alignment with, and to support, their particular domestic climate policies.
- A portfolio of measures exist to mitigate risks from an uncertain international demand.

Figure 3. Timeline and Progress of the Activities under the PMR



We also find four common elements:

- Use of policy analysis to underpin the crediting instrument.
- Enabling an institutional and regulatory framework.
- Establishment of MRV capacity and systems.
- Establishment of a GHG data management system and/or registry.

Choice of Instrument: There Is No Common Blueprint for the Design of Crediting Instruments

Most countries point to similar factors in their choice of instrument: past experience with carbon markets, convergence with other domestic policies, interest in market-based instruments (MBIs), perceived readiness for crediting and trading instruments, a desire to enhance other national and international climate change initiatives, and the opportunity to acquire additional finance.

Nevertheless, each country has specific settings and defines different key sectors. As a result, even when similar factors are taken as a starting point, the results are remarkably diverse.

Examples

- Morocco and Tunisia are examining sectoral crediting, building on their experience with CDM, and significant economic activity and interest in key emissions-intensive sectors.

- Driven by its strong emission reduction commitment and a history of pioneering offset efforts, Costa Rica is implementing a domestically oriented, project-based crediting system.
- Thailand is looking at a similar energy performance certification scheme for key sectors, combined with a city-oriented project-based crediting program that builds on its already established Voluntary Emission Reduction program.

In Morocco, Tunisia, Costa Rica, Vietnam and Thailand alike, the crediting instrument considered under the PMR is seen as a main instrument for GHG mitigation and a stepping stone towards another market-based instrument.

- In contrast, in Mexico and Peru, crediting complements existing, broader NAMA initiatives as a way to provide an additional source of finance to enable further implementation; in Mexico's case, PMR activities may be only one part of country's more ambitious climate policies, where a carbon tax has been approved and ETS is under consideration.
- Vietnam considers NAMAs with a crediting component as an intermediate instrument that could lead to an ETS in the long term.
- Like Thailand, Colombia is exploring multiple crediting instruments through the PMR, with a focus on the transport sector: from crediting NAMAs to a domestic offset scheme supported by a carbon levy, and a possible vehicle performance standard.

Instruments pursued under the PMR could evolve in response to new developments. Several countries are undertaking comprehensive assessments of policy options through the PMR as well as stakeholder discussions that could inform future changes. In addition, several of the eight countries examined have recently changed national governments. Such political changes could—and have—also influenced changes in approaches to climate policy. Signals regarding international demand for credits that could emerge from changes in carbon markets or new international agreements could have a similar impact.

Choice of Sectors: The Sectors Covered Often Reflect National Priorities

The eight countries have many criteria in common for selecting sectors for activities under the PMR, including:

- Significance in the total GHG emissions and energy consumption,
- GHG mitigation potential,
- Existing carbon market and MRV capacities,
- Willingness of entities in the sector to participate,
- Development of co-benefits,
- Potential to contribute to the development of MBIs, and
- National priorities and synergies with other ongoing initiatives aiming to support mitigation efforts.

Examples

- Both Morocco and Tunisia have particular emphasis and activities in renewable energy which contribute to a focus on the power sector.
- In Vietnam the steel and waste sectors, the focus of PMR activity, are a government priority for investment and reform.

- Likewise, cities and the industrial sector are priority areas in the national energy efficiency development plan of Thailand, and along with the building sector, and the focus of PMR activities.
- Furthermore, many countries are proposing NAMAs in the selected sectors and are looking to explore the synergies between the NAMA activity and the PMR activity in the sectors chosen, such as cement in Tunisia, transport in Colombia, and the focus sectors of Vietnam and Mexico.
- There are also regional commonalities in the choice of sectors, such as the electricity and cement sector in the Maghreb (Morocco and Tunisia) and urban transport in Latin America (Colombia and Mexico). The countries interested in transport and urban development activities under the PMR often have large, congested cities with planning challenges and have a history of innovation in urban transport, such as in Mexico and Colombia; mitigation activities in these sectors could result in many co-benefits.
- Peru and Costa Rica have a broader scope for sectors of focus under the PMR. The rationale behind this is either seeking a broad domestic effort, in the case of Costa Rica, or keeping the options open for future activities, as with Peru, which is still at an early stage of engagement with the PMR.

Role of Crediting Instruments: Crediting Supports Domestic Climate Policy and/or Markets

Given uncertainties in the future ambition of international climate change commitments, most PMR countries mainly intend to use the crediting instruments to strengthen their domestic climate policy. However, in the longer term, these instruments could also contribute to any international commitments that they make.

Examples

- Costa Rica, Mexico, Peru, Thailand, and Tunisia have national climate change strategies. In Costa Rica and Tunisia these strategies envision an important role for market-based instruments.
- Morocco, Colombia and Vietnam also put forward strategies to decouple GHG emissions from economic growth. In these domestic climate policies a significant contribution is expected from the selected sectors for activities under the PMR.
- In Peru, Mexico and Vietnam, crediting activities are also intended to enhance the proposed NAMAs.
- Domestic climate policies in the eight PMR countries include different types of targets. The Latin American countries have targets for GHG emissions, Vietnam uses GHG emission intensity targets, and the Thailand targets focus on energy savings and renewable energy. These countries view crediting instruments as ways to help achieve these targets, mindful of the fact that emission reductions achieved cannot be counted towards such targets if corresponding credits are sold internationally and used to meet other countries' targets.

Sources of Demand: Different Ways to Mitigate Risks from Uncertain International Demand

Most countries recognize that the large uncertainties in future international credit demand mean that they cannot count on a high volume or high price for credits sold, at least in the near term. PMR countries have taken different actions to mitigate these risks.

Examples

- Some countries turn to domestic buyers as the primary source of demand as in Costa Rica and Thailand, though uncertainty in demand remains.
- Instead of relying solely on the demand for credits, Vietnam, Peru, Colombia and Mexico are using other ways to obtain international funding for their activities.
- Rather than directly developing a crediting instrument, some countries focus on generating emission reductions that can be bought through RBF in the short-term before transferring these emission reductions into compliance-recognized credits once there is adequate demand.
- Unlike the other countries, Morocco, Vietnam and Tunisia are not yet explicitly considering domestic demand or NAMAs with crediting (still an undefined concept) as a source of funding. The international carbon market remains the principal anticipated source of demand for any sectoral credits in these two countries.

In recognition of the uncertainty surrounding the future international regime for climate change, the World Bank Group is developing a proposed piloting fund for scaled-up crediting in order to test new instruments to generate emission reductions at scale and at low cost, while also incentivizing developing countries to make long-term contributions to global mitigation and build their carbon pricing infrastructure. The Fund will support large-scale crediting programs in developing countries at a national, subnational, sectoral or city-wide level, by providing payments for carbon credits. While providing lessons for future mechanisms, these programs will also achieve significant mitigation in their own right.

Roadmap to Implementation: Common Activities

The MRPs for all eight countries share a few activities in common, though they may differ in approach or focus. These activities include:

Analyzing the policy context

Assessing in more detail which instrument is appropriate (policy analysis), including the coherence with existing and planned policies and initiatives. The objective of the analysis is to select the most suitable mitigation instrument(s) for the country.

Examples

- In Thailand and Vietnam, the analysis covers not only activities planned under the PMR, but the future development of the mitigation instrument, such as a potential future ETS.
- In the countries that have clearly selected a particular mitigation instrument, the upstream policy analysis focuses on how PMR activities can strengthen the instrument, as in Peru, where NAMAs has been selected.

Setting up a regulatory framework

An enabling institutional and regulatory framework is needed to lift regulatory barriers and strengthen institutional capacity. These activities are not limited to solely enabling activities under the PMR, but also aim to support countries' domestic climate policy.

Examples

- Lifting barriers that prevent investment in clean technology in Morocco and Tunisia.
- Assigning roles and responsibilities in relation to the crediting instrument in Thailand and NAMA development in Peru and Mexico.

Building MRV capacity

Building capacity and systems for the MRV of GHG emissions is essential to monitor mitigation actions and provide confidence that all mitigation activities meet a set of standards.

Examples

- Setting up a sectoral MRV system for three sectors in Morocco.
- The planned MRV activities can go beyond GHG emissions. For example, in Peru the MRV framework should cover development and climate impact, and in both Peru and Colombia, the MRV framework should also cover NAMAs.

GHG data management

Implementing a GHG data management system and/or registry ensures that reliable GHG emissions data are collected to inform future policy decisions.

Other shared activities

Several other activities are being pursued by more than one country; examples are provided below.

- *Setting of baselines and quantifying mitigation potential* are among the planned activities of many countries, including Mexico, Morocco, Peru, Thailand, Tunisia and Vietnam, as it is necessary to determine the GHG mitigation opportunities and costs and impact of mitigation activities.
- Most MRPs included mitigation *instrument design* activities, such as sectoral crediting mechanisms in Morocco and Tunisia, crediting components of NAMAs in Peru and Vietnam, and a potential ETS for Thailand.
- Colombia, Tunisia, Morocco, Thailand and Mexico are considering "piloting" their market-based instrument to some degree under the PMR, although in the latter two countries this is not covered in the first tranche of PMR funding.
- Costa Rica is already piloting its market-based instrument and is focusing on developing its *domestic carbon market infrastructure* for full implementation. Wider market readiness capacity-building activities are included in Colombia, Costa Rica and Mexico.
- Countries with instruments relying on voluntary domestic demand, such as Thailand and Costa Rica, are planning *outreach activities* under the PMR to strengthen demand.
- Vietnam, Tunisia, Peru and Mexico are also explicitly planning activities to increase *stakeholder participation* in the planned initiatives.
- *Strengthening the financial infrastructure* is included in the MRPs of Mexico, Colombia, and Peru; this covers *exploration of investment frameworks* for mitigation action, looking at how results-based budgeting with GHG metrics could work.

It is important to note that the activities discussed above have not been implemented yet, so it is not possible to assess the barriers to their implementation, or their ultimate success. However, it is helpful to understand whether the activities that these countries are undertaking will prepare them well for the wide range of policies they may eventually adopt. The extent to which these different crediting-relating activities can be considered no-regrets is explored in section 3.

3. Elements of a No-Regrets Market Readiness Work Program of the PMR

Given the many uncertainties surrounding crediting instruments, the notion of pursuing "no-regrets" readiness activities has emerged. The no-regrets term has a long history in the realm of climate policy. In the past, it has been used to refer to mitigation activities or investments that are desirable and justifiable for reasons other than GHG emission reductions: in other words, actors would not "regret" pursuit of an activity even if anticipated climate policies or carbon revenues did not ultimately materialize. Typically a no-regrets mitigation activity is one that yields a net economic benefit (positive Net Present Value) or is financially attractive (Internal Rate of Return above a certain threshold). It could also be justified due to social or non-climate environmental benefits. Cost-effective energy efficiency measures are the classic no-regrets activity.

In the context of readiness for crediting instruments under the PMR, "no-regrets" activities take on a similar meaning but in a different context. A crediting or market readiness-related activity can be considered "no-regrets" if it is desirable and justified for purposes other than supporting the implementation of a crediting instrument. In other words, actors would not "regret" pursuit of a crediting-related activity—such as upstream policy analysis or development of an MRV system—even if the targeted crediting instruments did not materialize as hoped (e.g., due either lack of implementation or lack of market).

A no-regrets activity could, for example, have value in laying the groundwork for other existing or future policies or mechanisms. These policies could include emissions reporting regulation, voluntary incentives, or the further development of other market mechanisms at the national or international levels. A key characteristic of a no-regrets activity is thus that it may yield multiple benefits, beyond those associated specifically with the targeted mechanisms, i.e., adaptable capacity and institutions. Ensuring that activities yield outputs that are credible, consistent and compatible—the "3Cs" that underpin PMR support—is also central to reducing the potential for future regret and opportunity costs.

This section develops criteria for assessing no-regrets market readiness efforts, and explores these criteria in more detail. Some conclusions are drawn about how to balance the priorities of minimizing regrets and maximizing benefits.

3.1. Criteria for Assessing No-Regrets Market Readiness Efforts

Ultimately, assessment of what one might or might not "regret" depends on uncertainties about future climate policies, economic development, and other market signals and factors. Criteria must thus include the ability for readiness activities to accommodate or adapt to circumstances that could be reasonably expected to occur. They should also reflect the readiness needs of different actors, such as government and the private sector, which can be addressed partly through some crediting-related activities, such as capacity building or institutional development. These are discussed further below.

In the next sub-sections, we consider the range of activities currently undertaken in the context of support for crediting instruments under the PMR, or those that might be considered in the future, and assess the extent to which they might:

1. **Create readiness** by facilitating frameworks for scaled-up mitigation and assisting in the implementation of various mitigation-related policies, including market and non-market instruments. At the same time, activities should minimize potential "regrets" by avoiding risks of missed opportunities or inefficient journeys, e.g., by considering a wide range of potential future policy frameworks, being adaptable to changing circumstances, creating realistic expectations, and avoiding over-investment in activities highly dependent on uncertain market rules.
2. **Maximize potential benefits** by increasing institutional or political momentum for low-carbon investment, strengthening stakeholder engagement in mitigation opportunities, promoting synergies among mitigation-related activities, or even through the learning that can take place when implementing mechanisms of limited duration.

Because they are very closely linked, we have combined the concepts of creating readiness and minimizing regrets. Put succinctly, readiness creates conditions for increased mitigation, while regrets can undermine those conditions by reducing interest or instilling a sense of futility due, for example, to perceptions of wasted effort. By enhancing readiness for increased mitigation that could be pursued through multiple policy options, well-designed activities should effectively reduce the risks of regret.

3.2. Crediting-Related Instruments and Other Policy Outcomes

To help evaluate the robustness of the crediting-related activities described in terms of contribution to readiness for a variety of possible climate policies, we consider the relevance of crediting-related activities to a range of climate policies, which include market and non-market instruments.

In most MRPs, these crediting-related activities are implemented to prepare for a specific crediting instrument, e.g., domestic project-based crediting in Costa Rica or sectoral crediting in Morocco. These fall into one of four categories:

- Domestic project-based crediting (e.g., to support an ETS, a carbon tax, or voluntary program);
- Domestic sectoral crediting (e.g., to support an ETS or a carbon tax);
- International project-based crediting (e.g., the CDM or a reformed CDM);
- International sectoral crediting (e.g., as might be implemented through the New Market-based Mechanism).

This analysis also considers the following additional possible future policies:

- ETS (domestic or regional);
- Carbon tax (likely domestic);
- Results-based finance (this is generally not a policy in itself, but as shown in figure 2, it can be a bridge to crediting).

In addition, some crediting-related activities can help countries assess and set of mitigation goals and pathways, e.g., Intended Nationally Determined Contributions (INDCs), and subsequently monitor and track achievement. Crediting-related activities can also be beneficial for NAMAs with a crediting component, which may be any kind of national mitigation policy that includes a methodology and approach to generate credits.

3.3. Crediting-Related Activities

In this section, we describe a range of crediting-related activities, and consider how their design and implementation may be relevant to other policy instruments, such as those noted in the prior sub-sections. This review, in turn, informs our assessment of how these activities might satisfy two criteria: 1) creating readiness while minimizing regret, and 2) maximizing benefits. We consider 15, in some cases overlapping, activities:

1. **Instrument design:** This activity involves the elaboration of specific design elements of a crediting instrument: the sequenced implementation of many of the activities that follow (MRV, baselines, etc.), which can lay the ground work for other, closely related policies. For example, the design elements of an international sectoral crediting system design could be easily transferred into a domestic sectoral crediting system. The coordinated implementation of MRV and baseline methodologies can be useful for assigning emission reduction benefits to non-market instruments such as RBF. However, for other more complex policies, such as a full ETS, the design of a crediting instrument would only provide some of the elements needed.
2. **Mitigation potential assessment:** Such an assessment can be used to inform the scale and nature of emission reductions that might be expected from a crediting instrument. It can be undertaken at any point, from design through to implementation and evaluation. A mitigation potential assessment for a crediting instrument may be useful for other policies, depending on the methodology used. While mitigation potential assessment is a part of good policy practice, it is not necessarily essential for the development of an individual policy. However, it is useful for a country's development of targets and actions, such as INDCs and NAMAs. By identifying the extent of low-cost or potentially cost-effective mitigation, a mitigation potential assessment can also help to build momentum for more ambitious climate policies.
3. **Data collection:** This activity covers the collection of data, such as emissions, energy consumption, activity data, emission factors, etc., needed expressly for the design or implementation of a crediting instrument (e.g., for setting baselines). Nearly all climate-related policy instruments require data collection for successful implementation, but the data sets are likely to be different in scope, depending on the instrument, and on level of detail, and possibly even on the timing of data collection. For example, some approaches, such as the EU Emissions Trading System (EU ETS), require ex-ante data, while others, such as RBF, may rely largely on ex-post data. That said, robust data collection systems, and the associated institutional and professional capacities developed in their implementation, can often remove key obstacles to progress in adopting more comprehensive policies.

4. **Data management:** The management of data can involve setting up systems or tools and processes and may overlap to some degree with MRV and data collection. The management of data, in the case of a crediting-related activity, relates directly to a data management approach and structure that is relevant for the crediting instrument considered. The transferability of the data management approach is most likely where similar sectors are covered, and at a similar point of obligation.
5. **MRV:** A crediting instrument requires the design and delivery of a monitoring, reporting and verification system for the emissions, activities, and other determinants of emission reductions relevant to the planned crediting instrument. It must consider what processes, actors, and institutions are involved, what they do and how they do it. This task can also lead to concrete implementation activities, such as registries and capacity-building (see other activities listed here). The MRV framework for the crediting instrument can be designed in a way that enables further expansion later on or starts off broad, enabling flexibility. For example, in many countries mandatory reporting of GHG emissions is introduced for industrial facilities over a certain threshold in advance of clear legislation on, e.g., an ETS, a tax or a crediting instrument.
6. **Regulatory and institutional frameworks and coordination:** This activity involves the development of the institutional structures, including relationships between institutions, and apportioning of roles and responsibilities for the planned crediting instrument. This includes a clear structure legislative framework, and the initial steps towards developing them. In some countries this type of legislation can be quite broad, enabling or stimulating the development of a range of related guidance documents. In other contexts, such legislation will be quite narrowly defined, and therefore less flexible for use for other purposes.
7. **Quantification approaches (including baseline-setting):** This is the development of methodologies, using existing data, or proxies, to set a baseline and quantify emissions either in preparation for the activity or once the crediting instruments is running. This activity may be linked to MRV. The development of a baseline for a given sector with a crediting approach in mind could be useful for the development of benchmarks, or caps within the context of an ETS, for example. As noted above, quantification approaches developed for crediting programs can have wide utility for other policies and actions. Indeed, the CDM and other offset program approaches have been widely considered for other purposes, such as in the development of impact assessment methods for climate finance (e.g., Green Climate Fund).
8. **Crediting methodologies or protocols:** Codification of quantification approaches, eligibility requirements, and other procedural aspects into clear and transparent methodologies is an essential feature of a crediting instrument. This activity may be linked to MRV developments and registries. These crediting methodologies, particularly quantification approaches they contain (per above), tend to be highly transferrable among policy instruments.
9. **Approaches to achieve net emission reductions:** This is the delineation of approaches to delivering net emission reductions as part of the crediting instrument. This is not yet an operational concept in existing crediting instruments (see appendix A).
10. **Registries for crediting projects and units:** This activity involves the development of a registry that is fit for purpose, as well as safe and secure. Whilst the broader structure of a registry can be

useful for a range of purposes, for example it could be modified to store domestic credits as well as international credits, sectoral or project credits, the functional specificity may need modification, e.g., for use in an ETS. The skills and institutions involved in developing and operating a crediting registry can prove valuable in other contexts. For example, the California Climate Action Registry was established in 2001 and closed in 2010 having evolved into a voluntary corporate emission registry (the Climate Registry) and the principal offset program registry, and methodology developer for the California ETS (Climate Action Reserve).
11. **Creation or strengthening of domestic demand:** This activity involves the implementation of complementary policies (e.g., regulatory requirements, financial incentives, or promotional programs such carbon-neutrality schemes), or strengthening of existing policies in order to stimulate domestic demand for credits that arise from the instrument.
12. **Investment frameworks:** This activity involves the elaboration of specific frameworks for public finance, or finance vehicles that can attract private sector participation in crediting instruments. These investment frameworks should operate well within the existing financial frameworks and environment to channel money safely to and from crediting investments. Finance approaches are likely to be very specific to the intended crediting instrument, and therefore will be quite different from e.g., the finance vehicles required for project-based or ETS-type instruments.
13. **Capacity-building, engagement, and stakeholder participation:** These activities can consist of a range of engagements, from preliminary soundings, to intense discussions about plans, data collection activities and target-setting. These activities can also include training, workshops and outreach with sectors participating in a crediting instrument, as well as those who may have a role as it develops, e.g., certain government departments, private-sector players (such as verifiers). The general engagement as well as specific capacity-building for a crediting instrument may have varying degrees of relevance for other policies. In many of the PMR countries, the pool of stakeholders, across all sectors, is quite small, and therefore undertaking such activities for crediting is likely to impact a range of players who are also involved in other, broader mitigation topics.
14. **Piloting activities:** This represents a limited-scale implementation of the crediting instrument, generally with some type of upfront funding, with the intention to test many of the design elements as described above. Such pilots can also deliver mitigation results and credits. Piloting should have a clear evaluation mechanism so that it can be used to test the viability of certain approaches. Piloting activities have the potential to test some transferrable elements of the crediting system, such as institutions, some methodological issues, but already show a significant commitment to one policy outcome.
15. **Implementation activities:** These activities are the actual implementation of the crediting instrument, such that it generates credits that can be used as intended, domestically or internationally. At this stage, the flexibility to steer towards other instruments is already most limited.

3.4. Criterion 1: Creating Readiness while Minimizing Regret

In this section, we consider how the range of crediting-related activities might contribute towards readiness for a suite of policy instruments, while minimizing regrets. It is important to underscore, however, that definitive evaluation of these activities in terms of this criterion would be extremely challenging and possibly counter-productive. Initially, we attempted such an evaluation, but we found limited basis for clear and replicable determinations. There is a wide variety of crediting instrument designs, country contexts, and implementation approaches. For example, "instrument design" for an international sectoral crediting, which is likely to rely to some extent on internationally set rules, will differ significantly from the design of domestic, project-based system, with its larger set of domestically defined rules.

With these caveats in mind, we developed an approach that enables one to consider the extent to which an activity (e.g., MRV system) designed with one crediting instrument in mind (e.g., domestic sectoral crediting) might prove valuable under a range of alternative policy instruments (e.g., project-based crediting or a carbon tax). To illustrate this approach, table 2 depicts how activities designed for the purpose of supporting implementation of a domestic sectoral crediting instrument might contribute to the design and implementation of the targeted instrument as well as five alternatives. We then assess whether, for a given instrument, the associated activity might be required or helpful. In principle, activities that are required, or to a lesser extent, helpful, for multiple instruments could—but do not necessarily—create readiness while minimizing regrets, as defined above. As noted however, the devil is in the details: good design and delivery of a given activity, and an eye towards other instruments in doing so, will be more consequential that the relatively simple assessment this table provides.

Table 2. Illustrative Assessment of the Relevance of Crediting-Related Activities Undertaken to Develop a Domestic Sectoral Crediting Approach to Other Policies and Funding Approaches

Options for crediting-related activities	Domestic sectoral crediting	International sectoral crediting	International project-based crediting	ETS	Carbon tax	Results-based finance
Instrument design	Required	Required	Helpful	Helpful	Helpful	Helpful
Mitigation potential	Helpful	Helpful	Helpful	Helpful	Helpful	Helpful
Data collection	Required	Required	Helpful	Required	Required	Helpful
Data management	Required	Required	Helpful	Required	Required	Required
MRV	Required	Required	Helpful	Required	Required	Required
Regulatory and institutional framework	Required	Helpful		Required	Required	Helpful
Quantification (+baseline)	Required	Required	Required	Required	Helpful	Helpful
Crediting methodology	Required	Required	Helpful	Helpful	Helpful	Required
Net emission reduction approach	Helpful	Helpful	Helpful			Helpful
Registries	Required	Required		Required		Helpful
Domestic demand	Required			Required		
Investment frameworks	Helpful	Helpful	Helpful			Helpful
Capacity building	Required	Required	Helpful	Required	Required	Required
Piloting activities	Helpful	Helpful				Helpful
Implementation activities	Helpful	Helpful		Helpful	Helpful	Helpful

Note: This table provides a subjective assessment based on the authors own interpretation of how each activity would look under domestic crediting, and the extent to which this development would be necessary or contribute to other potential policies and funding approaches.

How the Assessments Shown in Table 2 Were Developed

Required: The activity, as it is implemented for domestic sectoral crediting, is directly in line with the requirements of the alternative policy outcome considered. For example, taking the "required" square at the intersection of "data collection" and "international sectoral crediting" means that developing a data collection system for a domestic sectoral crediting instrument would involve designing elements that would also be essential part of the requirements of an international sectoral crediting instrument.

Helpful: The activity, as it is implemented for domestic sectoral crediting, can provide some assistance in the implementation of the alternative policy instrument. However, it might not exactly map onto the needs of this alternative policy instrument, so may need to be slightly supplemented. Or, this activity is not needed but carried out with crediting in mind, it may assist, and will not detract from this alternative instrument. For example, developing a clear crediting methodology for a domestic sectoral crediting instrument could be used for the methodologies that are essential for an international sectoral crediting approach, or for results-based financing at the sectoral level. However, under an international sectoral crediting instrument rules or guidance to develop methodologies are likely to be set top-down. These methodologies could also be helpful in a broad sense for other systems where credits might be generated, e.g., as complementary part of an ETS or tax, but it would not be essential.

Not required: This activity, as it is implemented for domestic sectoral crediting, will have little or no influence on this alternative policy instrument on the basis of our current understanding of what this policy instrument involves. For example, the development of a net emissions reduction approach for a crediting mechanism will not provide any value to an emerging ETS or carbon tax, although it could help inform other crediting policy instruments.

The entries in table 2 should be viewed as best guesses based on the judgment of report authors but not necessarily the "right answer." Crediting instruments and their contexts, and thus the need for specific elements (e.g., crediting baselines) can vary widely.

The following general observations can be drawn from table 2, and from the review of activities in the preceding section 3.2:

All of the crediting-related activities can contribute to preparing to more than one possible policy instrument and so whichever activities are chosen, some flexibility remains.

Some of the workstream options have quite broad applicability, notably, data management, MRV and capacity building. These elements are required for almost all policy outcomes and for these elements the types of activities undertaken for crediting could deliver equally for other elements.

A role for crediting-related activities could be possible in the context of a carbon tax or an ETS and therefore there are possible synergies, however, the extent to which these synergies will really come into play will depend on how a crediting instrument is combined with a tax or ETS. The CDM is already quite established and therefore the international project-based mechanism appears to benefit less from many of the workstream activities. Nevertheless, the actual impact of an activity will depend on the level of CDM capacity and knowledge available in the host country.

RBF is a flexible tool that can be applied both to sectoral and project-based approaches. The level of stringency for RBF might not need to be as high as for an offset mechanism. As such many of the crediting-related activities are helpful rather than required. In practice this will, however, depend on the agreement between the host country and the funder providing RBF.

Some of these workstream activities are necessary for all of the possible outcomes but the work done from a crediting perspective will not necessarily deliver for other outcomes as table 2 shows, the instrument design that is needed for a crediting element, is so different from the policy design required for an ETS or a carbon tax, it does not actually create a platform to build upon.

As the workstream activities get more specific, they become less flexible which is especially true for piloting, implementing actions and also financial vehicles. There can be some cross-learning but it will not be highly transferrable.

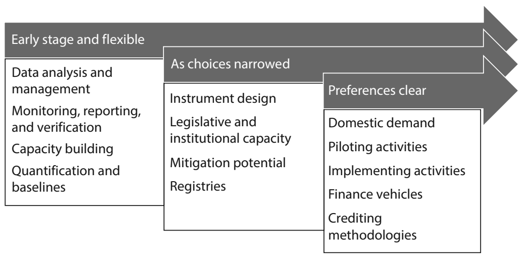
Using the analysis in table 2 as a starting point, it is possible to imagine a sequenced pathway of actions *if the goal is to maintain flexibility*. This is shown in figure 4.

This theoretical ordering considers criterion 1 only. It can also be argued that such an approach is very non-committal, and can signal a lack of certainty of action to other actors, including those in the private sector. These weaknesses could undermine, or at least slow, effective action on the climate agenda.

An Empirical Perspective: A Country Focus

It is informative to compare these theoretical findings to the experiences of the MRP countries outlined in section 2. In at least five countries, activities relate to building the institutional and regulatory framework and capacity in the recipient countries. These changes, in most cases, are planned in a broad manner, i.e., covering institutional capacity for investment in clean technology in Morocco and Tunisia. The focus is more on the institutional side, than the legislative side, again making the implementation of this activity quite open and perhaps aligning better with the concept of capacity building, than with the notion of developing an institutional and legislative structure—which is more constricting according to the theoretical framework.

Figure 4. A Possible Sequencing of Activities Consistent with Criterion 1



All of the eight countries have included some type of data management system and/or registry. The data management element is recognized to be one of the activities that promotes readiness most.

In addition to the detail of the individual activities pursued, the experience from the eight MRPs investigated underlines the truism that the route towards successful implementation of policies is as related to the political context as it is to the technical elements. The changing face of many policies in the countries investigated is related to high-level political decisions. It is therefore heartening to see that many investments provide broad readiness and can withstand the test of political changes by contributing to a wide range of potential outcomes.

So it seems that some activities are implemented in a way that strives to minimize regrets. On the other hand, five of the eight countries, are considering instrument design in detail, which could be less consistent with criterion 1, to the extent it is taken literally. Costa Rica has already started piloting its instrument, and a further five countries are considering piloting their market-based instruments under the PMR, but only three in the first tranche of funding.

Some countries are clearly keeping options open, but other countries are engaging in activities that show commitment to their choices of instruments and indicate that this readiness and no-regrets perspective is not the only criterion used. It is evident that despite the risk identified in the construction of the theoretical sequencing, countries are willing to make more concrete choices, and for them, preferences are clearer and criterion 1 may not be quite as important as other criteria or priorities.

3.5. Criterion 2: Maximizing Benefits

This second criterion considers the benefits of different activities, in addition to their direct contribution to the development of a crediting instrument. These benefits can include:

- **Increasing political momentum for low-carbon developments:** Certain activities, if undertaken for crediting, can demonstrate a political will to take action on low-carbon development as a whole, and it may also act as a demonstration to politicians and policy-makers who are not already convinced, that low-carbon developments are possible and desirable.
- **Providing confidence to stakeholders that can stimulate low-carbon investment:** Certain activities can provide investors in the private sector with confidence that they should invest in the low carbon sector in a given country. Concrete measures or clear financial structures are most likely to send this signal.
- **Broad support for mitigation policies:** Several activities can support a broader mitigation agenda, the example of an assessment of mitigation potential earlier in this report already indicated that this general activity can help policy-makers make better choices about policies. Other institutional and regulatory developments may also have a positive impact across the mitigation policy landscape.

These impacts should also contribute to more effective mitigation activities and more rapid achievement of emissions reductions.

- **Improving stakeholder engagement:** Many of the activities could use, or need the active participation of stakeholders. This engagement can be seen as an additional benefit of the activity itself, helping compliance participants, and others understand the opportunities and risks of new changes from the earliest moment.
- **Improving co-ordination of mitigation activities and promoting synergies:** Activities undertaken for crediting may also automatically relate to other mitigation activities and help with efficient and effective policy formulation.
- **Learning by doing, leading to better policy design and implementation more rapidly:** Some of the concrete activities undertaken by crediting will test different structures, methodologies and approaches in the field in a way that reveals lessons that would be unlikely to arise in a different context.

This criterion captures the benefits of crediting-related activities that are not directly relevant to one policy but which, however, might be important to the policy-maker. For example, understanding the mitigation potential of a crediting approach may not, at face value, add benefit to a policy that is not related to crediting. However, from a policy-maker's perspective, having a good understanding of the mitigation actions of each policy is important in developing a sufficient portfolio of climate mitigation actions that will help reach a target. And as noted above, knowledge of potential cost savings that such assessments often reveal, especially for energy savings investments, can build political support for action.

All of these broad benefits are directly relevant for the development and implementation of NAMAs and informing the setting of INDCs as well as tracking and monitoring their progress.

The achievement of any economy-wide or sectoral mitigation goal/pledge/objective within or beyond the UNFCCC legal agreement will rely on a full portfolio of policies and measures, and a range of crediting activities could bring broad benefits that will help in the successful structuring of INDCs and with their implementation.

Similarly, NAMAs can provide a structure for developing a wide range of different mitigation policies. Therefore crediting-related activities could create an enabling environment for NAMAs to be effective, but could also make a specific contribution to NAMAs that may be developed with a crediting component.

An assessment of these benefits is subjective, to a certain degree all activities will involve the engagement of stakeholders, for example, and all will also create political momentum. In the initial phase of this analysis a structured analysis was attempted, but the subjectivity involved did not lead to robust conclusions. So, instead some general statements seemed more appropriate.

Activities are considered to provide **political momentum** where the activity requires or will motivate a significant increase in momentum, e.g., through the decision-making process on domestic demand, or to set up finance vehicles. The activities which provide the greatest benefit here are the most concrete: regulatory frameworks, capacity building, domestic demand, finance vehicles, piloting and implementation activities.

Investor confidence can be improved wherever activities relate to concrete policy decisions or details, and moves towards implementation. Activities such as setting the regulatory framework, but also developing a source of domestic demand and clear finance vehicles can all encourage investors. Some of the softer, earlier stage measures such as policy analysis or data collection can act as signals to investors, and may stimulate interest, but not necessarily create confidence.

Several of the early stage policy and infrastructure activities for crediting, such as data collection and management, mitigation potential, development of domestic demand approaches and setting up MRV structures can all **support broader climate change strategies and policies** for a country. Developing regulatory and institutional frameworks and capacity building can also provide significant benefits for the overarching set of climate change strategies. These benefits can be seen as additional to the readiness for specific policies, as assessed for criterion 1, and are particularly relevant to the support of INDCs.

Policy synergies can be improved by activities that can deliver advantages for other policies too, e.g., registries, instrument design, broad policy analysis and crediting baselines. There is some correlation of this benefit to the ability to create readiness for a range of policies.

Improved stakeholder engagement is assumed to take place where the activity absolutely requires stakeholders to be involved, rather than where they could or should be involved, e.g., data collection, data management and the implementation of an MRV structure. However, in some cases stakeholders might be involved in an insufficient manner, which could be detrimental, or only a sub-set of stakeholders might be involved, again to the detriment of other policies or strategies.

Each activity has quite a unique set of benefits. Data collection and MRV activities are quite detailed actions that will engage a small pool of stakeholders and stimulate learning by doing, but are unlikely, on their own, to propel greater political support for mitigation activity, nor to create significant increased investor confidence. The quantification of baselines is a sufficiently concrete measure to encourage investors and engage stakeholders, but nonetheless has broad relevance and applicability to other crediting policies. As such, this activity can create knowledge that could also be used in target-setting, non-crediting policies and strategies, e.g., INDCs and ETS.

Several activities deliver significant co-benefits, including institutional and regulatory frameworks and some of the measures that do not minimize regrets but are quite far down the pathway of crediting development, e.g., investment frameworks, piloting and implementation activities.

3.6. Conclusions

In this section, we considered the range of crediting-related activities and the extent to which they could contribute to creating readiness, while minimizing regrets, and to maximizing benefits. We also referred back to the eight countries who have considered crediting as part of their MRPs.

The criterion of maximizing benefits leads to a different emphasis among activities than the creating readiness/minimizing regrets criterion would. In fact, we see this in play among the MRPs considered. Countries with clearer preferences among instruments and willingness to commit to them (and in so doing perhaps risk greater future regret) appear to have greater alignment with criterion 2. For example, five countries are setting up an institutional and regulatory framework, which scores highly in our assessment of benefits, and also is a medium priority in terms of minimizing regrets. GHG data management and collection and registry development are also widely chosen as activities, and these offer a balance of minimizing regrets and delivering wider benefits and readiness.

The analysis presented in this section arguably helps to clarify the relationship between specific crediting-related activities that countries undertake with support from PMR and their contribution to two broad criteria: creating readiness while minimizing regrets and maximizing benefits. However, this analysis cannot in itself provide direction to the PMR or Implementing Countries on where and how to invest in future activities. To do so, it needs to be coupled with individual country contexts and aspirations and with the future trajectory of the PMR.

4. How Can Future PMR Support for Crediting-Related Activities Support Scaled-Up Mitigation?

This section explores possible implications of the foregoing analysis for the PMR's future program of support for crediting-related activities.

Some lessons can be taken from the experiences of other international readiness efforts, such as the FCPF, NAMA Facility, EBRD PETER project, as well as GIZ Climate Finance Readiness Programme. These other readiness efforts suggest the importance of continuous learning with overlapping phases of instrument developing, testing and piloting activities.

The experiences of PMR countries thus far with crediting, as well as the evolving context, may lead to a change in priorities for the PMR participants. Their choices about which types of activities the PMR could support should be based on a number of considerations:

- **Goals:** The PMR may wish to more explicitly embrace support for a broader suite of policy instruments, even where crediting-based activities are the principle focus of MRPs. Furthermore, the PMR may wish to even more explicitly stress the importance of the process compared to the results, reflecting a lesson from other readiness initiatives. There is value at every stage of readiness from the identification of activities, including their review in the light of political and economic developments, through stakeholder engagement all the way to implementation.
- **Realistic expectations on pace of implementation:** The PMR, as well as other readiness initiatives, has often seen slower progress than originally hoped for. PMR Implementing Countries may require more support and investment than originally anticipated, as well as clearer political signals both domestic and international, before they are willing to make the political and resource commitments needed to ensure success. Some MRPs (e.g., Morocco) have explicitly sequenced crediting-related activities accordingly, so that progress can be made on less sensitive or challenging activities (e.g., data collection and management) while the conditions are established for more ambitious elements.
- **Stage of assessment:** As not all of the MRPs have yet been formalized in grant agreements and funds transferred, the assessment of the eight MRPs has only considered what has been planned rather what has been than undertaken. Consequently it is difficult to make broad generalizations or draw definitive conclusions at this early stage. Conversely, there is greater opportunity to consider these cross-MRP observations, should opportunities of adjustments arise.
- **Evaluation and Evolution:** Some of the existing MRPs that have addressed crediting have changed over time, e.g., due to political changes, even before the implementation phase. It is important that the PMR finds a way to support this inevitable change in national priorities without compromising the overarching goals of the partnership. An approach that supports a variety of activities related to crediting, and also acknowledges the process as well as the outcomes can enable more changes along the way.

- **Synergies with other initiatives:** To avoid duplication of efforts and ensure maximum added value/complementarity of PMR activities, it is key that the PMR works actively with other initiatives, such as those of the GCF and the NAMA Facility, as well as potential scaled-up crediting fund, to build bridges with those initiatives.

The findings of the prior sections suggest that the PMR should continue and perhaps even expand its support for a mix of activities that both support specific crediting instruments and bring wider benefits by paving the way for broader mitigation policies.

Under this approach the PMR could choose to strongly support certain outcomes in countries that are ready to be early actors, e.g., by piloting funds for crediting. At the same time, the PMR could continue to provide the no-regret support actions that are most supportive of a range of measures, namely: MRV, capacity building, data collection, capacity building and quantification (e.g., baselines), in countries that are at an earlier stage. It should be acknowledged, however, that these no-regrets activity do not always deliver the most benefits.

This case-by-case approach also allows the PMR to engage at the right speed. Where the PMR is concerned about adding more momentum to this process, there is also an argument for supporting some of the activities that are more concrete, e.g., financial instruments, piloting. However, if a slow and steady approach is more appropriate, taking the speed cue from Implementing Countries, then the activities that minimize regrets but also bring other benefits could be chosen, e.g., institutional and regulatory development. This approach would also allow the crediting instrument to be fully integrated into a wider mitigation strategy. The risk is, however, that action on climate change is delayed too long, and that recipients do not see the inward flows of investment that they were hoping for.

The process of this assessment has demonstrated that it is not possible to create a general approach—the variety of factors involved in understanding which activities to choose is vast, and is based not only on different desired, and uncertain outcomes, but also on each country's starting point. This attempt to create a common and general rationale seems to go some way to demonstrating that activities do need to be selected on a country-by-country basis.

The PMR should consider more explicitly using the criteria described here: creating readiness while minimizing regrets and maximizing benefits. In practical terms, this can help countries and PMR to work together to limit over-investment in some activities that have highly uncertain returns. It also means more explicitly expanding the goals of PMR activities, and support activities that serve multiple instruments such as baseline and MRV activities that consider application for RBF or for regulatory systems within their terms of reference.

The PMR has contributed unique value in recent years, whilst the carbon market was weak, and the UNFCCC processes stalled. The PMR continues to offer a safe and constructive dialogue, working towards real action on the ground. Currently the PMR is supporting a mix of these activities and multiple goals. This assessment demonstrates that there is merit in actively pursuing a full range of activities under the auspices of the PMR, provided that they are fit for purpose for each country and assessed over time.

Appendix A: Terminology

In this study, the following terms are used:

- *Readiness:* Readiness activities are those which can create the conditions necessary to scale-up investment in the target outcome, in this case the development of crediting instruments. Some readiness activities will need to de-risk investment opportunities to encourage private sector players to invest at scale. This de-risking includes providing a sound and certain policy, legislative and institutional infrastructure, which requires investment as well as clear commitments.
- *Project-based crediting instrument:* an instrument that issues credits based on the performance (relative to a baseline) of a project or program. This baseline is generally independent from the performance of the sector as a whole. Projects and programs can involve one to several actions or investments. Under a program, the exact number of the actions or investments is not known ex-ante. The project-based approach requires project related data to set the baseline. The baseline needs to be set at the installation[3], project or program level. Standardization, e.g., in the form of standardized baselines, can limit the costs linked to the development of individual baselines. The credits are allocated directly to the project or program by an international body (e.g., the CDM Executive Board under the CDM, the VCS under the VCS) or by a domestic body (e.g., the government or a body appointed by the government). Project-based crediting has historically been an offset instrument. All crediting programs currently in operation can be considered project-based instruments.
- *Sectoral crediting instrument:* an instrument that would issue credits based on the performance (relative to a baseline) of a sector as a whole. By aggregating emission sources and sending market signals across a broader sector, sectoral crediting seeks to spur deeper emission reductions than might be achieved through project-based approaches. However, this approach requires more extensive data on an entire sector in order to set the baseline, measure performance, and issue credits. At this stage the details of how the sectoral approach would translate at the country level are undecided. In one model, the credits would be allocated by an international body to the host country government. The government could then decide to allocate credits to the installations/companies based on installation-level baselines or other performance based related metric. No sectoral crediting instrument is in place.
- *Policy crediting:* an instrument that would issue credits for the emission reductions that result from the implementation of specific policies (e.g., a renewable energy tariff or energy efficiency standard). Policy crediting can requires many assumptions in order to demonstrate a causal link between to the implementation of a policy and its attendant emission reductions. No policy crediting instrument is currently in place, and, due to its complexity, the concept is not widely discussed.

[3] An installation is defined as the entity that reduces emission, e.g., a wind farm, a cement plant, a cookstove, or a solar water heater.

- *NAMA with a crediting component:* Crediting can be a source of finance that supports NAMA implementation. This concept is sometimes referred to as "NAMA crediting" or "credited NAMAs." NAMAs are in many cases broad in nature as they intend to promote transformational change in the economy, so the carbon market support is likely to come along other sources of financing, e.g., bilateral and multilateral sources, investments from the private sector, foreign direct investments and domestic funding. In this case only part of the NAMA is supported by crediting, hence the term "NAMA with a crediting component."
- *Domestic instrument:* an instrument developed, defined, and implemented within a country. Demand for the credits would likely come largely or exclusively from domestic sources.
- *International instrument:* an instrument for which rules are defined by an international body (e.g., UNFCCC, VCS, and Gold Standard), that is implemented and managed by a multi-national institution, and for which demand for credits may come from buyers outside the country where the emissions are reduced.
- *Compliance unit or credit:* a unit or credit that can be used to fulfill an emission reduction obligation or a carbon liability.
- *Voluntary unit or credit:* a unit or credit that can be used to fulfill a voluntary emission reduction target or to voluntarily offset emissions.
- *Net mitigation:* a concept first adopted by UNFCCC Parties in the Cancun Agreements in 2010, which called for "one or more market-based mechanisms" capable of "ensuring a net decrease and/or avoidance of global greenhouse gas emissions." Crediting instruments can contribute to net mitigation through a number of means, such as discounting the compliance value of credits (more than 1 credit needed to offset 1 ton of emissions) or through ambitious baselines, or crediting thresholds, set sufficiently below the business-as-usual baseline. This is not a strict definition as the concept of net mitigation is not operational yet.
- *Piloting activities:* This is a small-scale implementation of the crediting instrument, with guaranteed funding, to test many of the structures defined above. Such a pilot would be funded, and would deliver mitigation results and could deliver credits for the funders, but could also be testing the functioning of the processes, without generating credits. This activity should have a clear evaluation mechanism. Piloting activities have the potential to test some transferrable elements of the crediting system e.g., institutions, some methodological issues, but already show a significant commitment to one policy outcome.

Appendix B: Country Profiles

Colombia

At a glance	
Selected instrument	A suite of instruments for the urban transport sector are under consideration and development: 1) credited NAMAs; 2) a domestic offset scheme (for performance based transport projects) supported by a transport fuel carbon levy (carbon pricing); and 3) assessment of a performance standard for vehicles combined with tradable allowances between importers and producers.
Lead institutions	*Institutions:* Ministry of the Environment and Sustainable Development (MADS; focal point for the PMR), Ministry of Transport (MinTrans; sector ministry), Ministry of Finance and Public Credit (MinHac), National Planning Department (DNP); National Infrastructure Agency (ANI)
Principal stakeholders	*Industries:* The involvement of specific industrial association or stakeholders has not been discussed in detail yet.
Timeline for implementation	**Phase I (short-term, 2014–16):** PMR implementation phase to include NAMA Development Steps (Design and piloting in priority cities; preparatory work for domestic offset scheme; creating and enabling political and institutional environment; increasing know-how and MRV preparedness; institutional and regulatory reforms; design of performance standard based on international experiences and domestic requirements and preferences) **Phase II (mid-term, 2016–20)** (not funded): Operational launch of domestic offset scheme including carbon pricing instrument; phased introduction of NAMA to fully operational by 2020; implementation of performance standard.
Rationale	
Choice of instrument	Credited NAMAs are viewed a good option for acquiring additional finance for transport projects and for establishing a MRV system that be used in parallel with a domestic offset scheme. A domestic scheme to use revenue from a low carbon tax to purchase offsets is viewed as a way to support the credited NAMAs or other transport projects with attendant emissions and other sustainability benefits. A performance standard is considered of interest due to its ability to reduce emissions and to be effectively combined with an MBI. Other options, such as a fuller carbon tax/carbon pricing instrument in the transport sector, or inclusion of transport in an emissions trading systems, are not considered viable options due to low GHG impact combined with significant economic and political cost.
Choice of sectors	The transport sector is one of the prioritized sectors in the Colombian Low Carbon Development Strategy (CLDS/ECDBC) and is the focus sector for PMR due to: Considerable and expanding share in national GHG emissions. Preparedness of sector for Low Carbon Development action, with final Mitigation Action Plan submission completed and moving forward in structuring NAMAs and achieving NAMA finance.

	Climate change mitigation efforts in transport are politically well received at the ministerial level. Prior experience with the Clean Development Mechanism transport sector projects providing technical knowledge at the local level, placing the sector in a good position for implementation of other market mechanisms. Ability to build on an innovative set of transport policies, including support for large-scale mass transit projects, transport demand management (TDM) and nonmotorized transport (NMT) Potential for replicability elsewhere in the world.

Role of crediting instrument(s) in climate change mitigation policy mix

Domestic climate policy	Colombia's Climate Change agenda is structured around 4 pillars, the most relevant of which is the CLDC/ECDBC. The ECDBC is a medium and long term development program led by MADS, the DNP, and sectoral ministries with the aim of implementing plans and policies for promoting national economic growth with low GHG emissions. As part of the ECDBC, the MinTrans has submitted a Transport Sectorial Action Plan (PAS), the first submitted PAS. Participation in an international crediting mechanism (e.g., via NAMA Crediting) is anticipated to help attract climate finance to scale up the country's mitigation efforts.
Anticipated evolution of the instrument	The phase beyond PMR implementation (2016 on) could see implementation of the performance standard and the domestic offset scheme based on a carbon tax. Further evolution is not yet specified.

Ambition and demand

International demand	Crediting NAMAs will target international demand.
Domestic demand	The domestic offset scheme will be domestically funded through a transport fuel carbon levy. Tradable allowances for importers and producers under a performance standard for vehicles could also create demand domestically.

Roadmap to implementation—Summary of MRP activities

	Description	Objective
NAMA Development	NAMA design and piloting on priority cities, including baseline studies, MRV concept and validation, and financial structuring.	Establish NAMAs and MRV systems ready for full-scale implementation.
Political and Institutional Development	Strengthen the coordination of stakeholder activities at the local level; link existing policy & regulatory landscape to objectives and activities of the MRP; Establish an Inter-Ministerial Committee to coordinate stakeholder involvement and endorse important decisions related to operation of the MBIs.	Create an enabling political and institutional environment that involves all stakeholders and relevant institutions.
Upstream policy analysis	Prepare for domestic offset scheme by assessing feasibility of and testing upstream carbon pricing instrument.	Develop a comprehensive picture of inter-dependent policies and issues affecting climate policy objectives in the transport sector.
Capacity building	Increase domestic know-how and MRV preparedness, strengthen modeling capacity regarding carbon tax structures and fiscal and distributional impacts; address multiple identified capacity building needs of the Urban Mobility Unit; develop capacity for public information campaign and awareness through development of a communications strategy.	Establish a robust MRV structure to monitor impacts and increase chance for early implementation once NAMA finance is available on a large scale; Ensure acquired know-how and skills are developed and retained through capacity building measures.
Regulatory and institutional framework	Carry out necessary institutional and regulatory reforms (i.e., strengthening the Sustainable Urban Mobility Unit of the MinTrans and limiting overlapping and contradictory regulations); Develop specific regulations to implement performance standards.	Lay the legal ground for the development of the proposed MBIs, including the performance standards.
Implementation	*Domestic offset scheme launched into fully operational scheme with carbon pricing instrument by 2020, following phased implementation; Performance standard implementation.	Full mobilization of NAMA to realize low carbon growth goals in transport sector.

Sources: Government of Colombia. 2014. *Colombia FINAL Market Readiness Proposal (MRP)*. https://www.thepmr.org/system/files/documents/PMR%20CO%20Final%20with%20annex.pdf;
PMR website, National Context, http://www.thepmr.org/country/colombia-0.

Note: * indicates activities that are part of Colombia's roadmap to implement MBIs but that will not be covered by a first tranche of PMR funding. They might be part of a second request for funding to the PMR.

Costa Rica

At a glance

Selected instrument	A domestic carbon market with five priority sectors (energy, agriculture and livestock, solid waste management, transport, and sustainable construction). The voluntary carbon market will include the creation of a Costa Rican Carbon Offset Unit (COU).
Lead institutions	*Institutions:* Directorate of Climate Change (DCC) of the Ministry of the Environment and Energy (MINAE), Costa Rican Electricity Institute (ICE), Ministry of Agriculture and Livestock (MAG), Ministry of Public Works and Transportation, National Forest Finance Fund (FONAFIFO), Foundation Environment Bank (FUNBAM)
Principal stakeholders	*Industries:* The involvement of specific industrial association or stakeholders has not been discussed in detail yet.
Timeline for implementation	**2013/14:** Pre-operation phases for all activities (various domestic market infrastructure, demand strengthening, and sector readiness activities) **2013–15:** Initial implementation, including pilot project for C-Neutrality certification of initial companies (first 9 companies were issued official C-Neutral brand as of October 2013), and scaling up of offset program. **2015–17:** Implementation phase for all activities continues, with latest activities including: outreach activities in private sector for C-Neutrality, and sector offset program studies for participation in carbon market.

Rationale	
Choice of instrument	The domestic carbon market offers a credible and flexible alternative to the CDM and voluntary carbon market, presenting new opportunities and reducing barriers to participation. It enables offsets to be generated in new sectors not sufficiently covered by the CDM (e.g., transport) and offers opportunity of unlock investment in new sectors previously overlooked by the CDM. Approval and issuance of COUs designed to be flexible and less complex than the CDM, reducing costs and barriers to entry, particularly for small scale projects.
Choice of sectors	Sectors were selected based on: GHG emission reduction potential; availability of emissions data and acceptable methodologies for MRV; extending coverage as widely as possible, to attract investment in low emissions technology, research development and commercialization; investment in new sub-sectors and activities; and consideration of feasibility and transaction costs.
Role of crediting instrument(s) in climate change mitigation policy mix	
Domestic climate policy	Costa Rican National-Strategy on Climate Change (NCCS) seeks to align climate chance and economic competitiveness strategies for long-term planning. This includes a pledge to become carbon neutral by 2021, which was incorporated into the 2011–14 National Development Plan (NDP). The domestic carbon market is viewed as the primary policy tool to achieve the Carbon Neutrality target.
Anticipated evolution of the instrument	Not specified at this point (i.e., the instrument would be fully established through the MRP). Goal is to establish domestic offset programs in key sectors, although highest emphasis on C-Neutrality program for companies.
Ambition and demand	
International demand	Some sector mitigation programs may lend themselves for international support rather than through domestic carbon market incentives. A particular priority for the Carbon Board regarding the role of supported/credited NAMA instruments in the domestic market is avoiding double counting.
Domestic demand	Domestic demand, together with the Carbon Neutrality target, are the primary drivers for the domestic carbon market.

Roadmap to implementation—Summary of planned activities

	Description	Objective
Data management and MRV	Design and implement a GHG reporting system for major emitters along with a registry and tracking system.	Reliable data to ensure environmental integrity of the domestic carbon market. MRV system essential to provide confidence to market participants, allow domestic regulators to monitor emissions, and ensure compliance with the domestic policy goals.
Regulatory and institutional framework	Establish legal, institutional and economic framework. Appoint Carbon Board and implement institutional arrangements and technical support of the carbon board.	Lay the groundwork for the development and enforcement of the domestic offset programs.
Domestic market infrastructure	Generate protocols and methodologies for sector offset programs. Pilot C-neutrality certification for initial 'CHAMPIONS' companies.	Determine best approaches for domestic offset market and establish infrastructure for full implementation.
Strengthening of demand	Design and implement strategy of policy options for C-Neutrality and low emissions development strategy. Disseminate information and raise public awareness, including engagement of private sector for C Neutrality adoption and scale-up pilot offset program from initial companies.	Increase stakeholder and public awareness, engagement, and participation for greater impact of programs.
Sector readiness activities	Conduct studies on market participation of the sector; Improve GHG data generation and management; Institutional capacity building and social awareness; Engage stakeholders through consultation process; Formulate sector offset programs.	Prepare sectors for effective implantation of offset programs.

Sources: Costa Rica Ministry of Environment and Energy. 2013. *Costa Rica Market Readiness Proposal (MRP) Partnership for Market Readiness Final Report*. https://www.thepmr.org/system/files/documents/Costa%20Rica_MRP_Final_19-02-2013_0.pdf; Costa Rica Ministry of Environment and Energy and Directorate of Climate Change. 2013. *Costa Rica PMR Update*. https://www.thepmr.org/system/files/documents/Costa%20Rica_MRP%20Implementation%20Update%20Oct%2013.pdf.

Note: * indicates activities that are part of Costa Rica's roadmap to implement MBIs but that will not be covered by a first tranche of PMR funding. They might be part of a second request for funding to the PMR.

Mexico

At a glance	
Selected instrument	Three unilateral, large scale crediting NAMAs (Integrated Urban Mobility NAMA, Domestic Refrigerator NAMA, Urban NAMA), along with a NAMA Registry Tracking Tool (RTT). The *Integrated Urban Mobility NAMA* seeks to optimize existing conventional public transport systems in 29 high-density urban centers; the *Domestic Refrigerator NAMA* seeks to introduce energy efficient refrigerators with low or zero GWP refrigerants (HFCs) and to capture and safely dispose of HFCs from retired refrigerators; the *Urban NAMA* will build new, green field residential communities throughout Mexico with an aim to reduce energy demand and improve emissions efficiency, including housing, water services, waste management, and public lighting.
Lead institutions	*Institutions:* Secretariat of Environment and Natural Resources (SEMARNAT); Inter-Ministerial Climate Change Commission (CICC); National Bank of Public Works (BANOBRAS; for Integrated Urban Mobility NAMA); National Housing Commission (CONAVI; for Urban NAMA)
Principal stakeholders	*Industries:* National Association of Appliances Manufacturers (ANFAD; Domestic Refrigeration NAMA); National Network for Recycling of Refrigerant Gases (NNRRG; Domestic Refrigeration NAMA)

Timeline for implementation	**Through 2014:** Development, testing, and deployment of fully operational RTT for MRV; Initial phases for three NAMAs: 1) Policy context/considerations, institutional strengthening and capacity building, co-benefits assessment; 2) Scope/coverage/boundary definitions, crediting baseline construction, quantification of emissions reductions potentials, design and testing of specific MRV systems, investment plan strategies, regulatory and institutional framework building; **2014–17** (not yet funded): Post initial-PMR funding phases for *Urban NAMA and Integrated Mobility NAMA:* Methodology development for MRV and co-benefits quantification, pre-investment studies, pilot financial infrastructure, pilot project development and deployment, training/capacity building; *Urban NAMA* final phase, up to full-scale launch: MRV Capacity Building, financial structures and markets, technology package development, training and certification office creation, finalized rules and regulations. **TBD and Post-2017** (not yet funded): Integrated *Urban Mobility NAMA* final phase: Financial structures and markets, certification office, and full scale NAMA launch; *Domestic Refrigerators NAMA* pilot implementation.
Rationale	
Choice of instrument	Crediting NAMAs and other new market mechanisms can increase the scale of activities and participants, address entire sectors of the economy, and provide co-benefits, such as the national capacity development. Enhancing new market mechanisms like crediting NAMAs will foster the MRV system and bring credibility to international investors and multilateral bodies. Compared with CDM project-based approach, greater ability to help achieve national climate change and sustainable development goals. Capacity for setting up and implementing unilateral large scale NAMAs with a sectoral approach has been developed over the last 5 years, as shown by the design and implementation of the PECCC 2009–12.
Choice of sectors	The three sectors (households, transport, appliances) were chosen due to: • Likely future economic growth, leading to significant increase in GHG emissions. • Involvement and willingness to participate by local governments and the private sector. • Existing institutional and financial capacity, based on previous programs, allowing the NAMAs to move fast (full implementation within 2 years). • Ability to scale up for maximum nationwide impact. • Likely replicability in related in-country sectors or similar sectors in other PMR countries. • Ability to generate synergies across the three NAMAs.
Role of crediting instrument(s) in climate change mitigation policy mix	
Domestic climate policy	Mexico has committed to reduce emissions 30% below baseline levels by 2020 and 50% below 2020 emissions by 2050, dependent on the provision of international support and participation in external markets. Since the MRP was approved (March 2013), a new Special Program for Climate Change (PECC) covering 2013–18 has been announced and the National Climate Change Strategy (ENCC) was launched. In November 2013, a carbon tax on fossil fuels was approved, eligible to be paid through CDM CERs and a voluntary carbon exchange platform was launched. NAMAs and supporting infrastructure for current and future carbon markets are expected to play an important role in the low emissions growth goals developed in both the ENCC and the new PECC.

Anticipated evolution of the instrument	Mexico is creating a National Office for NAMA management to streamline NAMAs as key elements in mitigation strategies and to attract international financial assistance. The MRP envisions new institutional infrastructure and capacity building setting the stage for rapid implementation of a National emissions trading systems (ETS) when conditions allow, and it is anticipated that NMMs will enhance the scale of activities and participants. A Mandatory Emissions Registry is currently under development and will start operating in 2015.
Ambition and demand	
International demand	Mexico anticipates the need for large-scale international financial and technological support to achieve emissions reductions goals, including loans, donations, and emissions reduction credits derived from new market mechanisms. While Mexico has been active in the CDM, crediting NAMAs are anticipated to have a broader impact in national GHG reductions, with a sectoral rather than project-based approach.
Domestic demand	Mexico has established a carbon tax and may implement a National ETS when conditions allow, which could create additional domestic demand.

Roadmap to implementation—Summary of planned activities

	Description	Objective
Data management and MRV	Ongoing analysis of MRV system for NAMAs, inventories, LEDS; design and testing of MRV RTT. *Development of MRV methodologies and verification processes for NAMAs.	MRV system to provide assurance that all projects and programs meet clear standards, bringing credibility for attracting international financing.
Baselines and quantification	Development of crediting baselines; evaluation of the mitigation potential for each of the three NAMAs/sectors, including boundary definitions, data collection and needs, and modeling efforts.	Enhance understanding of mitigation opportunities and costs, and support development of GHG
Upstream policy analysis	Analysis of mitigation instruments and governance, and development of recommendations.	Selection of best policies for implementation.
Regulatory and institutional frameworks and strengthening	Support the establishment of a regulatory framework for mitigation measures in the three sectors, including capacity-building, trainings, collaborator engagement, creation of NAMA agents, and strengthening financial infrastructure; barrier analysis and workplan development; analysis of current rules.	Limit regulatory barriers, engage and prepare stakeholders for mitigation programs associated with NAMAs.
Training, capacity building, and institutional strengthening	Trainings on market instruments for relevant stakeholders, community developers (Urban NAMA)	Prepare stakeholders for effective implementation of NAMAs.
Piloting	*Pilot implementation of the refrigerator NAMA, including incremental cost funding	

Sources: Mexico Secretariat of Environment and Natural Resources. 2013. *Market Readiness Proposal (MRP) Mexico*. *https*://www.thepmr.org/system/files/documents/Mexico_MRP_Final_19-02-2013_0.pdf.

Note: * indicates activities that are part of Mexico's roadmap to implement crediting NAMAs but that are not expected to be covered by first tranche of PMR funding. They might be part of a second request for funding to the PMR.

Morocco

At a glance

Selected instrument	Sectoral crediting in the following sectors: electricity generation, cement production, and phosphates extraction and processing. This initial plan will be confirmed after a more extensive assessment of the MBI options appropriate for Morocco in general, and for these three sectors in particular.
Lead institutions	*Institutions:* Ministry of General Affairs and Governance (MAGG), Ministry of Economy and Finance (MEF), Deputy Ministry to the Minister of Energy, Mining, Water and Environment in charge of the environment (MdE).
Principal stakeholders	*Industries:* Electricity and Water Office (ONEE), Electricity Branch; National Phosphates Company (OCP); and Professional Association of Cement Producers (APC) and APC Members (cement producers).
Timeline for implementation	**2014:** *May:* implementation funding granted by the PMR. *Rest of the year:* grant agreement signature and preparation of the PMR grant disbursement. **2015–17:** setting the foundation for sectoral crediting (or other MBIs). **After 2018:** design and operation of sectoral crediting (or other MBIs).

Rationale

Choice of instrument	Experience with crediting through the CDM: CDM DNA established in 2002. 14 CDM projects and 3 PoAs registered (as of October 2013). Wind energy, biomass energy, waste management, solar energy. However, challenges with complexity of the mechanism and its constantly changing rules, the criteria for proving financial additionality, the transaction costs, and the limited experience available in the country. Concerns over the uncertainty around long-term price signal. Interest in new market instruments: expression of support for both project-based and sectoral approach under the New Market-based Mechanism (NMM) in Morocco's submission on NMM to the UNFCCC in March 2013. Emissions trading systems (ETS) is not an option at this stage: required preconditions not in place (e.g., targets), numbers of participants in each sector too low, low international ambition.
Choice of sectors	The reasons for selecting the three sectors are presented in the table below:

Reasons	Description
Significant mitigation potential	The three sectors selection present a significant mitigation potential.
Existing experience to build upon on MBIs and MRV	The three sectors have had experience with the CDM, which will facilitate the preparation to sectoral crediting: several registered projects and PoAs in the electricity sector; one registered project in the cement sector; and opportunities in the phosphates sector but issues with financial additionality. The three sectors, and especially electricity and cement, are represented in many countries around the world. Lessons learned from other international emissions reduction schemes can be applied in Morocco to fast-track preparation to carbon markets (e.g., CDM for the three sectors, CSI for cement). The three sectors have MRV systems in place, which can act as the basis for a sectoral MRV system. Activity monitoring is embedded in the day-to-day business of all three sectors, and GHG emissions are monitored and reported by most cement companies through their involvement in the CSI and in case of OCP as part of their internal carbon footprint system.

MBIs promising compared to other alternative approaches	An MBI is likely to be the most appropriate way to reduce emissions within the sectors, compared to other possible approaches such as emission standards, financial incentives or capacity building.
Sector organization suitable for the implementation of readiness activities	Actors in the sectors are concentrated and few, and/or the sector is centrally organized: ONEE is responsible for around 50% of the electricity generation and is fully responsible for transmission; all cement groups are members of APC to which they regularly report data; and the OCP is solely in charge of production and sales of phosphates and derivatives in Morocco. The coordination efforts needed to implement readiness activities are likely to be less significant than in other sectors involving more actors and sites.
Lessons learned in the sectors can help fast track the development of MBIs in other sectors	Carbon market development efforts in all three sectors may involve and impact other related sectors (e.g., demand side management for the electricity generation sector; construction, waste management and transport in the cement sector; and transport in the phosphates sector). Learnings in the three selected sectors can therefore contribute to market readiness and development of MBIs in other sectors.

Role of crediting instrument(s) in climate change mitigation policy mix

Domestic climate policy	The Government has published a climate change policy, Politique du Changement Climatique au Maroc (PCCM). The PCCM will be based on two principles: 1) decoupling economic growth from GHG emissions, particularly through the use of clean technologies; and 2) preserving the country's territory and ecosystems in the most appropriate manner. The PCCM mentioned market-based instruments as a possible long-term option to incentivize private options.
Anticipated evolution of the instrument	In the medium term (2020–22), after two years of operation, the sectoral crediting mechanisms in the 3 selected sectors might be expanded to cover other sectors. They might link to the international market, e.g., under the form of an NMM. In the longer term (after 2022) they might expand to national scheme, crediting and/or ETS, which could link to other ETS around the world.

Sources of demand

International demand	The international carbon market is currently the principal target (i.e., source of demand) for the mechanism. The decision to go ahead with sectoral crediting will depend on the evolution of the international carbon market, which the government will monitor, and on the assessment of the mitigation instruments that will take place in the initial phases of the PMR project. In the meantime, the government is willing to explore the possibility of piloting the instruments if there are other sources of demand for credits, e.g., in the form of a purchase program/fund (i.e., RBF).
Domestic demand	Domestic buyers have yet to be considered as a possible source of demand.

Roadmap to implementation—Summary of planned PMR activities

	Description	Objective
Data management and MRV	Design of a MRV system, and piloting of the MR in the three sectors covered by the MRP (electricity, cement and phosphates). *Design and pilot of following systems: a verification and accreditation system; an IT platform for data management and MRV; and a national registry.	Build the capacity and tools in the institutions and the sectors to effectively monitor and report GHG data.

Baselines	Development of a baseline for each of the three sectors and evaluation of the mitigation potential in the three sectors.	Increase the understanding of mitigation opportunities and costs, and support the definition of GHG reduction targets.
Upstream policy analysis	Analysis of mitigation instruments (carbon pricing and others) and MBI governance for Morocco, and recommendations.	Assist the government in making an informed decision on MBIs (confirmation of the initial selection of sectoral crediting, or alternatives) and setting up a governance system for MBIs.
Regulatory and institutional framework	Support for the establishment of a regulatory framework for mitigation measures in the three sectors.	Lift regulatory barriers preventing investment in clean technologies.
Instrument design	*Design and piloting of a sectoral crediting mechanism for the three sectors.	Provide experience with sectoral crediting in three key sectors.
Piloting	The PMR funding will cover the piloting of the MR system. The government is willing to consider designing and piloting the sectoral mechanisms if a demand for credits is created.	Provide experience with the use of MR tools in three key sectors and identification of learnings for other sectors. Create demand for the credits generated.

Source: Final MRP, May 2014.

Note: * indicates activities that are part of Morocco's roadmap to implement MBIs but that will not be covered by a first tranche of PMR funding. They might be part of a second request for funding to the PMR.

Peru

At a glance	
Selected instrument	Under the PMR Peru is exploring the possibilities of developing a crediting component in proposed NAMAs in the following sectors: energy supply, housing, industry, waste and transport. The form of the crediting-based approach will be further investigated in the PMR process to determine which of the proposed NAMAs could develop a crediting component.
Lead institutions	*Institutions:* Ministry of Economy and Finance (MEF), Ministry of Environment (MINAM), Ministry of Mining and Energy, Ministry of Transport, Ministry of Agriculture.
Principal stakeholders	*Industries:* The involvement of specific industrial associations or stakeholders has not been discussed in detail yet.
Timeline for implementation	**2014–15:** selection of NAMAs for crediting components and drafting of the MRP **After 2015:** allocation of PMR implementation funding to set up core market readiness infrastructure, ensure compatibility of the proposed NAMAs with other national initiatives and design crediting components for selected NAMAs. Other MBIs such as a scaled-up crediting mechanism or an emissions trading systems are being examined.

Rationale	
Choice of instrument	Experience with crediting through the CDM: 82 LoAs awarded that represent a reduction of 95 $MtCO_2e$, of which 30 CDM projects registered. Projects are in the sectors energy and industry, transport, waste and forestry, with majority of projects in hydroelectricity. Peru wants to explore innovative and more promising MBIs given their successful experience with the CDM. Crediting can support existing climate initiatives: Peru has seven proposed NAMAs in the five selected sectors. It considers that adding a crediting component to some of the NAMAs may provide a cost-effective approach to achieve its targets and incentivize private sector participation. Crediting-based approaches could lay the groundwork for the government's results-based budgeting (RBB) that is being considered. Options for a carbon market in Peru are already being investigated: Peru is investigating the feasibility of a domestic carbon market through a study supported by the IDB for the long term.
Choice of sectors	The reasons for focusing on the five sectors are presented in the table below:

Reasons	Description
Significant mitigation potential	The five selected sectors present a significant mitigation potential and/or the emissions are expected to grow significantly in these sectors.
Existing climate initiatives to build upon	The five sectors are in the NAMA development process and a crediting approach could be combined with some of the NAMAs. Synergies between the PMR and the funding for the proposed NAMAs can also be found. In several NAMAs monitoring systems are being investigated and developed. In the sustainable building NAMA for the housing sector a monitoring system of energy savings and GHG emission reductions is being established and the proposed NAMA in the construction material industry sector includes exchange of best practices in MRV system for that sector. In the solid waste management NAMA a sectoral GHG inventory will be developed.
Contribution to international commitments and aligned with national priorities	Peru has defined voluntary GHG reduction commitments in their energy consumption, forestry and waste sector. To meet the voluntary commitments, in the energy and industry sector several national initiatives are being introduced or have been put into place related to the promotion of less carbon-intensive fuels, renewable energy and energy efficiency. In the waste sector national initiatives have also been developed and Peru is involved in an international initiative in the forestry sector (see domestic climate policy below).
Sustainable development co-benefits	In the five selected sectors an MBI can lead to development co-benefits such as increasing employment and income, contributing to rural electrification, limiting water and air pollution, reducing resource consumption, improving health and quality of life, improving energy security and increasing Peru's competitiveness.
Potential responsiveness to market signals	Preliminary analysis shows that the construction material industry and waste sectors may be responsive to market signals to reduce GHG emissions.

Role of crediting instrument(s) in climate change mitigation policy mix	
Domestic climate policy	Peru established the National Strategy for Climate Change (ENCC) in 2003 and updated it in 2013. The updated ENCC includes voluntary commitments for GHG emissions reduction for 2021: Zero net emissions in LULUCF, 40% energy consumption from non-conventional renewable energy and hydropower, and the capture and reuse of methane from disposal of municipal waste. Together these commitments represent a 40% GHG emission reduction by 2021 compared to 2000 levels. In 2010 MINAM put forward the Action Plan on Climate Change Adaptation and Mitigation, which describes proposals of programs and projects to tackle climate change. MEF created a Climate Change Unit, which is tasked with efficient allocation of resources and implementation of climate change action, and identification of the potential climate risks in Peru. Other relevant policy context include the General Law for Environment in 2005, establishment of MINAM in 2008 and creation of the National Policy for the Environment in 2009. With the support of international organizations, Peru has proposed NAMAs in the energy sector on bioenergy and diversification of the energy supply, in the housing sector on sustainable housing and buildings, in the construction industry on energy efficiency and best-practices, in the waste sector on solid waste management and in transport on low carbon transport in Lima and Callao.
Anticipated evolution of the instrument	No concrete timeline has been established for the crediting instruments under consideration. In the short term crediting is planned as a component of the NAMAs. The feasibility of a domestic carbon market is currently being investigated.

Sources of demand	
International demand	Potential sources of international demand for credits are international funds by securing public funding to leverage international support for the proposed NAMAs.
Domestic demand	Potential source of domestic demand are public funding as part of the priority actions set out the ENCC. The potential domestic demand in a domestic carbon market is currently being investigated.

Roadmap to implementation—Summary of planned PMR activities

	Description	Objective
Data management and MRV	Design of an MRV framework for development and broader climate impact, and M&E procedures for domestic and international purposes. Technical assistance to develop an integrated GHG data collection/reporting (registry) system consistent with requirements of international carbon markets.	Build the capacity and tools in the institutions, assess the GHG data needs, and develop MRV methodologies.
Baselines	Develop metrics to measure the development and climate impact and development results of GHG mitigation action.	Support the development of GHG metrics and determine how these can be included in Peru's RBB system consisting of sectoral budget programs.
Upstream policy analysis	Identify and select NAMAs most suitable for a crediting component and ensure coherence with key national processes.	Assist the government in making an informed decision on developing a complementary crediting component in the proposed NAMAs, identify market readiness needs and capacity gaps, and analyze the relationship with the development priorities and RBB.
Regulatory and institutional framework	Support for the establishment of a regulatory framework and assess adequacy of the institutional infrastructure in the five selected sectors.	Lift regulatory barriers, establish institutional procedures and protocols at sector level, and determine roles and responsibilities to support the proposed NAMAs and ENCC.
Coordination of activities	Coordinate PMR activities with activities under other national and international initiatives.	Avoid duplication of efforts with other support programs in the five selected sectors.
Stakeholder management	Promote and position activities to increase private sector engagement.	Increase private sector participation and investments in climate change mitigation actions.
Instrument design	Develop crediting components in NAMAs most suitable for MBIs.	Explore how crediting can be applied in the context of NAMAs to incentivize private sector participation. Exchange experiences with other PMR countries.

Sources: Government of Peru. 2012. *Template for Expression of Interest and Market Readiness Capacity Questionnaire, October*. https://www.thepmr.org/system/files/documents/PA4_Peru_EoI.pdf;
Government of Peru. 2012. *Presentation of PMR Expression of Interest*. https://www.thepmr.org/system/files/documents/PA4_EoI_Peru_Presentation_0.pdf;
Government of Peru. 2013. *Organizing Framework for Scoping of PMR activities*. https://www.thepmr.org/system/files/documents/PA5_Organizing_Framework_Peru_0.pdf.

Thailand

At a glance	
Selected instrument	Thailand is looking to implement two instruments: 1) a voluntary energy performance certificate (EPC) scheme in the energy production, manufacturing and large commercial buildings sector, and 2) a project-based crediting mechanism named Low Carbon City Program (LCC) for municipalities and local communities, a new program under the existing Thailand Voluntary Emission Reduction Program (T-VER). Additionally, as part of the PMR activities Thailand is planning to establish a fund to support the LCC financially and technically. The preparation for setting up the EPC, LCC and LCC fund will be part of the first phase of PMR process. In the second phase the implementation of the EPC, LCC and LCC fund is planned. The EPC is intended to act as the precursor for a domestic ETS.
Lead institutions	*Institutions:* National Committee on Climate Change Policy (NCCC), Office of Natural Resources and Environmental Policy (ONEP—Ministry of Natural Resources and Environment), Thailand Greenhouse Gas Management Organization (TGO—Ministry of Natural Resources and Environment), Office of the National Economic and Social Development Board (NESDB), Department of Alternative Energy Development and Efficiency (DEDE—Ministry of Energy), Energy Policy & Planning Office (EPPO—Ministry of Energy), Department of Industrial Works (DIW—Ministry of Industry), Fiscal Policy Office (FPO—Ministry of Finance), Public Debt Management Office (PDMO—Ministry of Finance), Office of Transport and Traffic Policy and Planning (OTP—Ministry of Transport).
Principal stakeholders	*Industries:* Federation of Thai Industries (FTI), The Thai Chamber of Commerce (TCC), Municipalities and National Municipal League of Thailand (NMT), Electricity Generating Authority of Thailand (EGAT), Provincial Electricity Authority of Thailand (PEA), Metropolitan Electricity Authority (MEA).

Timeline for implementation	**2014:** *March:* implementation funding granted by the PMR. *Q2 and Q3:* grant agreement signature and preparation of the PMR grant disbursement. **Q4 2014–16:** preparation for setting up the EPC, LCC and LCC fund as well as preparation of legal framework and other components for a domestic ETS. **2017–19:** implementation of the EPC demonstration, operation of LCC and LCC fund (2017-onward), and continuation of developing market readiness components for a domestic ETS. **2020–onward:** preparation for setting up a domestic ETS. Continuation of EPC will depend on the outcome of the EPC demonstration.
Rationale	
Choice of instrument	Experience with crediting through the Clean Development Mechanism (CDM), VER and a domestic crediting mechanism: 221 LoAs awarded that represent a reduction of 13 $MtCO_2e$, of which 148 CDM projects registered as of October 2013. There are also 34 VCS projects and 54 Gold Standard projects in Thailand as of January 2014. Challenges with the CDM projects were no clear criteria for project approval and a modest contribution to low-carbon urban development in municipalities and communities. Thailand therefore launched a domestic project-based GHG crediting mechanism, the Thailand Voluntary Emission Reduction Program (T-VER), in 2013. The LCC will be part of the T-VER to ensure GHG abatement in cities will be rewarded equally and impartially. As of February 2014 there are 18 projects in the T-VER pipeline. Selected instruments support existing national policies: An Energy Conservation Act and two development plans related to energy are in place in the sectors selected for the EPC and LCC. To support the achievement of the energy savings target (under domestic climate policy), an energy performance scheme was selected. Additionally, the Thailand Carbon Offsetting Program (T-COP) is running. The T-COP is a platform through which voluntary participants can buy voluntary credits, including GS, VCS and T-VER credits and, in the future, credits from LCC, to offset their carbon footprint. Participants can be individuals, organizations, products, services or events. The contributions to the T-COP will be used to support GHG reduction programs, in particular domestic projects under the T-VER. Options for a domestic ETS in Thailand are foreseen for the future: Thailand intends to use the EPC as a demonstration pilot for a nation-wide ETS.
Choice of sectors	The reasons for focusing on the five sectors are presented in the table below:

Reasons	Description
Significant share in energy consumption and GHG emissions	The energy production, manufacturing industry and buildings sector account for more than half of the total energy consumption and national GDP. GHG emissions in large cities are expected to grow significantly as a part of urbanization.
Significant mitigation potential	Industry and the large commercial buildings sector are considered to have a better energy saving potential than the other sectors and be more suitable for the EPC. Through LCC a large reduction potential in municipalities and local communities can be unlocked.
Existing climate initiatives to build upon	The MRV system in the EPC can be built upon experience from China, the UK and India where energy savings certificate schemes have been operational. The LCC will be part of Thailand Voluntary Emission Reduction (T-VER) crediting mechanism and can build on the methodology under the T-VER.

Contribution national priorities	Thailand identified energy efficiency, renewable energy and low carbon city as the priority areas. In the Energy Efficiency Development Plan (EEDP) the industrial sector is the target of the largest reduction energy intensity. Large commercial buildings are also covered under the plan. The EEDP will also apply to buildings in cities. Furthermore, a development plan for renewable energy has also been put in place with a large role for municipalities and local communities. The EPC and LCC will contribute to achieving the targets in the energy efficiency and renewable energy development plants (see Domestic climate policy).

Role of crediting instrument(s) in climate change mitigation policy mix	
Domestic climate policy	Thailand released the first National Strategic Plan on Climate Change in 2008 for the period 2008–12 to raise awareness and capacity on climate change issues. Building on this experience, Thailand developed the Climate Change Master Plan of Thailand for the period 2014–50, a framework of integrated policies and action plans to tackle climate change and move towards a sustainable low carbon society by 2050. This is already being approved by the NCCC. The Master Plan is currently being considered for approval by the Cabinet. Thailand does not have specific targets on GHG reduction, but on energy savings and renewable energy. In the EEDP Thailand set an energy intensity reduction target of 25% by 2030 from the base year, with the industry sector expected to account for 42% of the target, large commercial buildings 9% and small commercial and residential buildings 9%. The EPC is expected to play an instrumental role in achieving the targets in first two sectors and the LCC in the latter. With the Alternative Energy Development Plan Thailand aims to increase renewable energy in the final energy consumption to 25% by 2021. Thailand has submitted NAMAs to the UNFCCC in December 2014. As a result of NAMAs, it is expected to reduce GHG emissions at least 7% below the business as usual in energy and transportation sectors by 2020 and possibly up to 20% with additional international support.
Anticipated evolution of the instrument	The LCC and LCC fund are expected to be fully operational from 2017 and cover all municipalities. The EPC will gradually evolve in a mandatory nation-wide ETS with the ETS preparation starting in 2020 and the actual compliance from 2026. Firms under the EPC will not be covered by the LCC. Compliance entities in the ETS would be able to use credits from the LCC as carbon offsets.
Sources of demand	
International demand	No direct sources of international demand for credits are foreseen. International voluntary buyers can indirectly purchase credits from the LCC fund.
Domestic demand	The voluntary EPC may include a sink fund that buys allowances against a guaranteed minimum price (floor price) to encourage energy savings. The sink fund will be funded by the Energy Conservation Promotion Fund and other funds. Carbon credits generated under the LCC may be sold to financial institutions in return for project finance or sold into the LCC Fund. The LCC Fund subsequently sells it to buyers through the T-COP or directly to other voluntary buyers such as CSR-oriented companies.

Roadmap to implementation—Summary of planned PMR activities

	Description	Objective
Data management and MRV	Evaluate the existing data reporting and MRV system. Develop a data reporting system for the EPC and future ETS. Analyze existing T-VER MRV system applicability to the LCC, and ensure the LCC MRV system is consistent with international standards. Develop LCC project design documents. Develop a registry system. Develop sector-specific verification protocols.*	Build the capacity and tools in the institutions, assess the GHG data needs, and develop MRV methodologies and MRV systems building on existing systems.
Baselines	Propose a baseline and target setting and allowance allocation methodology for the EPC.	Support the setting of a target on a sector level, develop a methodology for determining the allowance allocation for each firm under the EPC and identify data gaps.
Policy analysis	Develop a proposal on the legal framework and administrative guidelines for a Thai ETS. Study on detailed design elements for a Thai ETS. Evaluate the success or failure of the EPC and incorporate lessons learnt in the Thai ETS design.*	Review other ETS designs and develop a detailed design for a domestic nation-wide ETS.
Regulatory and institutional framework	Assess the current legal and institutional framework and propose required changes to implement the EPC and LCC fund.	Lift regulatory barriers and establish a project management unit coordinating the EPC and LCC.
Stakeholder management	Outreach activities for the EPC and LCC. Engagement and consultation with potential EPC and LCC participants.	Enhance participation in the EPC and LCC to increase energy savings and GHG reductions under the schemes and build capacity.
Instrument design	Analyze the scope and potential reduction in the EPC and LCC and develop action plans for GHG mitigation projects for LCC participants. Prepare documents detailing the full EPC (including the sink fund), LCC and LCC fund design.	Determine the potential energy and GHG reduction that can be achieved under the EPC and LCC. Prepare for the implementation of the EPC and LCC.
Implementation and piloting	Implement the LCC and LCC fund. Launch the EPC demonstration scheme.*	Provide experience to EPC participants and identify improvements for the future ETS.

Sources: Government of Thailand. 2014. *Thailand's Market Readiness Proposal (MRP)*. https://www.thepmr.org/system/files/documents/Final%20MRP_Thailand_07022014.pdf;
Government of Thailand. 2014. *Update on MRP implementation*. https://www.thepmr.org/system/files/documents/Update on Thailand%27s%20MRP Implementation %28PA9%29.pdf.

Note: * indicates activities that are part of Thailand's roadmap to implement the MBIs but that will not be covered by a first tranche of PMR funding. They might be part of a second request for funding to the PMR.

Tunisia

At a glance	
Selected instrument	Tunisia is exploring the possibilities of sectoral crediting in the following sectors under the PMR: electricity generation and cement production. The type of crediting instrument will be further investigated in the PMR process to choose the most appropriate MBI option for Tunisia in these two sectors. Options under consideration include sectoral crediting, technology-based approach and NAMA with a crediting component.
Lead institutions	*Institutions:* Ministry in charge of Environment and Climate Change (UNFCCC National focal point), National Agency for Energy Conservation (ANME), Ministry of Finance, Ministry of Industry—General Directorate of Energy, Ministry of Development and International Cooperation, Presidency of the Government, Ministry of Agriculture, National Sanitation Utility (ONAS), National Waste Management Agency (ANGed).
Principal stakeholders	*Industries:* Tunisian Company for Electricity and Gas (STEG), National Chamber of Cement Manufacturers (CNP), Tunisian Company of Petroleum Activities (ETAP), Tunisian Refining Industries Company (STIR), Tunisian Chemical Group (GCT), Tunisian Association for Energy Conservation.
Timeline for implementation	**2014–15:** drafting of the MRP **After 2015:** allocation of PMR implementation funding to set up a national coordination entity for mitigation policy, development of institutional capacity and an MRV system, and design and pilot of a sectoral crediting mechanism (or other MBIs).
Rationale	
Choice of instrument	Experience with crediting through the Clean Development Mechanism (CDM): 6 CDM projects and 1 PoA registered, equivalent to 5% of the potential national CDM portfolio. Wind energy, transport, biomass energy, landfill gas, solar heating. Main challenges were little private sector engagement and difficulty to find buyers for project credits. Significant improvements were made in capacity building in public institutions and other actors, and in the institutional framework. In combination with the unregistered CDM projects and PoAs, this can be used as a starting point for developing MBIs. Interest in new market instruments: Confirmation of engagement for the NMM in Tunisia's submission on NMM to the UNFCCC in March 2013. Recommended clear but pragmatic governance and technical rules and encouraged the adoption of common international rules at the 19th Conference of the Parties in November 2013. Initiative to assess the possibility of developing a NMM/NAMA in the cement sector started in 2012 and a study on NAMAs on renewable electricity generation in 2013. Options of sectoral crediting are already being investigated, ETS is being considered in the long term: Tunisia is exploring the possibilities of GHG reduction instruments in the electricity sector supported by UNDP (NAMAs and sectoral crediting). The National Climate Change Strategy (SNCC) foresees initial thinking and discussion on an ETS in the energy sector to start in the medium term (2017–21). The implementation of such an ETS would be considered from 2030 onwards.
Choice of sectors	The reasons for focusing on the two sectors are presented in the table below:

Reasons	Description
Significant mitigation potential	The two selected sectors present a significant mitigation potential.
Existing experience to build upon on MBIs and MRV	The two sectors have had experience with the CDM, which will facilitate the preparation to sectoral crediting: two registered projects in the electricity sector and one registered project in the cement sector. The two sectors have MRV systems in place, which can act as the basis for a sectoral MRV system. The cement sector already has monitoring systems in place for the production process, and some cement companies already monitor and report the emissions under the CSI protocol, WRI GHG protocol, CDM and monitoring of air pollutants. Activity in the electricity sector is monitored through the Energy Information System by the ANME.
Willingness of actors in the sector	Firms in the cement sector are willing to work together and engage in mitigation efforts. In the electricity sector the growing energy deficit and electricity demand makes energy security and energy conservation a priority in national policy. The PMR activities would be a continuation of the efforts the sectors have already started: the assessment of possibilities for an NMM in the cement sector started in 2012 and the study on NAMAs on renewable electricity generation started in 2013.
Sector organization suitable for the implementation of readiness activities	Actors in the sectors are concentrated and few, and/or the sector is centrally organized: STEG produces the majority of the electricity and is responsible for transmission; the CNP represents the cement sector and the sector is comprised of nine companies with monitoring equipment. The coordination efforts needed to implement readiness activities are likely to be less significant than in other sectors involving more actors.

Role of crediting instrument(s) in climate change mitigation policy mix	
Domestic climate policy	Tunisia has a national strategy on climate change and is one of the few countries that have recognized climate change in their constitution. The National Climate Change Strategy (SNCC) focuses on decreasing the economy's carbon intensity by employing an anticipatory approach to adaptation and proactive mitigation policies. MBIs are considered as key in the strategy, particularly in the energy sector. Additionally, NAMAs have been or are being developed in the buildings, waste, agriculture, forestry as well in the selected sectors electricity and cement. A feed-in tariff for renewables is also being discussed.
Anticipated evolution of the instrument	No concrete timeline has been established for the crediting instruments under consideration. In the short term piloting and testing of the credit instruments in the electricity and cement sector are foreseen. There is a desire to explore to possibilities of linking the feed-in tariff to the crediting instrument in the electricity sector. In the long term (from 2030 onwards) an ETS for the energy sector is being considered.
Sources of demand	
International demand	The potential source of demand for credits has not been considered so far.
Domestic demand	Domestic buyers have yet to be considered as a possible source of demand.

Roadmap to implementation—Summary of planned PMR activities

	Description	Objective
Data management and MRV	Design of a detailed MRV system for the proposed crediting mechanism that is internationally recognized, and coordination with existing initiatives in the two sectors. Technical assistance to develop a reliable national registry.	Build the capacity and tools in the institutions and the sectors to effectively monitor and report GHG data, and monitor mitigation actions, based on the existing systems in place.
Baselines	Defining national guidelines for establishing baselines and mitigation scenarios.	Increase the understanding of mitigation opportunities and costs, and support the definition of GHG reduction targets.
Upstream policy analysis	Analysis of regulatory bottlenecks and most appropriate crediting mechanism option, and exploring the possibilities of linking feed-in tariffs to the carbon market.	Assist the government in making an informed decision on MBIs (confirmation of the initial selection of sectoral crediting, or alternatives).
Regulatory and institutional framework	Support for the establishment of a regulatory framework for mitigation measures in the two sectors.	Lift regulatory barriers preventing investment in clean technologies and setting up a coordination entity for national mitigation policies.
Stakeholder management	Developing and implementing voluntary agreements with the cement sector.	Develop individual performance contracts for each cement plant and support the access to finance.
Instrument design and piloting	Designing, piloting and testing of a crediting mechanism for the two sectors.	Provide experience with sectoral crediting in two selected sectors and test the economic, legal, institutional and organizational framework. Exchange experiences with other PMR countries.

Sources: Government of Tunisia. 2014. *Expression of Interest of Tunisia*. https://www.thepmr.org/system/files/documents/PMR%20-EOI%20-%20Tunisia%20.pdf;
Government of Tunisia. 2014. *Organizing Framework for Scoping of PMR Activities*. https://www.thepmr.org/system/files/documents/OF-%20Tunisia_0.pdf;
Ministry of Environment Tunisia and GIZ. 2012. *Stratégie Nationale sur le Changement Climatique*. http://www.environnement.gov.tn/fileadmin/medias/pdfs/dgeqv/chang_climatique_3.pdf.

Vietnam

At a glance	
Selected instrument	Vietnam has targeted two sectors for crediting NAMAs to be developed (waste, steel), as well as emphasizing activities related to design of a carbon pricing instrument in the power sector. The steel sector crediting NAMA is intended to set the stage for a cap-and-trade system from 2020 onwards.
Lead institutions	*Institutions:* Ministry of Planning and Investment (MPI, focal point), Ministry of Natural Resources and the Environment (MONRE, focal point), Ministry of Industry and Trade (MOIT; steel), Ministry of Construction (MOC; solid waste management), Ministry of Finance (MOF; steering committee), Ministry of Transport (MOT; steering committee), Urban Environment Companies (URENCO, steering committee).
Principal stakeholders	*Industries:* The involvement of specific industrial associations or stakeholders has not been discussed in detail yet, although the Vietnam Steel Association is mentioned in relation to crediting NAMAs and company piloting in the steel sector.

Timeline for implementation	**2015–18:** Establish legal frameworks; pilot crediting NAMAs in steel and waste sectors; establish data management and reporting systems; assess different MBIs and institutional and regulatory frameworks in the waste sector; capacity building; design and implementation of strategies for stakeholder engagement; prepare for cap-and-trade in steel sector; activities to inform eventual decision on carbon pricing in the power sector. **2018–20:** NAMA implementation in steel sector. **Post-2020:** Operational cap-and-trade system for the steel sector; carbon pricing in the power sector.
Rationale	
Choice of instrument	MBIs can help to achieve climate change related policy goals and improving resource allocation, incentivizing participation by enterprises, attracting capital, and supporting the implementation of the Green Growth Strategy. MBIs are considered based primarily on: 1) competitiveness, where the preference is for potential crediting rather than trading instruments at the initial stage; 2) cost-effective mitigation; 3) donor coordination to avoid overlap with existing initiatives. Partnership with the PMR can accelerate deployment of MBIs. Prior experiences, capacity building, and lessons learned from Clean Development Mechanism (CDM) can be applied in Vietnam for new market mechanisms. These include capacity created for baseline determination, MRV, and familiarity with an MBI which pays based on achieved results. Around 250 CDM projects have been registered (as of November 2013), the 4th largest number worldwide and 7th largest number of CERs (9 million). The vast majority of projects are related to renewable energy (mostly hydropower), and the remainder were mainly methane capture from waste. One of the first CDM Afforestation/reforestation projects was initiated in Vietnam. Many of the projects were registered relatively late (resulting from lengthy validation and registration processes), at a time of declining CER market prices resulting in lower than expected financial impact. Promotion of projects with wider development impacts is desired.
Choice of sectors	Sectors considered based on several criteria: 1) alignment with Sustainable Development Strategy; 2) interest of stakeholders in the sectors; 3) experience with MBIs to date; 4) technical and MRV capacity; 5) donor coordination to avoid overlap with existing initiatives. Of the industrial sectors, the steel sector is most important in terms of GHG emissions, has significant abatement potential, and is a government priority sector. The sector has created a voluntary emission reduction target. The waste sector, a government priority sector, has significant know-how and capacity based on 6 registered NAMA projects and two NAMAs under preparation, along with significant abatement options.

Role of crediting instrument(s) in climate change mitigation policy mix	
Domestic climate policy	The Vietnam National Green Growth Strategy (VGGS), approved in 2012, outlines strategic tasks, solutions, priority actions, and a goal of reducing GHG emissions per unit of GDP by 8–10% without, and 16–20% with, international support, by 2020. The ongoing Green Growth (and Low Carbon Development) strategy process includes NAMA development in priority sectors, and assessment of the form and role of market based instruments.
Anticipated evolution of the instrument	As Vietnam has finalized its MRP. MBIs are viewed as an important component for meeting environmental aims. As noted above, there is interest in ultimately developing a comprehensive carbon trading scheme. Two main bottlenecks for the development of MBIs are reforms for state-owned sectors and the introduction of regulatory incentives and pricing instruments to effectively allocate resources.
Sources of demand	
International demand	The likely source of demand for crediting NAMAs.
Domestic demand	Vietnam is considering a cap-and-trade scheme in the steel sector, development of a business model for emissions reductions from solid waste management, and carbon pricing in the power sector.

Roadmap to implementation—Summary of planned PMR activities

	Description	Objective
Data management and MRV	Establish a reliable data collection platform and management system for detailed GHG emission data. Data availability is currently coarse and scattered and data collection limited and based on aggregated emissions. Establish national and sectoral MRV systems and the capacity to manage these systems. Establish accreditation standards and evaluate options for registry development.	Reliable data collection and reporting for GHG data to inform sector-based strategy development, monitor mitigation actions. Support various NAMAs under development for waste, steel, cement, chemical fertilizer, wind power, and biogas.
Baselines	Prepare emissions profiles and BAU emissions trajectories.	Increase the understanding of mitigation opportunities and support the definition of GHG reduction targets.
Upstream policy analysis	Study potential MBIs for the chosen sectors and integrate with development planning and policy. Assess viability, principles, and elements of a carbon pricing instrument. Assess option for steel sector cap-and-trade system.	Identify emissions reduction options and potentials and assess compatibility with other development aims to inform government decision making.
Regulatory and institutional framework	Strengthen market readiness capabilities in terms of technical, institutional, and legal frameworks of both central ministries and local authorities.	Lift regulatory barriers to implementing MBIs and achieving emissions reduction. Strengthen legislative enforcement and effectiveness of implementing institutions.

Stakeholder management	Increase stakeholder awareness of MBIs and develop network of supporting actors engaged in the development of MBIs. Stakeholders from the steel industry and local level governments are of particular emphasis. Pilot a voluntary reporting system in the steel sector with partner companies, and crediting NAMAs for 3 cities waste disposal sites.	Generate increased support for the necessary emissions reductions. Set the stage for a cap-and-trade system in the steel sector.
Instrument design	Study, deploy, and prepare for implementation NAMAs and MBIs for identified sectors and regions. Includes case studies of other participating countries, notable Mexico. Build capacity for management of the instruments.	Prepare the sectors for subsequent scaling-up of MBI programs to achieve targeted emissions reduction goals.

Sources: Vietnam Department of Science, Ministry of Planning and Investment. 2012. *Organizing Framework for Scoping of PMR activities*. https://www.thepmr.org/system/files/documents/PMR_PA3_Vietnam_OrganizingFramework.pdf;
Dr. Pham Hoang Mai, Vietnam Ministry of Planning and Investment. 2013.
Progress on the Viet Nam Green Growth Strategy. https://www.thepmr.org/system/files/documents/PA5_InfoSharing_Vietnam_GreenGrowthStrat.pdf.
Vietnam Ministry of Natural Resources and Environment and Ministry of Planning and Investment. 2014. *Partnership for Market Readiness Progress Update—Vietnam*. PA8 Mexico City. https://www.thepmr.org/system/files/documents/PMR%20PA%208%20Update%20progress_%20Vietnam2.pdf;
Vietnam Ministry of Natural Resources and Environment and Ministry of Planning and Investment. 2014. *Market Readiness Proposal (MRP) Vietnam*.

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Carbon Leakage

Theory, Evidence and Policy Design

WORLD BANK GROUP

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Please direct any comments and questions about this study to the PMR Secretariat (**pmrsecretariat@worldbank.org**).

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Technical Note 11 | October 2015

Carbon Leakage Theory, Evidence and Policy Design

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Executive Summary

What Is Carbon Leakage?

There is growing, global momentum for tackling carbon emissions and correcting "*the largest market failure history has seen*" (Lord Stern). Often this action involves the use of carbon prices—established either through carbon taxes or through cap and trade schemes—in recognition of their ability to achieve emissions reductions in a flexible and cost-efficient way. The introduction of carbon pricing forces firms and consumers to take account of the full economic costs associated with their production and consumption decisions. It therefore promotes a level playing field between polluting activities that impose climate change adaptation costs (and/or climate damages) on others and low-emissions activities that do not. In this sense, the *absence* of a carbon price can be thought of as a *subsidy* for "dirty" production. Reduction of these implicit subsidies and assigning cost of emissions to those who can control them is an intended goal of carbon prices. It leads to structural transformations and eventually more efficient allocation of resources in the economy. Stringent climate policies have also been found to stimulate clean technology innovations, in particular, among more advanced firms. Such technologies tend to have strong innovation multiplier (spillover) benefit throughout the economy, comparable to nano-technologies and robotics, unlike innovation in traditional fossil fuel-based technologies.

But this transformational economic impact of carbon prices may be skewed if the stringency of carbon price policy significantly differs between jurisdictions. Today climate action is still led by individual national and subnational jurisdictions. Despite the well-recognized benefits that could arise from a globally harmonized approach to regulating emissions (especially through carbon pricing), most countries are yet to decide whether and when to follow. Establishing carbon-pricing policies requires both supporting technical and institutional regimes, such as emissions measurement and verification, which may be challenging in countries with weaker capacity. It also involves substantial political debate and decisions. The trend seems to be changing, however, and the momentum for putting a price on carbon emissions is growing. According to the recent World Bank State and Trends in Carbon Pricing Report (World Bank Group 2014b)—around 40 countries and over 20 subnational jurisdictions are taking action to implement carbon pricing—from almost none 11 years ago. The number of carbon pricing initiatives doubled and the emissions covered trebled only since January 2012.

Before a critical mass of countries with a converging emissions price emerges, different stringency of policy ambition creates the risk of carbon leakage. Carbon leakage occurs when an emissions-reduction policy such as a carbon price inadvertently causes an increase in emissions in other jurisdictions that do not have equivalent emissions-reduction policies. This increase in emissions in other jurisdictions may arise because the differences in the costs of complying with policy can cause a shift in the location of production. If the emissions intensity of production in jurisdictions that see an increase in production is greater than in jurisdictions where production falls, it is conceivable that, under extreme circumstances,

this could even lead to a net increase in global emissions. As more and more jurisdictions move to adopt climate policies, including carbon pricing, the risk of emissions leakage and the distortions it may create will diminish and eventually disappear.

If it occurs, carbon leakage has the potential to have undesirable environmental, economic, and political consequences. Carbon leakage could undermine a carbon-pricing policy's environmental objective by causing emissions to increase in jurisdictions beyond the reach of the policy. This also implies that the economic cost of meeting a global climate stabilization objective would increase. Fear of leakage prevents international cooperation to mitigate climate change, as political leaders are often concerned that other countries will free ride on their effort. At home, the associated decline in domestic production and, hence, possibly, employment can create significant political challenges. This confluence of potentially undesirable environmental, economic, and political outcomes means that the risk of leakage is always one of the most controversial and important aspects when considering the design of carbon-pricing mechanisms (and, indeed, other carbon regulations).

Assessing Carbon Leakage

Modeling approaches are a valuable way of assessing the risk of carbon leakage. They provide understanding and evidence of carbon leakage risk that informs the judgment of experts or politicians and aid the transparency of any subsequent decisions.

There are two main approaches to modeling carbon leakage and carbon leakage rates that are described in this note.

- An empirical or "ex post" approach which tries to identify changes in patterns of emissions and production in historical data;
- A theoretical or "ex ante" approach which attempts to assess the impact of policy by comparing different modeling scenarios with and without the simulated impact of the policy.

Ex post modeling analyses have generally found little evidence of leakage. Almost all of these studies have been based on experiences in the EU ETS and European carbon taxes. The results are consistent, however, with the analyses of the impact of other local environmental policies that have been observed for a longer time in a wider range of countries. Ever since the 1970s they were also feared for causing the potential migration of industry to "pollution heavens" abroad, which has not materialized on a significant scale. Environmental policies have even been found to induce innovation that offsets part of the cost of compliance with the environmental policy. This is not surprising for economists who have long observed that firms do not compete on costs only, but on the overall efficiency of converting various inputs (including knowledge) into high-value products and services. Cost competition is more important to sectors offering homogenous products and commodities. Having said that, it is difficult to know for certain what explains the ex post modeling result of carbon leakage in Europe so far. While it could mean that the risk of leakage is negligible for the reasons described above, it could also be explained by the technical difficulties in identifying impacts over a relatively short period of time; or because carbon prices have been modest; or because of the efficacy of leakage-prevention mechanisms that have been part of policy design from the outset.

Ex ante modeling analyses suggest a wide range of potential leakage rates indicating large uncertainty. It implies that going forward the risk of carbon leakage cannot be dismissed. Two ex ante modeling approaches have been used with varying results on the risk of leakage:

- Computable General Equilibrium (CGE) modeling analyses tend to find a more narrow range of relatively small whole-economy leakage rates[1] (in the region of 5–15 percent). This approach uses large-scale CGE models that capture and highlight the effect of climate policy on production and emissions outcomes taking into account interactions and feedbacks across all sectors and markets.
- The range of leakage estimates from partial equilibrium models is much wider, suggesting possible future leakage rates between 0 and 100 percent, depending on assumptions and model specification. This approach uses partial equilibrium analysis to model detailed output and emissions patterns at the level of an individual sector in which only a subset of firms faces a carbon price (or another form of carbon policy), but ignores the interaction of that sector with the wider economy.

Both of these approaches have advantages and disadvantages; ideally they should be used in concert. CGE models tend to forecast lower leakage rates because they provide results for a blend of sectors that are more and less heavily exposed to leakage, while partial equilibrium models tend to focus on individual sectors expected to be particularly vulnerable to carbon leakage.

Managing the Risk of Carbon Leakage

Concerns about risk of carbon leakage have led most jurisdictions that implement carbon prices to design leakage-prevention mechanisms. The art of leakage policy design is to try to correct for the challenges that emerge when carbon prices are not yet globally harmonized, while, at the same time, not undermining the benefits that are expected from the carbon pricing in the first place, and not creating more distortions than such measures aim to rectify.

In addressing this challenge, there are two key (and interrelated) questions that policy makers need to consider:

- Which sectors should be targeted (supported) by the leakage prevention mechanism?
- What form should that leakage prevention mechanism take?

In terms of sectoral coverage, there is often a trade-off between policy integrity and political acceptability. On the one hand, leakage prevention mechanisms often involve the use of, or foregone, revenue that could be used for other purposes; and can undermine abatement incentives, which tends to point to

[1] A carbon leakage rate is defined in terms of the increase in emissions in the jurisdiction without a carbon price (or with a lower carbon price/less stringent regulation) expressed as a percentage of the decrease in emissions in the jurisdiction with a (higher) carbon price (or more stringent regulation). For instance, if the introduction (or further strengthening) of carbon pricing resulted in total carbon emissions in one country declining by 200 tones and foreign emissions increasing by 60 tones, the leakage rate would be calculated as 60 divided by 200, and expressed as 30 percent.

limiting the scope of the prevention mechanism. On the other hand, given the risk of carbon leakage could be real for some activities and the need to ensure sufficient political support for carbon pricing, coverage of leakage prevention measures may be more expansive. Different schemes have traded off these pressures in different ways and according to the maturity of the scheme. As individual schemes evolve, there has been a general trend toward narrowing the breadth of sectors that are targeted by the leakage prevention mechanism.

The most reasonable approach is to target those sectors that are truly vulnerable to carbon leakage. Typically this combines an assessment of the carbon intensity of firms with an assessment of their trade exposure. Carbon intensity captures the *impact* that carbon pricing has on a particular firm or sector. As carbon leakage is driven by carbon emission cost differentials between jurisdictions with and without carbon prices, the larger the impact of a given carbon price on sectors or firms, the greater the risk of leakage, all other things being equal. Trade exposure can be thought of as a proxy for the ability of a firm or sector to pass on costs without significant loss of market share and hence their *exposure* to carbon prices. Where factors such as trade barriers or transport costs make trade unlikely to occur, covered firms are insulated from competition from uncovered competitors and the risk of carbon leakage should be small. These assessments are likely to be better undertaken at the sectoral level than at an individual firm level: in the latter case, there is a risk of creating perverse incentives for firm behavior in order to ensure eligibility, and administrative costs are also likely to be higher.

Periodic reassessments of the risk of leakage and adjustments in the coverage and the type of risk-mitigation measures may be required in the future. In particular, to date most countries that have factored in trade exposure to their assessment of which sectors may be at risk of leakage have done so with an implicit assumption that no other country or region in the world has an equivalent policy. With a growing number of countries taking action to address emissions, this approach may become increasingly difficult to justify. There may also be a need to acknowledge the diversity of instruments that countries can use to reduce emissions, as some jurisdictions may use policy instruments other than carbon pricing that may have even higher embedded costs and therefore still be relevant for assessing the risk of leakage.

If some sectors have been assessed as being truly vulnerable to carbon leakage, a choice must be made on the most appropriate form for any leakage prevention mechanism. The main options available are:

- under an emissions trading scheme, the provision of free allowances allocated on a grandfathering approach, where allocations are proportional to an individual firm's historical emissions and there is no rapid adjustment if firms change their output;
- under an emissions trading scheme, output-based allocations (OBAs) of free allowances, where allocations are based on product-specific benchmarks and changes in output lead to rapid changes in allowance allocations;
- under an emissions trading scheme, fixed sector benchmarks (FSB), where allocations of free allowances are based on product-specific benchmarks (as with output-based allocation) but without rapid adjustment if there are future changes in output (as with grandfathering);
- rebates, either directly or through other taxes;

- administrative exemptions; and
- border carbon adjustments (BCAs).

BCAs theoretically perform most strongly on grounds of leakage prevention and abatement incentives, but face political, administrative (and, possibly, legal) challenges. They are appealing in that they simultaneously offer the potential to remove the competitive distortion associated with asymmetric carbon pricing, while ensuring that the firms with the lowest carbon intensities are at a competitive advantage, and also ensuring that demand-side abatement incentives are maintained. However, their application to carbon regulation remains largely untested, with proposals to date facing strong opposition and technical challenges.

At the other end of the spectrum, exemptions perform most weakly in terms of abatement incentives but will be the easiest to implement. They are likely to be appropriate only as an interim measure to ensure sufficient support for carbon pricing when a scheme is in its infancy.

Of the free allocation approaches, those that utilize benchmarking (either OBA or FSB) are generally preferable to providing free allowances on a grandfathered basis. The attraction of both benchmarking approaches is that they sever the link, which exists under grandfathering, between a firm's own historical emission levels and its free allowance allocation. Unless this link is broken, there is a risk that firms will have little incentive to reduce their emissions intensity, as lower emissions in one period will be expected to lead to fewer free allowances in the future. While the creation of benchmarks may incur some additional administrative costs, the experiences of the EU, Australia, New Zealand, and California—as well as the intention of South Africa (in a carbon tax context)—suggest that these challenges can be overcome. Benchmarking can also create a "race to the top" among firms—by rewarding production efficiency and emission intensity performance that is better than the benchmark. Grandfathering may be more appropriate when a scheme is in its earlier stages, where the need to tackle other administrative challenges may make benchmarking approaches appear too complex, or where there is a desire to provide assistance for firms even if they are not at risk of leakage.

Between the two benchmarking approaches (FSB and OBA), the trade-offs are more balanced. OBA may be more effective at preventing leakage but, depending on the specific design, can make the environmental outcome more uncertain because the number of allowances issued changes with the current production level, akin to a tax. Policy can be design to ensure a fixed cap with OBA by, for example, adjusting the number of allowances auctioned to offset increases or decreases in free allowances. If it does not ensure a fixed cap and production increases then this could result in a lower carbon price, and hence final product prices than an FSB approach, possibly blunting demand-side abatement incentives. This will be particularly problematic if OBA is applied to sectors where the risk of leakage is limited (and hence where prices would otherwise rise). Furthermore, OBA may have higher administrative costs than an FSB approach, because production levels must be reported and verified.

Under a carbon tax regime, rebate mechanisms can be designed to emulate the properties seen under the free allowance benchmarking options. An output-based rebate, such as that used in the case of the Swedish NOx charge, provides very similar properties to OBA; alternatively, lump-sum rebates would

resemble FSB approaches. Rebates through reductions in corporate income taxes or employer social security contributions represent an alternative that may reduce the risk of leakage without reducing incentives to reduce emissions. Given these similarities to the free allowance alternatives, the trade-offs between the different approaches, and the circumstances in which any one approach might be preferred, are also similar.

Complementary measures can also be used to guard against leakage risk. These measures include cash transfers to offset some of the carbon emission costs firms face, direct support for emissions-reduction projects, and energy efficiency measures. While these measures may be valuable in helping to deliver emission reductions, they typically have only an indirect impact on leakage and are unlikely to obviate the need for more integrated approaches.

Importance of Engaging with Stakeholders

Carbon leakage has already gained significant prominence in the overall policy debate around the introduction of carbon pricing. It is probably the single most common argument used to delay or derail the introduction of carbon prices around the world. Although the risk of carbon leakage is likely to be real at least for some activities, with genuine environmental implications, the arguments can be inflated by some stakeholders to capture windfall profits, seek trade protection from fair competition or just to fuel political opposition to the carbon price policy, especially during election campaigns. On the other hand, it can be too easily dismissed when the risk is real. The challenge of finding the right balance is aggravated by asymmetries of information between different stakeholders—policy makers, industry, and civil society. How this policy debate is managed can have a great influence on the successful design of leakage prevention policy and the successful introduction of a carbon price.

Stakeholder engagement allows for relevant parties throughout a society to be appropriately consulted and informed on issues relating to carbon leakage and the design and implementation of prevention measures. Stakeholder engagement comes in many different forms, capturing a wide range of relevant stakeholders, and using any number of different modes of engagement.

Stakeholder engagement on carbon leakage can be difficult and involve some conflict but has significant benefits, such as greater transparency in the policy debate; avoiding misinformation, resolving conflicts, and securing consensus and buy-in; ensuring policy reflects national priorities and circumstances, and draws on widespread expertise; enhancing trust between stakeholders and alleviating general skepticism; and helping raise and maintain public support.

There is no single approach to stakeholder engagement which is suitable for every situation. Stakeholder engagement will depend on the context in which it happens. With such a wide variety of cultures, communities, business practices, government processes, and transparency mechanisms in place across the world, different jurisdictions have taken different approaches to stakeholder engagement. Some of the modes of engagement that have proved successful to date include:

- formal consultation to seek written views and input on policy proposals
- surveys and questionnaires to gain information and views from stakeholders

- consultation meetings with stakeholders that may be one to many, one to some, or one to one meetings.
- establishing representative committees
- media campaign including radio, television, newspapers, and social media to explain policy and address concerns
- other modes such as web pages, frequently asked questions, webinars, phone calls, and letters.

An important aspect of engagement is how the introduction of a carbon price and any associated concerns about carbon leakage are framed. Different governments have taken different approaches for framing the debate, including by:

- framing concerns about carbon leakage within a comprehensive carbon price policy narrative;
- using a strong evidence base to frame the debate and address misinformation;
- testing specific claims about risk of carbon leakage with a range of stakeholders to more fully understand the real risks;
- having a clear and easy-to-understand narrative about the objective of leakage prevention measures;
- making explicit the trade-off between leakage prevention measures and other uses of the fiscal resources to help balance interests; and
- packaging the introduction of a carbon price and associated leakage concerns into a broader policy reform package.

Experience has shown that with the introduction of a carbon price incentives for lobbying can be high, with strong vested interests who may use arguments around carbon leakage to protect those interests. **A clear and sensible public policy framework supported by strong evidence and information can therefore help to manage the debate**.

Some political judgment will be required to formulate the most appropriate policy response. Compromises and trade-offs may be needed to find a policy formulation that is politically acceptable. High-level political leadership and commitment may be needed to drive the agenda.

Public opinion and therefore political support can shift overtime. There can be a trade-off between engaging in a long policy development process to design the perfect policy and getting the policy implemented while there is political support and/or momentum. In any event, carbon pricing policy, in particular, measures to address the risk of carbon leakage, can be reviewed and improved over time.

1. Introduction

A Technical Note to Support Knowledge Sharing on Carbon Leakage

1.1. Background and Terms of Reference

The World Bank's Partnership for Market Readiness (PMR) brings together developed and developing countries to build readiness for carbon market instruments to support cost-effective greenhouse gas emissions reductions.

As part of the PMR's Technical Work Program, the World Bank asked Vivid Economics to develop a technical note on the issue of carbon leakage and competitiveness. This issue is of interest to a range of PMR countries and is of great importance to successful design and implementation of carbon pricing policies.

The terms of reference identify three broad questions.

- How to evaluate the expected competitiveness and carbon leakage impacts (negative and positive) due to carbon pricing policies for different sectors and the entire economy?
- How to mitigate the risk of negative impacts and strengthen the positive impacts (through instrument design or complementary policies) in the short and long term, and for different levels of expected decarbonization?
- How to manage the process of dialogue between a government, business, and civil society on the implications for competitiveness and risks of emissions leakage, and their mitigation?

The first two of these questions have been analyzed by Vivid Economics, with oversight and input from the World Bank. The third question has been analyzed by the World Bank with the assistance of a survey conducted by Vivid Economics.

The analysis is based on desktop research and consultation with relevant experts, including both policymakers in jurisdictions with carbon pricing policy experience and independent experts.

1.2. The Issue of Carbon Leakage

Carbon leakage is much discussed in carbon pricing policy. Stakeholders, especially emissions-intensive industries, have expressed concern about the implications of carbon pricing when they compete with firms located in jurisdictions without equivalent policies. Two related concerns are often expressed. First, by imposing costs on firms that their international competitors do not face, their competitiveness will be harmed. Second, this loss of competitiveness may encourage activity and emissions to shift to jurisdictions without a carbon price, making the carbon pricing policy environmentally ineffective. These arguments have achieved resonance in both policy and public debates. Despite the importance that this issue has been given in public and policy debates, empirical evidence of the existence of carbon leakage has proven to be limited.

The purpose of this report is to draw lessons from policy-making experience and academic evidence to provide guidance to countries on how to address issues of leakage as they arise in their national contexts. Policy makers have developed a range of approaches to addressing these concerns, in light of their particular economic and social circumstances. Despite the variety that has arisen in response to these contextual factors, there is scope to learn from past policy-making experience and academic evidence in the future implementation of similar measures.

1.3. Report Structure

This report is structured into five further sections:

- section 2 introduces the concept of carbon leakage and explains how it relates to the context of developing and harmonizing carbon pricing policies;
- section 3 examines the theory and evidence of carbon leakage;
- section 4 explores how to determine which firms and sectors are at risk of carbon leakage and how to target leakage prevention measures;
- section 5 discusses the different policy options available to address carbon leakage; and
- section 6 discusses stakeholder engagement on carbon leakage.

Details of the findings of consultation with policy makers and independent experts are outlined in Appendix 1. Appendix 2 discusses the interrelationship of national competitiveness and the competitiveness of particular firms or sectors.

2. Carbon Pricing and Carbon Leakage

This section provides an introduction to the concept of carbon leakage and places it within the context of the broader discussions around both climate policy and competitiveness. Specifically:

- section 2.1 briefly outlines some of the key arguments in favor of carbon pricing;
- section 2.2 identifies that, while carbon pricing schemes are growing in reach, there is unlikely to be a global carbon price any time in the near future, and discusses the challenges this creates for policy makers in terms of carbon leakage;
- section 2.3 explores the links between carbon leakage and broader discussions surrounding firm, sector, and national competitiveness.

2.1. The Objective of Carbon Pricing Policy

Deep decarbonization of the global economy requires broad-based reductions in greenhouse gas emissions across a range of countries and sectors. In 2012 over 80 percent of the world's primary energy supply was from fossil fuels. In addition, a range of important production processes result in greenhouse gas emissions, including manufacture of cement, metals, and chemicals, livestock raising, rice cultivation, logging, and waste management. Such a broad-based challenge requires a broad-based solution. The substantial mitigation effort required to meet ambitious climate targets such as stabilization at 450 parts per million of carbon dioxide equivalent (CO_2e) will not be possible without action in all major emitting countries and across a range of economic sectors. The authors of one integrated modeling exercise described the mitigation challenge as follows (Clarke et al., 2009):

> *failure to develop a comprehensive, international approach to climate mitigation will constrain efforts to meet ambitious climate-related targets … regardless of the target, the global costs of achieving any long-term climate related target will be higher without comprehensive action.*

This will necessitate significant, economically efficient, structural change. Substantial technological change and investment is required to produce important goods and services such as electricity, steel, cement, chemicals, transportation, and agricultural commodities in a less emissions-intensive way. Inducing this change requires a deliberate policy of increasing the financial costs associated with emissions-intensive activities that impose climate change damage on society, and decreasing the costs of those activities that do not. This is an economically efficient outcome which levels the playing field between polluting and clean firms. Indeed, the absence of such policies can be thought of as providing a *subsidy* for "dirty" production (Helm, Hepburn, & Ruta, 2012).

Achieving this structural change cost effectively is unlikely to be feasible through direct government regulation. The future path of technological development, fuel prices, demand trends, and a range of other factors that affect abatement effort is inherently uncertain. Actions are required across a range of economic sectors with varying regulatory and market structures. Abatement actions may range from obvious and intentional, such as adopting renewable energy in place of fossil fuel energy, to unintentional, such as the movement of people or relocation of economic activity. Given this complexity, governments are unlikely to have sufficient information to be able to establish rules quickly enough to feasibly capture the lowest-cost abatement options.

Because carbon pricing is flexible and works through a number of channels, it is likely to be a critical policy tool to drive the required structural change at low cost. A carbon price will increase the cost of producing emissions-intensive goods and services which will motivate end-users to reduce consumption and/or switch toward lower-emissions alternatives. It will also cause firms to reduce their emissions to improve profitability: like any other business cost, if a firm can reduce its emissions, and therefore its carbon emission costs, more than its competitors, it will be likely to gain market share and/or increase its profit margin. Over time, therefore, carbon pricing will ensure that relatively emissions-intensive ("dirty") producers lose market share to lower-emissions ("cleaner") competitors. Carbon pricing can also promote innovation by improving the expected returns to developers of low-carbon technologies. Furthermore, these benefits are realized in a decentralized way rather than according to the direction of a prescriptive government regulation, meaning that carbon pricing will promote cheaper abatement options over more expensive ones, a finding that has been supported by empirical analysis (OECD, 2013a). Accordingly, such approaches are likely to be a critical part of the world's response to the need for decarbonization.

2.2. The Challenge of Incomplete Carbon Pricing

The most cost-effective emissions reduction policy would be a globally harmonized carbon pricing regime that imposes a uniform cost on emissions across all major emitting countries and sectors. In theory such a regime could be achieved by either coordinated national carbon taxes or linked emissions trading schemes. At present, the latter option appears more practical as it could be achieved by multiple emissions trading schemes recognizing permits and the associated right to pollute issued under other schemes but, in principle, multiple countries could agree on setting a minimum carbon tax rate. Either approach would allow emissions reductions to occur in whichever country they are most efficient, promoting a lower-cost global approach to abatement.

While harmonized carbon pricing may be the ideal, political realities dictate that individual approaches at the national and subnational level are inevitable. Individual governments must lead on establishing carbon pricing policies within their relevant jurisdictions. Establishing carbon pricing policies requires both supporting technical regimes, such as emissions measurement and verification, and substantial political debate in the relevant jurisdictions. These processes are time-consuming and complex even at a national or subnational level; attempting to coordinate them across multiple jurisdictions in the context of a high-profile and important policy change is infeasible for the foreseeable future. Arguments over the distribution of abatement efforts across different jurisdictions further complicate multilateral emissions reduction policy development and reinforce the primacy of carbon pricing policymaking at the national or subnational level.

The number of governments that have introduced carbon pricing is growing. Around 40 countries and over 20 subnational jurisdictions are putting a price on carbon, including the 28 nations of the EU, California, Quebec, Republic of Korea, New Zealand, and a range of cities and provinces in China

(World Bank Group, 2015). There are also some moves toward harmonization of carbon pricing through the linking of emissions trading schemes across multiple jurisdictions, such as between California and Quebec, as well as between the EU ETS and schemes in Norway, Iceland, and Liechtenstein, although many policies remain fragmented along national or subnational boundaries.

However, so long as some countries and regions do not introduce comparable policies[2], the issue of carbon leakage may arise. Carbon leakage occurs when an emissions reduction policy, such as a carbon price, causes a reduction in emissions in the jurisdiction where it is implemented but inadvertently causes an increase in emissions in other jurisdictions that do not have equivalent emissions reduction policies. This increase in emissions in other jurisdictions arises because the difference in policy can cause production to shift. If the emissions intensity of production in jurisdictions that see an increase in production is greater than in jurisdictions where production falls, it is conceivable that this could lead to a net increase in global emissions. As the European Commission (2015) states:

> *carbon leakage is the term often used to describe the situation that may occur if, for reasons of costs related to climate policies, businesses were to transfer production to other countries which have laxer constraints on greenhouse gas emissions. This could lead to an increase in their total emissions.*

Carbon leakage could present a combination of undesirable environmental, economic, and political outcomes for policy makers. Carbon leakage could undermine a carbon pricing policy's environmental objective by causing emissions to increase in jurisdictions beyond the reach of the policy. This also implies that the economic cost of meeting a given emission reduction objective increases. At the same time, the decline in domestic production and, hence, possibly, employment can create significant political challenges. This confluence of potentially undesirable environmental, economic, and political outcomes means that the issue of leakage is always one of the most controversial and important aspects when considering the design of carbon pricing mechanisms.

2.3. Competitiveness and Leakage

Carbon leakage is caused by competing firms facing different carbon emission costs and so is often closely related to the issue of cost competitiveness. At the level of an individual firm or sector, competitiveness refers to the ability of firms to maintain or increase international market share in an undistorted market environment. A key component of competitiveness for many emissions-intensive firms/sectors is the cost of production: while competitiveness can be driven by a range of factors, such as innovation, to deliver new products, to understand and shape consumer preferences, and to develop brand loyalty[3], such factors are typically less important than production costs for many emissions-intensive products. This reflects the

[2] Typically, equivalent policies are considered in terms of the introduction of an explicit carbon price in one jurisdiction and whether or not there is an equivalent explicit carbon price in other jurisdictions. However, as discussed further below, a range of policies—such as regulations demanding use of a particular technology—can also have an effective carbon price associated with them that, in principle, at least, should be taken into account when considering whether policies are comparable. See OECD (2013a), Productivity Commission (Australia) (2011) and Vivid Economics (2010).
[3] See, for instance, the five forces frameworks created by Porter (1979).

limited scope for product differentiation or potential to fundamentally change the quality or nature of the end product of most carbon-intensive goods.

However, it is important to distinguish competitiveness from competition interactions. The concept of competitiveness relates to how effective firms can gain market share in an *undistorted* market environment. It is generally recognized that input subsidies or other trade distortions can allow recipient firms to gain international market share and improve profits in the short term while simultaneously harming their long-run international competitiveness (by, for instance, reducing the incentives that they have to seek out cost savings). Carbon pricing can be seen through the same lens: while the absence of a domestic carbon price may allow firms to benefit in the short run, it may weaken their competitive position in the medium-to-long run as they are less well positioned to compete in a market environment in which carbon emissions are constrained.

Even if there is a focus on the short-term cost impacts of the carbon pricing, the cost impact of carbon pricing and the associated risk of carbon leakage must be seen in the context of a range of other business costs. A range of other energy and nonenergy input costs will be important in determining production decisions. In the long run, investment decisions will be influenced by a wide range of factors, such as proximity to product markets and low-cost inputs, construction costs for new facilities, transport costs for reaching key markets, as well as overall business risks as might be captured in firms' cost of capital[4]. Overall, carbon emission costs will be only one factor among many driving production and investment decisions, even in emissions-intensive sectors. It is notable, for instance, that survey studies of firms on the impact of carbon policies on competitiveness often cite other factors as more influential, such as changes in input costs like labor (Sartor & Spencer, 2013).

National competitiveness, to the extent that it is a meaningful term, is unlikely to be affected by carbon pricing. While the concept of cost competitiveness can be understood at the level of a firm or sector, the extension of this concept to the economy-wide level is more elusive. It is increasingly recognized that, to a significant extent, at a national level competitiveness is similar to the concept of productivity—in other words, the value of the goods and services that are produced in the economy for a given set of labor and capital inputs. In turn, this is largely recognized as being driven by factors such as the overall quality of institutions, education levels, the existence of efficient labor and financial markets, and the quality of the business environment. In this view, in the vast majority of countries, the cost of complying with environmental regulation is likely to be of minor importance. The interrelationship of national competitiveness, and the competitiveness of particular firms or sectors, is discussed further in Appendix 2.

[4] Many of the factors influencing the overall business risks faced by firms in a particular location are captured in indicators such as the World Bank Ease of Doing Business ranking (World Bank Group, 2014a).

3. Theory and Evidence of Carbon Leakage

Carbon Leakage Has Been Examined Extensively through Both Theoretical and Empirical Studies

Carbon leakage has been extensively discussed and modeled but remains politically contentious and analytically difficult to isolate and quantify. This section addresses these complexities by:

- defining leakage and identifying its key channels (section 3.1);
- comparing the key theoretical approaches to modeling leakage and assessing the impacts of carbon pricing on exposed sectors against the broader economic effects (section 3.2); and
- examining the empirical evidence of carbon leakage from historical studies of carbon-pricing policies (section 3.3).

These sectors will assist in framing the subsequent discussion of policy options to address leakage in sections 4 and 5.

3.1. Defining Leakage and Identifying Its Key Channels

As explored above, leakage refers to the transfer of production—and hence emissions—from one jurisdiction to another as a result of differences in the stringency of carbon regulation. A crucial component of this definition is that carbon leakage should be assessed by considering what may happen (or might have happened) as result of differences in carbon regulation that would not (have) happen(ed) if there were equivalent carbon regulation across all countries. This is different from simply observing changes in emissions or output over time. As stressed above, a multitude of factors can affect operating and investment decisions in industries and hence their emissions levels: carbon leakage arises only if those changes in emissions can be attributed to the introduction of, or change in, carbon-pricing policy, and if there is a corresponding increase in production in other jurisdictions. For instance, the closure of a plant after the introduction of a carbon price can be thought of as an example of carbon leakage only if it would have continued operating had the carbon pricing policy not been introduced and if there is also an increase in production in other jurisdictions that would not otherwise have occurred.

Carbon leakage can arise through four channels. These are:

- the output or short-term competitiveness channel;
- the investment or long-term competitiveness channel;
- the fossil fuel price channel; and
- reverse leakage through the technological spillovers channel.

1. **The output or short-term competitiveness channel operates through distorted output decisions.** Higher carbon emission costs can cause firms affected by carbon pricing (covered firms) to lose market share to the benefit of those not covered by carbon pricing (uncovered firms) (Reinaud, 2008). This in turn will lead to carbon leakage. It should be stressed that while individual firms in

jurisdictions introducing a carbon price may lose market share as a result of that carbon price, this will lead to carbon leakage only if their lost output is replaced by uncovered firms. If the output is replaced by other covered firms, because they are less carbon intensive, emissions in jurisdictions without a carbon price will not increase and no leakage will occur. Indeed, this is part of the intended effect of the policy.

2. **The investment or long-term competitiveness channel operates in the medium-to-long term if different carbon prices alter investment decisions between countries.** In the medium term this can occur through reduced investment in maintenance capital to sustain output levels from covered firms. This would lead to reduced efficiency and/or reliability, in turn potentially resulting in reduced output in the medium term, which could be taken up by uncovered firms. In the longer run, existing plants in jurisdictions with more stringent carbon regulation may close and/or new plants may be preferentially located in jurisdictions with less stringent carbon regulation due to lower costs and consequently higher returns on capital. However, as noted in section 2.3, it is crucial to recognize that major investment decisions are based on multiple factors, of which carbon policy is only one; changes in exchange rates, labor and capital costs, proximity to market, other taxes, as well as factors like the quality of institutions and infrastructure (often embedded in the firm's cost of capital) are, in many cases, far more significant in a company's decision than the existence of a carbon price (Reinaud, 2008). Given these multiple factors, it can be particularly challenging to determine the true rate of leakage occurring through this channel (Vivid Economics, 2014).
3. **The fossil fuel price channel exists because firms in jurisdictions with more stringent carbon regulation are likely to reduce fuel use in response to that regulation, which can reduce the price of globally traded fossil fuels.** These reductions in global energy prices would be expected to increase demand for these fuels in jurisdictions with less stringent regulations. This, in turn, will increase emissions in these jurisdictions, resulting in carbon leakage.
4. **The technological spill overs channel may mean that carbon regulation results in reverse leakage by spurring innovation in jurisdictions with a carbon regulation, leading to reduced output and emissions in jurisdictions without a carbon price.** Stringent climate policies could stimulate technology development and innovation, improving the international competitiveness of firms affected by the carbon price (Droge, Grubb, & Counsell, 2009). Broadly speaking, this is similar to the "Porter hypothesis" that environmental regulation can lead to unexpected improvements in firm competitiveness. This might lead to a decrease in global emissions if new low-carbon technologies become the most cost-effective production method, with firms in the stringent climate policy regions gaining international market share. The reduction in output and emissions in jurisdictions with less stringent carbon regulation would result in negative leakage, all other things equal.

The primary concerns of policy makers are typically the first and second channels; these channels are the main focus of this analysis. The short-term competitiveness and investment channels have, in theory, the potential to lead to both perverse emissions outcomes and to distort patterns of output; these are the concerns that have typically motivated policy makers to address carbon leakage when introducing carbon-pricing regimes. While the fossil fuel price channel can lead to similarly undesirable

outcomes, it is harder to directly target through policy due to the complex determinants of global fossil fuel prices. It is also not a leakage channel where there is a corresponding distortion in competition. Accordingly this channel has not typically been a focus of policy makers. The fourth channel is a potential positive effect of carbon-pricing regimes and works to reduce leakage, and so is not a focus of policy efforts to avoid leakage. However, it highlights the potential complementary role of technology development in promoting emissions reductions while minimizing unwanted economic effects, which is discussed further in section 5.4.

Carbon leakage is typically thought of in the context of explicit carbon prices, and this is the focus of this study, but could equally occur due to costs associated with implicit carbon prices imposed by other means. Explicit carbon pricing includes instruments such as emissions trading schemes or carbon taxes. However, even if countries do not have explicit carbon prices, they often implement some form of climate policy that has a "shadow" carbon price (Marcu, Leader, & Roth, 2014; OECD, 2013a; Productivity Commission (Australia), 2011; Vivid Economics, 2010), such as renewable energy targets and plant emissions standards, while fuel taxes also effectively imply some form of effective carbon price (OECD, 2013b). If the costs imposed by this policy are sufficiently high and affect firms facing competition from outside the scope of the policy they could create concerns about carbon leakage. For example, such concerns were raised by stakeholders in the context of Australia's expansion of its renewable energy target in 2009 on the grounds that it would increase costs and reduce the competitiveness of energy-intensive trade-exposed firms such as aluminum smelters. Likewise, energy-intensive industries in Germany are not required to pay as large a surcharge to support renewable power development as other electricity consumers in the country so as to prevent carbon leakage.

When considering carbon leakage it is important to consider both the direct and the indirect carbon emission costs faced by firms. Direct carbon emission costs will be proportional to the direct emissions resulting from a production process. In addition, firms can face indirect carbon emission costs when suppliers of inputs to their production process themselves face carbon emission costs, and are able to pass a portion of those costs on to the purchaser of the input. An important source of indirect carbon emission costs for many businesses is electricity, but cost increases from other emissions-intensive inputs are also possible.

It can sometimes be helpful to define a carbon leakage rate in terms of the increase in emissions in the jurisdiction without a carbon price (or with a lower carbon price/less stringent regulation) expressed as a percentage of the decrease in emissions in the jurisdiction with a (higher) carbon price (or more stringent regulation)[5]. For instance, if the introduction (or further strengthening) of carbon pricing resulted in total carbon emissions in one country declining by 200 tones and foreign emissions increasing by 60 tones, the leakage rate would be calculated as 60 divided by 200, and expressed as 30 percent. Carbon leakage rates can exceed 100 percent in cases where the increase in production from

[5] For simplicity, we subsequently refer to carbon leakage in the context of jurisdictions introducing carbon prices when other jurisdictions do not have carbon prices. However, identical dynamics can emerge if jurisdictions make their carbon-pricing policy more stringent when other regions do not have carbon prices or have lower carbon prices. This is discussed further below.

firms without a carbon price is more emissions-intensive than the production reductions from those affected by carbon pricing. Carbon leakage rates can also be negative if emissions fall in jurisdictions without a carbon price. However, these are extreme cases; typically one would expect carbon leakage rates to be between zero and 100 percent. While policy makers will not always need to rely on formal estimates of carbon leakage rates to set policy (especially because, as described in section 3.2 below, such numbers can be sensitive to different modeling assumptions), they can nonetheless be a useful analytical tool to understand differences between sectors, over time, or between different modeling analyses.

In cases where carbon leakage rates are estimated, it is necessary to formally make assumptions as to which countries have strict and lax carbon regulation. By definition, leakage is the increase in emissions in jurisdictions with lax carbon regulation (or with no carbon price) divided by the decrease in emissions from firms in jurisdictions with stringent carbon regulation (or with a carbon price). However, it is often a simplification to split jurisdictions into two categories for at least two reasons:

- it ignores the potential for variation in the stringency of different carbon pricing policies;
- as noted above, it is likely to ignore the fact that most jurisdictions impose implicit carbon prices through other policies.

However, making adjustments to leakage calculations to account for these factors is likely to be complex and contentious. Therefore, in practice, for the purpose of measuring leakage rates analysts tend to apply simple judgments to define which jurisdictions have or do not have a carbon price (strict carbon regulation), an approach which we reflect below. While this binary approach is somewhat less robust, it has the merit of being more transparent than applying complex weightings based on the assessed ambition of a variety of policies in each jurisdiction.

3.2. Modeling Leakage and Other Effects of Carbon Pricing Policies

Policy makers can use modeling analysis as one tool to help understand the risk of leakage across different sectors. Gaining an understanding of carbon leakage risk is important for policy makers when deciding whether to introduce or tighten carbon pricing and may also inform their policy response (see sections 4 and 5). This assessment can in part be informed by the judgment of experts or politicians, although modeling approaches can often play an important role, especially as this can aid the transparency of any subsequent decisions.

Modeling leakage can involve either a theoretical approach that models both "with policy" and "without policy" scenarios or a historical empirical approach using real, historical world data and an estimated counterfactual. Under each approach the modeling framework must account for the interaction of carbon pricing with a range of other economic variables, such as demand and prices of other inputs, to build an understanding of the world with and without the relevant policy. The former approach is sometimes referred to as an "ex ante" or theoretical approach as it can use theoretical simulated outcomes to estimate the effect of the carbon price in the future without direct reliance on historical data. As policy makers are generally interested in assessing the potential effects of policy in advance of its introduction, approaches to making "ex ante" assessments of leakage are likely to

be of particular interest. These are discussed further in section 3.2.1 below. The latter approach is sometimes referred to as the "ex post" approach because it relies on analysis of outcomes after the event. Use of this approach to identify evidence of carbon leakage is discussed further in section 3.2.2. This analysis is also very useful for policy makers as they seek to review the effectiveness of and refine policy over time.

3.2.1. Ex ante Estimates of Leakage: General and Partial Equilibrium Options

There are two primary subtypes of the ex-ante approach to modeling carbon leakage: general equilibrium and partial equilibrium approaches. The first approach uses large-scale computable general equilibrium (CGE) models that capture and highlight the effect of climate policy on energy and factor market prices, and thereby on production and emissions outcomes. The second approach examines carbon leakage by modeling detailed output and emissions patterns at the level of an individual sector in which only a subset of firms faces a carbon price (or another form of carbon policy), but ignores the interaction of that sector with the wider economy.

Typically, both types of model involve the development of a baseline or reference scenario which depicts an understanding of how the economy or sector is anticipated to develop in the absence of asymmetric carbon pricing policies (e.g., where no jurisdiction has a carbon price). The model is then run again with the impact of the asymmetric carbon price included (e.g., where one jurisdiction introduces a carbon price and others do not). The difference between the two scenarios can then be attributed to the asymmetric carbon pricing policy with increases in emissions in other jurisdictions not seen in the reference scenario used as an estimate of the carbon leakage. This approach is consistent with the concept of a leakage rate discussed in section 3.1 above. A third scenario might be run where all jurisdictions introduce the same carbon price to determine if any of the carbon leakage is efficient. Depending on the sophistication of the modeling approach, further modeling runs can be used to estimate the impact of different types of leakage prevention mechanisms.

Both types of models can provide insights on a wide range of variables of interest: our focus is on what they suggest regarding leakage. As well as estimating leakage rates, CGE models can provide estimates of the overall expected welfare impact of carbon pricing (often measured in terms of output), which can be of considerable interest to policy makers. Box.1 provides more information on some of these other insights that can be captured through CGE models. Partial equilibrium models often allow for the competitive dynamics between different producers in the market to be explored, or cost pass-through rates to be estimated, also of significant policy interest.

A key advantage of general equilibrium modeling is that it places leakage in the context of the broader effects of a carbon pricing policy. The whole-economy perspective of CGE modeling allows it to capture the indirect, feedback effects that might be relevant to sectors affected by a carbon price, for instance how the carbon price may lead to the reallocation of resources between economic sectors as input prices change. These indirect impacts can be particularly important when the carbon-pricing mechanism envisages recycling of any revenues that are raised by carbon pricing to different sectors of the economy. By contrast, partial equilibrium approaches focus only on a subset of sectors and cannot capture indirect, feedback effects resulting from carbon pricing.

Box 1. Modeled Welfare Impacts of Carbon Pricing Policies

General equilibrium models suggest that the welfare effects of carbon pricing are typically modest. For example, across 25 CGE models, the estimates of the impact on welfare (usually proxied for by output or GDP) of the unilaterally acting countries range from –1.58 percent to 0.02 percent (see meta-analysis by Branger & Quirion, 2013). To facilitate comparisons of different policy measures, these welfare impacts do not account for the environmental benefits of lower global greenhouse gas emissions. In any case, seen relative to the size of countries' overall economies, these welfare impacts are quite low, even in cases where leakage is relatively high. Partial equilibrium models are typically not able to provide global welfare estimates.

Technology development benefits from climate policy are often not captured in general equilibrium modeling approaches and hence in these welfare estimates, although an increasing number of CGE models are trying to incorporate these effects. If carbon pricing induces a domestic firm to introduce a new, cleaner product, the benefits from this will typically not be captured by existing modeling approaches. However, recent CGE modeling approaches incorporate this effect (see McKibbin & Wilcoxen, 2009, and Gerlagh & Kuik, 2014). Failure to incorporate these benefits will overstate the negative welfare impacts of climate policy and ignore the potential broader economic benefits of innovation. More generally, studies show that climate policy can encourage innovation. For example, Calel and Dechezlepretre (forthcoming) examine the impact of the EU ETS on European patent data and find that carbon pricing induced up to a 10 percent increase in low-carbon innovation by affected firms, with little discernible effect on those not affected by the carbon price. Such technological progress can form an important benefit from carbon pricing, in addition to the standard cost-effectiveness arguments.

On the other hand, the aggregated level of modeling in the general equilibrium approach cannot capture some aspects of market structure and competitive dynamics as well as partial equilibrium approaches. CGE models do not account for the details of market structure and how it may vary across different sectors in the economy, especially emissions-intensive sectors. Moreover, to maintain tractability, these models typically assume that individual markets are perfectly competitive. While this is a reasonable assumption for some sectors, it is often empirically implausible for highly emissions-intensive sectors such as electricity and cement. By contrast, partial equilibrium models usually provide greater empirical realism in terms of the model assumptions and inputs, especially by allowing for imperfect competition. They also allow for carbon leakage to be compared across different sectors, in a way that can help identify what sectoral characteristics are driving leakage rates at a more granular level.

There are striking differences in estimates of carbon leakage rates across the two approaches, with the range of results reflecting large uncertainty in leakage rates. In CGE models leakage rates tend be low, typically in a range of around 5 to 15 percent, although results are not conclusive of the existence of leakage[6]. By contrast, the range of leakage estimates from partial equilibrium models is much wider, suggesting possible leakage rates between 0–100 percent, depending on assumptions and model specification. These suggest large uncertainty in possible leakage rates. The variation in results is presented in Table 1.

[6] One key exception to this in the literature is Babiker (2005), which estimates a leakage rate as high as 130 percent as a result of increasing returns to scale production technologies, leading to oligopolistic market structures.

Table 1. General and Partial Equilibrium Approaches Demonstrate a Clear Difference in Predicted Leakage Rates

Author(s)	*Period covered*	*Sector and geography*	*Carbon prices, per tCO_2*	*Modeled carbon leakage rates, percent (direction of leakage)*
General equilibrium (CGE)				
Babiker (2005)	2010	Global; 7 commodities	No explicit price	50 to 130 (OECD to non-OECD)
Baylis et al. (2014)	2010 data	Global, multisector	No explicit price	10 to 15; falling to –8.5 to 3 with abatement resource effect (countries not indicated)
Burniaux & Martins (2000)	Pre-EU ETS; 1996–99	Global international coal market	A range of carbon prices are considered, but no explicit values are given	2 to 27 (from Annex 1 to non-Annex)
Carbone (2013)	1995–2011	Global (leakage from Annex 1 to non-Annex); 112 regions; 57 sectors	No explicit carbon tax considered, but tax is set so as to reduce emissions generation by 20%	–9 to 28 (Annex 1 to non-Annex 1)
Caron (2012)	1995–2008	Global; 51 sectors	US$41 to US$55	1 to 17 (an unspecified subset of countries)
Gerlagh & Kuik (2007)	1999–2005	Global; energy-intensive goods	Carbon prices are determined by the model so that countries achieve their emissions reductions target as in Kyoto Protocol statements	–17 to 17 (Annex 1 to non-Annex 1)
Kiuila, Wójtowicz, Żylicz, & Kasek (2014)	To 2020	Global, multisector	Ranging from US$197 to US$21 for EU and ranging from US$20 to 32 for non-EU	0 to 28 (EU to ROW)
Kuik & Gerlagh (2003)	Kyoto Protocol; 1995 trade and production statistics	OECD; GTAP economy-wide dataset	Endogenous calculation of carbon tax required for various regions to reach their emissions targets: for the US, US$3.5; for Japan, US$28; for the EU: US$17; other OECD, US$24	11 to 15 (Annex 1 to non-Annex 1)
Kuik & Hofkes (2010)	data calibrated to 2001–06	Global; mineral sector	€20	17 to 33 (EU to ROW)
Lanzi, Mullaly, Chateau, & Dellink (2013)	Calibrated to 2013–20	Global, multisector	Ranging from US$12 to US$163 for Annex 1 countries; US$0 for non-Annex 1	9 (Annex 1 to non-Annex 1)

Table continues next page

Table 1. General and Partial Equilibrium Approaches Demonstrate a Clear Difference in Predicted Leakage Rates *(continued)*

Author(s)	*Period covered*	*Sector and geography*	*Carbon prices, per* tCO_2	*Modeled carbon leakage rates, percent (direction of leakage)*
Monjon & Quirion (2009)	Calibration year 2005	Global; multisector	€14 to €27	5 to 12 (EU to ROW)
Paroussos, Fragkos, Capros, & Fragkiadakis (2014)	2015–2050	Global, multisector	Ranging from US$14 in 2020 rising to US$148 in 2050 for the EU; ranging from US$0 to 15 for China; ranging from US$0 to US$78 for the US	28 (EU to ROW) to 25 (EU + US to ROW) to 3 (EU + US + China to ROW)
Partial equilibrium				
Allevi, Oggioni,Riccardi, & Rocco (2013)	NA	EU ETS-covered part of cement (clinker) in Italy	Ranging from €32 to €100	17 to 100 (Italy to ROW)
Demailly & Quirion (2006)	Projections from 2008–12; policy calibrated to 2004	Global; focuses on cement	€20	0 to 50 (EU to ROW)
Droge, Grubb & Counsell (2009)	Projections to 2013–20	Electricity, steel, cement, and aluminum; draws on studies focusing on these industries in the UK, US, Poland, and the EU	€14	0 to 39 (EU to ROW)
Healy, Quirion, & Schumacher (2012)	2005–12	EU; grey clinker market	€20	22 (EU to ROW)
Ponssard & Walker (2008)	1995–2007; production data calibrated to 2006	Cement in a "typical Western European country market"	€50	70 to 73 (not specified)
Ritz (2009)	Ex ante; market data for 2004; parameters calibrated using data between 2003 and 2005	Focuses on EU ETS-covered steel	€20	9 to 75 (EU to ROW)

Table continues next page

Table 1. General and Partial Equilibrium Approaches Demonstrate a Clear Difference in Predicted Leakage Rates *(continued)*

Author(s)	*Period covered*	*Sector and geography*	*Carbon prices, per* tCO_2	*Modeled carbon leakage rates, percent (direction of leakage)*
Santamaría, Linares, & Pintos (2014)	2005–14	EU ETS-covered part of cement, steel, and oil refining in Spain	Ranging from €5 to €35	35 to 80 for cement, 18 to 95 for steel, 10 to 90 for oil (Spain to ROW)
Szabó, Hidalgo, Ciscar, & Soria (2006)	1990–97	EU and Kyoto Protocol Annex B countries; cement	Ranging from €28 to €40	Carbon leakage: 29; production leakage: 33 (EU and Annex B countries to ROW)
Vivid Economics (2014)	Projections to 2013–20	Models impact of Phase III of EU ETS on 25 UK industries	Ranging from €5 to €50	Rates of 0 to 100 by 2020 depending on the sector (UK to ROW)

Source: Vivid Economics

Note: Kiuila, Wójtowicz, Żylicz, & Kasek (2014) results reported using a common definition of leakage for comparability with other studies, rather than the authors' preferred definition

While the differences in leakage rates between general and partial equilibrium approaches have not been resolved in the literature, there are several plausible potential explanations. One consideration is that a comparison of leakage rates between an economy-wide figure from a CGE model and a sector-specific rate from a partial equilibrium analysis is not like-for-like. In particular, the partial equilibrium results, by construction, typically focus on an exposed sector, while the CGE result typically aggregates across many sectors, some of which are exposed and some are not. For example, the domestic electricity sector is a large source of emissions reductions but, in many countries, it has little or no trade exposure, and thus little or no leakage, which dilutes the leakage rate modeled across an economy using CGE. A further explanation is that while CGE models typically assume that firms are price takers, they do not take domestic and foreign firms' products to be perfect substitutes. In particular, they use trade elasticities to calibrate the degree of substitution, and these elasticities imply that firms' products are, in effect, quite strongly differentiated. By contrast, in partial equilibrium approaches, products are often assumed to be perfectly homogeneous and interchangeable from a buyer's point of view, irrespective of whether they are imported. Unless transport costs are prohibitive, this creates strong substitutability and competitive pressure between producers in different jurisdictions.

There are also important differences in the results observed within each category of model. Some of the key drivers for this are explored in Box 2 below. Model results are sensitive to inputs and assumptions that can be selected to support particular outcomes. Careful consideration should be given to these inputs and assumptions when comparing model results. Similarly, careful consideration should be given to the inputs, assumptions, and scenarios before using results from existing modeling exercises to inform new policy development.

Box 2. Variations in Key Assumptions Cause Leakage Rate Estimates to Vary between Studies Using Similar Approaches

The underlying assumptions used to calibrate both general and partial equilibrium models are key drivers behind the variation in results achieved within each approach. In terms of general equilibrium modeling, studies' findings have been found to be particularly sensitive to the choice of:

- Armington elasticities: in CGE models, these are parameters which estimate the degree to which internationally traded goods are substitutable between economies.
- Substitutability between factor inputs in the production process: in the context of analyzing leakage, this generally relates to the substitutability between energy and nonenergy factors of production.
- Elasticity of fossil fuel supply: allowing for a greater elasticity in fossil fuel supply, and thus assuming that regulated economies can switch to cleaner technologies, can lead to lower leakage rates in terms of global emissions; reductions in regulated economies are greater in magnitude than emissions increases in unregulated economies (Carbone, 2013)

As a result of the sensitivities of models to underlying assumptions, authors tend to present a range of estimates based on how the model is calibrated. As reported in Table 1 above, Burniaux & Martins (2000) estimate a range of leakage rates from 2 to 27 percent. This range is driven by the assumptions regarding trade and substitution elasticities. Their low-end estimate is derived from setting the trade substitution elasticities for coal at 0.5, setting the supply elasticity of coal at (downward) infinity and the supply elasticity of oil at 2. By contrast, their high-end estimate of 27 percent is derived by setting the trade substitution elasticity for coal at 2, the supply elasticity of coal at 0.1, and the supply elasticity of oil at 0.5.

In partial equilibrium models, an "off-model" assumption is normally made as to the geographic locus of competition—in other words, to the location of competitors and the proportion of market supply that is affected by the carbon price. For example, Smale, Hartley, Hepburn, Ward, & Grubb (2006) consider the impact of the EU ETS in five markets: grey cement, newsprint, refined products, cold-rolled flat steel, and primary aluminum. In their analysis, the cement market is considered national; newsprint, refined products and cold-rolled flat steel as regional; and aluminum as global. They find that the impact of carbon pricing on European aluminum output levels (and hence, it may be assumed, leakage risk) is higher than for the other markets studied because the assumed market definition means that only a small proportion of production in the aluminum market (global) is affected by the carbon price, whereas, in the other markets studied (national and regional) a greater proportion of production is affected by the carbon price.

While the outcomes of partial and general equilibrium approaches are somewhat difficult to reconcile, their different strengths and focuses make both approaches valuable to modeling leakage, and they should ideally be used in combination. As they are able to target different and important elements of the issue, using both approaches allows the granular nature of partial equilibrium estimates at the sectoral level to be combined with the general equilibrium effects of fuel price changes and resource reallocation across the economy. Where feasible, a combination of both approaches is ideal, with partial equilibrium outputs feeding into general equilibrium models and, in turn, being informed by general equilibrium outcomes. However, a clear drawback of such an approach is the time and modeling effort associated with iterating models, and the potential difficulty in achieving consistency between results from the two approaches. In the absence of a combined approach, general and partial equilibrium results may be more easily reconciled by separately reporting sector-level results from general equilibrium models to ensure a like-for-like comparison.

3.2.2. Ex Post Empirical Assessment of Leakage

While ex ante studies are useful to assess the potential effects of proposed policies, ex post empirical analysis of existing policies can help to draw on real-world experience to strengthen understanding of the risk of leakage and help to review appropriateness of policy over time. A common approach to ex post studies is to use econometric techniques to try to isolate the effect of the carbon pricing policy from other changes during the period of analysis. Another more qualitative approach is to use industry surveys.

Empirical examinations tend to find limited evidence of carbon leakage. These empirical studies typically use econometric techniques to examine historical effects of carbon pricing policies on output and emissions patterns while controlling for other influential factors. Other approaches utilize company-level data from affected sectors to examine the effects of carbon pricing on investment and company profitability. A summary of key empirical studies is provided in Table 2. As can be seen, most of these studies focus on the EU ETS as the longest established carbon pricing mechanism.

Table 2. Empirical Studies Provide Limited Evidence of Carbon Leakage

Author(s)	*Policy and period covered*	*Sector and geography*	*Strong evidence of leakage?*
Abrell, Zachmann, & Ndoye (2011)	Phases I and II of the EU ETS; 2005–08	Panel regressions; economy-wide coverage of the EU	No, but some sectors affected more than others
Barker, Mayer, Pollitt, & Lutz (2007)	Environmental (energy) taxes over period 1995–2005	Economy-wide coverage of six EU Member States	No
Chan, Li, & Zhang (2012)	EU ETS before and after implementation; 2001–09	Panel regressions covering power, cement, iron, and steel in the EU	No
Cummins (2012)	Phase I of the EU ETS	Panel regressions; economy-wide coverage of the EU	No
Ellerman, Convery, & Perthuis (2010)	Phase I of the EU ETS	Focuses on oil refining, aluminum, iron and steel, cement	No
Graichen et al. (2008)	Phase III of the EU ETS	Focuses on sectors in the EU ETS with more than three installations in Germany	No
Lacombe (2008)	Phase I EU ETS	Focuses on petroleum	No
Martin, Muûls, de Preux, & Wagner (2012)	Phases I and II of the EU ETS	Economy-wide; EU	No
Martin, Muûls, & Wagner (2011)	Phase I of the EU ETS up to 2009	800 companies in the EU ETS	No
Reinaud (2008)	Phase I of the EU ETS up to 2009	Covers steel, cement, aluminum, and refining in EU-25 Member States	No
Sartor (2012)	First 6.5 years of EU ETS	Focuses on aluminum	No
Sartor & Spencer (2013)	After introduction of EU ETS, anticipating Phase III; 1991–2010	Focuses on energy-intensive industries in Poland	No

Source: Vivid Economics.

These results are consistent with a recent review by the OECD of studies on the competitiveness impacts of carbon pricing. This review finds that empirical studies indicate that carbon pricing promotes abatement, but finds little evidence of negative competitiveness effects (Arlinghaus, 2015). Specifically, the study finds no causal effects of the EU ETS on output, profits, or trade outcomes, while employment reductions are mild and concentrated in nonmetallic minerals products.

Further supporting the broad conclusion that competitiveness effects are mild, two studies have failed to find evidence of within-country competitiveness impacts between firms that receive differential treatment under environmental policies. Flues & Lutz's (2015) econometric analysis compares German firms that did and did not receive support for the impact of higher electricity tax rates. The study found no difference between firms subject to the full tax rates and those receiving reduced rates in terms of turnover, exports, value added, investment, and employment. Their analysis suggests that the higher costs faced by the firms not receiving the reduced tax rates did not affect their competitiveness. Similar conclusions can be drawn from a study by Martin, Preux, & Wagner (2009), who found no difference in output or employment between firms that faced the full Climate Change Levy in the UK and those that received an 80 percent discount.

It is difficult to know for certain what explains the ex post modeling result of carbon leakage. While it could mean that the risk of leakage is negligible there are a number of other factors to consider.

- The accuracy of any econometric analysis depends largely on the amount of data available, which can be problematic given the short time frames many carbon pricing mechanisms, such as the EU ETS, have been in place (Vivid Economics, 2014). These time frames can be further shortened by contracting patterns in various sectors. For instance, the existence of long-term electricity contracts has also been a partial buffer to the impacts of the EU ETS (Varma et al., 2012; Sartor, 2013; Reinaud, 2008). Reinaud (2008) estimates that only 18 percent of capacity in the EU aluminum sector was exposed to higher electricity prices under the early years of the EU ETS, with the remainder protected, albeit temporarily.
- Operational schemes have typically been characterized by low carbon prices, which suggests that carbon prices may have had a smaller impact on production and investment decisions than a range of other factors, such as energy prices, raw material prices and changing international market conditions. Results could be different with higher carbon prices.
- Results could indicate that policy measures, such as free allowances and other measures to address leakage, have been effective. For example, in the EU ETS, the impact of carbon prices and risk of leakage may have been diluted by the free allowances available to industry in Phases I and II.

The empirical findings are, however, consistent with the analyses of the impacts of other environmental regulation on firm location and activity level. Ever since the 1970s they were also feared for causing the potential migration of industry to "pollution heavens" abroad, which has not materialized on a significant scale. This is briefly explored in Box 3 below. Environmental policies have even been found to induce innovation that offsets part of the cost of compliance with the environmental policy. This is not surprising for economists who have long observed that firms do not compete on costs only, but on the overall

Box 3. A Broader Literature on the Impact of Environmental Regulation on Firm Investment and Productions Decisions Tends to Find Little Impact

Carbon leakage is a specific case of the general concept known as the "pollution haven hypothesis," which states that polluting activities may be driven to jurisdictions with less stringent environmental regulations. This argument has been advanced in relation to regulation on a range of pollutants, including air pollutants such as sulphur dioxide, nitrogen oxides, particulate matter or volatile organic compounds, various water pollutants, and regulation of solid wastes such as heavy metals.

Research has not provided conclusive evidence of the pollution haven hypothesis affecting investment and trade patterns. A number of studies in the 1990s examined trade pattern changes, greenfield plant locations, and industry migration based on differences in environmental regulation, and fail to find evidence that environmental regulations have had much impact. According to Jaffe, Peterson, Portney, & Stavins (1995), "there is relatively little evidence to support the hypothesis that environmental regulations have had a large adverse effect on competitiveness." Other researchers have noted that environmental taxes are often relatively small and do not have a sufficiently large effect on unit costs to justify relocation to an unregulated jurisdiction (Barker, Meyer, Pollitt, & Lutz, 2007). An analysis of the effect of environmental regulations on energy- and non-energy-intensive industries in China indicated that firms shifted the composition of their production (in terms of capital and labor intensity) rather than the location, contradicting the pollution haven hypothesis (Zhu & Ruth, 2015). Finally, another study examining environmental policy in 21 European countries even suggests that higher environmental stringency is associated with increased, rather than decreased, investment levels (Leiter, Parolini, & Winner, 2011).

There are some contrary findings. Some studies criticize earlier work on the pollution haven hypothesis on methodological grounds, and find that increases in compliance costs do affect trade patterns and the location of heavy polluting industry. For example, Levinson (2009) estimates that a 1 percent increase in pollution abatement cost expenditures in the US is associated with a 0.4 percent increase in net imports from Mexico and a 0.6 percent increase from Canada.

efficiency of converting various inputs (including knowledge) into high-value products and services. Cost-competition is more important to sectors offering homogenous products and commodities.

Qualitative techniques, such as interviews with industry and policy-making stakeholders, surveys, and case studies, provide an alternative source of evidence on carbon leakage, but are subject to selection and reporting biases and inherent methodological weaknesses. While survey approaches usually limit the analyses to qualitative terms, some studies have performed regression analyses on the survey results in order to obtain quantified results. If questions are correctly phrased, surveys may be able to capture the degree to which carbon pricing has impacted investment and relocation decisions. However, surveys of this nature may be subject to selection and reporting biases, making their representativeness uncertain. A further complication is the difficulty of distinguishing between plant closures due to carbon policies and those which would have taken place regardless due to other market factors. For example, Cobb, Kenber, and Haugen (2009) report a view that carbon pricing had contributed to the closure of several aluminum smelters during the first six and a half years of the EU ETS, but this remains very difficult to substantiate.

These empirical challenges create difficult judgment calls for policy makers; it is difficult to determine whether leakage is low due to effective policy, because it is not a material concern, or because of other factors. As Karp (2010) observes, most non economists who have considered the question of leakage believe that it is important (in other words, that the risks of carbon leakage are significant). On the other hand, the weak empirical evidence, combined with modest rates of leakage in general equilibrium studies, gives some support to the view that leakage "will be small or moderate" (Karp, 2010). However, the higher rates of leakage in partial equilibrium studies, combined with the anecdotal concerns expressed by industry (Cobb, Kenber, & Haugen, 2009) and the political economy of lobbying, suggest that, on balance, leakage concerns will remain an important part of carbon pricing policy despite the generally weak evidence. Sections 4 and 5 consider in further detail the risks and benefits of policy action to reduce carbon leakage.

4. Policy Responses to Carbon Leakage: Which Sectors to Target?

Judicious Policy Choices Can Reduce Distortions and Save Scarce Fiscal Resources

In cases where policy makers are concerned that there is a substantial risk of leakage, they may decide to take action to reduce this risk. Such a policy may be seen as necessary to safeguard the environmental integrity and cost effectiveness of the carbon pricing regime, as well as in response to concerns from significantly affected firms and industries.

In terms of environmental integrity and cost effectiveness, the justification for establishing leakage prevention mechanisms is that some of the channels through which carbon pricing might be expected to reduce emissions under a globally harmonized carbon price may not materialize if only a few countries introduce carbon pricing. Broadly speaking, there are three main channels through which a global carbon price would be expected to reduce emissions that might be compromised in the absence of global harmonization.

- **Encouraging substitution from high-to low-carbon producers.** Under a globally harmonised carbon price all firms will face an equivalent carbon pricing regime with the intended effect that efficient producers will benefit more than less efficient ones. However, as discussed at length in the previous sections, without harmonization not all firms will face a carbon price, potentially distorting output patterns and resulting in carbon leakage.
- **Promoting demand-side abatement.** Under a globally harmonized carbon price the price of carbon-intensive goods and services will increase, prompting end-users to improve their efficiency. However, without harmonization, competition from producers that do not face a carbon price will tend to limit price rises and therefore reduce demand-side abatement.
- **Incentivizing firms to reduce their emissions intensity.** Under a globally harmonized carbon price lower emissions firms will gain a competitive advantage over higher emissions firms, allowing them to increase profit margins and/or market share. This will encourage firms to improve their emissions intensity. However, without harmonization firms may not be able to justify efficiency-enhancing investments if competition from uncovered firms causes them to lose market share.

The art of leakage policy is to try to correct for the challenges that emerge when carbon prices are not globally harmonized, while, at the same time, not undermining the benefits that are expected from the carbon pricing in the first place.

Policy makers must address these issues in relation to two important and interrelated considerations:

- choosing which entities to provide assistance to; and
- determining the mechanism for providing assistance.

The discussion in the remainder of this section considers the first of these issues; section 5 considers the second.

The above discussion also helps to identify a difference between "efficient" and "inefficient" leakage. As noted above, carbon pricing is intended to allow less emissions-intensive firms gaining market share at the expense of more emissions-intensive firms. This can be thought of as a desirable, or efficient, outcome of the policy, even if these less emissions-intensive firms are located in different jurisdictions[7]. By contrast, inefficient carbon leakage relates to shifts in production and hence emissions that arise because of a differential in the stringency of carbon pricing policies (or equivalent regulations). This distinction is discussed in the following sections.

4.1. Breadth of Assistance

Policy makers face a series of choices in determining how broadly to provide assistance to protect against leakage. Three key choices are:

- whether to give assistance to electricity generators;
- whether to provide assistance to all entities that are not electricity generators, or whether to limit assistance to only a subset of these entities; and
- whether to provide assistance to all eligible entities on a uniform basis, or whether to provide "tiered" assistance that increases according to a firm or sector's assessed exposure to carbon leakage.

The approaches to these questions adopted in a range of carbon pricing regimes are summarized in Table 3.

The decision over the breadth of coverage of the assistance provision involves a trade-off between political economy considerations and the desire to avoid economic distortions and save scarce fiscal resources. On the one hand, broad coverage may be required to generate sufficient acceptance for a carbon-pricing scheme, especially at its inception. On the other hand, and depending on the type of assistance provided, there is a risk that providing assistance will limit the incentives firms face to reduce emissions, hence undermining the rationale for introducing the carbon price in the first place. Assistance also requires (implicitly or explicitly) significant fiscal resources for which there will typically be many competing uses.

The combination of these choices will determine the overall generosity of the assistance provided, as well as the fiscal cost and the risk of distorting abatement efforts. All else being equal:

- limiting or avoiding assistance to electricity generators will reduce the cost of assistance and, where electricity generators are not materially exposed to international competition, this will not introduce a substantial risk of leakage;

[7] Indeed, it can even be thought of as desirable if the firms in the other jurisdiction do not currently face as high a carbon price, although in this case the extent of market share shifting between the cleaner and dirtier production is likely to be greater than would be achieved under a global carbon price.

Table 3. The Breadth of Assistance Provided Depends in Particular on Whether Generators Are Included, and Whether Eligibility or Tiers of Assistance Are Applied in Other Sectors

Scheme	*Period*	*Treatment of generators*	*Treatment of non-generators*	*Is assistance tiered or uniform?*
EU	Phases I and II	Included	All entities given assistance	Determined by national allocation plans but generally offered to all entities on the same basis
Kazakhstan	Since commencement	Included	All entities given assistance	Uniform
All Chinese ETS pilots (Beijing; Chongqing; Guangdong; Hubei; Shanghai; Shenzhen; Tianjin)	Since commencement	Included	All entities given assistance	Uniform
Korea	Since commencement	Included	All entities given assistance	Uniform
South Africa	From commencement	Included	All entities given assistance	Tiered based on trade exposure and the level of process emissions
California	2013 to 2017	Assisted through a mechanism specific to the electricity generation sector	All entities given assistance	Uniform
EU	Phase III	Generally excluded	All entities given assistance	Two tiers: entities exposed to leakage receive greater assistance
California	2018 to 2020	Assisted through a mechanism specific to the electricity generation sector	All entities given assistance	Three tiers: high, medium, and low exposure to leakage
Australia	Commencement to repeal	Assisted through a one-off compensatory assistance package	Limited to activities that meet eligibility criteria	Two tiers: "highly" and "moderately" exposed to leakage
New Zealand	Since commencement	Excluded	Limited to activities that meet eligibility criteria	Two tiers: "highly" and "moderately" exposed to leakage

Source: Vivid Economics

- providing assistance to all entities that are not electricity generators will introduce a greater fiscal cost and may risk reduced abatement effort compared with an approach where eligibility is limited; and
- providing assistance on a tiered basis will reduce the fiscal cost of assistance and may be appropriate to reflect the varying degree of exposure to leakage between sectors, although it will increase the complexity of the scheme.

To illustrate the interaction of these trade-offs, both the EU ETS Phase III and the (now repealed) Australian carbon-pricing mechanism have used a similar portion of their available emissions allowances, around 50 percent, as assistance measures to protect against the risk of carbon leakage, despite having quite different allocation approaches. The former does not provide safeguards against carbon leakage to electricity generators due to evidence of full cost pass-through, but focuses its efforts on the majority of manufacturing industries; the latter limited eligibility for non generators but provided an additional pool of assistance to generators as a transitional measure. As a demonstration on the point about political economy considerations, this transitional measure was not designed to protect against leakage since this was recognized as a low risk for this sector, but rather as a means of trying to smooth the transition to a new policy regime and to address energy security risks.

Often schemes have narrowed the breadth of sectors receiving assistance over time. For instance, the exclusion of the power sector in Phase III of the EU ETS reflected the recognition that providing assistance to entities that did not face international competition had led to windfall gains, where the cost of emissions were passed on to consumers irrespective of the value of assistance received. In addition, while nonpower sector entities continue to receive allocations even if they are not deemed to be exposed to carbon leakage, the extent of this assistance has been reduced.

4.2. Criteria to Determine Sectors at Risk

Where eligibility for assistance is limited or where the level of assistance is tiered, policy makers must make a judgment as to how to determine the relevant eligibility and assistance thresholds. Both approaches can be data-intensive, which may in part explain why early phases of carbon-pricing regimes often tend toward universal provision of free allowances. However, as noted above, this additional administrative complexity offers potentially significant advantages in the form of reduced fiscal costs and risk of distorting abatement efforts.

Policy makers have generally used two main indicators: carbon intensity and trade exposure, either in isolation or combination, to limit eligibility for assistance and to separate assistance categories into tiers. The logic of why these two factors are often used to determine exposure to leakage and the appropriate level of assistance is outlined below.

- Carbon intensity captures the *impact* that carbon pricing has on a particular firm or sector. It can be thought of, for these purposes, as the volume of emissions created per unit of output, revenue, value added, profit, or similar economic metric (the term *emissions intensity* can be used interchangeably). As carbon leakage is driven by carbon emission cost differentials between jurisdictions with and without carbon prices, the larger the impact of a given carbon price on sectors or firms, the greater the risk of leakage, all other things being equal.

- Trade exposure can be thought of as a proxy for the ability of a firm or sector to pass on costs without significant loss of market share, and hence their *exposure* to carbon prices. Trade, or the potential to trade, is what allows competition between producers in different jurisdictions. Therefore trade is critical to allow firms that face different carbon prices to compete. Where factors such as trade barriers or transport costs make trade unlikely to occur, covered firms are insulated from competition from uncovered competitors and the risk of carbon leakage should be small.

Table 4 shows the different factors that schemes have used to identify which sectors might be exposed to the risk of leakage. Consideration can also be given to the weighting of these factors and whether there is any feedback or relationship between criteria over time.

Table 4. Different Jurisdictions Apply Different Definitions and Thresholds to Assess Trade Exposure and Emissions Intensity

Scheme (period)	*Criteria*	*Definitions*	*Applied at firm or sectoral level?*
EU ETS Phase III	Cost increase >30%; or Trade intensity >30%; or Cost increase >5% and trade intensity >10% Qualitative assessment for borderline sectors	Cost increase: [(assumed carbon price (€30) × emissions) + (electricity consumption × carbon intensity of production × carbon price (€30))]/GVA) Trade intensity: (imports + exports)/ (imports + production)	Sectoral
South Africa	Trade intensity >10% on a combined exports and imports measure; or Trade intensity >5% on an exports-only measure; or High process emissions	Trade intensity: (imports + exports)/output; or exports/output Process emissions eligibility definition is currently undefined	Firm
California (2018-2020)	Variously split into high, medium, and low exposure. This was based on a combination of tiers of emissions intensity and trade intensity. Emissions intensity tiers are: High: >10,000 tCO_2e per million dollars of revenue Medium: 1,000–9,999 tCO_2e per million dollars of revenue Low: 100–999 tCO_2e per million dollars of revenue Very low: <100 tCO_2e per million dollars of revenue Trade intensity tiers are: High: >19% Medium: 10–19% Low: <10%	Carbon intensity calculated as tonnes of CO_2e per million dollars of revenue metric Trade intensity: (imports + exports) / (shipments + imports)	Sector

Table continues next page

Table 4. Different Jurisdictions Apply Different Definitions and Thresholds to Assess Trade Exposure and Emissions Intensity *(continued)*

Scheme (period)	*Criteria*	*Definitions*	*Applied at firm or sectoral level?*
New Zealand	Highly exposed if carbon intensity > 1,600 tCO_2e per million New Zealand dollars of revenue and trade exposed Moderately exposed if carbon intensity >800 tCO_2e per million New Zealand dollars of revenue and trade exposed	Carbon intensity is calculated as tonnes of CO_2e per million dollars of revenue metric Trade exposure is qualitative and based on the existence of trans-oceanic trade in the good in question. Electricity is explicitly excluded	Sector
Australia	Highly exposed if trade exposed and one of the following: carbon intensity >2,000 tCO_2e per million Australian dollars of revenue, or >6,000 tCO_2e per million Australian dollars of GVA Moderately exposed if trade exposed and one of the following: carbon intensity >1,000 tCO_2e per million Australian dollars of revenue, or >3,000 tCO_2e per million Australian dollars of GVA Trade exposed >10%	Carbon intensity is calculated as tonnes of CO_2e per million dollars of revenue metric or, alternatively, tonnes of CO_2e per million dollars of GVA Trade exposure based on either a quantitative test: (imports + exports)/production; or a qualitative assessment	Sector

Source: Vivid Economics
Note: GVA denotes gross value added

However, while these criteria are broadly recognized as being important in determining sectors exposed to carbon leakage, there are a number of important considerations.

- **First, in the academic literature a number of authors have argued that trade intensity, while relevant, is not a standalone driver of carbon leakage and only has an effect only when a sector or firm is also carbon-intensive.** One study finds that while carbon intensity is a strong indicator of leakage risk, trade exposure is not (Martin, Muûls, de Preux, & Wagner, 2014). Another argues that trade intensity provides no indication of the competitive dynamics of domestic firms against international competition, such as relative size and output, geographic scope and concentration, which would be necessary to evaluate market power inclusive of imports (Okereke & McDaniels, 2012). The suggestion that it is only the combination of impact (cost increase) and exposure (trade intensity) that is important in determining leakage risk is relevant to a number of country examples. For example, the South African carbon tax and Phase III of the EU ETS both, in differing ways, offer support to entities that are deemed to be trade-exposed, even if they are not carbon-intensive[8].

[8] By definition, the resources expended on providing leakage prevention to any one sector that is not carbon-intensive will be small, but the overall impact may still be significant if a sufficient number of sectors are protected.

- **Second, when considering carbon intensity, it is important to take into account the carbon emission costs passed through from the supplying sectors, particularly electricity, as well as the direct carbon emission costs incurred in production.** As noted earlier, carbon emission costs can affect production and investment decisions both through direct costs from a firm's own emissions and from indirect carbon emission costs, i.e. the increased input costs resulting from carbon pricing. However, estimating the effect of indirect carbon emission costs on a firm is more complicated than for direct emission costs as ideally the rate of cost pass-through from the supplying sector needs to be taken into account. This can be particularly challenging in the power sector, where it is most important, as the change in prices will depend on the structure of the electricity market: in some structures, it is possible that the impact of carbon prices on electricity prices could vary by time of day or season. Nevertheless, indirect carbon emission costs can be substantial for some industries, even allowing for incomplete pass-through. For example, a survey-based study estimated that the indirect costs for primary aluminum producers during Phase II of the EU ETS amounted to more than 3.5 percent of total production costs (Centre for European Policy Studies 2013).
- **Third, while energy cost shares can be used as a proxy for carbon intensity, they need to be used with caution as they can be quite imprecise.** Some schemes have suggested that carbon intensity can be approximated by examining energy intensity. This, for instance, was one of the options for assessing leakage discussed in the Waxman Markey bill that failed to pass through the US Congress in 2009. This approach can be attractive, especially as energy consumption data may be easier to obtain than emissions data. However, while fuel combustion on site and indirect emissions associated with electricity use will be broadly related to energy cost share, the price and emissions intensity of different fuels vary significantly, and the emissions intensity of electricity can vary greatly by location. Accordingly, energy cost share must be recognized as a highly simplified proxy for carbon intensity.

A further consideration is whether emissions intensity and/or trade exposure is assessed at the firm or sector level. In general, assessments have been made at the sector level to avoid rewarding firms that are more emissions-intensive than their competitors, and to avoid firms distorting sales patterns in order to satisfy trade exposure tests. It can also be more data-intensive to make assessments at the firm level, increasing administrative complexity. However, a firm-level approach could potentially limit eligibility for assistance, or higher tiers of assistance, thereby reducing the fiscal costs.

In addition to carbon and trade intensity, theoretical literature and historical experience suggest at least five other indicators of relevance:

1. Price sensitivity of consumers.
2. Competition within an industrial sector.
3. Availability and cost of abatement options.
4. Carbon pricing (implicit and explicit) among competitors.
5. The carbon intensity of production in other jurisdictions.

1. **If consumers are highly price-sensitive, covered firms will be more likely to lose market share to uncovered competitors.** A general pattern holds that the more price-sensitive consumers are (i.e. the more elastic the demand curve), the lower the expected rate of pass-through[9]. In turn, the lower rates of cost pass-through generally imply high rates of output leakage, and vice versa. As this relationship is quite strong—and given that output and carbon leakage are strongly related—the degree of customer price sensitivity may be a useful indicator of leakage exposure. However, in practical terms, estimating the shape and slope of a sector's demand curves can be challenging (Wooders, Cosbey, & Stephenson, 2009).

   The nature of competition within a sector, capturing the dynamics of both covered and uncovered firms, will affect the exposure of covered firms to carbon leakage. Concentration ratios have been found to be influential in determining exposure to leakage. The capacity to pass through the carbon emission cost in product prices will depend in part on the competitive nature of the relevant market (Reinaud, 2008). In a similar vein, Ritz (2009) finds that output leakage depends on the number and market share of unregulated firms; he argues that tougher competition in a given industry would be expected to lead to higher leakage rates for a given level of carbon and trade intensity. Intuitively, we would expect industries with a larger number of firms competing for market share to have lower profit margins, and vice versa. Accordingly, sector profitability could be used as a proxy measure of the intensity of competition, although measures of this type can face practical challenges due to profit volatility and confounding effects of tax practices (Sato, Neuhoff, Graichen, Schumacher, & Matthes, 2015). However, it is of note that in the qualitative assessment of carbon leakage risk used in Phase III of the EU ETS—for sectors that did not quite qualify for assistance under the quantitative assessment—sector profitability was taken into account.
2. **Abatement potential and cost can change the expected impact of carbon emission costs, thereby influencing investment decisions and leakage.** If a firm is able to reduce emissions at low cost it will be able to cost effectively reduce the carbon emission cost it faces, thus also reducing the risk of leakage. Following this logic, a lack of abatement opportunities is sometimes presented as a reason to expect loss of market share and therefore preferential policy treatment (Okereke & McDaniels, 2012). Abatement availability will depend on the time dimension required to develop less intensive technologies, the existence of these cost-effective technologies, and the effectiveness and credibility of the carbon price signal. Again, this factor was used in the qualitative assessment of carbon leakage risk used in Phase III of the EU ETS. However, despite the linkage drawn in the political and policy debate on this issue, and the literature showing that flexible mechanisms like carbon prices are effective at uncovering cheap abatement opportunities (Stavins, 1998), no studies have firmly established an empirical relationship between abatement opportunities and leakage.

[9] Strictly speaking, this depends on the shape of the demand curve. For instance, under a linear demand curve the rate of cost pass-through is invariant to the elasticity of demand. However, under other typical demand curve specifications, including isoelastic demand curves, the relationship between elasticity and cost pass-through holds.

3. **The level of implicit and explicit carbon pricing among competitors would be expected to affect the rate of leakage.** As carbon leakage is driven by carbon price differentials, if competing countries introduce carbon pricing policies of equivalent stringency this should lessen the risk of leakage. However, while the economic logic of this idea is sound, there are at least two practical challenges. First, it can be complicated by leakage mitigation measures in other countries: if one jurisdiction has a carbon price with leakage mitigation measures and the other has a carbon price with no such measures, the potential for distortion could remain. Second, in the case of firms exporting goods to a trading partner, it will not only be the presence or absence of carbon pricing in the trading partner itself that matters, but also the presence or absence of carbon pricing in third countries where there are firms located that are also trying to sell into the same export market. The growth in jurisdictions introducing carbon pricing means that this is very likely to be an increasingly important policy issue in the future. Indeed, prior to the repeal of its carbon pricing mechanism, Australia intended to take this issue into account when considering its carbon leakage provisions.
4. **The carbon intensity of competitor firms.** As discussed above, one of the mechanisms by which carbon pricing can reduce emissions is by encouraging market share shifts from high- to low-emissions firms. This, in principle, means that "efficient" shifts in output from high- to low-emissions firms may be of less concern to policy makers, even if the low-emissions firms are located in different jurisdictions. This might suggest less need to provide leakage protection in cases where the carbon intensity of uncovered firms is lower than that of covered firms. However, despite some policy focus on this issue (Bosch & Kuenen, 2009), it has not yet been used as a criterion for determining which sectors should or should not receive policy support. This is partly because of difficulties in tracking the jurisdictions where output might increase following the introduction or strengthening of a carbon price, and partly because of uncertainty and variation in the carbon intensity of production in other jurisdictions.

The challenges in considering these issues has led to a focus on adopting relatively simple approaches to date, but this may change in future. As the value of assistance for individual firms and sectors is often politically contentious, policy makers have, to date, used relatively simple approaches based on emissions intensity and trade exposure that can achieve a high degree of targeting without introducing excessive complexity. However, as the carbon pricing landscape changes, especially as more jurisdictions introduce carbon pricing and other schemes reach maturity, it is plausible that there will be further refinement of the process of identifying sectors at risk of carbon leakage.

5. Policy Responses to Carbon Leakage: How to Support Sectors at Risk

5.1. Integrated versus Complementary Measures

Policy makers have considered and/or adopted a range of policy instruments to reduce the risk of leakage when designing a carbon pricing regime. These instruments can be split into two main groups: measures that are integrated into design of a carbon pricing scheme, or "integrated measures," such as free allowance allocation; and measures that are external to, and operate in parallel with, the carbon pricing scheme, typically known as "complementary measures." These include cash transfers to offset some of the carbon emission cost firms face, direct support for emissions reduction projects, and energy efficiency measures.

Integrated measures have a range of advantages in addressing leakage compared with complementary measures, and have been the generally preferred approach to date. The establishment of a carbon pricing scheme is normally dependent on establishing leakage measures deemed to be satisfactory to a range of interest groups. Directly incorporating measures that protect against leakage in the carbon pricing legislative package transparently addresses leakage concerns and can help secure the necessary political support. In addition, most integrated approaches are designed so that the value of the assistance automatically changes with the carbon price. This provides an effective hedge for firms facing the carbon price, and also reduces fiscal risks for governments as the cost of assistance varies with the potential revenue from issuing allowances. By contrast, complementary measures tend to have a less immediate impact on addressing leakage and are more challenging to design in a way that flexes in value with the carbon price. Reflecting the weight of practical experience, this section primarily focuses on the advantages and disadvantages of various forms of integrated measures; these are discussed in sections 5.2 to 5.4. Complementary measures are addressed in section 5.5.

5.2. Different Forms of Integrated Measures

A range of integrated measures are either operating in practice and/or have been discussed at length in the relevant literature:

- free allowance allocations (which, as described further below, can be broken down into three main types: OBA, grandfathering, and FSB);
- administrative exemptions;
- rebates (either direct or through changes in other taxes); and
- border carbon adjustments (BCAs).

These are all mechanisms that, in principle, can be targeted at specific sectors. As section 4 illustrates, there is likely to be merit in increasing focus on leakage prevention measures to a defined subset of sectors, especially as a scheme matures. As such, this section focuses on mechanisms where this is possible. In addition, other measures can be integrated into the design of the carbon price scheme that can reduce leakage risk by reducing the cost impact faced by all firms affected by carbon pricing. Such measures can include designing the scheme so that prices rise slowly from a low base, or through allowing the use of offsets. While these measures may have other merits, they tend not to discriminate between sectors, and are therefore not considered further.

5.2.1. Free Allowance Allocations

The most common policy mechanism that policy makers have used to address leakage to date is through the provision of free allowances under cap and trade schemes[10]. Providing free allowances reduces the total carbon emission costs that firms face and so is expected to reduce the risk of leakage. Free allowances have also been provided to achieve policy objectives other than leakage prevention.

Free allowances can be allocated in many different ways but are easiest to analyze when considered through two questions:

- Does the number of free allowances received by a firm vary (quickly) as the output of that firm varies?
- Is the number of free allowances received by a firm linked to the actual emissions of individual firm?

Allocations can either vary quickly as firm output levels change or they can stay fixed in the short-to-medium term. At one extreme, allocations can increase or decrease in proportion to a firm's output from one year to the next. At the other extreme, allocations are determined according to the firm's output in a historical period and left unchanged for an extended period. In practice, most schemes either update allocations annually, as in California, New Zealand, Australia, and Kazakhstan, or after a period of three or more years, as in the first two phases of the EU ETS and most of the recent Chinese ETS pilots.

In addition, the amount of allowances a firm receives can either reflect its actual emissions or be linked to a predefined "benchmarked" emissions intensity. The former approach is normally implemented through providing allowances that are some proportion of the firm's total emissions. By contrast, a benchmarking approach severs the link between a firm's own emissions and the allowances it receives. Instead, under this approach, a sector-wide assessment of an "appropriate" emissions intensity is made for all firms in the sector, and firms receive allowances in some proportion to their output multiplied by this benchmark. Firms that have an emissions intensity lower than the benchmark are advantaged and receive (proportionally) more allowances than firms that have an emissions intensity higher than the benchmark.

Combining the two approaches for allocating on the basis of output and emissions intensity suggests four conceptually distinct approaches to assistance. These four approaches are set out in Table 5. However, as the approach in the top left corner represents a "virtual exemption"[11] that would be more easily implemented through an administrative exemption, this option is not considered further here; administrative exemptions are instead discussed in section 5.5.2. Therefore, three primary assistance approaches remain. In practice, as Table 5 also shows, most approaches fit comfortably within one of these three categories, even if there are a range of subtle differences between each application.

It should be noted that, in principle, it is possible to include more than one type of assistance measure within any scheme. Box 4 explores the examples of Korea and Australia.

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[10] Impacts that are economically similar to free allowances under a cap and trade scheme can be achieved by transferable tax exemptions under a carbon tax. For example, carbon tax equivalents to free allowance allocations have been described in Pezzey (1992) and Pezzey & Jotzo (2012).

[11] If a firm were allocated allowances on the basis of both its actual output and its actual emissions intensity, the volume of allowances granted would move in direct proportion to its carbon cost, and so the firm would effectively be exempted from some or all of the carbon cost.

Table 5. Free Allocation Approaches Can Be Distinguished by How Allocations Vary with Respect to a Firm's Output and Its Emissions Intensity

		Do allocations vary in proportion to a firm's output?	
		Yes: allocations update with the firm's own output on a regular basis	*No: allocations are based on a firm's historical output with occasional periodic updating*
Do allocations vary in proportion to a firm's emissions intensity?	**Yes: allocations are directly proportional to the firm's own emissions intensity**	Virtual exemption: This would effectively eliminate the carbon price	Grandfathering: allocations are directly based on a firm's historical emissions and do not vary as output changes, except between phases
		Examples: none based on allocations	Examples: EU ETS Phases I and II; Korea (all but three sectors); Kazakhstan Phases I and II; Beijing; Chongqing; Guangdong; Hubei; Tianjin
	No: allocations are benchmarked to an independent measure of emissions intensity	Output-based allocation (OBA): Allocations are proportional to sector-wide benchmarks and a firm's current output levels	Fixed sector benchmark (FSB) allocation: allocations are proportional to sector-wide benchmarks and firm-specific historical activity levels. Adjustments for changes in output only between phases
		Examples: California; New Zealand; Australia; Korea (three sectors); Shenzhen	Examples: EU ETS Phase III

Note: Some schemes use grandfathering for the majority of their allocations but adopt benchmarking approaches for new entrants or capacity expansions. These schemes are categorized as grandfathering for simplicity. The Shanghai ETS pilot involves a hybrid approach combining some elements of grandfathering and benchmarking, and so is not included in this typology.

Source: Vivid Economics

Box 4. Some Countries Provide Different Types of Free Allowance Allocation for Different Sectors

In the case of Korea, the intention is to aim for 100 percent of free allowance provision during the first phase of the scheme. However, the dynamics associated with the provision of free allowances differ across sectors. For the bulk of sectors, the scheme designers have adopted a grandfathering approach to free allowance allocation. However, they have opted for an OBA in the clinker, refineries and aviation sectors. This reflects the perceived relative ease of creating benchmarks in these three sectors. Policy makers have expressed a desire to shift increasingly toward the use of benchmarks in future phases of this scheme, although there is also concern about the complexity of creating a benchmark in cases where one plant produces a range of different product types.

In the case of Australia's ETS, prior to its repeal, EITE sectors received assistance using an OBA approach with benchmarks. However, in addition, a one-off non updating allocation of allowances was provided to electricity generators. The allocations were not based directly on historical emissions but were similar in principle and intent to a pure grandfathering regime. The difference in approach in the nature of the assistance provided to these sectors had different policy rationales: with EITE sectors, there was a desire to protect against leakage; for generators, the intention was to smooth the transition to a new policy regime and address any risk to energy security. This is reflected in the different economic incentives created by alternative allocation approaches, as described further below.

5.2.2. Partial or Full Exemptions

Most carbon pricing regimes exempt some sectors or emitters through not defining the carbon price as applying to them, or by setting much reduced rates. Sometimes these exemptions are driven by practical difficulties in coverage or by broader political concerns about the sensitivity of imposing a cost on these sectors. This is often the case, for example, for small emitters, transport emissions, land use, land use change and forestry emissions, waste, and agriculture emissions. However, sometimes these are also justified on the basis of concerns about leakage. Some prominent examples are provided in Box 5.

5.2.3. Rebates

Sometimes policymakers aim to reduce the leakage risks associated with carbon prices by reducing other taxes paid by industry, or providing other subsidies to industry, often by an equivalent amount. This is an approach most commonly adopted in countries pursuing a carbon tax regime. The intention is to discourage carbon emissions while not increasing the overall tax liability faced by industrial firms. Box 6 provides a number of examples.

Box 5. Exemptions to Address Leakage Have Been Applied (or Are Planned to Be Applied) in a Number of Carbon Taxes

A prominent example of the proposed use of administrative exemptions to address leakage is under the proposed South African carbon tax. While all entities under this regime are expected to receive a basic 60 percent exemption irrespective of their exposure to leakage, exemption rates can be increased by up to 10 percent for firms that have high trade exposure (measured using the approach discussed in section 4.2) plus a further 10 percent for organizations that have a high proportion of process emissions (considered difficult to reduce). Firms will also be entitled to use offsets for up to 5–10 percent of their emissions liability. It is expected that, over time, these exemptions will be gradually withdrawn. Policy makers anticipate that a withdrawal of exemptions may be an easier way to increase the marginal tax rate faced by firms than a straightforward increase in the nominal rate.

A number of European countries have also provided for exemption from national CO_2 and energy taxes to address competitiveness concerns of heavy industry (Institute for European Environmental Policy, 2013):

- Under **Denmark's** CO_2 tax, a refund of 75 percent of the CO_2 tax paid is provided for energy used for heavy energy-intensive process purposes. "Heavy processes" are defined in law. Sectors are included if a CO_2 tax rate of €6.7 on the energy consumption of a particular process would result in a tax that exceeds 3 percent of the value added or 1 percent of the turnover.
- In **Finland**, where the CO_2 and energy taxes paid by a company for electricity, coal, natural gas, and other products exceed 0.5 percent of the company's value added during the accounting period, the company is entitled to apply for a refund of 85 percent of the amount of the excise duties paid for the products or the excise duties contained in their acquisition price. Only the part exceeding €50,000 of the calculated tax refund is repaid.
- In **Germany**, a relatively complicated system of reduced tax rates applies to a range of manufacturing sectors. However, notably, defined energy-intensive processes—including electrolysis and chemical reduction processes, the production of glass and ceramic products, and metal production and processing—benefit from a full exemption from all energy taxes, including the electricity tax.

Box 6. Carbon and Energy Taxes Can Be Introduced in Conjunction with Reductions in Other Taxes or Other Forms of Rebate

- In the **UK**, the introduction of the Climate Change Levy—a tax on industrial consumption of different fossil fuels—was intended to offset a reduction in national insurance contributions for those affected by the tax (Sumner, Bird, & Smith, 2009)[a].
- In **Denmark**, increases in energy taxes during the 1990s were accompanied by a reduction in the required employers' contributions to the additional labor market pension fund, as well as a reduction in employers' national insurance contributions (Institute for European Environmental Policy, 2013).
- **Sweden:** Although not related to carbon emissions, the Swedish tax on NOx emissions provides an interesting example. In this case, Sweden originally set a tax rate of 40 SEK for every kilogram of NOx emitted from any stationary combustion plant producing at least 50 megawatt hours (MWh) of useful energy per year[b]. However, it also committed to returning all of the revenues raised to participating plants, in proportion to their production of useful energy. The result was that only plants with high emissions per unit of energy were net payers of the tax (OECD, 2013c).

[a] Mandatory contributions paid by employees and employers on earnings, and by employers on certain benefits-in-kind provided to employees. National insurance contributions were subsequently increased.
[b] The coverage has subsequently been expanded to all plants producing more than 25MWh of useful energy.

These examples show that there is a wide diversity in the implementation of this approach. Options differ depending on the tax/subsidy base through which the revenues are recycled—for example, output in the case of the Swedish NOx tax, and employment in the case of the UK Climate Change Levy. It can also differ depending on whether the revenues from the carbon tax are first explicitly calculated and then the rebate provided (to guarantee revenue neutrality at the government level), or whether the offsetting tax/subsidy change is introduced simultaneously, based only on an estimate of the expected revenue effects of the different fiscal changes[12].

5.2.4. Border Carbon Adjustments

BCAs are an integrated measure that has some common features with free allowance allocations, but fundamentally different economic, environmental, and political effects. BCAs involve a carbon emission cost being imposed at the border on importers of carbon-intensive goods and/or a rebate being provided to exporters. In common with free allowance allocation approaches, the carbon emission cost imposed or rebated could be determined through benchmarking akin to free allowance allocations. Further similarity arises in that one possible design is for exporters to receive their rebate in the form of free allowance allocations. The fundamental difference between BCAs and standard free allowance approaches is the effective extension of the carbon pricing regime to entities outside the implementing jurisdiction. This in turn dramatically changes the economic, environmental, and political effects of such a regime.

[12] For example, NERL reports that the Climate Change Levy revenues raised in 2006–07 were far less than the estimated revenue loss associated with the cut in national insurance contributions (Sumner, Bird, & Smith, 2009).

Box 7. Aspects of the Californian Carbon Price Scheme Resemble a BCA

California imposes a carbon liability on "first deliverers of electricity," which includes both in-state generators and electricity importers. Importers can incur an emissions obligation based either on the emissions associated with a specified source of electricity or on a default factor in the absence of a specified source. Despite the narrow sectoral focus, the effect of these provisions is broadly equivalent to that of a BCA as they impose carbon emission costs on emissions from all sources of electricity supply, both inside and outside the relevant jurisdiction, with the intention of minimizing competitive distortions between in-state generators and importers.

The state has also publicly discussed the possibility of developing a BCA for the cement sector and will hold public workshops on this topic in summer 2015.

BCAs have been widely modeled and discussed, but less frequently implemented by policy makers. Though not explicitly described as such, the Californian ETS applies a form of BCA in the electricity sector. This is described in more detail in Box 7 above. The EU also considered a scheme that bore some similarities to BCAs for civil aviation in that it that would have imposed carbon emission costs on flights originating or ending outside the EU, as well as on intra-EU flights. However, as is discussed later in Box 14, this plan is currently suspended. Outside of the climate context, the United States imposed a tax on imports whose production relied on ozone-depleting chemicals and provided a tax rebate to manufacturers or exports of the same products (Hoerner, 1998).

5.2.5. Summary

This discussion indicates that there are six distinct types of integrated measures, three of which involve free allowance allocations. These approaches are:

- free allowances allocated on a grandfathering basis, where allocations are proportional to an individual firm's historical emissions and there is no rapid adjustment if firms change their output;
- OBA of free allowances, where allocations are based on product-specific benchmarks and changes in output lead to rapid changes in allowance allocations;
- FSB, where allocations of free allowances are based on product-specific benchmarks (as with OBA) but without rapid adjustment if there are future changes in output (as with grandfathering);
- rebates, either directly or through other taxes;
- administrative exemptions; and
- BCAs.

The pros and cons of these various options are discussed in more detail in section 5.3 below.

5.3. Pros and Cons of Different Options

The integrated measures discussed above will create different economic and environmental incentives, and face different administrative and political challenges. In some cases these effects will be inherent to their fundamental design, and in others specific to detailed elements of design and implementation. For this reason, the following section discusses each option by drawing on the specific implications of the design of individual jurisdictions' policies where relevant, while highlighting the general points inherent to each option. The section discusses both the economic and the environmental implications of each major policy option, as well as some of the key administrative issues surrounding the implementation of each.

Each mechanism is assessed against the outcome that would be expected under a globally harmonized carbon price. This builds on the discussion at the start of section 4. In particular, the following questions are considered for each leakage prevention mechanism:

- Will it allow firms in a relevant market to compete on a level playing field, or will differences in carbon regimes distort competition?
- Will it allow prices of emissions-intensive goods and services to increase so as to promote demand-side abatement?
- Will firms have an incentive to reduce their emissions intensity?

5.3.1. Grandfathering

Grandfathering appears attractive as it should not influence firm behavior and abatement incentives, and because of its relative ease of implementation. Under a pure grandfathering scheme, firms would receive assistance directly related to their historical emissions, and the amount would remain independent of future output decisions or decisions to reduce their carbon intensity. This means that grandfathering continues to provide firms with a strong incentive to reduce their emissions intensity: such a reduction lowers the carbon cost liability faced by the firm but has no impact on the free allowances it receives. It can therefore sell the surplus allowances and use the profits to pay off its abatement investment. This feature, combined with the relative simplicity of working out how much assistance to provide each firm, has made it a popular method of providing assistance in the initial stages of many carbon pricing schemes. Prominent examples include the first two phases of the EU ETS, the first phase of the Korea ETS (for most sectors), and various Chinese ETS pilots.

However, the corollary of not influencing firm behavior is that pure grandfathering is likely to be ineffective at addressing leakage in exposed sectors. Providing assistance on a grandfathered basis does not affect the incentives that firms face under a carbon price. As a consequence, even if higher costs brought about the carbon price would lead to a reduction in firm output[13], this would still happen even with the provision of free allowances. If this reduction in output is associated with an increase in output from uncovered firms then output leakage—and hence some degree of carbon leakage—is likely to occur. In turn, this means that grandfathering may not be the allocation method that minimizes the cost of meeting a given emissions reduction target in cases where carbon leakage risk is significant (see, for example, Fischer & Fox, 2004).

In part because of leakage concerns, no carbon price scheme has involved a pure grandfathering allocation approach for the specific purpose of addressing leakage. Of greatest importance is updating:

[13] This reduction in output takes place because the free allowances have an opportunity cost: by keeping output elevated and surrendering the allowance to cover the additional emissions associated with this high level of output, firms lose the option to sell the allowance instead. If the additional profits from selling the allowance are higher than the additional profits associated with keeping output at an elevated level, it will be rational for the firm to cut back on production and sell the allowances.

rather than maintain assistance levels indefinitely, schemes tend to revisit allocation decisions periodically. This typically takes place every three years, including in the case of first phases of the EU ETS and the Korea ETS, as well as in the various Chinese pilot ETSs: Beijing, Chongqing, Guangdong, Hubei, and Tianjin[14]. In addition, and for a variety of reasons[15], schemes have tended to implement closure rules. Whereas under pure grandfathering, firms would be entitled to retain assistance indefinitely, even if they closed down with closure rules, continued entitlement to free allowances is made contingent on maintaining a minimum level of production.

Updating of allocations (and closure rules) can help to reduce leakage when applied to exposed sectors. Both these departures increase the incentive on firms to maintain output at higher levels than under pure grandfathering. Updating creates a link between current output—and therefore emissions—and future allocations. Firms will be conscious that reduced output and emissions in this phase of the scheme is likely to result in less assistance in the next phase of the scheme. This creates an incentive for continued production and reduces the risk of output—and hence carbon—leakage where sectors are exposed to international competition. However, the strength of this incentive will depend on how far into the future the update will take place and the expected level of that allocation. Similarly, closure rules encourage firms to stay in operation to receive an allocation.

These rules reduce the otherwise strong incentive that firms would have to undertake abatement under grandfathering approaches.

- Updating rules limits the incentive to abate through reducing both output and the carbon intensity of production. Firms may be concerned that they will receive less assistance in the subsequent phases of the scheme. This is likely to be addressed only if it is signalled at an early stage that subsequent allocations will not be based on grandfathering, as indeed has been the case in a number of schemes[16].
- Closure rules make it more likely that plants will stay open, even if it is more efficient for them to close. Indeed, much of the academic literature examining the early phases of the EU ETS highlight the effect of closure rules on keeping inefficient power generators in operation (see, for example, Sijm, Neuhoff, & Chen, 2006; Schleich & Betz, 2005; and Grubb & Sato, 2009). However, while closure rules limit the incentive to reduce emissions through reducing output, they should not influence the incentive to reduce emissions through reducing the carbon intensity of production.

Grandfathering may preserve demand-side abatement incentives but also runs the risk of windfall profits in nonexposed sectors. If the reduction in domestic output brought about by a carbon price with grandfathered emissions does not lead to an increase in overseas production because the domestic

[14] The Korean and Chinese ETS are structured in phases. It is plausible that the allocation approaches of each scheme will be revisited for future phases; this is the explicit policy of the Korean ETS. Future phases may or may not retain a grandfathering approach.

[15] Often these reasons are not linked, or perceived to be linked, to leakage considerations, but are instead introduced to prevent windfall profits or have a "common-sense" justification.

[16] The EU ETS announced very early in Phase II a move to a benchmarking-based approach in Phase III. The Republic of Korea has adopted a grandfathering approach for most sectors for 2015 to 2017, but has expressed a general intent to move toward benchmarking from 2018. Policy makers in Kazakhstan have also indicated a preference for a move toward benchmarking from 2016 (World Bank Group, 2014a).

firms operate in a market with limited international competition, it will result in a price increase instead. This might stimulate some demand-side abatement, and indeed this is often seen as one of the benefits of grandfathering approaches. However, it may also lead to firms earning “windfall profits” from free allowance allocations. This occurs when the value of allocations a firm receives exceeds the cost exposure it faces, once adjusted for its ability to pass through carbon emission costs. The issue of windfall profits was widely discussed in the context of the power sector in Phases I and II of the EU ETS (Sijm, Neuhoff, & Chen, 2006). On the one hand, the presence of windfall profits might be thought of as part of a market-led reaction to the introduction of carbon pricing and so can help to smooth its introduction. However, especially if such profits become pervasive and permanent, they can be politically damaging, especially as they occur at the expense of other potential uses of carbon pricing revenue.

Grandfathering may also be an attractive way to provide assistance for reasons other than (inefficient) leakage. As noted in Box 4, prior to its repeal, the Australian carbon pricing mechanism included a one-off, non-updating allocation of allowances to electricity generators. These allocations were not provided on this basis that generators were exposed to leakage; rather, they were intended to provide a one-off support to those affected by the scheme. In this context, the fact that the allocation had limited impact on leakage was not a problem, while the retention of strong incentives for abatement, further strengthened by the fact that it was a one-off transfer, was a clear advantage. Similar arguments would support the use of (one-off) grandfathering in schemes where the majority of leakage would be efficient—in other words, where the carbon intensity in the jurisdiction introducing the carbon price is higher than in other jurisdictions—but where there is a desire to provide support to the affected industry.

In summary, grandfathering regimes face difficult trade-offs in addressing both abatement and leakage objectives, and while potentially attractive in the short term, they are unlikely to be a sustainable approach to providing assistance in the medium term. The pure grandfathering approach is ineffective in addressing output and carbon leakage in genuinely exposed sectors and is rarely adopted in practice. However, introducing adjustments to improve their effectiveness at reducing leakage compromises their effectiveness in stimulating abatement, especially because firms expect future assistance levels to be based on current emissions. There may, however, be a strong role for grandfathered support, especially on a one-off basis, as a form of transitional assistance (summarized in Box 8).

Box 8. Pros and Cons of Grandfathering

- Grandfathering is relatively easy to implement as it is primarily based on historical emissions data.
- Demand-side abatement incentives may be preserved.
- Incentives to reduce emissions intensity are diluted when allocations are likely to be updated as firms expect any reductions in emissions intensity to result in lower allocations in the future.
- Some risk of windfall profits, although such profits may also help ease the process of introducing carbon pricing.
- Leakage prevention is relatively weak, relying on closure rules to maintain minimal levels of output, and on updating to indirectly incentivize firms to maintain output.

5.3.2. Fixed Sector Benchmarking

FSB combines two features:

- as with grandfathering, assistance levels do not vary quickly and smoothly as firms change their level of output and emissions; and
- in contrast to grandfathering, the level of assistance is determined by reference to a product or sector-level benchmark emissions intensity rather than by reference to the current or historical emissions (intensity) of each individual firm.

In broad terms this is the approach adopted in Phase III of the EU ETS. A series of benchmarks were created for different activities under the cap, and the free allowances received by firms/installations in the sector were set by multiplying the firms’/installations’ historical output level by the benchmark (plus a further downward adjustment). However, once the level of free allowance was set, future changes in firm/installation output had limited impact on the allowances received by each firm/installation.

Crucially, by severing the link between the emissions intensity of the firm and the allowances the firm receives, benchmarking better preserves incentives for firms to improve their emissions intensity than grandfathering. As explained above, under a grandfathering approach with periodic updating, firms may be reluctant to reduce their emissions intensity as it will reduce the free allowances they are entitled to receive in the future. Such a challenge is largely eliminated by this approach: it is the industry-wide benchmark, rather than firm-specific emissions, that will determine the amount of free allowances received in the future.

From an economic perspective the stringency of a FSB benchmark will have a minimal effect on incentives to reduce emissions and is largely a distributional question. In principle, regardless of where the benchmark is set, firms should have the same marginal incentive to reduce their emissions intensity. It should be immaterial whether a firm is more or less efficient than implied by the benchmark: if firms that are more emissions-intensive than the benchmark reduce their emissions intensity they will face a reduced carbon emission cost net of allocations. If they are less emissions-intensive than the benchmark, a further reduction in their emissions intensity would result in an excess of allowances, which they could sell. This is illustrated with a simple worked example in Table 6 below. This would imply that the level of the benchmark in the short run should not affect efficiency incentives, but does determine the allocation of resources between shareholders and taxpayers, who forgo revenue from auctioning allowances.

In practice the stringency of the benchmark may have implications for incentives, if for behavioral reasons firms respond more to the additional costs incurred as a result of having to make up the shortfall on their assistance levels than to the prospect of extra profits from further outperformance against the benchmark. This would support a more stringent benchmark to retain a strong incentive for abatement. It would also explain why many stakeholders are particularly interested in the stringency and level of the benchmark. The only current scheme using an FSB approach—Phase III of the EU ETS—sets a benchmark equal to the carbon intensity of the average of the best 10 percent performers in each sector.

Table 6. Investments That Reduce Emissions Intensity Earn the Same Return under Two Different Benchmarks

		Low benchmark		*High benchmark*	
Variable	*Unit*	*Before investment*	*After investment*	*Before investment*	*After investment*
Firm emissions intensity	tCO_2e/unit of output	1.0	0.8	1.0	0.8
Historical output	Units of output	100			
Benchmark	Allowances/ unit of output	0.7		0.9	
Allocation	tCO_2e	70		90	
Output	Units of output	100			
Emissions	tCO_2e	100	80	100	80
Carbon liability (emissions less allocations)	tCO_2e	30	10	10	−10
Reduction in carbon liability from abatement investment	tCO_2e	20		20	

Source: Vivid Economics

The calculation of benchmarks is data-intensive and creates potential for lobbying around the allocation methodology, but is feasible. Complications arise through issues such as the existence of similar products with different production processes, and through multi-output production processes. However, the successful development of benchmarking approaches in the EU, as well as in relation to OBA in New Zealand, Australia, and California, as discussed below, indicates that these technical challenges can be overcome.

As with grandfathering, an FSB approach will be dependent on closure rules and updating to be very effective in addressing leakage. In principle, it would be possible to create an FSB scheme where the level of assistance was determined by reference to a benchmark level of emissions intensity multiplied by a historical output level, and for this assistance amount to remain unaltered, regardless of future output. However, this creates a similar dynamic to that of grandfathering; sectors genuinely exposed to international competition would still cut back on production and would lose market share to those not facing carbon prices. Accordingly, policy makers are likely to use closure rules and periodic updating to reduce the risk of leakage. The only practical example of FSB—Phase III of the EU ETS—has adopted a series of output thresholds to reduce leakage risk, although these have created further challenges, as explored in Box 9 below.

As with grandfathering, FSB approaches carry a risk of delivering windfall gains if applied to sectors that are not exposed to leakage. As the level of allocation is not dependent on current output levels, firms that are not exposed to international competition will have an incentive to reduce output and raise prices in response to a carbon emission cost. As with grandfathering, this increase in prices might stimulate some demand-side abatement but may also lead to firms earning windfall profits from free allowance allocations. While such windfall profits may help to smooth the process of introducing carbon pricing, they may also undermine public confidence in the scheme if they persist in the medium term.

Box 9. FSB in Phase III of the EU ETS

The FSB allocation approach under the EU ETS Phase III has a long period in which the output basis of the allocation is not updated. To improve its effectiveness in preventing leakage, policy has been designed to create a stronger link between allocations and output, which therefore facilitates stronger protection against leakage. Specifically, a historical output level is set, based either on output in 2005–08 or 2009–10 (Decision 2011/278/EU). Firms producing:

- less than 10 percent of their historical level in any one year receive no allocations in the subsequent year, effectively acting as a closure threshold;
- between 10 and 25 percent of the historical level activity receive allocations with a 25 percent weighting in the next year;
- between 25 and 50 percent of their historical level receive 50 percent of their full allocation in the next year; and
- more than 50 percent of their historical level receive their full allocation, including if their output exceeds their historical activity level.

In a comparison of production decisions in the EU cement sector between 2011 and 2012, one study indicates that firms might have increased their output levels in 2012 in order to ensure higher allowance allocations in 2013, the first year of Phase III (Branger, Ponssard, Sartor, & Sato, 2014). If it is considered that cement is at risk of carbon leakage, this suggests that the thresholds and allocations are having some effect in preserving output and hence addressing leakage.

However, the non-linearities built into this scheme provide a possibility for gaming: by setting production at a level just above a threshold, firms can receive allocations that exceed the carbon emission costs they face—i.e. at an output level of 51 percent of their historical activity level, firms would be entitled to receive 100 percent of their allocation (Branger, Ponssard, Sartor, & Sato, 2014).

Overall, FSB maintains incentives to improve emissions intensity better than grandfathering but its effectiveness in preventing leakage will depend on detailed design elements. Crucially, by severing the link between a firm's own emissions (intensity) and the amount of current and future assistance it provides, it preserves incentives to improve carbon intensity better than grandfathering. However, without closure rules and updating, it is likely to face the same challenges as grandfathering in terms of preventing leakage. Some of the refinements to the basic model, such as those used in Phase III of the EU ETS, could help to address this problem by preserving stronger incentives for continued production (summarized in Box 10).

Box 10. Pros and Cons of FSB

- Demand-side abatement incentives may be preserved.
- Emissions intensity incentives are preserved by using firm-independent benchmarks.
- Establishing benchmarks creates a degree of administrative complexity and a risk of lobbying but experience suggests that these can be overcome.
- A risk of firms making windfall profits (although these may help smooth the introduction of a carbon pricing regime).
- Leakage prevention is relatively weak (although inclusion of closure rules or intermediate output thresholds can improve leakage prevention and periodic updating may also indirectly incentivize firms to maintain output).

5.3.3. Output-Based Allocations

OBA has two key properties:

- assistance is allocated according to a predetermined benchmark of emissions intensity; and
- when firms increase or decrease their output, the amount of assistance that they receive correspondingly rises or falls, according to the predefined benchmark level of intensity.

This model is similar to the FSB approach in that the initial allowance allocation is determined by an emissions benchmark (which could be calculated in exactly the same way as the FSB approach) multiplied by the firm output level. However, in contrast to the FSB approach, if there are subsequent changes in firm output, with just a small lag there is an adjustment in the allowances that the firm receives. Variants on this basic model are used for providing assistance in California, New Zealand, previously in Australia, some sectors in Korea, and in Shenzhen, China.

By using benchmarks OBA preserves incentives to reduce emissions intensity in a similar manner to FSB. OBA uses benchmarks to provide the same allocation to producers of identical products, meaning that less carbon-intensive firms will gain a competitive advantage through lower carbon emission costs net of allocations. As with FSB, this property broadly preserves the desired pattern of competition—i.e. that emissions-efficient firms will have an advantage over emissions-inefficient firms. All else being equal, the efficiency-preserving properties of both benchmarking approaches, OBA and FSB, make them preferable to those without benchmarking.

In contrast to FSB and grandfathering, OBA targets leakage more strongly. Under OBA an extra unit of output will directly result in additional allocations. This can be contrasted with grandfathering and FSB schemes where extra output does not lead to additional assistance, other than where closure or other thresholds are applied. This works to maintain or increase output levels despite the pressure of competition from firms that do not face the carbon price. As such, it offers strong leakage protection. The volume preservation feature of OBA is even more attractive if there are opportunities to reduce the carbon intensity of production that firms will pursue only if they are confident that they will retain high levels of output in the future.

The level at which a benchmark is set will affect the level of protection against leakage. Because of the direct link between a firm's production and the amount of assistance it receives under this mechanism, the value at which the benchmark is set has a material impact on firms' incentives to produce. A stringent benchmark will offer weaker leakage protection as most firms would have an emissions intensity greater than the benchmark, and hence experience a net increase in costs from producing an extra unit of output. Conversely, a higher benchmark will better protect against leakage but could have the perverse outcome that even those firms with a relatively high emissions intensity (but lower than the benchmark) might increase production. In practice, benchmarking under OBA approaches has tended toward benchmarks that are between the average and best practice performance of industry in the jurisdiction in question. The benchmarks are often also changed over time to reflect one or both of the tightening of emissions targets or expected improvements in firm efficiency. The different approaches adopted in practice are summarized in Table 7.

Table 7. Benchmark Levels under OBA Are Generally Lower Than Average Industry Practice and Higher Than Best Practice in the Jurisdiction in Question

Jurisdiction	*Phase*	*Leakage exposure*	*Benchmark set by reference to*	*Adjustment over time*
New Zealand	Since commencement	High	90% of average emissions	None
New Zealand	Since commencement	Moderate	60% of average emissions	None
Australia	Prior to repeal	High	94.5% of average emissions	Annual decline of around 1.3% per year
Australia	Prior to repeal	Moderate	66% of average emissions	Annual decline of around 1.3% per year
California	2013–17	All	Higher of 100% of best practice (single observation) or 90% of average emissions	Annual decline of around 2% per year
California	From 2018	High	100% of the benchmark set for 2013–17, on the basis described above	Annual decline of around 2% per year
California	From 2018	Moderate	75% of the benchmark set for 2013–17, on the basis described above	Annual decline of around 2% per year
California	From 2018	Low	50% of the benchmark set for 2013–17, on the basis described above	Annual decline of around 2% per year

Source: Vivid Economics

OBA will limit price increases in sectors to which it is applied, dulling demand-side abatement but also protecting against windfall profits. OBA provides a strong incentive to maintain production levels. In turn, higher levels of output mean that end-user prices are lower than they would be under alternative forms of allocation. In sectors exposed to leakage this may not be material as international competition would serve to limit price increases in any case. However, in sectors that are not strongly exposed to international competition, this can mean that OBA dents incentives for demand-side abatement. This can often be a relatively low-cost form of abatement (for example, improving energy efficiency as a result of higher energy prices) and hence means that the cost of meeting a given emission reduction target may be unnecessarily high. A positive effect of OBA is that the suppression of price increases will reduce the risk of windfall gains compared with grandfathering or FSB.

One concern with an OBA approach is that there may be challenges in reconciling free allowance allocations with the overall cap; this may render the domestic environmental outcome of a carbon pricing regime less certain. The concern is that if firms that produce more output receive more assistance, the overall level of assistance they are entitled to receive cannot be known when a particular phase of the scheme starts, and it may rise to potentially higher levels than the overall cap on emissions. In these cases, there are three broad options available for policy makers (some or all of which could be adopted simultaneously).

- First, a range of steps can be taken to ensure that OBA approaches do not result in free allocation amounts that exceed the domestic emissions cap. As outlined in Table 7, all OBA approaches reduce the level of benchmarks over time, in part to ensure that allocations do not exceed any relevant domestic emissions limit. However, as discussed above, a more stringent benchmark will offer weaker leakage protection, especially if the rate of decline in the benchmark is quicker than carbon intensity improvements. Alternatively, caps could be placed on the overall allowances that can be allocated on an OBA basis, although if this cap was reached then the mechanism would begin to resemble the FSB approach discussed above. Finally, tightly targeting the sectors receiving allocations under an OBA can help to ensure that the level of allowance allocation is substantially below the level of any domestic emissions cap.

- Second, increases in allowances allocated under an OBA approach could be offset by a reduction in the number of allowances offered through auctioning. This will increase the importance firms and sectors attach to being considered at risk of carbon leakage, which may lead to greater difficulties in managing the process of determining which sectors should receive this classification. There are also limits to the efficacy of this approach if the overall cap continues to be respected. However, assuming that the allocations genuinely target leakage, they can also be seen to be preserving the intended environmental objective of the scheme by minimizing the risk that emissions reductions within the scheme will be offset by increases in other jurisdictions.
- Third, the emissions cap can be relaxed so that it accommodates all increases in the output in sectors considered to be at risk of carbon leakage. This will ensure that leakage prevention measures continue to be effective but will undermine the environmental certainty of the scheme. As environmental certainty is seen as one of the key attractions of a cap and trade scheme over a carbon tax, this may be an unattractive option. The additional allowances will also reduce the carbon price within the scheme, lowering the long-term incentive to invest in more ambitious abatement options.

OBA approach could also involve higher administrative costs than Benchmarking and FSB approaches, because output data must be regularly reported.

In summary, OBA is attractive where it is closely targeted at sectors genuinely at risk of carbon leakage, but it is particularly unattractive if applied too broadly. OBA can be more effective at tackling leakage than the other allowance-based allocation methods discussed above. However, it delivers this by providing a stronger incentive to maintain or increase production than the alternatives. This keeps production levels elevated, lowering prices from the levels they would reach without the measure and hence reducing opportunities for demand-side abatement. As such, it is an approach that is damaging to abatement incentives when applied to sectors that are not genuinely at risk of leakage. Without careful design, there is also a risk that the environmental integrity of the scheme may be compromised (summarized in Box 11).

Box 11. Pros and Cons of Output-Based Allocations

- Emissions intensity incentives are preserved by using benchmarks.
- Leakage prevention is likely to be strong due to the clear and explicit link between output and allocations, although this is dependent on the level at which benchmarks are set.

box continues next page

Box 11. Pros and Cons of Output-Based Allocations *(continued)*

- Demand-side abatement incentives are likely to be dulled if applied too broadly
- Risk environmental outcome is less certain depending on design features.
- Establishing benchmarks creates a degree of administrative complexity and a risk of lobbying, but experience suggests that these can be overcome.
- Higher administrative costs as output data must also be regularly reported.

5.3.4. Exemptions

Exemptions are likely to be effective in addressing leakage and are administratively easy to implement, but fundamentally undermine the abatement incentives of carbon pricing. By reducing the effective carbon price that firms face, the risk of carbon leakage is directly reduced. However, reducing the effective carbon price also means that abatement incentives are reduced in three important ways: firms have a reduced incentive to improve their emissions intensity; relatively carbon-intensive firms do not suffer a competitive disadvantage compared with firms with lower emissions intensities; and product prices of carbon-intensive goods will not rise in a way that stimulates demand-side abatement.

As noted above, most carbon pricing regimes exempt some sectors or firms; the primary example where leakage concerns are clearly relevant to an exemption is the proposed South African carbon tax. All entities under this regime receive a basic 60 percent exemption. Of more relevance to leakage, this regime makes a modest adjustment of exemption rates of up to 10 percent on the basis of trade exposure, and of up to 10 percent where a sector has a large portion of process emissions. The former provision directly addresses the trade driver of leakage, while the latter provision works on the logic that these emissions are harder to abate, which, as noted in section 4.2, is a potential driver of leakage. While these provisions may broadly target leakage, they do so at the cost of preserving abatement incentives. The proposal to adjust the core 60 percent leakage rate by up to 10 percentage points to reward more efficient producers may have some effect in retaining abatement incentives, but its effect on leakage is unclear.

In general, exemptions for the purposes of leakage prevention are most likely to be necessary when establishing a carbon pricing regime and should be accompanied by an explicit plan to phase them out. This thinking underpins the South African carbon tax; the current policy proposal is to reduce the basic exemption rate from 2020, therefore increasing the carbon pricing signal. As any phase-out occurs it may be that further changes are required to ensure that South Africa's leakage protection measures are effective and sufficient to address economic concerns about leakage and any consequential political concerns. Box 12 provides a summary of the pros and cons of exemptions.

Box 12. Pros and Cons of Exemptions

- Demand-side abatement incentives will be dulled.
- Incentives to improve emissions intensity will not be preserved.
- Leakage prevention is likely to be strong, but inefficient firms will be artificially protected from competition from both domestic and international firms with lower emissions.
- Administrative exemptions are straightforward to implement.

5.3.5. Rebates

The impact of reducing other tax rates on preventing leakage will depend very heavily on the specific design. As noted above, there are many different ways in which these schemes can be designed. The most important of these in the context of leakage prevention is the way in which revenues are subsequently recycled.

All tax rebate schemes will preserve an incentive for firms to reduce their emissions intensity. The attractiveness of addressing leakage through changes elsewhere in the fiscal system is that it will not dilute the impact of the carbon price on the incentive of firms to reduce their carbon intensity. If a particular abatement opportunity that will reduce the emissions intensity of the firm is attractive at the prevailing (and expected future) carbon price then it would be sensible for the firm to reduce its emissions in this way; it will reduce the liability that it faces from the carbon price while not affecting how much revenue it receives through any recycling mechanism. This will also mean that less emissions-intensive firms will tend to gain market share to the benefit of more emissions-intensive firms.

The impact on leakage will depend very much on the way in which revenues are subsequently recycled. Two examples help to illustrate options at either end of the spectrum.

- First, as with the Swedish NOx tax approach, revenues could be recycled in proportion to *future* output. This creates a strong incentive to sustain production levels. If the intensity of international competition means that this sustained production would otherwise have switched to a location without an equivalent carbon price, this means that leakage has been effectively prevented. However, if the same approach is applied in sectors that are not strongly exposed to international competition, the impact that carbon price might have had on increasing product prices will be reduced (as firms will be incentivized to maintain/increase production), and hence opportunities for demand-side abatement will be reduced. These advantages and disadvantages closely resemble an output-based allocation under an ETS.
- At the other end of the spectrum, firms could be compensated on a lump-sum basis in a way that is entirely unlinked to future production decisions, apart from, perhaps, exceeding some minimum production threshold. An approach similar to this has been suggested as a design option under the South African carbon tax whereby firms considered to be at risk of carbon leakage would be entitled to receive grants to help reduce their carbon intensity (University of Cape Town Energy Research Centre, 2013). Under this approach, recycling would provide no incentive to maintain output, and the advantages and disadvantages are broadly reversed compared with the situation above. Firms will cut back on production. If this is associated with increases in production in other countries with less stringent policies then the result will be carbon leakage, despite the leakage prevention mechanism. However, in other markets where overseas production would not increase, the higher prices resulting from the reduction in production will lead to additional demand-side abatement and a more cost-effective policy. This closely resembles the advantages and disadvantages of the FSB approach described above.

Other cases represent intermediate outcomes. For example, some rebate schemes have focused on reducing employer national insurance contributions. As employment costs are likely to have some

relationship with output levels, this approach is likely to provide a stronger incentive to sustain production than the lump-sum allocation approach, but a weaker incentive than in the case of the pure output-based approach. It may also support reductions in carbon intensity per unit of output if those reductions in carbon intensity can be achieved by capital–labor substitution. The pros and cons of rebates are summarized in Box 13.

Box 13. Pros and Cons of Rebates

- Strong incentives to reduce emissions intensity.
- Remaining features depend on how the rebate is designed:
  - if the rebate is linked to output then it will resemble OBA under an ETS: effective at preventing leakage, but providing strong incentives to keep production levels high;
  - if the rebate is in the form of a lump-sum transfer, there is less protection against leakage but more incentive for demand-side abatement.

5.3.6. Border Carbon Adjustments

BCAs aim to extend the reach of carbon pricing. They do this by requiring a carbon emission cost to be imposed at the border on importers of carbon-intensive goods, unless the country from which the goods are being imported already has an equivalent carbon pricing regime. This can be introduced either as a border tax or, under an ETS, by requiring importers to surrender allowances at the point at which the good is imported. In some variants, it is proposed that rebates on carbon prices are provided to those exporting carbon-intensive goods to countries where there is no equivalent carbon pricing regime.

In principle BCAs can successfully mimic economic and environmental outcomes under a widely harmonized carbon pricing regime, indicating its broad efficiency and effectiveness. By imposing a carbon emission cost on imports that would not otherwise be subject to such a cost, BCAs effectively increase the price of emissions-intensive goods. This has three key effects on abatement incentives. First, it promotes demand-side abatement. Second, it means that firms competing to supply the good do so on level terms, helping firms with a lower emissions intensity to outcompete relatively emissions-intensive firms. Third, all firms selling into the domestic market, both domestic and foreign, have an incentive to reduce their emissions intensity. In cases where the BCA regime also provides a rebate for those exporting carbon-intensive goods, there is no beneficial impact on demand-side incentives or on incentives to reduce emissions intensity, but a level playing field is maintained.

A further possible advantage of BCAs is that they may encourage the spread of carbon pricing as the introduction of domestic carbon pricing would allow revenues to be collected domestically. The strength of this argument in favor of BCAs will depend largely on the magnitude of the impact that they have on trade patterns and the likelihood that those introducing a BCA would be able to sustain the arrangement, potentially in the face of significant political pressure and threat of retaliatory trade measures. This will lead to an overall increase in mitigation only if the domestic carbon price introduced by other countries in response to the BCA is higher and/or has a broader coverage than the BCA.

Modeling of the potential effectiveness of BCAs generally suggests that they would be effective in reducing leakage. Branger & Quirion (2013) examine 25 studies and find 310 estimates of carbon leakage ratios across the various scenarios and models used. Their meta-regression analysis indicates that BCAs reduce leakage rates by around 6 percentage points on average, holding all other parameters constant. This rate is substantial given that leakage rates studied range only from –5 to 15 percent in the BCA scenarios, and 5 to 25 percent without the policy. The potential effectiveness of BCAs was also supported by analysis utilizing harmonized parameters across a variety of models through the Energy Modeling Forum; this analysis found that BCAs on average reduced leakage rates from 12 percent to 8 percent relative to a reference scenario with no BCAs or allocations (Böhringer, Balistreri, & Rutherford, 2012). Likewise, Hoerner (1998) suggests that the experience of the import tax adjustment for ozone-depleting substances in the United States *"establishes the importance of BTAs [Border Tax Adjustments] to achieving the benefits of environmental taxation."*

However, the administrative difficulties associated with border adjustments may be substantial. Administratively, BCAs require rules to calculate the embodied emissions and country of origin of products to deal with the trade of embodied intermediate inputs. Accounting for components of a product with embodied emissions arising from different places can generate complexity. Difficult choices arise in respect of determining the carbon intensity to attribute to imports; arguments can be made in favor of rates based on an individual facility, firm, or country, or conversely a general product-level rate. The facility- or firm-level approaches increase abatement incentives for firms outside the carbon pricing scheme, but also create incentives to "shuffle" production between destinations to minimize the border impost. By contrast, a product-level rate may not appropriately discriminate between different producers, but recognizes the substitutability of equivalent products from different locations within a global market. Different practitioners and commentators have taken different views on the extent of these administrative challenges: some consider that they make BCA regimes very difficult to implement in a way that maintains their environmental integrity (Persson, 2010). Others argue that, while administratively challenging, the experience of the tax for ozone-depleting substances, for example, suggests that it can be made to work. A number of commentators have suggested that, given the potential challenges, BCAs may be easier to introduce in a select number of sectors with relatively homogeneous products, such as cement, at least in the first instance (Helm, Hepburn & Ruta, 2012).

An alternative approach that would avoid these administrative challenges would be to impose a blanket tariff on all goods imported from countries without a carbon price. This tariff would be unrelated to the carbon content of any particular traded good. As such, the focus would be less on using BCAs to try to remove competitive distortions between different producers, and more on encouraging countries to adopt domestic carbon pricing (Nordhaus, 2015).

A related idea is to apply a carbon price on the consumption of carbon intensive products that are trade exposed, whether produced domestically or imported—such as (clinker) cement, aluminum, steel or certain fertilizers (Neuhoff et al., 2015). This would avoid the risk of leakage while encouraging demand-side abatement opportunities for these products. The downside is that they are also untested, and to be trade-neutral they would have to have a flat rate that does not differentiate between more or less carbon intensive products. Hence, they would not provide an incentive to improve production efficiency.

The concern that BCAs will drive leakage "downstream" to producers of more elaborately transformed products is unlikely to be a significant concern in many cases. Generally, leakage concerns are focused on energy-intensive transformation processes such as smelting and refining, rather than downstream processes such as fabrication and casting. Because BCAs raise the price of carbon-intensive commodities, downstream users of the products will pay more for their inputs. They may then face competition from downstream producers outside of the carbon pricing regime who can purchase commodity inputs such as steel or aluminum without a carbon price incorporated. The political implication is that leakage risk moves downstream, typically to sectors with greater employment and therefore often with greater political influence. The administrative implication is that a greater range of more elaborately transformed products may need to be incorporated within the BCA, requiring additional baselines to be established and, because more sectors are covered, including those not necessarily directly responsible for significant emissions, additional compliance effort. However, concerns about leakage of more elaborately transformed products should be tempered by the fact that these products are of higher value and so any embedded carbon emission cost would tend to be low compared with its overall value.

Legal considerations will influence any design but, many commentators suggest, will not represent an insuperable barrier. A number of commentators contend that World Trade Organization (WTO) requirements are likely to impose legal constraints on policy design, but that these could potentially be overcome. For example, one route to demonstrating the legality of BCAs would be under Article XX of the General Agreement on Tariffs and Trade; this allows for exemptions to general provisions for "measures that are necessary to protect human, animal or plant life, or health" (Article XX, b), and for measures that are "related to the conservation of exhaustible natural resources and are made effective in conjunction with restrictions on domestic production or consumption" (Article XX,g). This has been interpreted as implying that BCAs will need to be able to demonstrate their effectiveness at reducing emissions, rather than addressing carbon leakage (Monjon & Quirion, 2011). In turn, this may make export rebates more difficult to justify than import tariffs. Ultimately, it will be possible to assess the legality of BCAs only through the introduction of a regime and any (potential) subsequent challenge.

The political challenges may be as great, or greater, than any legal constraints. The experience of the EU in seeking to establish a regime that bore some similar characteristics to a BCA in the civil aviation sector demonstrates that the political challenges of introducing BCAs may be as, or more, significant than the legal challenges (see Box 14). Experts interviewed as part of this study claimed that it is possible that BCAs will become more feasible as and when (if) a sufficient proportion of major emitters are committed to such a regime. Border adjustment measures appear more feasible when introduced by a coalition of partners who account for a significant share of world trade. The most feasible path to this outcome may be through individual action by a number of major emitters, which might then seek to harmonize their regimes through a common BCA imposed on countries outside the grouping.

In summary, BCAs perform strongly against both abatement and leakage objectives but may be politically and administratively challenging to implement. In principle they are likely to be an effective measure for preventing leakage but implementation challenges may limit their application to a relatively specific set of circumstances. The pros and cons of BCAs are summarized in Box 15.

Box 14. EU Attempts to Set a Price on Foreign Emissions in the Civil Aviation Sector Proved Challenging

The EU attempted to develop a policy that bears some similarity to a BCA for the civil aviation sector. In January 2012 it launched the Aviation EU Emissions Trading System (Aviation EU ETS) to govern emissions from both flights within the European Economic Area, or EEA (which covers the EU plus Norway, Iceland, and Liechtenstein) and flights on starting or ending in the EEA. All such flights would be liable to surrender allowances under the EU ETS, with airlines facing a fine of €100 per ton of CO_2 emitted when this did not occur. Persistent offenders faced the possibility of bans from EU airports.

The Aviation EU ETS faced strong opposition from both developed and emerging economies. Representatives from 20 countries opposed to the rules, including the United States, China, India, and Russia, met in February 2012 to discuss measures they would take if the EU pursued the Aviation EU ETS (International Centre for Trade and Sustainable Development, 2012). These included:

- banning their airlines from participating in the scheme, a move which Chinese authorities had already enacted;
- filing a formal complaint with the International Civil Aviation Organization (ICAO);
- imposing levies or charges on EU airlines as a countermeasure;
- stopping talks with EU carriers on new routes; and
- asking the WTO to rule on the legality of the move. Although the European Court of Justice had previously deemed the rules compatible with international law.

The inclusion of flights to and from non-EEA countries has been suspended. In October 2013, the ICAO Assembly agreed to develop a global market-based measure to address international aviation emissions. It is due to take a decision on the measure in 2016, and to implement it from 2020. In response, the EU has decided to limit the scope of the EU ETS to flights within Europe until the end of 2016 and will further review the scope of the Aviation EU ETS following, 2015 ICAO Assembly.

The EU's policy preference is for aviation emissions to be dealt with through a global scheme such as that being negotiated in the ICAO Assembly. However, some commentators have interpreted the reasons for the EU's change in policy to include concerns regarding WTO compliance; the impact on international trade if countervailing measures were taken and consequences for international relations; and the prospect of an international climate change agreement (Marcu, Leader & Roth, 2014).

Box 15. Pros and Cons of BCAs

- Demand-side abatement incentives will be maintained due to the carbon emission costs imposed on imported goods, allowing domestic firms to raise prices.
- Incentives to improve emissions intensity will be preserved and may also be extended to firms outside the direct scope of the policy.
- Leakage prevention is likely to be strong.
- Political, administrative, and possibly legal challenges may limit application (with political challenges diminishing when introduced by a coalition with significant market power).

5.3.7. Summary

Policy makers must weigh the specific advantages and disadvantages of each leakage prevention measure in the context of their particular circumstances. Policy makers will need to make trade-offs between competing objectives with factors such as administrative complexity, the breadth of sectors receiving assistance, the maturity of the scheme, and political considerations influencing the specific mechanism at any one point in time.

BCAs arguably perform most strongly on grounds of abatement incentives, but face political, administrative (and, possibly, legal) challenges. They are particularly appealing in that they simultaneously offer the potential to remove the competitive distortion associated with asymmetric carbon pricing, while also ensuring that the firms with the lowest carbon intensities are at a competitive advantage, and also ensuring that demand-side abatement incentives are maintained. However, their application to carbon regulation remains largely untested. They appear more likely to be feasible when introduced by a coalition of partners who account for a significant share of world trade.

At the other end of the spectrum, exemptions perform most weakly in terms of abatement incentives but will be the easiest to implement. They are likely to be appropriate only as an interim measure to ensure sufficient support for carbon pricing when a scheme is in its infancy.

Of the free allocation approaches, those that utilize benchmarking (either OBA or FSB) are generally preferable to providing free allowances on a grandfathered basis. The attraction of both approaches is that they sever the link, which exists under grandfathering, between a firm's own historical emission levels and its free allowance allocation. Unless this link is broken there is a risk that firms will have little incentive to reduce their emissions intensity, as lower emissions in one period will be expected to lead to fewer free allowances in the future. While the creation of benchmarks may incur some additional administrative costs, the experience of the EU, Australia, New Zealand, and California—as well as the intention of South Africa (in a carbon tax context)—suggests that these challenges can be overcome. Grandfathering may be more appropriate in schemes in their earlier stages, where the need to tackle other administrative challenges may make benchmarking approaches appear too complex, or where there is a desire to provide one-off compensation for firms even if they are not at risk of leakage.

The trade-offs between the two benchmarking approaches (FSB and OBA) are more balanced. Output-based allocation may be more effective at preventing leakage but at the same time the greater incentive for continued/increased production it provides will result in lower product prices than an FSB approach, hence blunting demand-side abatement incentives. This will be particularly problematic if OBA is applied to sectors where the need for leakage protection is limited (and hence where prices would otherwise rise). Depending on the specific design, OBA may also not guarantee a specified environmental outcome.

Under a carbon tax regime, rebate mechanisms can be designed to emulate the properties seen under the free allowance benchmarking options. An output-based rebate, such as that used in the case of the Swedish NOx tax, provides very similar properties to output-based allocation; alternatively, lump-sum rebates would resemble FSB approaches. Rebates through reductions in employer social security contributions represent an alternative between each extreme. Given these similarities to the free allowance alternatives, the trade-offs between each approach are also similar.

Table 8 provides a high level summary of the different integrated policy measures that can be used to reduce the risk of carbon leakage.

Table 8. Summary of Different Policy Responses

	Grandfathering	*FSB*	*OBA*	*Exemption*	*Rebates*	*BCA*
Leakage prevention	Weak, unless closure rules and updating included	Weak, unless closure rules and updating included	Strong	Strong	Depends on design	Strong
Incentives to improve emissions intensity	In principle strong, but diluted when updating included	Preserved	Preserved	Not preserved	Preserved	Preserved
Demand-side abatement incentives	Preserved	Preserved	Dulled, especially if applied to broadly	Removed	Depends on design	Preserved
Administrative complexity	Easy to implement	Some complexity in establishing benchmarks	Some complexity in establishing benchmarks and costs in collecting output data	Easy to implement	Some complexity	Very complex
Risk of windfall profits	Some risk	Some risk	No	No	No	No
Risk to environmental outcome	No	No	Some risk, depending on design	Yes, exempt emissions uncapped	Depends on Design	No
Political and legal challenges	No	No	No	No	No	Yes

5.4. Complementary Policies

Carbon pricing may not unlock all possible abatement options at least cost due to a range of market failures; these market failures create a case for complementary policies. Some important market failures include:

- Knowledge spillovers: private entities may not capture all of the benefit of their innovations, which may "spill over" to others. This reduces the expected return on innovation and means that the expected profits may not be sufficient to drive a socially optimal level of innovation. This observation holds generally, but is of particular importance to the development of low-emissions technologies, which are crucial to achieving low-cost long-run reductions in greenhouse gas emissions.
- Access to finance: firms may identify attractive abatement opportunities but financiers may not be aware of their benefits or may perceive their risks to be high. This imperfect and asymmetric

information may make it difficult for firms to finance cost-effective abatement investments. A lack of competition between capital providers may also restrict access to finance.
- Information barriers: firms (especially SMEs) and households may not have the time or expertise to identify and implement cost-effective abatement options such as energy efficiency investments. There may be a role for government intervention to overcome this barrier and drive adoption of equipment with a higher upfront cost but a lower lifecycle cost when energy savings are taken into account.
- Network effects: some technologies and practices become more attractive to an individual or firm as the general level of adoption increases. This may mean that private incentives to adopt are lower than ideal, and uptake is slowed. Government policy can play a role in overcoming these effects. An example in the context of low-emissions technologies might be electric vehicles: widespread adoption of electric vehicles would result in greater availability of charging stations, but adoption is unattractive until users can be confident that the charging infrastructure will be widely available.

Complementary policies may also be implemented for political reasons, such as directing support to strategic sectors, or to address existing distortions in the tax system.

Complementary policies could also be used to target assistance to sectors at risk of leakage. This might occur through grants, tax incentives, or financing assistance for emissions reduction projects for firms in leakage-exposed sectors, or for R&D on low-emissions technologies applicable in leakage-exposed sectors.

There are a few examples of sector-specific complementary measures that are directly aimed at addressing leakage. The clearest example of using cash transfers as a complementary measure to address carbon leakage is under Phase III of the EU ETS. Indirect carbon costs are associated with the costs of indirect emissions, i.e. emissions related to the production of consumed electricity. The ETS Directive allows Member States the opportunity to compensate for indirect carbon costs through national resources via state aid schemes. To ensure that such measures are undertaken in line with the EU's state aid rules, and applied within predefined boundaries across Member States, the Commission has published guidelines on state aid measures related to the ETS which, among other things, determine the eligibility of sectors for such compensation. Cash grants were also provided to address leakage concerns for coal mines with high fugitive emissions under the Australian carbon pricing mechanism through a policy known as the Coal Sector Jobs Package.

But in many cases addressing leakage was not necessarily the primary policy objective of the sector-specific complementary measures. For example, New Zealand provided support for R&D into emissions reduction opportunities in agriculture, while the Australian carbon pricing mechanism developed a range of complementary measures as discussed in Box 16. In these cases, the link between these measures and leakage prevention may not be strong: New Zealand also exempts agriculture from emissions liabilities, while the Australian measures may have been related more to managing broader political economy concerns related to the introduction of carbon pricing rather than to an expectation that they would have a material impact on leakage.

Box 16. Examples of Sector-Specific Complementary Measures under the Australian Carbon Pricing Mechanism

The now-repealed Australian carbon pricing mechanism was supported by a range of complementary measures for sectors that also received free allocations to address leakage under the *Jobs and Competitiveness Plan* (JCP) as well as for several sectors that in many cases were close to, but not quite, eligible for free allocations. These policies include:

- the *Steel Transformation and Advanced Assistance Plan*, which provided A$300 million funding for R&D into low-emissions steel technologies, in addition to allocations to the steel sector under the JCP;
- the *Coal Mining Abatement Technology Support Package*, which provided A$70 million in grants to support innovative emissions reduction projects by emissions-intensive underground coal mines, recognizing that coal mining was not eligible for JCP assistance but that some mines were particularly emissions-intensive;
- the *Clean Technology Investment Program*, which provided A$800 million of grant funding for a range of emissions reduction projects in the manufacturing sector, particularly energy efficiency. A$200 million was reserved for the firms in food and beverage processing and metals manufacturing; many firms in these areas were either recipients of assistance under the JCP or narrowly missed out on assistance.

As well as sector-specific complementary measures, broader-based complementary measures can be deployed; under some circumstances these can indirectly reduce leakage risk. A range of complementary policies can potentially unlock efficient abatement options that might otherwise be forgone due to the market failures identified above. These policies include: tax incentives, grants or financing assistance for low-emissions projects to overcome financing barriers resulting from asymmetric information; funding for low-emissions R&D to reflect the existence of positive knowledge spillovers; regulatory interventions to promote energy efficiency options that might be forgone due to information barriers; or direct support for abatement technologies where network effects hold back adoption. Where there are genuine market failures, these measures can reduce the overall cost of abatement. Furthermore, in many cases, these measures will work to reduce the prevailing carbon price under an ETS. In effect, the sectors benefiting from the complementary measures carry more of the specified emissions reduction burden, “taking pressure” off other sectors, potentially including those sectors exposed to leakage. However, there is a risk that this is achieved only by targeting abatement effort at relatively high-cost sources of abatement, losing one of the primary benefits of carbon pricing.

In summary, complementary measures are valuable in supporting broader emissions reduction objectives, as is reflected by their wide adoption across jurisdictions, but in most cases they have had only a marginal role in addressing leakage risk to date. Most jurisdictions with carbon prices also have some combination of support for emerging renewable technologies, energy efficiency measures, and low-emissions R&D. The nature and ambition of these policies vary across jurisdictions, but their broad adoption indicates the widespread acceptance of their value as part of the policy landscape in promoting deep decarburization. These can help reduce carbon leakage risk in genuinely exposed sectors: either by

directly reducing the cost impact that particular sectors face, or indirectly, under a cap and trade scheme, by reducing the carbon price. Typically, the objective of these policies is unrelated to reducing carbon leakage risk, although there are a few cases where such measures have been directly focused on leakage concerns. Nonetheless, to date, there are no cases where countries have relied exclusively on these mechanisms to address leakage risk. This is likely to reflect the fact that these mechanisms are typically insufficiently comprehensive in terms of the sectors they cover or the extent of the cost increases they ameliorate. Furthermore, because they are not integrated within the broader carbon pricing framework, key stakeholders may not have sufficient confidence regarding their permanence.

6. Engaging Stakeholders on Carbon Leakage

As previously discussed, the confluence of potentially undesirable environmental, economic, and political consequences of carbon leakage means it is typically one of the most controversial and prominent aspects of the policy debate around the introduction of a carbon price. Carbon leakage is probably the single most common argument used to delay or derail the introduction of carbon prices around the world. This means that how this policy debate is managed can have a great influence on the successful design of policy to address these concerns and the successful introduction of a carbon price.

This section considers the role of stakeholder engagement in analyzing and addressing concerns about carbon leakage. Drawing from the experience to date, it discusses the modes of engagement that have been used, the options to frame the policy dialogue, and some of the lessons learned.

6.1. The Policy Debate and Role of Engagement

Carbon leakage has the potential to gain significant prominence in the overall policy debate around the introduction of carbon pricing. Arguments that the risk of leakage undermines the environmental outcomes, while at the same time leading to a decline in domestic production with potential job losses, can weaken support for the introduction of carbon pricing. In addition, measures to address carbon leakage normally involve the use of fiscal resources (explicit or implicit) that could be used for other purposes (to compensate households or other affected groups, or other general uses of revenue). This trade-off often requires a degree of political judgment providing the impetus for different interests to lobby decision makers.

Some incumbents will have an interest in resisting the introduction of a carbon price and/or to seek to be shielded from it through specific assistance measures and may use arguments around carbon leakage to support their interests. What they might share with the government and general public about their risk to carbon leakage is likely to be strategically selected.

Additionally, **concerns about carbon leakage are often at their most prominent when the introduction of a new carbon pricing policy is being considered**. That is, when industry and the general public do not have experience with carbon pricing to observe its real impact. This may result in inflated concerns about the potential for carbon leakage.

Effective stakeholder engagement can help to shape the public debate to make sure that it is not captured by certain interest groups and is grounded in evidence.

Effective stakeholder engagement will also be important for the more technical policy dialogue. Should the risk of leakage be assessed as significant for certain sectors, the effective design of leakage prevention measures would likely benefit from active cooperation from a range of stakeholders, for example to test and refine policy proposals, and provide important data and other technical inputs to the policy design process.

A successful stakeholder engagement process would therefore need to manage the more general public policy debate on the issue, as well as, the more technical dialogue. The modes of engagement and the

strategies' for framing those debates will need to be tailored to the level of debate. For example, while the technical dialogue may best be supported by detailed in-depth policy analysis, the more general public policy debate might be better served with a clear and simple-to-understand narrative. Furthermore, the policy debate will likely evolve over time and the best strategy for stakeholder engagement with it.

6.2. Modes of Engagement

Stakeholder engagement allows for relevant parties throughout a society to be appropriately consulted and informed on issues relating to carbon leakage and the design and implementation of prevention measures. Stakeholder engagement comes in many different forms, capturing a wide range of relevant stakeholders, and using any number of different modes of engagement.

Stakeholder engagement on carbon leakage can be difficult and involve some conflict but has significant benefits, such as: greater transparency in the policy debate; avoiding misinformation, resolving conflicts, and securing consensus and buy-in; ensuring policy reflects national priorities and circumstances allows for policy to draw on widespread expertise; enhancing trust between stakeholders and alleviate general skepticism; and helping raise and maintain public support. Stakeholder engagement is often a key driver of success in effective design and implementation of policy.

There is no single approach to stakeholder engagement which is suitable for every situation. Stakeholder engagement will depend on the context in which it happens. With such a wide variety of cultures, communities, business practices, government processes, and transparency mechanisms in place across the world, different jurisdictions have taken different approaches to stakeholder engagement. Typically the mode of engagement will be chosen to best suit the audience and purpose of the engagement. Some of the modes of engagement that have proved successful to date are discussed below.

Policy makers will often lay out a plan that defines the process for stakeholder engagement, setting out the objectives of the different engagements, whom to engage with, when to engage, what issues to engage on, and how to engage. Such a plan can provide a structured approach to stakeholder engagement and make the process more efficient and effective.

Several jurisdictions have used a formal consultation process to seek views and input on policy proposals. This involves the preparation and release of policy proposals on which stakeholders are invited to share their views. Typically the consultation occurs based on a concrete policy proposal or a set of options that have already been designed in some detail. Written discussion papers or policy papers are usually made available to stakeholders who are given a specified amount of time to submit their views on the proposal(s) in writing. These formal consultation processes can be open to the general public or targeted to the most relevant stakeholders. Box 17 explains the formal consultation process conducted in South Africa.

Some jurisdictions have used surveys and questionnaires to gain valuable information from stakeholders. Often the assessment of the risk and effective design of measures to address leakage will require in-depth knowledge and data on potentially affected firms. Surveys are one way to solicit this information. Surveys and questionnaires can also be used to gather views of different policy options and proposals. Box 18 illustrates how surveys and questionnaires have been used to inform the EU ETS.

Box 17. Formal Public Consultation on South Africa's Proposed Carbon Tax

The South African National Treasury conducted two formal public consultation processes in the development of the carbon tax policy. First in 2010 a discussion paper was released setting out three implementation options: taxes on measured GHG emissions, a fossil fuel input tax or taxes on energy outputs. Written submissions were invited from the public. Taking into account feedback received in those submissions, a broader consultation process, and further policy design, a carbon tax policy paper was released in 2013 outlining the tax's rationale and proposed design features. Again written submissions were invited from the public. Submitters where given a 3-month period to provide their views on the policy as proposed in the policy paper.

The stakeholder consultation process highlighted a number of issues that affect the carbon tax's design features. These included concerns about impacts on economic competitiveness. The currently proposed tax free thresholds were introduced in response to these views.

For additional information see: www.treasury.gov.za

Box 18. Questionnaire to Consult Stakeholders on EU ETS Post-2020 Carbon Leakage Provisions

In 2014 the European Commission conducted a 12-week stakeholder consultation on the post-2020 carbon leakage provision for the EU ETS using an electronic questionnaire. The results of the consultation fed into the policy development process on the 2030 climate and energy policy framework regarding the determination of post-2020 rules on free allocation and carbon leakage provisions in the EU ETS.

The consultation was open to all citizens and organizations. The stakeholder consultation process gathered a total of 440 responses from business and trade associations representing business interests, public authorities, civil society, and the general public.

The questionnaire consisted of 23 multiple choice questions alongside the possibility to provide written comments. [A sample of the questions].

The nature of the questionnaire allowed for stakeholder's views from the multiple choice questions to be quantified, which helped in analyzing views. The flexibility for stakeholders to add written comments to their submissions allowed for specific input to be captured during the consultation.

A summary analyzing the responses received during the consultation was prepared and made publicly available. Also to increase transparency organizations where asked to provide to the Commission and general public information about whom and what they represent in a transparency register.

For additional information see: http://ec.europa.eu/clima/consultations/articles/0023_en.htm

Consultation meetings with stakeholders are also typically an important part of engagement. Consultation meetings can take many different forms, including:

- one to many, for example a large meeting open to all interested stakeholders can be useful for communicating ideas and seeking input from a wide range of stakeholders (Box 19 illustrates how public meetings have been used in California);
- one to some, for example targeting a select group of representatives from industry, government, NGOs, or academia, where the group is smaller and potentially more interactive;
- one to one meetings with specific stakeholders that can be useful for addressing particular concerns or seeking specific input.

Representative committees can also be established to support the stakeholder consultation process. These committees are often established with a specific mandate and would be engaged regularly throughout the policy development process. Participants in the committee would be chosen for their particular expertise or view point. Box 20 provides some examples of groups and committee's established in New Zealand as part of the policy development process.

Stakeholder engagement will also often include a media campaign that might use radio, television, newspapers, and social media to explain policy or address concerns as they arise. These forms of engagement are particularly relevant for managing the general public policy debate. Typically the issues of carbon leakage would be incorporated into a wider campaign around carbon pricing.

Finally a range of other modes of engagement, such as a web page with relevant information, frequently asked questions, webinars, phone calls, and letters, can also be used to engage and communicate with stakeholders.

Box 19. Public Meeting on Possible Border Carbon Adjustment for the Cement Sector

On February 5, 2014, the California Air Resources Board held a public workshop to discuss potential inclusion of cement importers in the California Cap-and-Trade Program in the second compliance period using a border carbon adjustment mechanism. The workshop was open to all interested persons.

The workshop commenced the public process to consider regulatory amendments that would include cement importers as an additional covered sector subject to the California Cap-and-Trade Regulation (Regulation) in the second compliance period using a border carbon adjustment mechanism, potentially in concert with free allocation. The meeting was used to discuss options and technical considerations for including cement importers as part of the Regulation.

Staff of the Air Resources Board made a presentation providing the background and definitions; setting out the concept of a border carbon adjustment and then the design considerations. Following the presentation participants engaged in open discussion on the issues. Written comments on the issues and options presented were also invited for a 2-week period following the workshop.

For additional information see: http://www.arb.ca.gov/cc/capandtrade/meetings/meetings.htm

Box 20. Expert Groups Established to Support the Development of the New Zealand Emissions Trading Scheme

A number of expert groups were formed to provide advice on designing, improving, and operating the New Zealand ETS.

Electricity Allocation Factor (EAF) Contact Group: The EAF is a component of the allocative baseline that is used to calculate the allocation received by eligible industries. The contact group was established to develop a recommendation of the EAF for the period 2013-17 for the responsible minister. The group consisted of representatives from significantly affected parties that are familiar with electricity market issues and the NZ ETS. This includes people from government agencies, emissions intensive and trade exposed firms, power companies, and specialist consultants.

Climate Change Leadership Forum: The Climate Change Leadership Forum had 33 members, including six government chief executives and private sector participants from the agriculture, electricity, forestry, and industrial sectors. Additionally members also covered the science, environmental, and local government sectors and there were three Maori representatives. The purpose of the Forum was to facilitate communication between the government and the broader community as policy decisions were taken on the proposed design of a NZ ETS. The Forum provided an opportunity for community and business leaders to air their differing views on emissions trading and wider climate change policy as well as an opportunity to provide advice to help shape the design features of the ETS.

Technical Advisory Groups: A number of sector specific technical advisory groups were also formed during the policy development process. These groups were made up of technical and policy experts from the industry, government, and the science system. They provided input and guidance on ETS design options and acted as the principal forum for engaging with sector specific experts.

For additional information see: http://www.climatechange.govt.nz/emissions-trading-scheme/building/groups/

6.3. Framing the Debate

An important aspect of engagement is how the introduction of a carbon price and any associated concerns about carbon leakage are framed. Different governments have taken different approaches for framing the debate. Some of these options are discussed in this section.

Experience has shown that it can be helpful if concerns about carbon leakage are framed within a comprehensive carbon price policy narrative. If the case for carbon pricing is not well understood or widely supported, then concerns about carbon leakage, even if unfounded, can be used more easily to delay or undermine the introduction of the carbon price.

A strong evidence base can also help to frame the debate and address misinformation. As previously discussed, economic modeling and other ex-ante analysis can help policy makers and other stakeholders to better understand the potential risk of carbon leakage. This can help counter unfounded claims about risks of carbon leakage and better target assistance to those sectors and firms generally at risk.

Testing specific claims about risk of carbon leakage with a range of stakeholders can also be helpful to more fully understand the real risks. For example, testing a firm or sector's claim that they can't pass on the cost to their consumers with downstream producers who might also seek assistance because they expect the full cost to be passed on to them but do not expect to be able to pass it on further.

A clear and easy to understand narrative about the objective of any leakage prevention measures can also help to frame the debate. There can be a tendency for vested interests to move the carbon leakage debate into a broader discussion on industrial competitiveness, rather than environmental effectiveness. This risks carbon pricing policy being seen as a substitute for industrial policy. Explaining the difference between shifts in economic activity that are efficient and intended from the introduction of the carbon price, and those that are inefficient and resulting from asymmetric carbon pricing policy, can help to target assistance. Ideally any prevention measures would keep incentives sharp for companies and investors to improve emissions performance. A clear narrative will also directly relate the risk of carbon leakage to the carbon pricing policies in other countries. This provides a clear rationale/expectation to reduce assistance over time as more countries implement policies that provide an explicit or implicit carbon price. Box 21 describes how such a narrative has been provided for the EU ETS.

Making explicit the trade-off between leakage prevention measures and other uses of the fiscal resources can help balance interests. For example, if the general public understands that there is a direct relationship between the assistance provided to firms to reduce the risk of leakage and the resources available for other uses, including to support households, it may help decision makers make more balanced decisions.

It might even be possible to package the introduction of a carbon price and associated leakage concerns into a much broader policy reform package. For example, concerns around carbon leakage may be more moderate if revenue raised from the carbon price is explicitly tied to other public policy outcomes that are widely supported and have prominence (Box 22 provides an example).

Box 21. Easy to Understand Narrative on Carbon Leakage and the EU ETS

The European Commission sets out a clear narrative on carbon leakage with a dedicated web page to the issue. The web page clearly describes the issue, sets out the policy, and provides relevant documentation, related studies, and some frequently asked questions.

For more information see: http://ec.europa.eu/clima/policies/ets/cap/leakage/index_en.htm

Box 22. Chile's Carbon Tax a Part of a Broader Tax Reform Package

In September 2014 Chile passed legislation for the implementation of a carbon tax. The new legislation was a part of a much broader set of reforms, including changes to other tax laws, improvements to health and education systems, measures to increase social mobility, and other new environmental protections.

If concerns about carbon leakage are strong and unwavering despite the evidence base, and likely to become a barrier to the introduction of a carbon price, then the debate could be managed with the phasing-in of carbon pricing. One option would be to start with a lower price that rises over time, as for example is proposed in South Africa. Another option could be to start with somewhat generous assistance for firms potentially at risk of carbon leakage which can be phased down and/or narrowed over time, as for example was the experience in the EU ETS. Concerns over carbon leakage could be placated with some experience with carbon pricing and policy better targeted with the benefit of ex-post analysis. Ideally the intention to review or adjust assistance over time would be made explicit at the time of introducing the carbon price to avoid creating any expectation for ongoing entitlement.

6.4. Lessons Learned on Stakeholder Engagement

Stakeholder engagement is likely to be a key determinant of success in managing carbon leakage concerns and designing any prevention measures. Several jurisdictions have successfully used a transparent policy development process that incorporates both formal and informal engagement with a wide range of stakeholders. Experience has shown that policy makers can expect to engage on these issues with industry, technology providers, banking and services, civil society, and the general public throughout the policy development process. A clear engagement strategy that takes into account the different interests of, and draws on expertise and information from, a wide range of stakeholders can help manage the engagement process and make it more efficient and effective.

Carbon leakage could be raised as part of the general public policy debate, as well as in the technical policy development process. These two streams of debate might not progress in step with each other. For example, it is possible that the strongest and most active opponents in the general public debate will still engage constructively in the technical dialogue. Different modes of engagement will likely be needed throughout the course of the policy development process. Modes are best chosen to suit the audience and objective of the engagement.

Experience has shown that with the introduction of a carbon price, incentives for lobbying can be high, with strong vested interests who may use arguments around carbon leakage to protect those interests.

A clear and sensible public policy framework can therefore help to manage the debate. A strong evidence base, that assesses the potential risk of carbon leakage, is also important in this regard.

Some political judgment will be required to formulate the most appropriate policy response to concerns around carbon leakage. Compromises and trade-offs may be needed to find a policy formulation that is politically acceptable. High-level political leadership and commitment may be needed to drive the agenda. General political acceptance of the carbon price should help to contain the debate on carbon leakage. Engaging broadly at the political level can support this, for example, by briefing politicians across government, in opposition, and at different levels of government. Similarly, a whole-of-government process that keeps relevant ministries engaged and informed can support the policy development process and help to effectively manage the debate. Box 23 provides a practical example of how this was achieved in the Republic of Korea.

Box 23. Korea's Presidential Committee in Green Growth

Given the relevance of the proposed emissions trading system to a range of different interests and across different ministries, the Presidential Committee on Green Growth was charged with leading the development of the Korean emission trading legislation. The committee was established in 2013 and was co-chaired by the prime minister and a private-sector representative, with members from different government ministries.

Public opinion and therefore political support can shift over time. As such, there can be a trade-off between engaging in a long policy development process to design the perfect policy and getting the policy agreed and implemented while there is political support and/or momentum. In any event, carbon pricing policy and, in particular, measures to address the risk of carbon leakage can be reviewed and improved over time.

The broader policy context is likely to influence the policy debate around the introduction of a carbon price and associated carbon leakage concerns. For example, the public's general confidence in the economy could influence opinions on the importance of carbon leakage risk and associated output and job losses. Similarly, general trends in electricity prices could influence opinions on how much assistance should be given to firms to address the risk of leakage relative to households to offset the further increase in electricity prices that might be expected from the carbon price. Likewise, concerns around carbon leakage may be more moderate if revenue raised from the carbon price is explicitly tied to other public policy outcomes that are widely supported and have prominence.

The carbon pricing policies of other countries, including their measures to address the risk of carbon leakage, will likely be raised as part of the policy debate. A good understanding of those policies can help to inform the policy analysis, as the risk of carbon leakage will be reduced as more countries take on equivalent policies. At the same time, providing clarity on what other countries are doing and what this implies for the effective carbon price competing firms face can help to address misinformation and manage the carbon leakage debate.

Appendix 1: Leakage Prevention Mechanisms in a Range of Carbon Pricing Schemes

This appendix details the practical elements of the leakage prevention mechanisms in a selected number of carbon pricing schemes. As appropriate, it addresses:

- whether assistance is provided to all sectors/firms or just a subset of firms/sectors considered to be at risk of carbon leakage;
- how the scheme distinguishes between sectors deemed to be at risk of carbon leakage and those that are not;
- the type of assistance provided to sectors considered to be at risk of carbon leakage; and
- if the scheme uses benchmarking, how that benchmark is determined.

It concludes with a general discussion on the relative importance attached to different rationales for addressing carbon leakage, different approaches to modeling leakage risk, and broader policy considerations.

The detail—and the selection of countries covered—is informed by responses to a questionnaire designed by Vivid Economics and shared with selected countries as determined by the PMR Secretariat.

Australia

Prior to its repeal, the Australian carbon pricing scheme provided assistance to activities considered "Emissions Intensive Trade Exposed" (EITE) on a tiered basis. The level of assistance for which an activity was eligible was determined by the level of exposure:

- "highly exposed" activities were those which were both trade-exposed and one of the following: carbon intensity greater than 2,000 tCO2e per million Australian dollars of revenue, or greater than 6,000 tCO_2e per million Australian dollars of GVA;
- "moderately exposed" activities were those which were trade-exposed and one of the following: carbon intensity greater than 1,000 tCO2e per million Australian dollars of revenue, or greater than 3,000 tCO_2e per million Australian dollars of GVA.

The test for trade exposure was based on either a quantitative test: [(imports + exports) / production] which needed to exceed 10 percent for a product from an activity to be considered trade-exposed; or a qualitative assessment.

EITE activities in Australia received assistance through an OBA approach using benchmarks. Allocations were updated in line with the activity's output on a regular basis. In addition, a one-off non-updating allocation of allowances was provided to electricity generators. These allocations were not based directly on historical emissions but were similar in principle and intent to a pure grandfathering regime. The difference in approach for these sectors reflected different policy rationales: with EITE sectors, there was

a desire to protect against leakage; for generators, the intention was to smooth the transition to a new policy regime.

The benchmark was determined using two years of emissions data and the assistance rates were set according to whether the activity was "highly" or "moderately" exposed. Two years of emissions data (2006–07 and 2007–08) were used to determine the average emissions intensity of each activity. Assistance rates were set at 94.5 percent and 66 percent of this benchmark for "highly" and "moderately" emissions-intensive activities, respectively. The assistance rates declined at a rate of 1.3 percent per year, which was the same decline rate as the default cap. This was to ensure that the EITE share of allocations did not grow excessively relative to the default cap, but did not hold if more ambitious caps where determined. In general, the benchmark was set on the basis of one product/one benchmark. However, there were some exceptions: for example, petroleum-refining benchmarking was administered on the basis of inputs rather than outputs as there were fewer inputs than outputs and the emissions relationship between inputs and outputs was stable.

California

In the first phase of the California scheme (2013–17), with the exception of the power sector, all firms were entitled to free allowances under an output-based allocation. The benchmark for each sector was set on the basis of the higher of 90 percent of average emissions or 100 percent of the best practice, with an annual decline in the benchmark of 2 percent. A separate scheme for power generators exists.

From 2018, California intends to maintain an output-based allocation scheme but split sectors into highly exposed, moderately exposed, or low exposure, or based on a combination of emission intensity and trade intensity metrics. The emissions intensity tiers are:

- High: >10,000 tCO2e per million dollars of revenue;
- Medium: 1,000–9,999 tCO2e per million dollars of revenue;
- Low: 100–999 tCO2e per million dollars of revenue;
- Very low: <100 tCO2e per million dollars of revenue.

The trade intensity tiers are:

- High: >19%;
- Medium: 10–19%;
- Low: <10%.

Trade intensity is measured as (imports + exports) / (shipments + imports).

Table 9 shows how these different tiers are to be combined to determine the overall assessed exposure to carbon leakage risk.

The level of free allowance allocation received by different sectors will depend on the sector's classification. Those at high risk of carbon leakage will receive free allowance at 100 percent of the 2013–17 benchmark; those moderately exposed receive 75 percent of the 2013–17 benchmark; and those

Table 9. From 2018, the Californian Scheme Intends to Classify Sector Exposure According to a Combination of Carbon Intensity and Trade Exposure

	High trade exposure	*Medium trade intensity*	*Low trade intensity*
High carbon intensity	HIGH	HIGH	HIGH
Medium carbon intensity	HIGH	MEDIUM	MEDIUM
Low carbon intensity	MEDIUM	MEDIUM	LOW
Very low carbon intensity	LOW	LOW	LOW

Source: Californian Environmental Protection Agency

with low exposure receive 50 percent of the 2013–17 benchmark. The benchmark in all three categories will continue to decline by 2 percent per annum.

Chile

Chile's carbon pricing scheme was focused on the power sector so carbon leakage concerns were not significant. There is no electrical interconnection between Chile and other countries and so the risk of leakage does not arise directly for electricity generation. In addition, energy users did not express concerns about carbon leakage or competitiveness effects. This could be due, in part, to the nature of pass-through from electricity generation to end-users: for large users the pass-through mechanism depends on long-term contracts, but is likely to be slow; while for smaller users the regulatory system also slows the rate of pass-through. Concerns about the effects of carbon pricing in the construction sector led to a policy decision to exclude industrial process emissions generally, and cement in particular.

EU

Under Phase III of the EU ETS, all entities other than electricity generators are given assistance, with those considered to be exposed to leakage receiving a higher proportion of free allowances. This represents a decline in the proportion of allowances provided for free compared with Phases I and II, during which allocation decisions were made at the Member State level. The general exclusion of the power sector in Phase III was in recognition of the fact that providing assistance to entities that did not face international competition had led to windfall gains, where the cost of emissions was passed on to consumers irrespective of the value of assistance received. In addition, under Phase III, while nonpower sector entities continue to receive allocations even if they are not deemed to be exposed to carbon leakage, the extent of this assistance has been reduced.

The EU determines whether a sector is at risk of carbon leakage through a combination of trade intensity and cost increase metrics. The quantitative criteria are satisfied if the sector:

- faces a cost increase of greater than 30 percent; or
- has a trade intensity greater than 30 percent; or
- faces a cost increase greater than 5 percent and has a trade intensity greater than 10 percent.

Cost increase is calculated as: [(assumed carbon price (€30) × emissions) + (electricity consumption × carbon intensity of electricity production (0.465tCO_2/MWh) × carbon price (€30))]/GVA). Trade intensity

is calculated as: [(imports + exports) / (imports + production)]. For borderline sectors, the European Commission carries out a qualitative assessment.

The EU ETS uses FSB to determine the level of assistance. The Commission established a series of benchmarks for different activities under which the cap with free allowances received by firms/installations in the sector was set by multiplying an installation's historical output level (either average output between 2005 and 2008 or average output between 2009 and 2010) by the benchmark, with a further cross-sectional adjustment factor. However, once the level of free allowance was set, future changes in installation output had limited impact on the allowances received by each installation. The benchmark was set equal to the carbon intensity of the average of the best[17] 10 percent of performers in each sector. Sectors deemed to be at risk of carbon leakage receive 100 percent of the benchmark, while other sectors receive 80 percent of their benchmark in 2013, falling to 30 percent by 2020.

The regime allows for some link between output and allocations. In general terms**,** the FSB allocation approach under the EU ETS Phase III means that a change in installation output would have no impact on allocation amounts. However, there are exceptions if firms produce significantly less output than their historical output. Specifically, firms producing:

- less than 10 percent of their historical output in any one year receive no allocations in the subsequent year. This effectively acts as a closure threshold;
- between 10 and 25 percent of their historical output receive allocations with a 25 percent weighting in the next year;
- between 25 and 50 percent of their historical output receive 50 percent of their full allocation in the next year; and
- more than 50 percent of their historical output receive their full allocation, including if output exceeds their historical output level.

New Zealand

New Zealand provides assistance on a tiered basis to sectors at risk of carbon leakage. The level of assistance is determined by the level of exposure:

- "highly exposed" sectors are those where carbon intensity is greater than 1,600 tCO2e per million New Zealand dollars of revenue and they are trade-exposed;
- "moderately exposed" sectors are those where carbon intensity is greater than 800 tCO2e per million New Zealand dollars of revenue and they are trade-exposed.

Trade exposure is assessed qualitatively on the basis of the existence of transoceanic trade of the good in question. Generators are excluded from receiving assistance.

EITE sectors in New Zealand receive assistance using an OBA approach with benchmarks. Allocations are updated on a regular basis in line with the sector's output.

[17] In other words, the least carbon- intensive.

The benchmark was determined using two years of emissions data and the assistance rates were set according to whether the sector was "highly" or "moderately" exposed. The period from which the benchmark was set was flexible due to the availability of data. In general, a three-year period set by calendar or financial years through 2006–8 was used for all sectors as allocation rates were being set in late 2009/early 2010. Assistance rates were set at 90 percent of average emissions for "highly" emissions-intensive activities, and 60 percent for "moderately" emissions-intensive activities.

South Africa

South Africa provides assistance on a tiered basis to all sectors. Assistance is provided in the form of tax exemption with greater levels of assistance provided for firms that are trade-exposed and/or that have high process emissions. A 60 percent exemption applies to all firms and there is a further maximum of 10 percent for trade-exposed firms and 10 percent for firms in sectors deemed to have process emissions. The 60 percent exemption rate can also be adjusted up to 5 percentage points if a firm has a lower than average carbon intensity within the sector. The 60 percent rate will be in place for the first five years of the tax to 2020 and will then be reviewed.

Sectors eligible for extra assistance are those which have:

- a trade intensity greater than 10 percent on a combined exports and imports measure; or
- a trade intensity greater than 5 percent on an exports-only measure.

Trade intensity is: [(imports + exports)/output] or (exports/output) as appropriate.

South Africa plans to reduce the basic exemption rate over time in order to increase the carbon pricing signal.

Republic of Korea

100 percent of allowances will be allocated for free in the first phase (2015–17) of the Korean ETS, although with different approaches in different sectors. For the bulk of sectors, the scheme designers have adopted a grandfathering approach to free allowance allocation. However, they have opted for OBA in the clinker, refineries, and aviation sectors. This reflects the perceived relative ease of creating benchmarks in these three sectors. These are based on average emissions in the base period 2011–13. Policy makers have also expressed a desire to shift increasingly toward the use of benchmarks in future phases of this scheme, although there is also concern about the complexity of this.

In subsequent phases, it is intended that a greater proportion of allowances will be auctioned, but sectors considered to be EITE will continue to receive 100 percent of allowances for free. To assess which sectors are EITE, the scheme uses a combination of trade exposure and production cost increase, according to the following criteria:

- if trade intensity is greater than 30 percent, irrespective of cost uplift;
- if the production cost increase is greater than 30 percent;
- if trade intensity is greater than 10 percent and production cost uplift is greater than 5 percent.

Trade intensity is: [(exports + imports) / (sales + imports)] while production cost increase is: (greenhouse gas emissions level * permit price) / (total value added). Most sectors qualify for assistance under the trade intensity threshold, with over 90 percent of sectors qualifying as EITE on this basis.

General Considerations

Among jurisdictions that have introduced carbon pricing schemes, the key rationale for introducing mechanisms to address carbon leakage was to prevent a movement of activity to unregulated countries. Most respondents referred to these concerns and noted that they were particularly important if carbon pricing is introduced during an economic downturn. The second most cited reason for measures was to provide transitional assistance to industry to cope with new policy. Indeed, some stakeholders cited them as jointly important. The least cited rationale for introducing measures to counteract potential carbon leakage was to compensate industry for a change in the policy environment and to prevent an increase in global emissions.

Most countries used general equilibrium modeling to assess the risk of leakage and the effectiveness of mechanisms to prevent it, while few used partial equilibrium modeling. For some respondents, modeling was carried out in the context of policy development. Others indicated that macroeconomic modeling was not used for policy design; empirical data and analysis of stakeholder arguments were considered more important. This may be because macroeconomic modeling may not allow a very granular assessment within the most affected sectors or because of challenges in agreeing input assumptions. Sectoral modeling was carried out in some cases, but this was limited to one or two sectors in a few countries.

Appendix 2: Leakage and National Competitiveness

Carbon leakage is caused by competing firms facing different carbon costs and so is closely related to the issue of cost competitiveness. At the level of an individual firm or sector this issue is relatively easy to understand. Holding all other things constant, if firms in one jurisdiction face a new cost that their competitors do not, they will face either a loss of market share or a reduction in profit margins, or both. However, as discussed extensively in the main body of the text, the importance of carbon costs within the overall cost base of a firm or sector, and the importance of costs as a driver of firm or sector competitiveness, can differ significantly between sectors.

However, competitiveness at the national level is substantially different from that at the sector or firm level, and the implications of carbon pricing for national competitiveness are easily exaggerated. As cost competitiveness is not the sole or primary driver of competition in many markets, and because in a diversified economy competitiveness will be driven by a much broader range of factors than cost, it is important to draw a distinction between the broad concept of national competitiveness and the much narrower focus of the competitiveness implications of a regulatory cost change for a particular group of firms and sectors. Conflating national and sector- or firm-level competitiveness could lead to incorrect policy conclusions on the economic implications of leakage.

National competitiveness has proven an elusive concept to define: one focuses on a nation's relative productivity and associated trade outcomes, while the alternative sees absolute levels of productivity as driving overall economic success.

- **Under the relative productivity view, countries are seen as analogous to firms.** In this view, firms compete in a zero-sum game where a gain in market share means a direct loss for its competitors, and vice versa. A perspective of this kind places a country's productivity relative to other countries as paramount; it must increase its exports and reduce its imports so as to displace these competitors from the global market for goods and services. Trade balance is a critical indicator of economic success. Krugman gives a prominent example of the use of this view in political debate, quoting former US president Clinton's statement that each nation is "like a big corporation competing in the global marketplace" (Krugman, 1994).
- **The alternative view is that international trade is not a zero-sum game and absolute domestic productivity is of primary importance irrespective of what other nations do.** Krugman (1994) argues that, unlike corporations, nations are each other's export markets and sources of imports: if the European economy does well, its consumers will demand more US goods and sell better quality imports to US consumers at lower prices. Krugman argues that for large nations, such as the United States, it is *domestic productivity* that is critical, especially as only a small portion of its goods are exported. He further argues that the relationship between economic performance and trade balance is ambiguous, citing the example of Mexico, which ran large trade surpluses when its economy was performing poorly as it needed to service foreign debt, and then ran trade deficits when its economy recovered and foreign capital flows returned.

Box 24. International Organizations Incorporate Many Elements in Their Definition of Competitiveness

The World Economic Forum (2014) identifies 12 factors in three groupings that are important in determining a country's global competitiveness:

- basic requirements: these include the strength of institutions, infrastructure, macroeconomic environment, health, and primary education;
- efficiency enhancers: these include higher education and training, goods market efficiency, labor market efficiency, financial market development, technological readiness, and market size; and
- innovation and sophistication factors: these focus primarily on business innovation.

In practice, most modern conceptions of national competitiveness are broad and focus on domestic productivity. Laura D'Andrea Tyson, Chairman of the US Council of Economic Advisors, was an early mover to combine both perspectives; to her, the competitiveness of an economy is its "ability to produce goods and services that meet the test of international competition while [its] citizens enjoy a standard of living that is both rising and sustainable" (Tyson, 1992). The former element reflects something of the relative productivity view, but the latter is broadly consistent with Krugman's thesis. Other, more recent, definitions of national competitiveness can essentially be reduced to productivity and anything that supports it; examples are Aiginger (2006) and Porter (2003). Another approach is to focus on drivers of national competitiveness; this is the approach of the World Economic Forum detailed in Box 24. This example highlights a range of measures that are largely directed toward enhancing productivity, resulting in a conception of competitiveness that is difficult to distinguish from productivity.

A 2012 National Bureau of Economic Research (NBER) paper offers a potentially useful synergy of the two conceptions of productivity. The authors define "foundational competitiveness" as a measure of potential productivity, but separately define the concept of "global investment attractiveness" as the gap between a nation's potential productivity and its current factor costs (Delgado, Ketels, Porter, & Stern, 2012). This view captures some elements of the relative productivity conception of competitiveness in a more robust framework; one would expect a nation with factors of production that are cheap relative to its actual or potential output to attract investment activity.

While this suggests that national competitiveness is primarily determined by domestic productivity, the importance of cost competitiveness will differ across countries. Countries that fail to grow and diversify away from commodity production will tend to be more impacted by changes in costs, including changes in environmental compliance costs.

Even for emissions-intensive economies, national competitiveness concerns need not prevent adoption of carbon pricing; prudent leakage prevention measures and broader economic diversification may be a more long-term robust strategy. Carbon leakage can be addressed through targeted leakage prevention measures rather than by abandoning emissions reduction objectives. Addressing climate change implies global structural change in the production and consumption of emissions-intensive goods; countries and firms that fail to prepare for these changes may find that the basis of their comparative advantage in a world without carbon pricing is not sustainable. Seeking to preserve the basis of today's cost competitiveness in the long run in the face of fundamental structural change may well prove a riskier strategy than one of gradual adaption and diversification. Carbon pricing prepares a country for these longer-run changes, and leakage prevention measures can be an appropriate transitional measure to allow these changes to occur gradually. In the long run prosperity is protected by effectively diversifying away from emissions-intensive goods and services.

References

Abrell, J., Zachmann, G., & Ndoye, A. (2011). "Assessing the Impact of the EU ETS Using Firm Level Data." Bruegel Working Paper, 2011/08. Brussels: Bruegel.

Aiginger, K. (2006). "Competitiveness: From a Dangerous Obsession to a Welfare Creating Ability with Positive Externalities." *Journal of Industry, Competition and Trade*, *6*, 161–77. doi:10.1007/s10842-006-9475-6.

Allevi, E., Oggioni, G., Riccardi, R., & Rocco, M. (2013). "A Spatial Competitive Analysis: The Carbon Leakage Effect on the Cement Industry under the European Emissions Trading Scheme." Banca D'Italia Working Paper.

Arlinghaus, J. (2015). "Impacts of Carbon Prices on Indicators of Competitiveness: A Review of Empirical Findings." OECD Environment Working Papers (87).

Babiker, M. H. (2005). "Climate Change Policy, Market Structure and Carbon Leakage." *Journal of International Economics*, *65*, 421–45.

Barker, T., Junankar, S., Pollitt, H., & Summerton, P. (2007). "Carbon Leakage from Unilateral Environmental Tax Reforms in Europe, 1995–2005." *Energy Policy*, *35*(12), 6281–292. doi:10.1016/j.enpol.2007.06.021.

Barker, T., Meyer, B., Pollitt, H., & Lutz, C. (2007). *Modelling Environmental Tax Reform in Germany and the United Kingdom with E3ME and GINFORS*. Cambridge, UK: Cambridge Econometrics Ltd.

Baylis, K., Fullerton, D., Karney, D. H., Baylis, K., Fullerton, D., & Karney, D. H. (2014). "Negative Leakage." *Journal of the Association of Environmental and Resource Economists*, *1*(1/2), 51–73.

Böhringer, C., Balistreri, E. J., & Rutherford, T. F. (2012). "The Role of Border Carbon Adjustment in Unilateral Climate Policy: Overview of an Energy Modeling Forum Study (EMF 29)." *Energy Economics*, *34*, S97–S110. doi:10.1016/j.eneco.2012.10.003.

Bosch, P., & Kuenen, J. (2009). Greenhouse Gas Efficiency of Industrial Activities in EU and Non-EU. Retrieved from http://ec.europa.eu/clima/policies/ets/cap/leakage/docs/bmsh_6_11_09_tno_report_en.pdf.

Branger, F., Ponssard, J.-P., Sartor, O., & Sato, M. (2014). *EU ETS, Free Allocations and Activity Level Thresholds, the Devil Lies in the Details*. CESifo Working Paper No. 5394. Munich: Center Economic Studies & Ifo Institute.

Branger, F., & Quirion, P. (2013). *Would Border Carbon Adjustments Prevent Carbon Leakage and Heavy Industry Competitiveness Losses? Insights from a Meta-analysis of Recent Economic Studies* (No. 52-2013).

Burniaux, J., & Martins, J. O. (2000). *Carbon Emission Leakages: A General Equilibrium View* (No. 242). OECD Economics Department Working Paper.

Calel, Raphael, and Antoine Dechezlepretre. Forthcoming. "Environmental Policy and Directed Technological Change: Evidence from the European Carbon Market." *Review of Economics and Statistics*.

Carbone, J. (2013). "Linking Numerical and Analytical Models of Carbon Leakage." *American Economic Review: Papers and Proceedings*, *103*(3): 326–31.

Caron, J. (2012). Estimating Carbon Leakage and the Efficiency of Border Adjustments in General Equilibrium - Does Sectoral Aggregation Matter? *Energy Economics,* 34, suppl. 2: S911–S126.

Centre for European Policy Studies. 2013. "Assessment of Cumulative Cost Impact for Steel and the Aluminum Industry." Brussels.

Chan, H. S., Li, S., & Zhang, F. (2012). Firm Competitiveness and the European Union Emissions Trading Scheme. World Bank Working Paper, Washington, DC.

Clarke, L., Edmonds, J., Krey, V., Richels, R., Rose, S., & Tavoni, M. (2009). "International Climate Policy Architectures: Overview of the EMF 22 International Scenarios." *Energy Economics*, *31*, S64–S81. doi:10.1016/j.eneco.2009.10.013.

Cobb, M., Kenber, M., & Haugen, O. (2009). *The Effects of EU Climate Legislation on Business Competitiveness: A survey and Analysis*. *The Climate Group, Climate and Energy Paper Series* (Vol. 9).

Cummins, M. (2012). EU ETS market interactions: A Multiple Hypothesis Testing Approach. Mimeo, Dublin City University Business School.

Delgado, M., Ketels, C., Porter, M. E., & Stern, S. (2012). *The Determinants of National Competitiveness: Working Paper 18249*. Cambridge, MA: National Bureau of Economic Research.

Demailly, D., & Quirion, P. (2006). "CO2 Abatement, Competitiveness and Leakage in the European Cement Industry under the EU ETS: Grandfathering versus Output-Based Allocation." *Climate Policy*, *6*(1), 93–113. doi:10.3763/cpol.2006.0606.

Droge, S., Grubb, M., & Counsell, T. (2009). *Tackling Carbon Leakage: Sector-Specific Solutions for a World of Unequal Carbon Prices*. London: Carbon Trust.

Ellerman, A. D., Convery, F. J., & de Perthuis, C. (2010). *Pricing Carbon: The European Union Emissions Trading Scheme*. Cambridge, UK: Cambridge University Press.

European Commission. (2015). Carbon Leakage. Retrieved July 6, 2015, from http://ec.europa.eu/clima /policies/ets/cap/leakage/index_en.htm.

Fischer, C., & Fox, A. (2004). *Output-Based Allocations of Emissions Permits: Efficiency and Distributional Effects in a General Equilibrium Setting with Taxes and Trade*. Discussion Paper 04-37, Washington, DC: Resources for the Future.

Flues, F., & Lutz, J. (2015). Competitiveness Impacts of the German Electricity Tax. *OECD Environment Policy Papers*, 1–25.

Gerlagh, R., & Kuik, O. (2007). Carbon Leakage with International Technology Spillovers. *Fondazione Eni Enrico Mattei Note Di Lavoro, Nota Di Lavoro 33.2007* (March). Retrieved from http://papers.ssrn.com /sol3/papers.cfm?abstract_id=979915.

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Gerlagh, R., & Kuik, O. (2014). "Spill or Leak? Carbon Leakage with International Technology Spillovers: A CGE Analysis". *Energy Economics*, *45*, 381–88. doi:10.1016/j.eneco.2014.07.017.

Graichen, V., Schumacher, K., Matthes, F. C., Mohr, L., Duscha, V., Schleich, J., & Diekmann, J. (2008). *Impacts of the EU Emissions Trading Scheme on the Industrial Competitiveness in Germany: Final Draft Report Prepared under the UFOPLAN*. Berlin: Öko-Institut.

Grubb, M., & Sato, M. (2009). "Ten (Plus One) Insights from the EU Emissions Trading Scheme with Reference to Emerging Systems in Asia." *Climate Strategies*.

Healy, S., Quirion, P., & Schumacher, K. (2012). "Modelling the Allowance Allocation Method of the EU ETS: An application to the Cement Industry." Climate Strategies Working Paper (05796323).

Helm, D., Hepburn, C., & Ruta, G. (2012). "Trade, Climate Change, and the Political Game Theory of Border Carbon Adjustments." *Oxford Review of Economic Policy*, *28*(2), 368–94. Retrieved from http://oxrep .oxfordjournals.org/content/28/2/368.abstract.

Hoerner, A. (1998). *The Role of Border Tax Adjustments in Environmental Taxation: Theory and US Experience*.

Institute for European Environmental Policy. (2013). *Evaluation of Environmental Tax Reforms: International Experiences—Annexes to Final Report*.

International Centre for Trade and Sustainable Development. (2012). Possible Countermeasures to EU Aviation Emissions Scheme Established in Moscow. Retrieved from http://www.ictsd.org/bridges-news /biores/news/possible-countermeasures-to-eu-aviation-emissions-scheme-established-in.

Jaffe, A. B., Peterson, S. R., Portney, P. R., & Stavins, R. N. (1995). "Environmental Regulation and the Competitiveness of US Manufacturing: What Does the Evidence Tell Us?" *Journal of Economic Literature*, *33(1)*, 132–63.

Karp, L. (2010). "Reflections on Carbon Leakage." Working Paper, Berkeley, CA.

Kiuila, O., Wójtowicz, K., Żylicz, T., & Kasek, L. (2014). "Economic and Environmental Effects of Unilateral Climate Actions". *Mitigation and Adaptation Strategies for Global Change*. doi:10.1007/s11027-014-9597-9.

Krugman, P. (1994). "Competitiveness: A Dangerous Obsession". *Foreign Affairs*. Retrieved from http:// www.foreignaffairs.com/articles/49684/paul-krugman/competitiveness-a-dangerous-obsession.

Kuik, O., & Gerlagh, R. (2003). "Trade Liberalisation and Carbon Leakage". *The Energy Journal*, *24*(3), 97–120.

Kuik, O., & Hofkes, M. (2010). "Border Adjustment for European Emissions Trading: Competitiveness and Carbon Leakage". *Energy Policy*, *38*(4), 1741–1748. doi:10.1016/j.enpol.2009.11.048.

Lacombe, R. H. (2008). "Economic Impact of the European Union Emission Trading Scheme: Evidence from the Refining Sector". Thesis for the Degree of MTech, Massachusetts Institute of Technology.

Lanzi, E., Mullaly, D., Chateau, J., & Dellink, R. (2013). *Addressing Competitiveness and Carbon Leakage Impacts Arising from Multiple Carbon Markets: A Modelling Assessment* (Vol. September).

Leiter, A. M., Parolini, A., & Winner, H. (2011). "Environmental Regulation and Investment: Evidence from European Industry Data." *Ecological Economics*, *70*(4), 759–70. doi:10.1016/j.ecolecon.2010.11.013.

Levinson, A. (2009). "Offshoring Pollution: Is the United States Increasingly Importing Polluting Goods?" *Review of Environmental Economics and Policy*, *4*(1), 63–83. doi:10.1093/reep/rep017.

Marcu, A., Leader, P., & Roth, S. (2014). *Carbon Leakage: Options for the EU*. CEPS Special Reports. Brussels: Centre for European Policy Studies.

Martin, R., Muûls, M., de Preux, L. B., & Wagner, U. J. (2012). "Industry Compensation under Relocation Risk : A Firm-Level Analysis of the EU Emissions Trading Scheme." Centre for Economic Performance Working Paper (1150).

Martin, R., Muûls, M., de Preux, L. B., & Wagner, U. J. (2014). "On the Empirical Content of Carbon Leakage Criteria in the EU Emissions Trading Scheme". *Ecological Economics*, *105*, 78–88. doi:10.1016/j.ecolecon.2014.05.010.

Martin, R., Muûls, M., & Wagner, U. (2011). Climate Change, Investment and Carbon Markets and Prices—Evidence from Manager Interviews Carbon Pricing for Low-Carbon Investment Project. Climate Policy Initiative Report (January).

Martin, R., de Preux, L. B., & Wagner, U. J. (2009). The Impacts of the Climate Change Levy on Business: Evidence from Microdata. Grantham Research Institute on Climate Change and the Environment Working Paper, 6.

McKibbin, W. J., & Wilcoxen, P. J. (2009). "The Economic and Environmental Effects of Border Tax Adjustments for Climate Policy." In I. Sorkin & L. Brainard (Eds.), *Climate Change, Trade, and Competitiveness: Is a Collision Inevitable?* Washington, DC: Brookings Institution Press.

Monjon, S., & Quirion, P. (2009). "Addressing Leakage in the EU ETS: Results from the CASE II Model". Climate Strategies Working Paper, 3.

Monjon, S., & Quirion, P. (2011). "A Border Adjustment for the EU ETS: Reconciling WTO Rules and Capacity to Tackle Carbon Leakage." *Climate Policy*, *11*(5), 1212–225.

Nordhaus, B. W. (2015). "Climate Clubs : Overcoming Free-Riding in International Climate Policy". *American Economic Review*, *105*(4), 1339–370. Retrieved from https://economics.stanford.edu/files/NordhausApril28.pdf.

Neuhoff, K., Acworth, W., Barrett, J., Owen, A., Fischer, C., Munnings, C., Ismer, R., Kim, Y., Pauliuk, S., Wood, R., Sartor, O., Sterner, T., Xiliang, Z., Zetterberg, L., and Roth, S. (2015). Inclusion of Consumption of Carbon Intensive Commodities in Carbon Pricing Mechanisms, Climate Strategies Policy Paper. Retrived from http://climatestrategies.org/wp-content/uploads/2015/05/Policy-Brief-IoC-of-Carbon-Intensive-Commodities1.pdf.

Organisation for Economic Co-operation and Development (OECD). (2013a). *Effective Carbon Prices*. Paris: OECD Publishing. doi:10.1787/9789264196964-en.

Organisation for Economic Co-operation and Development (OECD). (2013b). *Taxing Energy Use: A Graphical Analysis* (January). Paris: OECD Publishing.

Organisation for Economic Co-operation and Development (OECD). (2013c). *The Swedish Tax on Nitrogen Oxide Emissions: Lessons in Environmental Policy Reform*. Paris: OECD Publishing.

Okereke, C., & McDaniels, D. (2012). "To What Extent Are EU Steel Companies Susceptible to Competitive Loss Due to Climate Policy?" *Energy Policy*, *46*, 203–15. doi:10.1016/j.enpol.2012.03.052.

Paroussos, L., Fragkos, P., Capros, P., & Fragkiadakis, K. (2014). "Assessment of Carbon Leakage through the Industry Channel: The EU Perspective". *Technological Forecasting and Social Change*, *90*, 204–19. doi:10.1016/j.techfore.2014.02.011.

Persson, S. (2010). *Practical Aspects of Border Carbon Adjustment Measures*: *ICTSD Global Platform on Climate Change, Trade and Sustainable Energy*.

Pezzey, J. (1992). "The Symmetry between Controlling Pollution by Price and Controlling It by Quantity". *Canadian Journal of Economics*. doi:10.2307/135776.

Pezzey, J. C. V., & Jotzo, F. (2012). "Tax-versus-Trading and Efficient Revenue Recycling as Issues for Greenhouse Gas Abatement." *Journal of Environmental Economics and Management*, *64*(2), 230–36. doi:10.1016/j.jeem.2012.02.006.

Ponssard, J. P., & Walker, N. (2008). "EU Emissions Trading and the Cement Sector: A Spatial Competition Analysis." *Climate Policy*, *5*, 467–93.

Porter, M. E. (1979). "How Competitive Forces Shape Strategy". *Harvard Business Review*, *57*(2), 137–41.

Porter, M. E. (2003). Building the Microeconomic Foundations of Prosperity : Findings from the Business. In P. Cornelius, K. Schwab, & M. E. Porter (Eds.), *The Global Competitiveness Report: 2002–2003* (pp. 29–56). Oxford: Oxford University Press.

Productivity Commission (Australia). (2011). *Emissions Reductions Policies in Key Economies*.

Reinaud, J. (2008). Issues behind Competitiveness and Carbon Leakage: Focus on Heavy Industry. International Energy Agency Information Paper (October).

Ritz, R. A. (2009). Carbon Leakage under Incomplete Environmental Regulation: An Industry-Level Approach. University of Oxford, Department of Economics, Discussion Paper Series (461).

Santamaría, A., Linares, P., & Pintos, P. (2014). The Effects of Carbon Prices and Anti-leakage Policies on Selected Industrial Sectors in Spain—Cement, Steel and Oil Refining. *Energy Policy*, *65*, 708–17. doi:10.1016/j.enpol.2013.10.031.

Sartor, O. (2012). Carbon leakage in the Primary Aluminium Sector: What Evidence after 6 ½ Years of the EU ETS? CDC Climate Research Working Paper 2012-12.

Sartor, O., & Spencer, T. (2013). *An Empirical Assessment of the Risk of Carbon Leakage in Poland*. Working Paper No. 8. Paris: Institut du développement durable et des relations internationales.

Sato, M., Neuhoff, K., Graichen, V., Schumacher, K., & Matthes, F. (2015). "Sectors under Scrutiny: Evaluation of Indicators to Assess the Risk of Carbon Leakage in the UK and Germany." *Environmental and Resource Economics*, 1–26. doi:10.1007/s10640-014-9759-y.

Schleich, J., & Betz, R. (2005). *Incentives for Energy Efficiency and Innovation in the European Emission Trading System*. *ECEEE 2005 Summer Study — What Works & Who Delivers?* (pp. 1495–506).

Sijm, J., Neuhoff, K., & Chen, Y. (2006). CO_2 Cost Pass Through and Windfall Profits in the Power Sector. *CWPE 0639 and EPRG 0617* (May).

Smale, R., Hartley, M., Hepburn, C., Ward, J., & Grubb, M. (2006). "The Impact of CO_2 Emissions Trading on Firm Profits and Market Prices." *Climate Policy*, *6*, 29–48.

Stavins, R. N. (1998). "What Can We Learn from the Grand Policy Experiment? Lessons from SO_2 Allowance Trading." *Journal of Economic Perspectives*, *12*(3), 69–88.

Sumner, J., Bird, L., & Smith, H. (2009). *Carbon Taxes : A Review of Experience and Policy Design Considerations*. Golden, CO: National Renewable Energy Laboratory.

Szabó, L., Hidalgo, I., Ciscar, J. C., & Soria, A. (2006). "CO_2 Emission Trading within the European Union and Annex B Countries: The Cement Industry Case." *Energy Policy*, *34*(1), 72–87. doi:10.1016/j.enpol.2004.06.003.

Tyson, L. D. (1992). *Who's Bashing Whom? Trade Conflict in High-Technology Industries*. Washington, DC: Institute for International Economics.

University of Cape Town Energy Research Centre. (2013). Comments on the Carbon Tax Policy Paper Issued by National Treasury in May 2013 (May), 1–31.

Varma, A., Milnes, R., Miller, K., Williams, E., de Bruyn, S., & Brinke, L. (2012). Cumulative Impacts of Energy and Climate Change Policies on Carbon Leakage. *CE- Delft Report* (February).

Vivid Economics. (2010). *The Implicit Price of Carbon in the Electricity Sector of Six Major Economies*. London: Vivid Economics.

Vivid Economics. (2014). *Carbon Leakage Prospects under Phase III of the EU ETS and Beyond*. London: Vivid Economics.

Wooders, P., Cosbey, A., & Stephenson, J. (2009). *Border Carbon Adjustment and Free Allowances: Responding to Competitiveness and Leakage Concerns*.

World Bank Group. (2014a). *Doing Business 2014*. Retrieved from http://www.doingbusiness.org/. Washington, DC.

World Bank Group. (2014b). *State and Trends of Carbon Pricing*. Washington, DC.

World Bank Group. (2015). *Carbon Pricing Watch 2015* (pp. 1–12). Retrieved from http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2015/06/02/090224b082ee87a1/3_0/Rendered/PDF/Carbon0pricing0e0released0late02015.pdf.

World Economic Forum. (2014). *The Global Competitiveness Report* (p. 565). Retrieved from http://www.weforum.org/pdf/Global_Competitiveness_Reports/Reports/factsheet_gcr03.pdf.

Zhu, J., & Ruth, M. (2015). "Relocation or Reallocation: Impacts of Differentiated Energy Saving Regulation on Manufacturing Industries in China". *Ecological Economics*, *110*, 119–33. doi:10.1016/j.ecolecon.2014.12.020.

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