行政院所屬各機關因公出國人員出國報告書

（出國類別：考察）

「赴歐洲拜會德國排放交易局及歐盟碳市場相關組織」出國報告

服務機關：行政院環境保護署

姓名職稱：蔡玲儀 主任

高俊璿 科長

林斐婷 隊長

派赴國家/地區：德國/柏林、比利時/布魯塞爾

出國期間：112年3月1日至3月9日

報告日期：112年6月16日

摘　要

本次赴歐係由本署氣候變遷辦公室蔡處長玲儀率隊，帶領氣候變遷辦公室高俊璿科長、環境督察總隊林斐婷隊長、經濟部研究發展委員會莊銘池執行秘書、國際貿易局鄭悅庭簡任秘書、外交部條約法律司許柏逸副司長，以及智庫團隊臺灣綜合研究院侯仁義副院長、永智顧問公司石信智總經理及張思詠專員，於 2023 年 3 月 1 號至 3 月 9 號赴德國柏林與比利時布魯塞爾，與德國排放交易局(Deutsche Emissionshandelsstelle, DEHSt)，就我國甫於本(2023)年 2 月 15 公布施行之「氣候變遷因應法」及碳定價推動規劃，與德國排放交易局官員就德國實施國家排放交易制度經驗進行討論，並規劃後續雙邊合作進行碳市場制度技術層級交流。

此行亦前往比利時布魯塞爾，拜訪歐盟執委會氣候行動總局(DG CLIMA)、歐盟執委會研究及創新總署(DG RTD)、歐盟執委會稅務暨關務總署(DG TAXUD)，以及 VAN BEAL & BELLIS 法律事務所，分享我國近期推動氣候政策（淨零轉型關鍵戰略、氣候變遷因應法等），討論「歐盟 55 套案」氣候和能源政策之最新發展，包括 EU ETS 改革、再生能源與能源效率等議題，同時就碳邊境調整機制(Carbon Border Adjustment Mechanism, CBAM)最新發展、相關實施細節和因應策略，進行深入洽談。

目　錄

「赴歐洲拜會德國排放交易局及歐盟碳市場相關組織」出國報告

一、目的

我國自西元（下同）2013 年以來，與德國就碳排放交易經驗議題維持良好合作關係，並於 2018 年 4 月完成《臺德碳交易合作意向書共同宣言》簽署。2019 年赴德參與臺德排放交易研習課程之後，本署與德方規劃以每年互訪機制進行交流，此次拜會為疫情後首次實體會面。與德國排放交易局(Deutsche Emissionshandelsstelle, DEHSt，以下簡稱 DEHSt)在碳市場制度之技術層級進一步交流，延續資訊與經驗分享的合作關係，有助於推動我國碳定價制度。

隨著歐盟碳邊境調整機制(Carbon Border Adjustment Mechanism, CBAM，以下簡稱 CBAM)的推行，透過與歐盟執委會氣候行動總局(DG CLIMA)、歐盟執委會研究及創新總署(DG RTD)、歐盟執委會稅務暨關務總署(DG TAXUD)等歐盟相關總署與 VBB 法律事務所的會面，深入洽談碳邊境調整機制 CBAM 之最新發展、相關實施細節和因應策略，並針對歐盟與我國氣候變遷調適進行交流。

二、過程

（一）行程表

2023 年 3 月 1 日至 9 日前往德國柏林與布魯塞爾，行程如下：

日期	時間	行程	住宿地點
3/1 (三)	21:55	啟程	搭機
3/2 (四)	10:55	經法蘭克福抵達柏林	德國柏林
3/3 (五)	13:00 ｜ 16:00	拜會德國排放交易局(DEHSt)	德國柏林
3/4 (六)		內部討論會議及整理資料	德國柏林
3/5 (日)		柏林搭機至布魯塞爾	比利時 布魯塞爾
	19:00	外館周慶龍公使與訪團餐敘	
3/6 (一)	09:15 ｜ 11:00	拜會歐盟執委會氣候行動總署(DG CLIMA)及環境總署(DG ENV)	比利時 布魯塞爾
		陳立國大使邀 DG CLIMA 與訪團餐敘	
	15:00	拜會歐盟執委會研究創新總署(DG RTD)	
3/7 (二)	下午	拜會 VBB 法律事務所	比利時 布魯塞爾
3/8 (三)	10:00	拜會歐盟執委會稅務暨關稅總署(DG TAXUD)	搭機
	16:50	返程－布魯塞爾搭機回國	
3/9 (四)	18:15	抵達臺灣	搭機

（二）拜會德國排放交易局(DEHSt)就雙方氣候政策與碳市場制度進行技術交流

此行由本署氣候變遷辦公室蔡玲儀處長率隊，出席團員包括本署氣候變遷辦公室高俊璿科長、環境督察總隊林斐婷隊長、經濟部研究發展委員會莊銘池執行秘書、外交部駐柏林辦事處薛迪宇組長，以及我方智庫臺灣綜合研究院侯仁義副院長、永智顧問公司石信智總經理及張思詠專員參與會議。

本次交流我方先就2050淨零排放目標及12項淨零關鍵戰略行動計畫進行分享，德方對我方的進展及計畫表達肯定，但在淨零規劃部分，德方表示與國外合作的碳抵換政策需釐清，並建議專注於國內減碳為主，另外在能源轉型延伸之循環經濟需求，如可回收太陽能設備，可作為未來雙方交流項目之一。

自2021歐盟公布55套案後，德國在各個領域相關法令的策略實施工作正在逐步展開，DEHSt將準備實施新的ETS任務和義務，包括涵蓋海洋運輸的部分，並且通過最新的改革為氣候中和做出重大貢獻。根據55套案，資金和收入循環的部分都將特別得到加強及改善，像是擴展和創建新的基金或是將收入著重於氣候保護措施及社會平衡。其中德國將會把新的ETS收入用於補助脆弱族群的電費或是暖氣；另外，也補助這些家庭可以更新耗電設備協助低碳轉型，以確保社會公正和公眾的接受度。

德國於2021年開始啟動用於供暖和運輸燃料的國家排放交易系統(nEHS)，此措施補充了歐盟排放交易體系(EU ETS)並成為了德國2030年氣候行動計畫(2030 climate action package)中不可或缺的一部分。nEHS的目標為引入燃料排放的認證交易，因而除了主要的供暖及運輸部門的排放外，EU ETS之外的小型行業也被包括在內，並且從2024年開始將進一步涵蓋垃圾焚化爐。在nEHS與EU ETS重疊的部分將透過

事先避免重複收費，或是後續對於已經重複徵收的燃料進行退款。

我方詢問，有關出口至歐盟多個國家時，出口國應向哪一個國家彙報並提交 CBAM 憑證，德方答覆為進口商應向委員會做回報，並提交 CBAM 相關資料，然德方也尚未設置主要的 CBAM 主管機關。另考量臺灣將規劃徵收碳費，詢問德方在初期如何制定住商和運輸方面的價格，以供臺灣參考。德方表示，這方面基於政治因素較多，在排放量與減量成本的考量較少。此外，德方也對臺灣為何優先選擇推動碳費表示關切，我方答覆相較於碳交易系統，碳費較為簡易實施，且臺灣的主要排放來自於少數大排放源，如實施 ETS 市場將有流通不佳，無法達成減量目標疑慮。

為促進雙方合作關係之延續，我方進一步邀請德方於今年度下半年訪台，共同舉辦排放交易制度能力建構研習會，討論我國推動現況挑戰及碳定價制度設計上可能面臨之困難，並研擬後續雙邊合作之細節。德方表示，非常樂意前來，也很期待雙方未來的合作。

圖 1、代表團向 DEHSt 人員介紹臺灣 12 項淨零關鍵戰略之行動計畫

圖 2、代表團與 DEHSt 人員於會後合影留念

（三）拜會歐盟氣候行動總署(DG CLIMA)討論歐盟排放交易制度改革相關事項以及交流氣候相關政策

此次拜會係為瞭解歐盟氣候政策，包括其總量管制及排放交易改革發展方向。由本署氣候變遷辦公室蔡玲儀主任率隊，出席團員包含本署高俊璿科長、林斐婷隊長、經濟部莊銘池執行秘書、鄭悅庭簡任秘書、外交部許柏逸副司長，我方智庫臺灣綜合研究院侯仁義副院長、永智顧問公司石信智總經理及張思詠專員，我國駐歐盟兼駐比利時代表處周慶龍公使、經濟組許莉美組長、陳邑瑄秘書、政務組黃奕婷秘書共同出席。

本次交流我方先分享我國「氣候變遷因應法」修法內容，以及未來實施徵收碳費與自願減量額度交易之規劃方向。歐方則分享其 ETS 主要是涵蓋在《減量責任分配規則》(Effort Sharing Regulation, ESR)下運作，儘管不是所有排放量都可以被計量或是買賣，但 ETS 系統也涵蓋了 45%的排放量，並且擴及 30 多個國家、26 個會員國，依其經驗，ETS 將會是最佳的促進減量的方式。他們正進一步的規劃納入海上運輸的排放量，規劃在 2030 年時，預計可達到較 2005 年減少 66.1%的排放量。

在 ETS 的部分，由於歐盟 ETS 機制不接受使用自願減量額度遵約，

我方提問對於事業層級自行採用自願市場之減量額度進行碳中和宣告，或是參與相關的自願性倡議，歐盟有何管制規範或措施。歐方表示，其主要專注在製造部門的減量，在產業減量的部分已透過 ETS 設定限額及核配機制，並規劃減少核配，因而不會接受使用自願減量額度，以避免損及其減量成效。

鑑於 2023 年 2 月 22 日，歐盟碳價來到 100 歐元高點，我方詢問考量到市場穩定性，歐方啟動市場穩定儲備機制(Market Stability Reserve, MSR，以下簡稱 MSR)的標準為何。歐方回應，其主要尊重自由市場，但透過計算公式協助調整 MSR 的標準。另詢問歐盟是否有參與巴黎協定第六條的規劃，歐方回覆他們主要落實歐盟境內減量，國際間推動巴黎協定第六條市場，需避免重複計算。

有鑑於 DG CLIMA 已與日本承諾建立新的綠色聯盟，並也有意與韓國合作，我方詢問是否也將有機會參與次類型的合作。歐方回覆，目前歐盟的確與日本、摩洛哥等國簽署綠色協議，但目前還在觀察這類型合作的成效，所以暫不考慮與更多國家進行此一類型的合作案。

最後，歐方進一步分享 ETS 收入的支用規劃，歐方將其分為三大類「創新基金」、「現代化基金」，以及「社會氣候基金」。創新基金主要是用於支持低碳技術，現代化基金用於特別支持 10 個低收入的成員國實現能源系統現代化並提高能源效率，社會氣候基金則支持特別受能源和交通貧困影響的弱勢家庭、微型企業和交通用戶。結合這三大項基金規劃，歐盟期待能形成良好的循環，讓市場上的清潔創新技術更臻成熟。

圖 3、DG CLIMA 雙邊關係單位主管 Ms. Caroline EDERY 說明歐盟未來願景

（四）拜會研究及創新總署(DG RTD)探討減量技術研發政策及經費的發展

本次交流係我方希望與 DG RTD 就歐盟推動氣候變遷調適科學及技術創新議題，包含歐洲地平線(Horizon Europe, 2021~2027 年歐盟旗艦型科研補助計畫，以下簡稱 HE)、歐盟氣候變遷調適跨總署之任務小組(EU Mission on Adaptation to Climate Change)、以自然為本的解決方案(Nature-based Solution, NbS)等進行交流，由本團 9 人、我國駐歐盟兼駐比利時代表處科技組張怡玲組長共同出席。

本署先就我國近期氣候變遷政策推動成果向歐方說明，包含我國已提出 2050 淨零轉型路徑及 12 項淨零關鍵戰略行動計畫，且我國已於今 2023 年 2 月總統令公布「氣候變遷因應法」，亦強化科學研究及增列調適相關工作。

歐方介紹 Horizon Europe 計畫中涉及氣候科學(climate science)之 2021~2027 年補助經費約 22 億歐元，並提到目前正開放申請 2023~2024 年期之補助經費，涉氣候變遷議題之科研主軸包含「地球系統科學(Earth system science)」、「氣候變遷減緩，邁向氣候中和路徑(Climate change

mitigation, pathways to climate neutrality)」及「氣候變遷調適、社會與行為科學(Adaptation to climate change, social and behavioral science)」，歡迎臺灣參與相關計畫，惟臺灣非歐盟會員國，需自行籌措經費參與科研合作計畫。Horizon Europe 計畫下各補助計畫之研究成果皆公開於 CORDIS 網站(https://cordis.europa.eu/)，歡迎我方至該系統查詢氣候變遷相關計畫之研究團體與研究成果。

我方現場檢視歐方提供之目前開放申請的計畫項目，初步回應我國或可參與以下 Horizon Europe 計畫，藉以強化我國氣候變遷科研量能，以輔助氣候變遷政策決策，回國後將盤點我國資源，並評估如何參與 HE 的計畫。另環保署於會後請駐歐盟兼駐比利時代表處科技組張怡玲組長將參與計畫方式及相關程序供本署參考：

1. HORIZON-CL5-2024-D1-01-04:評估氣候與環境對貿易政策造成影響的強化工具 (Improved toolbox for evaluating the climate and environmental impacts of trade policies)
2. HORIZON-CL5-2024-D1-01-05: 符合《巴黎協定》的新一代低排放、氣候調適路徑和國家自定貢獻(Next generation low-emission, climate-resilient pathways and NDCs for a future aligned with the Paris Agreement)
3. HORIZON-CL5-2023-D1-01-07: 地方韌性模式建構-發展支持地方調適評估與計畫(Modelling for local resilience - Developments in support of local adaptation assessments and plans)

於討論過程中，我方詢問歐方如何決定補助對象（計畫），歐方回復有機制判斷申請計畫與歐盟推動氣候政策的關聯性與重要性，藉以決定核定的計畫項目；歐方詢問我國訂定 2030 年及 2050 年之中、長程減碳目標，如果 2030 年達不到目標臺灣的應對政策將為何。我方回覆，淨零減碳目標需由各部會合作以達成，會定期檢視減碳成果，並搭配減碳

技術之發展情形，動態調整各部門的減碳政策與措施，以確保達成預定目標。

最後，我方向歐方表示，據聞 Gaia 政策官將於今年 5 月到臺灣參加歐盟創新週(EU Innovation Week)活動，本署希望屆時邀請 Gaia 政策官就環保署參與 Horizon Europe 計畫進一步討論，並邀請 B.3 處 Mr. Philippe TULKENS 處長及 Mr. Marco FRITZ 副處長於下半年來臺參加氣候變遷調適相關研討會，分享歐盟在氣候變遷調適科技及以自然為本解決方案相關的成功經驗。

圖 4、代表團與 DG RTD 人員進行交流會面

（五）拜會比利時 VAN BEAL & BELLIS (VBB)事務所

本次會面係為瞭解 VAN BEAL & BELLIS（簡稱為 VBB）事務所作為協助各界因應歐盟碳邊境調整機制之智庫，其對於 EU CBAM 未來發展趨勢之看法，由本團 9 人、我國駐歐盟兼駐比利時代表經濟組許莉美組長、陳邑瑄秘書共同出席。

我方就我國碳費制度規劃作法是否可獲得歐盟 CBAM 抵減進行詢問，VBB 事務所建議我國參考歐盟創新基金(Innovation Fund)案例，將碳費收入作為對廠商減碳獎勵之補助，廠商所支付全額碳費可被 CBAM

認定並抵扣外，亦可提供廠商減碳誘因。VBB 另表示，CBAM 的機制將會增加歐盟境內的消費成本，再加上近日以來通貨膨脹的狀況日益增加，兩者相加之下可能會影響到 CBAM 的實施時程。

我方說明，我國碳費制度允許廠商購買國內與國外自願減量專案產生減量額度進行抵減，由於廠商購買減量額度亦須負擔減碳成本，訴求應視為實際碳定價，納入 CBAM 抵減項目。VBB 表示，CBAM 第 3 條列舉碳定價項目僅含碳稅費與總量管制有償核配額度等項目，廠商購買減量額度之成本能否抵減，可於雙邊協議提出討論與協商。

VBB 詢問，我國碳費制度是否針對產品出口至碳管制強度較弱國家，設計出口退費機制，以確保產品競爭力；並表示，歐洲議會在討論 CBAM 草案時，強力要求要將出口退稅納入草案，惟執委會認為有 WTO 禁止性補貼疑慮。最終改為要求執委會須於 CBAM 實施兩年後，再就是否要實施出口退稅，提出評估報告。我方回應我國氣候法並無出口退費相關授權，目前亦未考量增訂相關規範。

VBB 另詢問，我方既規劃於 2024 年開始課徵碳費，是否有意依據 CBAM 第 2.12 條與歐盟簽署協議。我方表示，已探詢過歐盟意願，並獲告僅規劃與歐盟前 10 大貿易夥伴簽署，並擔心與臺灣簽署協定之政治影響。然而我方已向歐盟表達，我國為歐盟 CBAM 納管產品第 8 大來源國，且碳定價機制認定屬技術協議，並涉及貿易議題，訴求歐方應與我國進行相關協商，以免對歐盟供應鏈產生影響。VBB 表示，歐方此項做法係歧視其他國家，違反 WTO 最惠國待遇原則，建議我方持續與歐盟溝通。

我方詢問，CBAM 目前只承認經 EU ETS 認證的查驗證機構，尚未針對歐盟境外認證機構及查驗證機構之相互承認或合作訂立規則，是否可能由臺歐雙方政府各自授權民間機構簽署相關協議。VBB 回應應屬可行，且因 CBAM 的實施亦將導致外國廠商查證需求大增，實務上亦

不可能僅由歐盟境內查驗證機構執行。惟 VBB 強調須以歐盟 2023 年 5 月上旬公布相關執行細則為準，並建議我方可透過國際認證論壇相互承認協議(IAF MRA)架構進行，儘可能淡化政府的角色，增加成功的機率。

我方說明，中小企業廠商因應 CBAM 所面臨困難，訴求簡化計算與查證程序，並允許上游廠商所繳交中間產品碳費可抵減 CBAM 憑證。VBB 表示，後續歐盟將依國家各別設定產品碳含量預設值，建議臺灣可協商爭取設定合理預設值。針對上游廠商對中間產品所繳交碳費可否抵減 CBAM 憑證部分，VBB 認同應允許抵減，方能符合 WTO 規範，並建議我方後續與歐盟協商，可提案簡化認定程序。

VBB 表示，該事務所長期以來針對 CBAM 持續向政府、產業協會與個別企業提供諮詢服務，依據其經驗，建議臺灣企業應儘速建立內部碳排放盤查機制，以因應 2023 年 10 月將上路的申報機制，因為雖然形式上的申報者是歐盟進口商，但相關資料仍須仰賴臺灣出口商/製造商提供。另雖然過渡期間的申報資料不會要求完成第三方認證，仍建議廠商透過符合資格的認證機構確保相關資料是可供認證的(can be verified)。

圖 5、代表團與 VBB 事務所就 CBAM 事項進行商討

（六）拜會歐盟稅務暨關務總署(DG TAXUD)交流 CBAM 最新發展與實施相關議題

為促進臺灣產業邁向低碳發展並確保國際競爭力，更進一步掌握CBAM規範的細節與內容至關緊要，本次會面由本團9人、我國駐歐盟兼駐比利時代表經濟組許莉美組長、陳邑瑄秘書共同出席。

歐方說明 CBAM 為一全新的環境措施，目的係促使他國加速實施碳定價，以有效降低碳排放。歐盟將按階段逐步推動，目前正進行CBAM官方文本製作程序（據悉2023年3月底公布文本），預定2023年5月上旬公布執行細則(implementing act)。歐盟在過渡期期間將透過進口商申報數據及持續蒐集資料並與各國討論，作為2026年方正式施行之第三方查證及抵減等規範之訂定參考依據。

我方首先簡要說明我國規劃於 2024 年開始課徵碳費，適用對象為碳排放量大於 25,000 噸的排放源(installation)，並非以部門別或產品來區分，且繳交一致的費率。此次拜會目的之一亦盼確認未來歐盟是否能承認我方碳費可抵減CBAM。歐方表示，由於2026年方正式實施CBAM，目前針對其他國家碳定價認定方法仍在非常初期階段(very early stage)，故無法立即承諾可予抵減。歐盟亦在蒐集相關資訊，增進對其他國家碳定價制度瞭解，並請我國提供相關資訊供其參考。

我方表示，氣候法之碳費規範設有優惠費率制度，倘企業能做到更多減碳，可繳交較少的碳費，由於廠商投資減量亦需成本，爭取其產品輸歐時可否仍以原碳費費率申請CBAM抵減。歐方表示，CBAM規定是針對實際費用(actual payment)做抵減，就以上例子而言，歐盟會認定該廠商實際支付較少碳費，故須繳交更多 CBAM 憑證（亦即在我國獲得抵減的部分需繳給歐盟），初步認定將無法獲得抵減。

歐盟先前在制定CBAM相關政策時已先就其影響範圍進行了評估，最終因 CBAM 主要影響範圍為大企業而決定不給予中小企業特別待遇。

然而我國受 CBAM 政策影響的範圍主要以中小企業為主，需考量其履行 CBAM 之成本相對較高，希望未來在協商時能關注到此特殊狀況且簡化 CBAM 申報的程序。歐方表示後續將會在與各國協商的時候建立雙邊協議，但由於尚在早期階段，相關細節尚未做出決議。然而，歐方表示他們瞭解供應鏈的問題，強調將朝儘可能精簡、避免廠商重覆支付碳費，造成過多負擔的方向去制定規則。

我方進而表示，臺灣某些 CBAM 產品（例如螺絲螺帽）大多為中小企業購買中間產品加工生產後出口至歐盟，由於我國中小企業均非碳費課徵對象，若前述中間產品已繳過碳費，是否可申請就原物料已繳交碳費部分進行抵減。歐方回覆有關 CBAM 納管之產品作為原料（如中鋼），生產 CBAM 納管之下游產品者（如螺絲螺帽），其原料生產者所繳交之碳定價將朝可抵減方向設計規則。

我方表示，廠商須於每年 5 月 31 日完成前 1 年度 CBAM 申報，然鑑於需要一定作業時間，特別是對須申報電力與中間產品間接排放之納管產品，訴求前述申報期限宜加以延長並提供更正申報機會，或依我國現況設定產品碳含量預設值以加速廠商申報參數取得。歐方表示，感謝我國反映廠商實務申報可能面臨困難，並表示產品碳含量預設值將依公開統計進行設定，廠商有參數取得困難，可利用預設值進行申報。

我方說明，我國係歐盟 2022 年 CBAM 納管產品第八大進口來源，盼未來能與歐方持續就各項 CBAM 議題進行建設性討論，俾將其對臺歐貿易的影響降至最低。歐方表示同意，並盼我方提供我國輸歐 CBAM 納管產品占對歐盟總出口比例供其參考。

另針對我方詢問的若干 CBAM 執行細節（過渡期間資料申報、查驗證機構認證等），歐盟均復以，目前規劃就是利用過渡期儘量廣泛蒐集資料，故無法多作說明，相關指南(guideline)預計於 2023 年 10 月過渡期開始前進行公布。惟歐盟強調，CBAM 係一環境管制措施，目的為促使各國實施碳定價，歐盟並不欲藉此牟利取得憑證收入，因此，相關碳定價收入是由哪國政府取得，歐盟並不在意。歐方另也表示，後續將會在與各國協商的時候建立雙邊協議(bilateral agreement)，但由於尚在早期階段，相關細節尚未做出決議。

圖 6、DG TAXUD 政策官 Mr. Nicolas Katsilis 向代表團講解 CBAM 相關內容

三、結論與建議

（一）此行與德國 DEHSTs 會面順利延續臺德雙方良好的合作關係，德方也表示接受本署邀請，於 2023 年底前訪臺進行進一步的交流。此次會面瞭解歐盟 55 套案最新進展，包括 EU ETS 改革、CBAM、再生能源與能源效率等，以及德國應對之相關政策與措施，以利於我國後續規劃和實施。亦就德國 2021 年開始實施住商與運輸燃料之國家 ETS(nEHS)相關實施方法及成效和其價格設定做討論，可供我國未來設定碳費率及規定之參考。

（二）對於臺德碳定價雙邊合作後續討論議題，建議納入德國 nEHS 固定價格之設定方法、德國聯邦環境署(UBA)於 2021 年「韓國排放交易制度與電力部門」個案分析、UBA 於 2022 年 9 月「東亞與南亞之碳定價潛力」研究報告初稿（台灣個案分析），以及德方提出之能源轉型相關循環經濟，如可回收太陽能設備等。

（三）歐盟執委會 DG CLIMA 表示，根據其經驗 ETS 系統將會是最有效的促進減碳的方式，其設立的目的為致力於達到整體減量的目標和配合減量議程，並將透過對 ETS 收入的基金的規劃回饋社會，讓弱勢族群不會被排除於不斷更新的能源系統之外。然而考量於臺灣目前並未計畫設置 ETS 系統，也許臺灣未來碳費收入之規劃可以參考 EU ETS 與 nEHS 之資金分配狀況做調整。

（四）我國環保署氣候變遷辦公室於 2023 年 4 月 22 日改為環境部氣候變遷署籌備處，後續組織改革也規劃成立國家環境研究院進行氣候變遷相關科研工作，後續建議可與 DG RTD 持續交流及合作並參與其 Horizon Europe 計畫，逐步建構及強化我國氣候變遷科研量能。

（五）歐盟執委會現正進行著 CBAM 正式文本定稿程序，預計將於 5 月上旬公布施行細則(implementing act)。在與 VBB 事務所與 DG TAXUD 會面後，得知由於目前 CBAM 仍在初期階段，難以提供具體的回應，但願意持續與我方交流意見。根據歐方的回應，建議能持續提供相關

資料給歐方作為政策制定時的參考，像是碳定價政策的相關制度、減量額度與碳定價和 CBAM 抵減之相關資訊、查驗機構規範等，以利其完善 CBAM 相關規則。

（六）歐盟執委會 DG TAXUD 表示，在 CBAM 全面實施前將與貿易夥伴簽屬雙邊協議(bilateral agreement)，因此，後續可透過成立跨部會 CBAM 工作小組，包括環保署、經濟部工業局與貿易局等，以進行籌備後續雙邊協議之談判。由於我國受歐盟 CBAM 影響以中小企業為主，與其他受影響之國家之國情不同，且其履行 CBAM 之成本相對較高，建議可做為後續雙邊協議談判之主要籌碼，以爭取相關特別待遇。

（七）本次出團除了達到促進臺德碳定價雙邊合作關係之目的外，也透過與歐盟執委會各機構的會面，對於 ETS 的設置規範與進程，以及 CBAM 目前規劃階段與涵蓋的範圍有了進一步的了解，將有助於我國在「氣候變遷因應法」基礎下推動相關政策與措施，以及碳費制度規劃設計上，可與國際接軌，並達成國家減量目標。

四、附錄

（一）DEHSTs 德方於會議時使用之簡報資料

（二）DG CLIMA 於會議時使用之簡報資料

（三）DG RTD 於會議時使用之簡報資料

European Commission

THE EU RESEARCH & INNOVATION PROGRAMME

2021 – 2027

Research and Innovation

The Horizon Europe Framework Programme

European Commission

HORIZON EUROPE

EURATOM

SPECIFIC PROGRAMME: EUROPEAN DEFENCE FUND

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- Research actions
- Development actions

SPECIFIC PROGRAMME IMPLEMENTING HORIZON EUROPE & EIT*

Exclusive focus on civil applications

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EXCELLENT SCIENCE

- European Research Council
- Marie Skłodowska-Curie
- Research Infrastructures

Pillar II
GLOBAL CHALLENGES & EUROPEAN INDUSTRIAL COMPETITIVENESS

Clusters

- Health
- Culture, Creativity & Inclusive Society
- Civil Security for Society
- Digital, Industry & Space
- Climate, Energy & Mobility
- Food, Bioeconomy, Natural Resources, Agriculture & Environment

- Joint Research Centre
- EU Missions

Pillar III
INNOVATIVE EUROPE

- European Innovation Council
- European Innovation Ecosystems
- European Institute of Innovation & Technology*

WIDENING PARTICIPATION AND STRENGTHENING THE EUROPEAN RESEARCH AREA

- Widening participation & spreading excellence
- Reforming & Enhancing the European R&I system

EURATOM

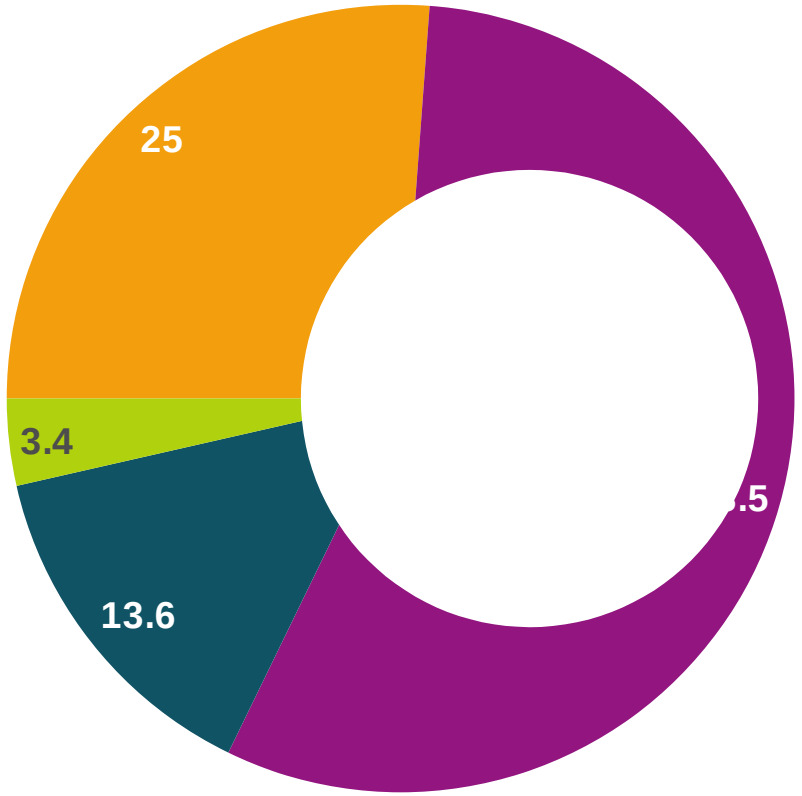
- Fusion
- Fission
- Joint Research Center

* The European Institute of Innovation & Technology (EIT) is not part of the Specific Programme

European Commission

Horizon Europe Budget: €95.5 bn (2021-2027)

including €5.4 bn from NGEU (Next Generation Europe) = EU funding instrument for Recovery from COVID-19 crisis



Political agreement December 2020

€ billion in current prices

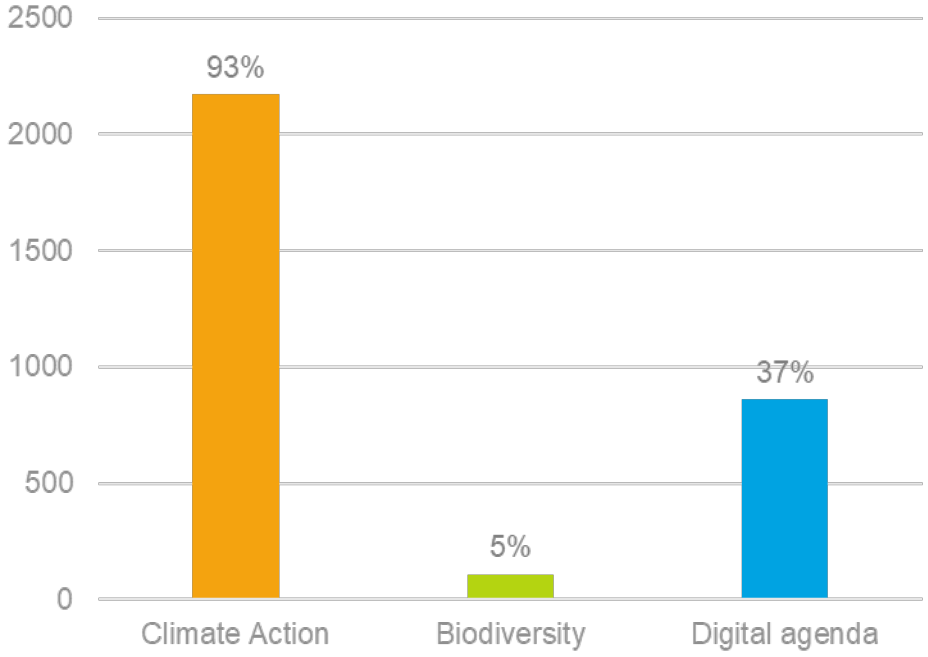
- Excellent Science
- Global challenges and European ind. comp.
- Innovative Europe
- Widening Part and ERA

European Commission

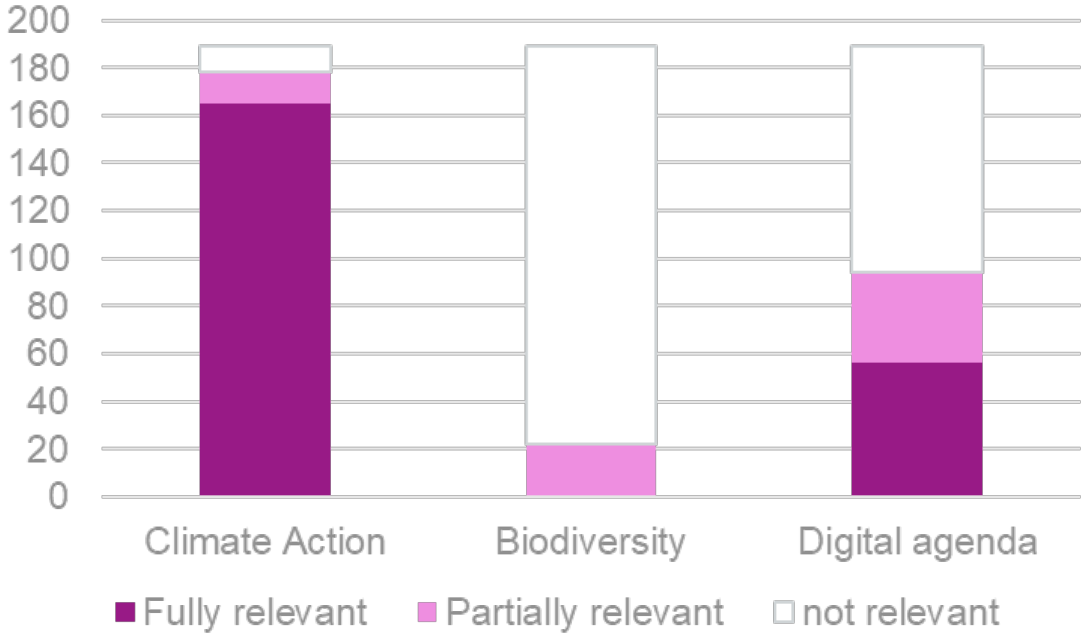
Cross-cutting policy priorities
(Climate Action, Biodiversity, Digital Agenda)

This presentation focuses on the opportunities available for research on **climate science**, but climate *action* covers a far larger range of research opportunities

Budget for cross-cutting policy priorities
(call budget in Mio EUR and share of total call budget)



Number of topics contributing to cross-cutting policy priorities



European Commission

THE HORIZON EUROPE
FRAMEWORK PROGRAMME

Cluster 5: Destination 1: **Climate science**

European Commission

Destination 1 – Earth system science

Objectives

- **Advancing knowledge about the Earth system**
- **Contributing to key international assessments**, e.g. Intergovernmental Panel on Climate Change (IPCC)
- Increasing the **transparency, robustness, trustworthiness and practical usability** of the knowledge base on climate change

Issues covered in topics 2023-2024

- advanced science and technologies for analysing Earth system data, tipping points, cloud-aerosol interactions, role of hydrogen in the climate system, methane emissions and sinks, inland ice (cryosphere), paleoclimate, ecosystem-climate interactions

Destination 1 – Earth system science

Eligible topics for Tunisia

Topics 2023

- HORIZON-CL5-2023-D1-01-01: Further climate knowledge through advanced science and technologies for analysing Earth observation and Earth system model data
- HORIZON-CL5-2023-D1-01-02: Climate-related tipping points
- HORIZON-CL5-2023-D1-01-03: Climate impacts of a hydrogen economy
- HORIZON-CL5-2023-D1-01-04: Improved knowledge in cloud-aerosol interaction

Topics 2024

- HORIZON-CL5-2024-D1-01-01: Enhanced quantification and understanding of natural and anthropogenic methane emissions and sinks
- HORIZON-CL5-2024-D1-01-02: Inland ice, including snow cover, glaciers, ice sheets and permafrost, and their interaction with climate change
- HORIZON-CL5-2024-D1-01-03: Paleoclimate science for a better understanding of the short- to long-term evolution of the Earth system
- HORIZON-CL5-2024-D1-01-07: Quantification of the role of key terrestrial ecosystems in the carbon cycle and related climate effects

Destination 1 – Climate change mitigation, pathways to climate neutrality

Objectives

- **Advancing solutions to reduce human interference with the climate system**
- Contributing substantially to key **international assessments**, e.g. Intergovernmental Panel on Climate Change (IPCC)
- Increasing the **transparency, robustness and relevance** of the knowledge base on emission pathways, including integrated assessment models for use by policy makers, practitioners and citizens

Issues covered in topics 2023-2024

- Transition pathway analysis including NDCs, impacts of trade policies, climate foresight for raw material supply, voluntary climate change initiatives, ‘blue carbon’, including co-operation with China

Destination 1 – Climate change mitigation, pathways to climate neutrality

Eligible projects for Tunisia

Topics 2023

- HORIZON-CL5-2023-D1-01-05: Science for successful, high-integrity voluntary climate initiatives
- HORIZON-CL5-2023-D1-01-06: Broadening the range of policy options in transition pathway analysis
- HORIZON-CL5-2023-D1-02-01: EU-China international cooperation on data and model development for pathways to carbon neutrality: focusing on decarbonisation, energy efficiency and socio-economic implications of the transition
- HORIZON-CL5-2023-D1-02-02: EU-China international cooperation on blue carbon

Topics 2024

- HORIZON-CL5-2024-D1-01-04: Improved toolbox for evaluating the climate and environmental impacts of trade policies
- HORIZON-CL5-2024-D1-01-05: Next generation low-emission, climate-resilient pathways and NDCs for a future aligned with the Paris Agreement
- HORIZON-CL5-2024-D1-01-06: The role of climate change foresight for primary and secondary raw materials supply

Destination 1 – Adaptation to climate change, social and behavioral science

Objectives

- **Advancing knowledge on climate impacts**
- Support **better policy design** and more effective implementation **through behavioural insights**
- Contributing to **international assessments**, e.g. Intergovernmental Panel on Climate Change (IPCC)
- Supporting the **Mission on Adaptation**

Issues covered in topics 2023-2024

- Modelling for local resilience, needs-based adaptation in Africa, behavioural change for systemic transformation, climate change education, governance of research on solar radiation modification

Destination 1 – Adaptation to climate change, social and behavioral science

Eligible projects for Tunisia

Topics 2023

- HORIZON-CL5-2023-D1-01-07: Modelling for local resilience - Developments in support of local adaptation assessments and plans
- HORIZON-CL5-2023-D1-01-08: Solar Radiation Modification: governance of research
- HORIZON-CL5-2023-D1-01-09: Behavioural change and governance for systemic transformations towards climate resilience
- HORIZON-CL5-2023-D1-01-10: Improving the evidence base regarding the impact of sustainability and climate change education and related learning outcomes
- HORIZON-CL5-2023-D1-01-11: Needs-based adaptation to climate change in Africa

Important websites

National Contact Points (NCPs)

https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/support/ncp

Horizon Europe Info Days

https://research-and-innovation.ec.europa.eu/events/horizon-europe-info-days_en

Funding & Tender Portal

https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/programmes/horizon

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European Research Council: https://erc.europa.eu/

European Commission

Thank you!

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http://ec.europa.eu/horizon-europe

European Commission

Science for Climate Action

EU research contribution to IPCC Working Group I on the Physical Science Basis

Understanding the changing climate, enabling effective response strategies

Research and Innovation

Science for Climate Action: EU research contribution to IPCC Working Group I on the Physical Science Basis
European Commission
Directorate B — Healthy Planet
Unit B.3 — Climate & Planetary Boundaries

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Manuscript completed in December 2022
1st edition.

PDF ISBN 978-92-76-58884-9 doi:10.2777/276632 KI-04-22-179-EN-N

Luxembourg: Publications Office of the European Union, 2022

EUROPEAN COMMISSION

Science for Climate Action

EU research contribution to IPCC Working Group I on the Physical Science Basis

edited by Mathilde Mousson
co-edited by Alfonso Acosta Goncalves and Sophie Berger
with contribution by CINEA Executive Agency

Directorate-General for Research and Innovation
2022 Horizon 2020

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INTRODUCTION

Science is the backbone of evidence-based, future-proof policymaking. Whereas scientific research was instrumental in bringing climate change to the forefront of political agendas, it continues to play a central role in addressing this existential threat by creating consensus, bringing positions together and offering response options. The Intergovernmental Panel on Climate Change (IPCC) is the authoritative institution within the science-policy interface of global climate governance. It is currently finalizing its seminal 6th Assessment Report, with contributions from the three working groups published in 2021 and 2022.

The IPCC Working Group I report Climate Change 2021: The Physical Science Basis provides state of art understanding of the climate system under changing climate, combining the latest advances in climate science and multiple lines of evidence. It establishes as a fact that humans have warmed the ocean, atmosphere and land, affecting every inhabited region. The planet will continue to warm until we stop adding more carbon dioxide to the atmosphere, and it now looks increasingly likely that global warming will exceed 1.5°C in the early 2030s. Weather will become more extreme, with heatwaves, droughts, floods and wildfires becoming more intense more frequent and lasting longer.

We don't have to wait long for these dangerous phenomena to materialise –climate change and its consequences are already being felt. The world is already 1.1°C warmer than pre-industrial times, and the year 2022 has seen multiple climate records broken: Pakistan was ravaged by unprecedented floods, Eastern Africa has been suffering a record drought, monster storms have hit the Pacific and the Caribbean while Europe has experienced its worse drought in 500 years, persistent heatwaves, ravaging wildfires and dry rivers. Scientists are warning that this year of extremes will become the norm in the future and worsen unless immediate, rapid and large-scale reductions in greenhouse gas emissions are implemented. The positive message is that humans still have the chance to avoid the worst climate impacts, but the window to act is closing fast. And yet, the pace of change is far too slow, and a large gap remains between science and policies at global level, as shown at the latest climate summit in Egypt (COP27).

Against this background, the EU remains committed to high climate ambition and is not willing to give up on the 1.5°C goal. The European Green Deal is providing strong momentum for climate action and is firmly anchored in the latest scientific evidence. With the entry into force of the European Climate Law, reaching climate neutrality at Union level by 2050, and reducing net greenhouse gas emissions by 2030 by at least 55% compared to 1990 became legally binding. The importance of climate adaptation has also been increasingly recognised. The EU Strategy on Adaptation to Climate Change sets out how the European Union can adapt to the unavoidable impacts of climate change and become climate resilient by 2050, with the EU Mission on Adaptation to Climate Change as a key implementing vector. Recognising

the key role of science as a compass for effective policies, the European Climate Law also provides for the establishment of a European Scientific Advisory Board on Climate Change to inform the design and implementation of EU climate action.

The Intergovernmental Panel on Climate Change (IPCC), consisting of the world's leading climate scientists, plays a unique role within climate science and in informing policy decisions. First convened in 1988 by the United Nations and the World Meteorological Organisation, the IPCC is tasked to provide policymakers with regular, comprehensive, and authoritative scientific assessments on climate science knowledge, building on the work of hundreds of scientists worldwide.

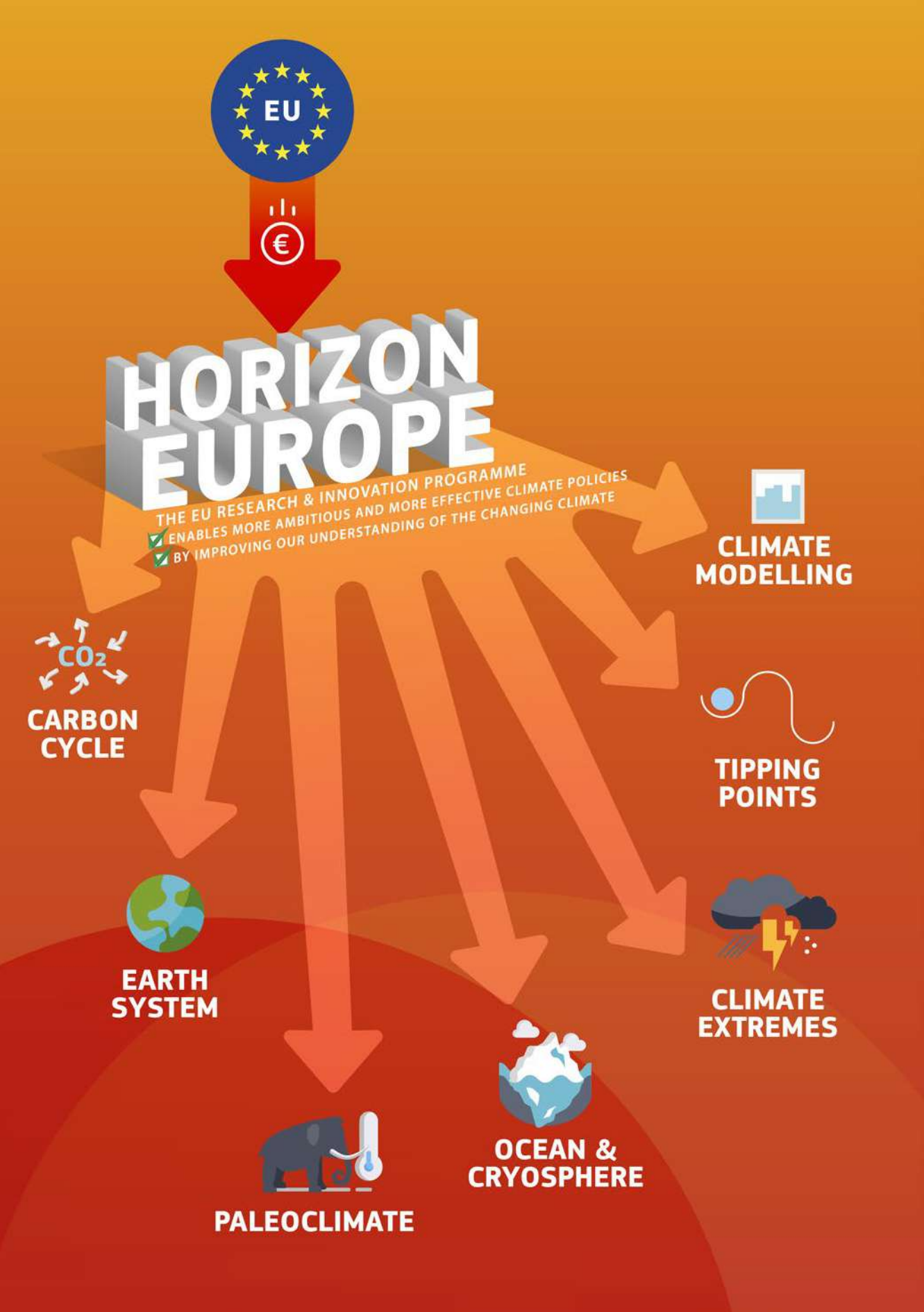
The Panel's work has been instrumental in creating a broad, evidence-based consensus, not only on the link between human activity and climate change, but also on the associated impacts, future risks, and options for adaptation and mitigation. The consecutive reports have seen an increased confidence on the findings, based on continuous progress in climate science and modelling, and have reinforced the warnings and calls for action. The IPCC reports thus represent an essential source of information for the implementation of the Paris Agreement.

The latest IPCC 6th Assessment Report (AR6), consists of three parts: the first instalment, on the physical science of climate change, was published in August 2021, delivering the starkest warning so far, and described by the UN Secretary-General António Guterres as a "code red for humanity". The second part, approved in February 2022 and focusing on impacts, adaptation and vulnerability does not paint a much brighter picture — it warns that any further delay in climate action "will miss a brief and rapidly closing window of opportunity to secure a liveable and sustainable future for all". The third report that came out in April 2022 is centred on mitigation and highlights how the world must take deep and rapid cuts in emissions to keep global warming in check.

The adoption of the Synthesis Report concluding the 6th Assessment Cycle is expected in March 2023.

The European Union, through its successive Framework Programmes for Research and Innovation (R&I), is among the top funders of the evidence base underpinning the IPCC reports: publications to which EU funding has contributed account for approximately 12% of all references cited . By filling critical knowledge gaps, EU-funded research increases the robustness of climate science, thereby improving the effectiveness of climate policies and processes. EU-backed projects also play an important role in increasing public support for more ambitious climate action through a variety of outreach activities.

This brochure highlights and celebrates the contribution of EU-funded projects to the physical science behind the changing climate as addressed by the IPCC Working Group I. It provides examples of outstanding projects financed through the EU Horizon 2020 Framework Programme for Research and Innovation that improve our understanding of how the climate system works, and how it is changing in response to human activity, providing a basis for more effective responses. The topics addressed range from functioning of the carbon cycle and assessments of carbon budgets, through modelling of Earth System processes, improving climate predictions and projections, exploring the impacts of Arctic warming and extreme events up to evaluating likelihood and proximity of climate tipping points.


EU
HORIZON EUROPE
THE EU RESEARCH & INNOVATION PROGRAMME
ENABLES MORE AMBITIOUS AND MORE EFFECTIVE CLIMATE POLICIES
BY IMPROVING OUR UNDERSTANDING OF THE CHANGING CLIMATE
CLIMATE MODELLING
CO2
CARBON CYCLE
TIPPING POINTS
EARTH SYSTEM
CLIMATE EXTREMES
OCEAN & CRYOSPHERE
PALEOCLIMATE

EARTH SYSTEM PROCESSES AND MODELS

In order to better understand the processes governing the Earth System, science divided its study into several sub-systems: atmosphere, hydrosphere, cryosphere, biosphere… These divisions allow the in-depth investigation of the processes happening in each sphere: How does the air move? How do ocean currents work? How is ice formed? As EU R&I pushed forward scientific knowledge, the larger-picture question arose: How does the Earth work: as a whole, not in parts? Which are the main processes of the Earth System, and how are we, humans, affecting them through our daily activities?

The challenge of solving this question cannot be overstated. The different Earth sub-systems interact with each other in extremely complex patterns that are difficult to identify, study and model. They require working across different disciplines, discovering hidden relations, and overcoming challenges associated with technological capacity to gather and process the necessary data.

> “Which are the main processes of the Earth System, and how are we, humans, affecting them through our daily activities?”

Earth-system models (ESMs) play a crucial role in helping us understand how Earth’s climate works and in making projections of what we can expect in the future. For example, ESMs provide irrefutable proof that it is humans and not natural factors that are causing climate change: they show how the Earth’s temperature would not have changed in the last century if we had not burnt all that coal, oil and gas. The first models developed were called “climate models” because they only represented physical processes like air and ocean currents. As our understanding and technological capabilities developed through R&I, these models changed into “Earth-system models” that are now able to represent how life in all ecosystems are impacted by and impact climate.

To make the knowledge on Earth System processes actionable to our communities, the EU is funding research to improve the realism of these processes in our models, increasing their quality and their reliability to make climate projections. For example, cloud formation and the impact of aerosols on them and on climate have always been very hard to simulate accurately. With new observations from European satellites and by developing analysis techniques, EU R&I is expanding our understanding and modelling of these processes. And with that, we are better positioned to assess and anticipate future impacts of climate change on nature and society, making adaptation responses much more effective and targeted. Projects are working to improve the representation not only of climate processes, but of bio-geo-chemical cycles as well, supporting research into methane, ice-sheets or tipping points. EU R&I is leading the development of models in support of Destination Earth, a highly accurate digital model of the Earth to monitor and predict the interaction between natural phenomena and human activities.

CLIMATEUROPE

Project Name:
European Climate Observations, Modelling and Services - 2

Description:
Climateurope coordinated and supported Europe's knowledge base to enable better management of climate-related risks and opportunities, thereby creating greater social and economic value, all in support of IPCC Working Group I. Climateurope had four main objectives:

a. develop a European framework for Earth-system modelling and climate service activities built around a managed network of European, national and international activities and organizations;

b. coordinate and integrate European climate modelling, climate observations and climate service infrastructure initiatives, and facilitate dialogue among the relevant stakeholders, including climate science communities, funding bodies, providers and users;

c. establish multi-disciplinary expert groups to assess the state-of-the-art in Earth-system modelling and climate services in Europe; and identify existing gaps, new challenges and emerging needs;

d. enhance communication and dissemination activities with stakeholders, through events to bring the network together and showcase progress; stakeholder-oriented reports on the state-of-the-art in Earth-system modelling and climate services in Europe; operating a website; and undertaking additional stakeholder interactions to increase awareness and maximize project impacts

Project coordinator & participating countries:
Met Office (United Kingdom)
France, Spain, Italy, Germany, Netherlands, Serbia, Sweden

Total investment / EU contribution:
EUR 3 052 435 / EUR 2 994 37

Start & End dates (Duration):
December 2015 to January 2021
(5 years & 2 months)

Website:
https://www.climateurope.eu/

CONSTRAIN

Project Name:
Constraining Uncertainty of Multi-Decadal Climate Projections

Description:
CONSTRAIN's main aim is to address uncertainty in climate projections, to make significant progress in understanding of how natural and human factors affect multi-decadal regional climate change. CONSTRAIN focuses on four topics that direct this research: 1) the magnitude and pattern of effective radiative forcing; 2) cloud feedbacks and the role of cloud-circulation coupling; 3) ocean variability; and 4) our ability to translate these insights and uncertainties into improved near-term climate projections that can effectively inform policy decisions through IPCC Working Group I.

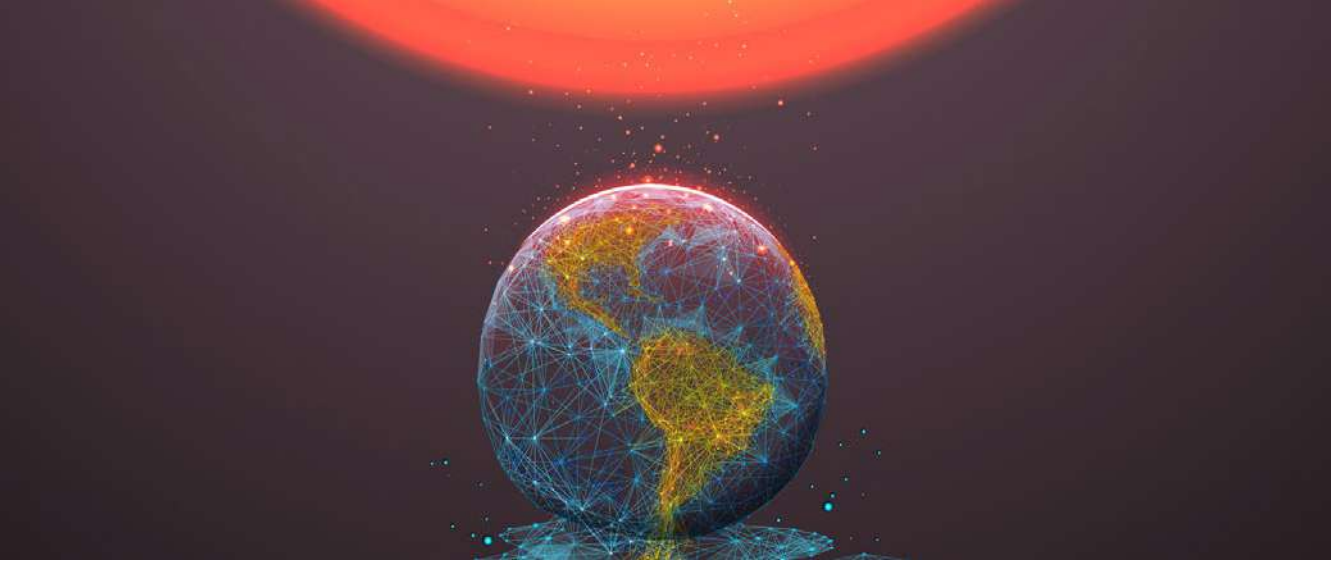
The first period of CONSTRAIN delivered a timely characterization of this physical science uncertainty, and how it affects projections and committed levels of warming, to the IPCC Working Group I report. Over 80% of CONSTRAIN's scientific output at the time of the publication cut-off were referenced.

Project coordinator & participating countries:
University of Leeds (United Kingdom)
Switzerland, France, Germany, Norway, Netherlands, Sweden, Israel, Austri

Total investment / EU contribution:
EUR 7 999 804 / EUR 7 999 804

Start & End dates (Duration):
July 2019 to June 2023 (4 years)

Website:
https://constrain-eu.org/



CRESCENDO

Project Name:
Coordinated Research in Earth Systems and Climate: Experiments, kNowledge, Dissemination and Outreach

Description:
The goal of CRESCENDO was to improve the process-realism and simulation-quality of European Earth System Models to increase the reliability of future Earth System projections.

This was done through: developing a new set of emission scenarios, that more explicitly link future socio-economic development pathways with global radiative forcing; further developing several biogeochemical processes and aerosol feedbacks in Earth System Models; making the Earth System Model evaluation tool openly available and applying it to evaluate the quality of Earth System Models; ensuring all data produced by CRESCENDO was made available to the regional climate modelling community and to the impact assessment community; applying this new knowledge to assess the realism of climate models in future projections.

CRESCENDO delivered a large set of simulations, including an ensemble of scenario projections. In addition to the evaluation tool being used by the IPCC, many of the 350 plus peer-reviewed publications from the project were referenced in the IPCC AR6 Working Group I latest report. Numerous CRESCENDO scientists contributed directly to IPCC AR6, either as coordinating lead authors, lead authors, and contributing authors.

Project coordinator & participating countries:
UNIVERSITY OF LEEDS (United Kingdom)
France, Germany, Italy, Netherlands, Norway, Sweden, Switzerland, Austria, Finland

Total investment / EU contribution:
EUR 15 003 511 / EUR 14 338 876

Start & End dates (Duration):
November 2015 to March 2021
(5 years & 5 months)

Website:
https://ukesm.ac.uk/crescendo/

ESM2025

Project Name:
Earth-system modelling and climate research in support of the Paris Agreement

Description:
ESM2025 aims to develop the new generation of Earth System Models, with improved representation of climate and biogeochemical cycles. The objective is to significantly improve the coupling between existing and new Earth System Model components for carbon, methane, reactive nitrogen, nitrous oxide and dynamic ice sheets. This will allow for the new generation of Earth System Models to not only run-in emission-mode for a range of greenhouse gases, but also to capture the full spectrum of climate-relevant interactions across the Earth System, including tipping points or High Impact Low Probability events.

The new Earth System Models will be developed in close synergy with an IPCC-class European Integrated assessment model, thereby co-developing a novel template for improving critical climate and geophysical consistencies relating to their respective representations of climate and land-use. Such development will bridge the gap between communities and IPCC working group and will result in improving the scenario generation process. This development will support future assessment of IPCC, specifically Working Group I and II.

Project coordinator & participating countries:
Météo France – CNRM (France)
Germany, Austria, United Kingdom, Norway, Belgium, Switzerland, Sweden, Australia

Total investment / EU contribution:
EUR 11 333 275 / EUR 11 333 275

Start & End dates (Duration):
June 2021 to May 2025 (4 years)

Website:
https://www.esm2025.eu/

FORCES

Project Name:
Constrained aerosol forcing for improved climate projections

Description:
FORCeS strives to improve climate projections by reducing the uncertainty related to anthropogenic aerosol forcing. This is done by identifying the most important cloud- and aerosol-forcing processes that control aerosol climate effects and improving these processes in a set of leading European climate models.

FORCeS evaluates the performance of several climate models that have been used as a basis for the IPCC AR6 and improves the process descriptions in these models by using existing and new observations and novel statistical techniques. Furthermore, different types of observations (in-situ measurements, satellite data) are used together with models on different scales to obtain a fundamental understanding of the emissions and physical processes governing the characteristics of atmospheric aerosols as well as their influence on clouds and climate.

FORCeS scientists have participated as authors in the IPCC Working Group I report, whereas results from the project were used in terms of modeling output and scientific publications.

Project coordinator & participating countries:
Stockholm University (Sweden)
Norway, Switzerland, Germany, Greece, Netherlands, Finland, United Kingdom, Italy, Spain, France, Austria

Total investment / EU contribution:
EUR 8 026 287 / EUR 7 998 287

Start & End dates (Duration):
September 2019 to September 2023 (4 years)

Website:
http://forces-project.eu

NEXTGEMS

Project Name:
Next Generation Earth Modelling Systems

Description:
NextGEMS has three overarching goals:

a. to develop two Earth System Models that explicitly represent storms and other vertical movements in the atmosphere;

b. to use the latter to test emerging and long-standing hypotheses underpinning our understanding of climate change;

c. to build new, more integrated communities of Earth System Models users.

This new generation of climate models developed within NextGEMS will provide the tools (state-of-the-art models, high-resolution climate simulation data sets, publications) for either fine-tuning targets, or dealing with the possible implications of a world continuing to warm, and carbon emissions continuing to rise and will be available for further coordinated modeling activities in support of future IPCC assessments.

Storm-Resolving Earth System Models also provide information on scales familiar and more relevant to end users. The high-resolution simulations by these newly developed models allow for an assessment of climate change impacts on worldwide and regional scales, and for a better understanding and quantification of regional changes in a global context.

Project coordinator & participating countries:
Max-Planck-Institute for Meteorology (Germany)
United Kingdom, Norway, Denmark, France, Sweden, Poland, Spain, Netherlands, Switzerland, Portugal, Finland, Italy, Senegal

Total investment / EU contribution:
EUR 11 000 000 / EUR 11 000 000

Start & End dates (Duration):
September 2021 to August 2025 (4 years)

Website:
https://www.nextgems-h2020.eu

PRIMAVERA

Project Name:
Process-based climate simulation: Advances in high resolution modelling and European climate risk assessment

Description:
PRIMAVERA aimed at delivering high-resolution global climate models, capable of simulating and predicting regional climate with unprecedented fidelity. The goal was to understand the impact of increased global model horizontal resolution on climate simulation and implications for regional climate change. The project demonstrated that many long-standing model biases can be reduced with higher resolution, and showed that processes leading to some climate risks over Europe, such as greatly increased winter rainfall, can only be represented at higher resolutions

PRIMAVERA developed the High-Resolution Model Intercomparison Project, a new experimental design that enables comparison of consistent multi-model ensemble. In addition to attracting numerous international modelling groups, this outcome supported the IPCC Working Group I in various ways, including through references to model biases and to impacts of ocean resolution on the Atlantic Meridional Overturning Circulation and future projections.

Project coordinator & participating countries:
Met Office (United Kingdom)
Netherlands, Sweden, France, Germany, Belgium, Spain, Italy, International (ECMWF)

Total investment / EU contribution:
EUR 14 967 969 / EUR 14 967 969

Start & End dates (Duration):
November 2015 to July 2020
(4 years & 9 months)

Website:
https://www.primavera-h2020.eu

THE CARBON CYCLE

Carbon is the key element of life, the backbone of all organic molecules making up living organisms from the simplest creatures to human beings. This essential function extends beyond individual organisms, as carbon plays an essential role at the level of the biosphere, in the transfer of energy and nutrients as well as regulating Earth's climate.

Carbon cycles through different parts of the Earth System mostly in the form of carbon dioxide (CO2), a simple inorganic molecule. Before humanity exerted a major impact on the climate system, the concentration of CO2 in the atmosphere remained remarkably stable at around 280 ppm (parts per million). As people started to clear land for food, energy and other purposes, the carbon cycle got perturbed. The impact of this on the atmosphere was initially modest, as human action was limited to some ecosystems.

However, the process accelerated vastly at the time of industrialisation, when humankind learned to tap into fossil fuels, and ever since natural processes have not been able to fully counterbalance the massive amount of additional carbon rapidly released to the atmosphere. As a result, CO2 began to rapidly accumulate in the atmosphere, reaching 420ppm today. This additional CO2 is largely responsible for the 1.1 °C warming experienced to date, while the land and ocean have roughly absorbed half of human-induced CO2 emissions.

> "Natural processes have not been able to fully counterbalance the massive amount of additional carbon rapidly released to the at mosphere."

Plants (from tiny sea algae to giant trees) play an important role in the carbon cycle: through photosynthesis, they can use solar power, CO2 and water to create the carbohydrates that we and all other animals eat. Plants can also store carbon dioxide in their bodies, or bury it in soils, and thus help us fight climate change.

Whilst the above processes are well known in principle, there are important gaps in our understanding and significant uncertainties in the quantification of underlying processes, with important ramifications on policy. For example, whilst the emissions from fossil fuels are well constrained, there is uncertainty about the quantities absorbed and emitted by land and oceans, and thus about the distinction between human-induced and natural flows of carbon. A better understanding of the expected changes in climate and Earth processes as concentrations in the atmosphere increase, such as the responses of ecosystems, require a wide array of research, from the reconstruction of paleoclimatic records, improving observational data, to developing process-based models with increasing predictive power. These efforts need to be pursued on different scales, from local to global, to match the different needs of all stakeholders and ensure EU-funded research leaves no one behind.

4C

Project Name:
Climate-Carbon Interactions in the Current Century

Description:
4C addresses the crucial knowledge gap in the climate sensitivity to carbon dioxide emissions, by reducing uncertainty in our quantitative understanding of carbon-climate interactions and feedbacks. This will be achieved through innovative integration of models and observations, supporting IPCC assessments and policy objectives. To meet this objective, 4C will (a) provide a step change in our ability to quantify the key processes regulating the coupled carbon-climate system, (b) use observational constraints and improved processes understanding to provide multi-model near-term predictions and long-term projections of the climate in response to anthropogenic emissions, and (c) deliver policy-relevant carbon dioxide emission pathways consistent with the Paris Agreement goals.

Within the IPCC Working Group I report, 4C strongly contributed to the IPCC assessment of the global carbon budget: anthropogenic sources from fossil fuel combustion and land use changes, estimates of land and ocean carbon sinks. 4C also contributed to the development of new emergent constraints on the carbon cycle assessed in the IPCC. The researchers funded under the project participated as coordinating lead author, lead author or contributing authors in IPCC reports.

Project coordinator & participating countries:
University of Exeter (United Kingdom)
Spain, Norway, France, Germany, Switzerland

Total investment / EU contribution:
EUR 7 784 750 / EUR 7 784 750

Start & End dates (Duration):
June 2019 to November 2023
(4 years & 6 months)

Website:
https://4c-carbon.eu/

BEYOND EPICA

Project Name:
Beyond EPICA Oldest Ice Core: 1,5 Million year of greenhouse gas – climate feedbacks

Description:
The Antarctic ice sheet contains a unique record of the Earth's climate history. As the ice form from compacted snow, air bubbles are trapped. Ice cores are therefore the only climate archive that record direct and quantitative information about past climate conditions and atmospheric composition. Currently, the longest ice core record available to date covers only the last 800,000 year.

The overarching scientific objective of Beyond EPICA is to obtain quantitative, high-resolution ice core information on climate and environmental changes over the last 1.5 Million year.

A key advance in the study of past climate would be to understand the shift in Earth's climate response to orbital forcing during the 'Mid-Pleistocene transition' (900,000 to 1.2 million years ago), when the rhythm and intensity of ice age cycles drastically changed. It is critical to understand what drove this past climate transition and especially the role of greenhouse gases. It will help us better understand the key processes governing our climate system, the linkages between the carbon cycle, ice sheets, atmosphere and ocean.

Project coordinator & participating countries:
Institute of Polar Sciences - National Research Council of Italy (Italy)
Germany, United Kingdom, France, Netherlands, Norway, Sweden, Switzerland, Denmark, Belgium

Total investment / EU contribution:
EUR 10 999 942 / EUR 10 999 942

Start & End dates (Duration):
June 2019 to May 2026 (7 years)

Website:
https://www.beyondepica.eu/en/

NUNATARYUK

Project Name:
Permafrost thaw and the changing arctic coast: science for socio-economic adaptation

Description:
The loss of a year-round sea ice cover in the Arctic severely affects Arctic ecosystems and amplifies Arctic warming with potential consequences for the warming of the surrounding permafrost regions and ice sheets. Despite past investigations on the mechanisms of the permafrost-climate feedback from land to reduce uncertainties, critical knowledge gaps on lateral transfer of organic matter and subsea permafrost have still prevented credible projections of the full permafrost-climate feedback.

Nunataryuk investigates the terrestrial and coastal permafrost carbon stocks in combination with transport pathways, soil-water leaching potential, degradation rates, sedimentation and burial rates on the shoreface, and coastal erosion retreat rates in order to allow upscaling across the circum-arctic coast for the generation of a total permafrost carbon budget for the Arctic coast.

In addition, the Nunataryuk project quantifies organic matter, sediment and contaminant fluxes from thawing coastal and subsea permafrost and integrated into Earth System Modelling frameworks to perform modelling and evaluation of carbon dioxide and methane fluxes from subsea permafrost and lateral transfer of organic matter at the pan-Arctic scale.

Several researchers funded under the project participated as lead/contributing authors to IPCC reports.

Project coordinator & participating countries:
Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (Germany)
Sweden, Netherlands, France, Canada, Finland, Denmark, Iceland, Austria, Italy, Norway, Portugal, Belgium

Total investment / EU contribution:
EUR 11 467 317 / EUR 11 467 317

Start & End dates (Duration):
November 2017 to October 2023 (6 years)

Website:
https://nunataryuk.org

SO-CHIC

Project Name:
Southern Ocean Carbon and Heat Impact on Climate

Description:
The Southern Ocean regulates the global climate by controlling heat and carbon exchanges between the atmosphere and the ocean. Rates of climate change on decadal time scales ultimately depend on oceanic processes taking place in the Southern Ocean, yet too little is known about the underlying processes. Limitations come both from the lack of observations in this extreme environment and its inherent sensitivity to intermittent small-scale processes that are not captured in current Earth System Models.

To contribute to reducing uncertainties in climate change projection, the overall objective of SO-CHIC is to understand and quantify variability of heat and carbon budgets in the Southern Ocean through an investigation of the key processes controlling exchanges between the atmosphere, ocean and sea ice using a combination of observational and modelling approaches. Beyond citation within IPCC Working Group I report, numerous key partners were involved as authors, and SO-CHIC science motivated the production of a cross-chapter box on ocean carbon-heat nexus.

Project coordinator & participating countries:
Sorbonne Université (France)
United Kingdom, Germany, Norway, Switzerland, Sweden, Italy, Netherlands, South Africa, Ireland

Total investment / EU contribution:
EUR 7 989 925 / EUR 7 989 925

Start & End dates (Duration):
November 2019 to October 2024 (5 years)

Website:
https://www.sochic-h2020.eu

VERIFY

Project Name:
Observation-based system for monitoring and verification of greenhouse gases

Description:
VERIFY proposed to quantify more accurately carbon stocks and the fluxes of carbon dioxide, methane, and nitrous oxide across the EU based on independent observations in support of inventories that rely only on statistical data. Accurate characterization of the space-time variations of greenhouse gas fluxes, separating their anthropogenic and natural components and their drivers, has been based on advanced modeling approaches using atmospheric greenhouse gas measurements, tracer transport inversions and various arrays of land observations, in-situ and from space. The improved knowledge of greenhouse gas budgets from VERIFY will be used to improve national inventories, in collaboration with national inventory agencies, and to deliver policy-relevant information to track progress of the EU mitigation efforts to meet the targets of the Paris Agreement.

VERIFY developed comprehensive national greenhouse gas flux synthesis for European countries and groups of countries as well as for USA, China and Indonesia.

Project coordinator & participating countries:
Commissariat à l'énergie atomique et aux energies alternatives – CEA (France) Germany, Netherlands, United Kingdom, Italia, Norway, Finland, Sweden, Ireland, Belgium, Austria, Switzerland, Turkey

Total investment / EU contribution:
EUR 10 229 339 / EUR 9 998 964

Start & End dates (Duration):
February 2018 to July 2022
(4 years & 6 month)

Website:
https://verify.lsce.ipsl.fr/

OCEAN AND CRYOSPHERE

To date, global warming has affected the ocean and the cryosphere in different ways than the rest of the world. The phenomenon termed "arctic amplification" highlights that, since 1979, the Arctic has warmed nearly four times faster than the planet average. Greenland's glaciers, for example, are now releasing hundreds of billion tonnes of melted ice into the ocean each year. Such changes will affect the EU and the rest of the planet through rising sea levels, changing weather patterns, a higher incidence of extreme weather events, permafrost thawing, and release of greenhouse gases and various pathogens, etc., calling for their better understanding.

As noted by the IPCC sixth assessment report, large-scale indicators of climate change in the atmosphere, ocean, and cryosphere are reaching levels, and changing at rates, unseen in centuries to millennia. Over the 21st century, the ocean is projected to transition to unprecedented conditions with increased temperatures, greater upper ocean stratification, further acidification, oxygen decline, and altered net primary production. There is much uncertainty about the extent of these changes and about the subsequent reactions of marine ecosystems. Many consequences of global warming are irreversible on centennial to millennial time scales, especially the changes affecting the ocean, ice sheets and global sea level.

> "The Arctic has warmed nearly four times faster than the planet average."

The EU is supporting scientific knowledge on global climate change and biosphere integrity, by investments in observations, improved understanding, modelling, projections, and predictions of impacts. This new knowledge is then channelled to tackle environmental and climate change in the ocean and the cryosphere, identifying and deploying innovative and sustainable solutions based on win-win strategies like nature-based solutions, which support biodiversity while bringing climate mitigation and adaptation benefits.

EU-funded projects deliver forecasts and early warnings, climate projections and assessments, and protect cryosphere and ocean health and integrity. Climate models have significantly improved, and EU projects have strongly contributed to the sixth IPCC assessment cycle. A new generation of high-resolution simulations offer new and considerably more accurate insights into the nature of climate and weather extremes. Decadal climate predictions on ocean and cryosphere are now regularly available; they are skilful and offer a unique opportunity to address climate-related aspects. Based also on new standards for user uptake, the information provided becomes ever more relevant to our citizens and European climate action policies.

APPLICATE

Project Name:
Advanced prediction in Polar regions and beyond: modelling, observing system design and Linkages associated with a Changing Arctic climate

Description:
APPLICATE aimed at improving predictive capacity for weather and climate in the Arctic and beyond. It had the objective to determine the influence of Arctic climate change on Northern Hemisphere mid-latitudes, for the benefit of policymakers, businesses and society alike.

APPLICATE contributed to the latest IPCC scientific assessment by addressing the fidelity of climate models in simulating key Arctic processes. It made model improvements on aspects that are pivotal for weather and climate prediction: the atmospheric boundary layer including clouds; sea ice; snow; atmosphere-sea ice-ocean coupling, and; oceanic transports.

Many of the results published by APPLICATE have been included, directly or indirectly, in the IPCC Working Group I report. Notable achievements include participation in model intercomparison projects and the development of a new version of the Earth System Model Evaluation Tool, along with climate model simulations.

Project coordinator & participating countries:
Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (Germany)
Spain, Europe, Norway, United Kingdom, Belgium, Sweden, France, Russia

Total investment / EU contribution:
EUR 8 715 066 / EUR 7 999 591

Start & End dates (Duration):
November 2016 to April 2021
(4 years & 6 months)

Website:
https://applicate-h2020.eu/

BLUE-ACTION

Project Name:
Blue-Action: Arctic Impact on Weather and Climate is a Research and Innovation action

Description:
Important changes in climate variability and extreme weather events are difficult to pinpoint and account for in existing modelling and forecasting tools. Many changes in the global climate are linked to the Arctic, where climate change is occurring rapidly, making weather and climate prediction a considerable challenge.

Blue-Action evaluated the impact of Arctic warming on the northern hemisphere and developed new techniques to improve forecast accuracy at sub-seasonal to decadal scales. Blue-Action specifically worked to understand and simulate the linkages between the Arctic and the global climate system, and the Arctic's role in generating weather patterns associated with hazardous conditions and climatic extremes.

Blue-Action's objectives were to improve the safety and wellbeing of people in the Arctic and across the Northern Hemisphere, reduce the risks associated with Arctic operations and resource exploitation, and support evidence-based decision-making by policymakers worldwide. Blue-Action contributed to the IPCC Working Group I report, with the collection and publication of new data, and the provision of improved models and projections to represent Arctic warming realistically and address its impact on regional and global atmospheric and oceanic circulation.

Project coordinator & participating countries:
Danish Meteorological Institute (Denmark)
Finland, Portugal, Italy, France, South Korea, Norway, Germany, Faroe Islands, China, Russia, Iceland, United Kingdom, USA, Netherlands, Spain, Switzerland, Ireland

Total investment / EU contribution:
EUR 8 103 125 / EUR 7 500 000

Start & End dates (Duration):
December 2016 to September 2021
(4 years & 10 months)

Website:
https://www.blue-action.eu

CRICES

Project Name:
Climate relevant interactions and feedbacks: the key role of sea ice and snow in the polar and global climate system

Description:
Climate and Earth System Models are key tools for projecting future climate change. However, these models have significant shortcomings regarding their descriptions of polar ocean-ice/snow-atmosphere interactions, limiting their effectiveness.

CRiceS has four overarching objectives: (1) translate knowledge across scales from observed ocean-ice-atmosphere processes to controlling climate scale processes within models that describe the coupled polar system; (2) advance descriptions of the ocean-ice-atmosphere system in numerical models in order to produce more robust projections and quantification; (3) deliver open data and models that service the scientific community, stakeholders, and beyond; and (4) develop proactive communication pathways, building on existing research initiatives, aimed at engaging in regional and global climate assessment processes.

Parallel to climate model development, CRiceS will develop impact and hazard indicators specifically for polar systems and polar-global interactions. CRiceS climate models will be simulated through selected future pathways providing storylines and analysis of polar impacts on global climate system. CRiceS will further develop integrated assessments for selected sectors in collaboration with stakeholder groups.

Project coordinator & participating countries:
Finnish Meteorological Institution (Finland)
France, Norway, Sweden, Italy, South Africa, Germany, Spain, United Kingdom, Switzerland, Netherlands, Canada, India

Total investment / EU contribution:
EUR 8 507 794 / EUR 7 999 266

Start & End dates (Duration):
September 2021 to August 2025 (4 years)

Website:
https://www.crices-h2020.eu/home

POLARES

Project Name:
Polar Regions in the Earth System

Description:
PolarRES aims to make climate projections more reliable for assessing social and environmental impacts of climate change in the polar regions. This will be achieved by applying an innovative storylines approach and resolving critical knowledge gaps in our understanding of atmosphere-ocean-sea ice interactions, and their role in the global climate system.

PolarRES' research will contribute new knowledge on ocean acidification, regional phenomena, drivers, feedbacks and teleconnections, past and future changes in marine and terrestrial cryosphere, regional climate projections, and increased confidence in regional climate information.

The consortium will publish datasets of climate change projections for the Arctic and Antarctic in support of future IPCC assessments, in particular the IPCC Working Group I Atlas. This will provide transparent access to climate change projections and allow for further development of additional analyses based on this resource.

The researchers funded under the project participated as lead/contributing authors in the latest IPCC Working Group I report.

Project coordinator & participating countries:
NORCE Norwegian Research Centre (Norway) United Kingdom, Finland, Germany, Netherlands, Belgium, Denmark, Ukraine, Sweden, Russia, China

Total investment / EU contribution:
EUR 7 996 321 / EUR 7 996 321

Start & End dates (Duration):
September 2021 to August 2025 (4 years)

Website:
https://polarres.eu

PROTECT

Project Name:
PROjecTing sEa-level rise: from iCe sheets to local implicaTions

Description:
PROTECT is assessing and projecting losses in continental ice that is contributing to sea-level rise. The objective is to produce robust global, regional, and local projections of sea-level rise on decadal to multi-centennial timescales across all relevant spatial and temporal scales: from today's coastal management decisions (decadal), through infrastructure planning (centennial), to the long-term viability of coastal cities, small islands, and low-lying states (multi-centennial).

The project aims at co-designing and co-constructing sea-level projections together with users and stakeholders to tailor outputs to their specific needs and contexts – in terms of exposed assets, levels of risk aversion, or stakeholder objectives. PROTECT will lay the foundation for innovative and fit-for-purpose coastal climate services to support adaptation to future flood risks in Europe.

Scientific publications from the project contributed to the IPCC assessment, and several scientists were lead or contributing authors to the IPCC reports.

Project coordinator & participating countries:
Centre National de la Recherche Scientifique (France)
Netherlands, United Kingdom, Denmark, Germany, Belgium, Switzerland, Norway, Greenland, Maldives

Total investment / EU contribution:
EUR 9 996 661 / EUR 9 996 661

Start & End dates (Duration):
September 2020 to August 2024 (4 years)

Website:
https://protect-slr.eu/

ABRUPT CHANGES AND TIPPING POINTS

While many consequences of climate change (e.g., drought or heatwaves) are proportional to the level of global warming, some parts of the climate system may change abruptly and substantially faster than their typical rate in history, challenging our capacity to adapt. Abrupt changes often arise from slow changes eventually passing a critical threshold – or tipping point – that leads to a qualitatively different climate, with significant impacts for ecosystems and human society. Such changes may be irreversible within human time frames, lasting from several decades to millennia regardless of how fast human-induced greenhouse gas emissions decrease. Examples of tipping points include: collapse of the West Antarctic ice sheet, reorganisation of the Atlantic Meridional Overturning Circulation or dieback of the Amazon Forest.

> “Some parts of the climate system may change abruptly and substantially faster than their typical rate in history, challenging our capacity to adapt.”

The key challenge associated with tipping points is their inherent uncertainty – in principle, we will not know exactly when a tipping point is crossed, until it is too late. The consequences cannot be predicted by extrapolating from what we know about our current climate. What we know for sure is that the risk of crossing tipping points increases with global warming and with the duration of a temperature overshoot above 1.5°C or any given threshold. The potentially drastic impacts of crossing tipping points reinforce the case for ambitious mitigation action in line with the motto “prevention is better than care”.

The EU-supported research helps advance the understanding about the likelihood, reversibility, and proximity of abrupt changes and crossing climate tipping points. Projects explore climate feedbacks and research threats and impacts, through the development of improved modelling and simulations, among other scientific methods. They resort to in-situ and remote observations to observe the present and recent past, and also find new evidence from previously unexplored past climate with paleo reconstructions.

TIPES

Project Name:
Tipping points in the Earth System

Description:
The underlying mechanisms of the abrupt transitions the Earth goes through are still not fully understood, current models cannot simulate past abrupt transitions realistically. TiPES focuses on the urgent need to examine passed tipping points of Earth subsystems, to improve the modelling of abrupt transitions, and to estimate the stability of desirable states. TiPES contributes to better prediction of possible future abrupt changes caused by anthropogenic global warming, clarifies what crossing the tipping points means socioeconomically, and helps policymakers plan strategies to create safe operating spaces for humanity.

The project has five objectives: identify subsystems exhibiting abrupt transitions and developing novel detecting methods for skilful predictions; evaluate potential shortcomings; develop a climate sensitivity theory accounting for tipping points and feedbacks; define safe operating spaces; facilitate policymaking through knowledge dissemination.

TiPES develops formal approaches to define the socioeconomic risks of crossing tipping points and derives decision strategies to keep anthropogenic forcing below levels where abrupt transitions may occur.

Project coordinator & participating countries:
University of Copenhagen (Denmark)
United Kingdom, Germany, Spain, Switzerland, Netherlands, Belgium, Italy, France, Norway, Portugal

Total investment / EU contribution:
EUR 8 561 239 / EUR 8 561 239

Start & End dates (Duration):
September 2019 to February 2025
(5 years & 6 months)

Website:
https://www.tipes.dk

TIPACCS

Project Name:
Tipping Points in Antarctic Climate Components

Description:
The overall aim of TiPACCs is to assess the likelihood of large and abrupt near-future changes in the contribution of the Antarctic Ice Sheet to global sea level, caused by tipping points in the Antarctic continental shelf seas and the Antarctic Ice Sheet. A comprehensive study of the triggering processes will reveal the likelihood of reversibility, while the study of ice–ocean feedbacks will provide insight into the threat of sudden sea level rise. The combination of numerical work with existing remote sensing and in-situ observations and paleo-reconstructions is ideal for defining the proximity of the simulated tipping points.

Improved understanding of these processes directly feeds into the scientific basis of IPCC Working Group I. TiPACCs researchers participated as contributing author and expert reviewers in the latest IPCC assessment.

Project coordinator & participating countries:
NORCE Norwegian Research Centre AS (Norway)
United Kingdom, Germany, France

Total investment / EU contribution:
EUR 4 602 897 / EUR 4 602 897

Start & End dates (Duration):
August 2019 to July 2023 (4 years)

Website:
https://www.tipaccs.eu

COMFORT

Project Name:
Our common future ocean in the Earth System – quantifying coupled cycles of carbon, oxygen, and nutrients for determining and achieving safe operating spaces with respect to tipping points

Description:
COMFORT's objective is to close knowledge gaps for key ocean tipping elements within the Earth System under anthropogenic physical and chemical climate forcing through a coherent interdisciplinary research approach. It aims to provide added value to decision and policy makers in terms of science-based safe marine operating spaces, refined climate mitigation targets, and feasible long-term mitigation pathways. It focuses on the triple threat of a) warming, b) deoxygenation, and c) ocean acidification, and how to optimally deal with this threat.

COMFORT has provided new insight into abrupt physical and biogeochemical change, for example through the quantification of the frequency of marine heatwaves under future further climate warming. It has investigated and quantified the ir-/reversibility of deoxygenation, as well as that of ocean pH changes.

COMFORT brought results that were referenced by the IPCC in its latest assessment.

Project coordinator & participating countries:
University of Bergen (Norway)
Sweden, Austria, Switzerland, Germany, Spain, France, Iceland, United Kingdom, Canada, South Africa, India

Total investment / EU contribution:
EUR 8 482 148 / EUR 8 191 664

Start & End dates (Duration):
September 2019 to August 2023 (4 years)

Website:
https://comfort.w.uib.no/

EXTREMES EVENTS

In every inhabited region of the world, human-induced climate change has increased the frequency and intensity of extreme events. The IPCC working group I concludes that every fraction of warming causes significant changes in extremes both at the regional and global scales. A weather and climate extreme event is one that is historically rare at a particular place and time. Extremes include heatwaves, heavy precipitation, pluvial and river floods, storms and droughts. Because of global warming, extreme events may occur in previously unheard-of-areas and over longer periods of time or with advance or delay in the season. Events that are unprecedented in magnitude, frequency, timing and location have already been experienced in recent years. In addition, multiple extremes could happen in succession or in combination, creating compound events that bear higher risks. As an example, wildfires are more probable in a place experiencing both drought and extreme heat.

The changes in extremes depend on the location and context, making their observation and prediction much more challenging. Each region will change in its own way, and while extreme precipitation will increase across all regions, a number of areas will also experience droughts as well. This goes into some of the main projections for Europe identified by the IPCC Working Group I: heat and drought stress will cause substantive stress on agricultural production; at 2°C of warming, a third of the Southern European population will be exposed to water scarcity, and; coastal flood damage is estimated to increase 10-fold by the end of the century.

> “In every inhabited region of the world, human-induced climate change has increased the frequency and intensity of extreme events.”

EU-funded research helps better understand the science behind extreme events, including improved climate predictions and projections on short, medium or multi-decadal timescales. Projects are developing multi-model forecasts, high-resolution climate simulations, regional downscaling, and trans-sectoral and trans-regional risk management, with the end goal to better inform decision-making, and enable effective adaptation strategies.

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IMPREX

Project Name:
IMproving PRedictions and management of hydrological EXtremes

Description:
Future high impact hydrological extremes may disrupt safety of citizens, agricultural production, transportation, energy production and urban water supply, and overall economic productivity. The IMPREX project was conducted to better anticipate such eventuality.

IMPREX aimed at targeting the quality of hydro-meteorological predictions, enhancing the reliability of future climate projections in the short to medium term. This was done by applying this information to strategic sectoral and pan-European surveys at different scales and evaluating and adapting current risk management strategies. IMPREX's objective was to increase the realism of relevant events by specific high-resolution regional downscaling, explore compounding trans-sectoral and trans-regional risks, and design new risk management paradigms.

As a key outreach product, IMPREX produced a periodic hydrological risk outlook for Europe, incorporating the dynamic evolution of hydro-climatic and socio-economic processes. The project outreach maximizes the legacy impact of the surveys, aimed at European public stakeholder and business networks, including user-friendly assessment summaries, and training material.

Project coordinator & participating countries:
Koninlkijk Nederlands Meteorologisch Instituut-KNMI (Netherlands)
United Kingdom, Sweden, France, Germany, Belgium, Spain, Greece, Italy

Total investment / EU contribution:
EUR 7 996 848 / EUR 7 996 848

Start & End dates (Duration):
October 2015 to September 2019 (4 years)

Website:
https://www.imprex.eu/

EUCP

Project Name:
European Climate Prediction System

Description:
EUCP developed important new science to improve predictions and projections of future climate on timescales out to 40+ years.

a. EUCP co-generated a new ensemble of kilometer scale convection-permitting simulations for Europe, which for the first time allow an assessment of the robustness of simulated changes in hourly precipitation extremes. EUCP demonstrated that high-resolution climate simulations provide more realistic, finer spatial details and better represent hourly precipitation and the associated daily cycle than lower resolution models. The use of these simulations to explore future changes in extreme rainfall offered further evidence for the greater changes in European extreme rainfalls;

b. EUCP contributed to climate projections on timescales beyond a decade ahead and provided the first major study to intercompare methods to constrain or filter ensembles of projections over the European region;

c. EUCP has facilitated improved approaches towards decadal forecasts.

Examples of key inputs to the IPCC process include provision of decadal projections data. Several EUCP scientists have contributed their expertise as authors in the Working Group I report.

Project coordinator & participating countries:
Met Office (United Kingdom)
France, Netherlands, Germany, Sweden, Italy, Switzerland, Spain, Denmark

Total investment / EU contribution:
EUR 12 999 515 / EUR 12 999 515

Start & End dates (Duration):
December 2017 to May 2022
(4 years & 6 months)

Website:
https://www.eucp-project.eu

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The portal data.europa.eu provides access to open datasets from the EU institutions, bodies and agencies. These can be downloaded and reused for free, for both commercial and non-commercial purposes. The portal also provides access to a wealth of datasets from European countries.

The European Union is among the top funders of the evidence base underpinning the IPCC reports, contributing to improving the effectiveness of both national and international climate policies and processes, and building public support for more ambitious climate action.

This brochure highlights and celebrates the contribution of EU-funded projects to pushing the boundaries of the science underlying the IPCC AR6 Working Group I report on the Physical Science Basis of Climate Change. It provides examples of projects funded by Horizon 2020 — the EU Framework Programme for Research and Innovation — which provide the evidence-base for the implementation of the Paris Agreement.

Studies and reports

Publications Office
of the European Union

European Commission

Science for Climate Action

EU research contribution to IPCC Working Group II on Impacts, Adaptation and Vulnerability

Providing solutions, enabling resilient development

Research and Innovation

Science for Climate Action: EU research contribution to IPCC Working Group II on Impacts, Adaptation and Vulnerability

European Commission
Directorate-General for Research and Innovation
Directorate B — Healthy Planet
Unit B.3 — Climate & Planetary Boundaries

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Manuscript completed in June 2022.
1st edition.

PDF ISBN 978-92-76-49044-9 doi:10.2777/236581 KI-06-22-137-EN-N

Luxembourg: Publications Office of the European Union, 2022

EUROPEAN COMMISSION

Science for Climate Action

EU research contribution to IPCC Working Group II on Impacts, Adaptation and Vulnerability

edited by Onélica Andrade, Alfonso Acosta Gonçalves and Katarzyna Drabicka

Directorate-General for Research and Innovation
2022 Horizon 2020

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INTRODUCTION

Climate change is one of the greatest threats facing humanity, with potentially devastating impacts on people and the natural environment – this realisation is becoming clearer and more concrete every day as new climate extremes manifest themselves around the globe. To respond to this challenge, the European Union has made climate action its top priority through the European Green Deal. The overarching goal is reaching climate neutrality by 2050, while at the same time making the continent climate resilient.

While mitigating emissions is at the heart of climate action and constitutes a pre-condition for avoiding the worst climate impacts, increased focus on climate adaptation has never been more urgent. This message transpires from the latest scientific assessment by the **Intergovernmental Panel on Climate Change (IPCC)**, the most authoritative source of knowledge about the changing climate. The IPCC **Working Group II report Climate Change 2022: Impacts, Adaptation and Vulnerability** warns that the world faces unavoidable, multiple climate hazards over the next two decades, and risks for society and nature are set to increase. And indeed, it is very worrying to see three of the four main risks identified by the IPCC: 1) extreme heat over land and at sea, 2) water scarcity and 3) the negative effects on food production, already materialising across Europe this summer and challenging our adaptation capacities. Beyond 2040 and depending on the level of global warming, impacts could be up to multiple times higher than currently observed. Paraphrasing Darwin, humanity might soon find itself facing the "adapt or die" choice. Against this background, the scientific community cautions that the window to act and secure a liveable future is closing fast.

As more and more intense climate impacts are already being felt, the world needs to urgently step-up action and re-balance the focus between adaptation and mitigation to allow countries to better respond to climate change impacts. Globally, the momentum on adaptation is indeed building up, reflecting the increased understanding that climate resilience is central to smart policy making – it is not only a moral and ethical imperative towards the most vulnerable, but it also makes economic sense.

At COP26, the Glasgow Climate Pact set the path forward to the Global Goal on Adaptation, and all parties were urged to further integrate adaptation actions into local, regional, and national planning. In Europe, the new **EU Strategy on adaptation to climate change**[1] was adopted in early 2021 and sets out how the EU can adapt to the unavoidable climate impacts and become climate resilient by 2050. As the key implementing vector of the Strategy, the EU Mission for Adaptation to Climate Change[2] seeks to support at least 150 European regions and communities towards climate resilience by 2030. It will strengthen the scientific understanding of climate-related risks and possible adaptation responses at a local level, pilot solutions across sectors,

1. COM(2021) 82 final
2. EU Mission: Adaptation to Climate Change

build capacity, mobilise stakeholders and, crucially, engage citizens to upscale and accelerate transformational adaptation towards a climate-resilient society.To maximise the effectiveness and impact of adaptation responses, it is imperative that they rest upon the best available climate science. This is clearly acknowledged in the EU Adaptation Strategy, which asserts that anchoring decisions in the latest science can facilitate decision-making. In this regard, the IPCC assessments play a special role as they constitute the ultimate source of knowledge on climate change. They not only build consensus around key scientific questions, and inform policies, but also provide an important guidance for the strategic programming of EU-funded research, helping to focus on the most pressing knowledge gaps and policy-relevant research. The year 2022 is key for the Panel and climate science as it brings about the finalisation of IPCC milestone reports.

The Intergovernmental Panel on Climate Change (IPCC), consisting of the world's leading climate scientists, plays a unique role within climate science and in informing policy decisions. First convened in 1988 by the United Nations and the World Meteorological Organisation, the IPCC is tasked to provide policymakers with regular, comprehensive, and authoritative scientific assessments on climate science knowledge, building on the work of hundreds of scientists worldwide.

So far, the Panel has produced five Assessment Reports and its work has been instrumental in creating a broad, evidence-based consensus, not only on the link between human activity and climate change, but also on the associated impacts, future risks, and options for adaptation and mitigation. The consecutive reports have seen an increased confidence on the findings, based on continuous progress in climate science and modelling, and have reinforced the warnings and calls for action. The IPCC reports thus represent an essential source of information for the implementation of the Paris Agreement.

The latest IPCC 6th Assessment Report (AR6), consists of three parts: the first instalment, on the physical science of climate change[3], was published in August 2021, delivering the starkest warning so far, described by the UN Secretary-General António Guterres as a "code red for humanity". The second part, approved in February 2022 and focusing on impacts, adaptation and vulnerability[4] does not paint a much brighter picture — it warns that any further delay in climate action "will miss a brief and rapidly closing window of opportunity to secure a liveable and sustainable future for all". The third report[5] that came out in April 2022 is centred on mitigation and highlights how the world must take deep and rapid cuts in emissions to keep global warming in check.

The European Union, through its successive Framework Programmes for Research and Innovation (R&I), is among the top funders of the evidence base underpinning the IPCC reports. Our recent

3. https://www.ipcc.ch/report/ar6/wg1/
4. https://www.ipcc.ch/report/ar6/wg2/
5. https://www.ipcc.ch/report/ar6/wg3/

analysis covering a sample of IPCC reports concludes that publications to which EU funding has contributed account for approximately 12% of all references cited[6]. By filling critical knowledge gaps, EU funded research contributes to increasing the robustness of research findings. This way, EU-funded projects contribute to improving the effectiveness of both national and international climate policies and processes, including those underpinning the implementation of the Paris Agreement. They also play an important role in increasing public support for more ambitious climate action through a variety of outreach activities.

To celebrate the publication of the IPCC Working Group II report on Impacts, Adaptation and Vulnerability, this brochure highlights the contribution of EU-funded projects to developing science and solutions for climate adaptation. The projects featured in this publication showcase some of the outstanding EU-funded research on topics that range from improved understanding of physical climate impacts at global-to-local scales, tipping points in Earth systems, extreme weather events and their cascading effects on the economy and society; to customised adaptation measures that build resilience through climate services, nature-based solutions and other innovations. The results are invaluable in paving the way towards a climate-resilient development.

6. Contribution of the Framework Programmes (FP7 and H2020) to the knowledge base of recent IPCC reports based on openly available data


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LAND USE & FOOD SYSTEMS
ECOSYSTEMS & NATURE-BASED SOLUTIONS

UNDERSTANDING THE IMPACTS and RISKS OF CLIMATE CHANGE

REGIONAL and LOCAL IMPACTS

When it comes to adaptation to climate change there is no room for applying the "one size fits all" strategy. Good adaptation requires customised solutions, tailored to specific local needs. This is because the physical impacts of climate change and their associated socio-economic consequences differ significantly not only from country to country, but within countries themselves depending on geographical conditions, socio-economic characteristics and adaptive capacity. For example, some regions of Europe are already experiencing and will continue to experience more rapid changes than others and each region will be faced with different types of extreme weather events. In addition, within the same location, the same climate change impacts can be experienced very differently across sectors and social groups, with the most vulnerable often hit the hardest.

> "Good adaptation requires customised solutions, tailored to specific local needs."

This makes adaptation responses complex and context-dependent, putting local actors on the frontline of action. To implement successful adaptation responses, they need to understand well the risks, impacts and options that are specific to them. While modern climate science provides robust projections of future changes in the climate, based on socioeconomic development scenarios, the uptake of this information is hindered by the frequent mismatch in spatial and temporal scales between data produced by global and regional climate models and data relevant for local decision making. This is one of the key challenges that the EU Mission on Adaptation to Climate Change aims to tackle.

EU-funded projects play an important role in overcoming these problems by generating knowledge and data that serve the needs of local adaptation practitioners and decision-makers. They boost the availability, reliability and accessibility of climate information at high spatial resolution, while reducing the uncertainty of the projections. In their work, the projects deploy cutting-edge digital technologies such as artificial intelligence, high-performance computing and smart sensors. The findings form a basis for identifying adaptation options, selecting priorities and formulating strategies to build resilience across communities and sectors, and are therefore an essential input to the efforts of the EU Mission on Adaptation to Climate Change.

PROTECT

Project Name:
PROjecTing sEa-level rise: from iCe sheets to local implicaTions

Description:
PROTECT is assessing and projecting changes in the land-based cryosphere to produce robust global, regional, and local projections of sea-level rise on decadal to multi-centennial timescales across all relevant spatial and temporal scales: from today's coastal management decisions (decadal), through infrastructure planning (centennial), to the long-term viability of coastal cities, small islands, and low-lying states (multi-centennial).

The project aims at co-designing and co-constructing sea-level projections together with users and stakeholders to tailor outputs to their specific needs and contexts — in terms of exposed assets, levels of risk aversion, or stakeholder objectives. PROTECT will lay the foundation for innovative and fit-for-purpose coastal climate services to support adaptation to future flood risks in Europe. Scientific publications from the project contributed to the IPCC assessment, and several scientists were lead or contributing authors to the IPCC reports.

Project coordinator & participating countries:
Centre National de la Recherche Scientifique (France)
Netherlands, United Kingdom, Denmark, Germany, Belgium, Switzerland, Greenland, Maldives

Total investment / EU contribution:
EUR 9 996 661 / EUR 9 996 661

Start & End dates (Duration):
September 2020 to August 2024 (4 years)

Website:
https://protect-slr.eu

COACCH

Project Name:
CO-designing the Assessment of Climate CHange costs

Description:
COACCH produced a new set of high spatial resolution climate change damage estimates in the EU, highlighting the possibility of macro-economic losses larger than previously estimated. Losses are estimated per region, sector, and impact type identifying where and when major vulnerabilities are expected.

COACCH advanced the analysis of climatic and socio-economic tipping points, showing that many EU regions could already meet these highly damaging events by mid-century. It also demonstrated impact variability across alternative climate and socio-economic scenarios. Further, the project investigated attitudes toward climate risk by EU citizens and developed assessments of cost–benefit and policy effectiveness.

The project elaborated a new generation of climate change damage functions that are now freely available to the scientific community for the validation and use. It also developed a comprehensive and transparent description and quantification of scenario and model uncertainty, as well as best practices for co-design and co-production of research that can guide similar exercises in the future.

Project coordinator & participating countries:
Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici (Italy)
Germany, Austria, United Kingdom, Netherlands, Czechia, Spain

Total investment / EU contribution:
EUR 4 999 843 / EUR 4 999 843

Start & End dates (Duration):
December 2017 to November 2021 (4 years)

Website:
https://www.coacch.eu/

EUCP

Project Name:
EUropean Climate Prediction system

Description:
EUCP is examining a number of adaptation issues and addressing the challenges raised in the IPCC Working Group II report, including how to improve decadal predictions and simulations of future local extreme weather, providing examples of how to use these improvements to inform resilience building and adaptation efforts.

Data and methods developed during EUCP, in particular the improved decadal forecasting, will play an important role in addressing the needs for improved adaptation planning and implementation. The very high resolution convective-permitting models will enable improved simulation of present and future extreme events over Europe — an essential component of organizational, regional, and national risk assessments. The intercomparison of methods to constrain projections will better inform planners on the likely range of temperatures and rainfall over Europe, helping them to avoid either over- or under-adaptation.

The project publications contributed to the IPCC Working Group II report, and a number of EUCP scientists directly participated as contributing authors.

Project coordinator & participating countries:
Met Office (UK)
France, Netherlands, Germany, Sweden, Italy, Switzerland, Spain, Denmark

Total investment / EU contribution:
EUR 12 999 515 / EUR 12 999 515

Start & End dates (Duration):
Dec 2017 to May 2022 (4 years & 6 months)

Website:
http://eucp-project.eu

EXHAUSTION

Project Name:
Exposure to heat and air pollution in Europe: cardiopulmonary impacts and benefits of mitigation and adaptation

Description:
The EXHAUSTION project has five overarching goals in support of the IPCC process:

a. study the quantitative relationship between ambient temperature and cardiopulmonary mortality and morbidity in European populations;

b. study to what extent air-pollution exposure modifies the relationship between temperature and health;

c. project the health burden due to extreme heat and air pollution (including from wildfires);

d. calculate the associated socioeconomic consequences of the health burden;

e. identify effective strategies for minimizing adverse impacts.

The project has contributed to the IPCC Working Group II report in several ways, including by providing global datasets on climate extreme indices and heat stress indicators, estimates of the mortality burden associated with non-optimum temperatures (like the burden attributable to climate change), estimates of the economic costs of heat-induced reductions in worker productivity, or an assessment of the importance of air conditioning in reducing sensitivity to heat stress.

Project coordinator & participating countries:
CICERO Center for International Climate Research (Norway)
Denmark, Germany, Portugal, Romania, Greece, UK, Luxembourg, Italy, Finland

Total investment / EU contribution:
EUR 6 573 508 / EUR 6 573 508

Start & End dates (Duration):
June 2019 to May 2023 (4 years)

Website:
http://www.exhaustion.eu

COMPOUND, CASCADING IMPACTS and RISKS

In its latest reports, the IPCC warns that the impacts and risks of climate change are becoming increasingly complex and more difficult to manage. The Panel also emphasises that with rising temperatures multiple climate hazards will occur simultaneously, and different (climatic and non-climatic) risks will interact, exacerbating the overall risk and leading to risks cascading across sectors and regions. Some interventions to address climate change will also result in new impacts and risks, highlighting the need to carefully design and evaluate available options and policy responses.

Resonating with these messages, there is increasing scientific evidence on Europe's sensitivity to remote climate hazards: tropical cyclones are disrupting industrial production and supply chains, droughts are putting pressure on our food and feed security, and natural disasters are harming workforce in developing countries, on which we depend. Due to their intrinsic complexity, the costs associated with these risks have been systematically underestimated. Whereas the COVID-19 pandemic has painfully exposed some of Europe's vulnerabilities associated with globalisation, it has also provided lessons that enable the continent to rethink how to prepare for global, high-impact cascading disruptions triggered by climate change.

> "The IPCC warns that the impacts and risks of climate change are becoming increasingly complex and more difficult to manage."

The science is clear: we need to treat climate change as a systemic risk, threat multiplier and continue to improve our understanding of not only its direct environmental impacts, but also of the potential spillover effects, including macro-fiscal ones, that might not always be obvious. The EU is funding R&I projects developing new tools, assessments, and projections that play an important role in increasing the awareness about the significance and implications of climate-related hazards, in helping to account for them more holistically in various thematic policies and in promoting climate resilient development. Their findings are an important source of information to mainstream climate resilience considerations across EU thematic and sectorial policies that deal with economic and financial stability, civil protection and humanitarian aid, external development and other important policy areas. In this way, the projects act as enablers of a more systemic approach to climate adaptation, which is one of the key pillars of the EU Adaptation Strategy.

CASCADES

Project Name:
CAScading Climate risks: towards ADaptive and resilient European Societies

Description:
CASCADES generated knowledge on cross-border and cross-sectoral climate impacts that propagate through trade, political, and financial channels, and that have the potential to alter Europe's risk exposure. The project contributed work on cross-sectoral exposure to climatic hazards at different levels of warming, and how these may affect future generations. CASCADES also focused on quantifying climate impacts on ice roads in permafrost areas for which no multi-model-based projections existed so far. The project developed a conceptual framework to help describe and analyse the impacts, and to inform adaptation policies.

Due to their extreme complexity, these cross-impacts have not been widely studied in scientific literature, which instead has focused on direct climate impacts — a knowledge gap recognised by the IPCC. CASCADES filled in this gap, producing research papers in support of IPCC 6th Assessment Report and contributing to the Working Group II report.

Project coordinator & participating countries:
Potsdam Institute for Climate Impact Research (Germany)
United Kingdom, Austria, Sweden, Netherlands, Finland, Italy, Poland, Switzerland, Spain

Total investment / EU contribution:
EUR 6 944 384 / EUR 6 944 384

Start & End dates (Duration):
September 2019 to August 2023 (4 years)

Website:
https://www.cascades.eu/

RECEIPT

Project Name:
REmote Climate Effects and their Impact on European sustainability, Policy and Trade

Description:
RECEIPT is mapping connections between European socio-economic activities and remote climatic hazards, aiming at providing quantitative information on the European risks from remote climatic events. The project will develop a map of global hotspots of remote areas with climatic features relevant for Europe, and scientific narratives describing the impact on Europe's food security, financial sector, international development and coastal infrastructure. It will deliver a Europe-wide socio-economic risk assessment showing the differences between high-end and moderate climate change conditions.

Several partners supported the IPCC assessment reports as lead or contributing authors. Publications on food security impacts of export restrictions, impact of multiple hazards on the global trade and production networks, and strategies to increase societal resilience produced by the project were also cited in the Working Group II report.

Project coordinator & participating countries:
Stichting Deltares (Netherlands)
Austria, Germany, Norway, Italy, United Kingdom, Belgium, Switzerland, Poland, Austria

Total investment / EU contribution:
EUR 6 998 996 / EUR 6 998 996

Start & End dates (Duration):
September 2019 to August 2023 (4 years)

Website:
http://climatestorylines.eu/

EXTREME EVENTS and OVERSHOOTING

The risks and extremes will worsen with rising temperatures. IPCC warns that exceeding 1.5°C warming will expose many human and natural systems to additional severe risks, compared to remaining below this important threshold. The Panel underlines the benefits of near-term mitigation as a way to substantially reduce projected losses and damages related to climate change. The ultimate message from the scientific community is therefore very powerful: "there are clear benefits to keeping warming to 1.5ºC rather than 2ºC or higher. Every bit of warming matters".

Climate change increases the frequency and intensity of extreme weather and climate events. It also changes the spatial extent and location of extreme events, which can occur over wider regions or in previously unheard-of areas, as well as their duration and timing, so they last longer and happen earlier or later in the season. While understanding extreme events is key to prepare for and avoid the worst impacts, it is challenging because these events are location- and context-specific.

> "There are clear benefits to keeping warming to 1.5ºC rather than 2ºC or higher. Every bit of warming matters."

In this challenging context, it is critical that we leverage all the instruments in our toolbox to accelerate progress in building our adaptative capacities as highlighted by the EU Adaptation Strategy. It also requires continuation of efforts on strengthening coherence and synergies between climate adaptation and the broader work on disaster risk reduction as part of various policy efforts, including the Union Civil Protection Mechanism and the Sendai Framework for Disaster Risk Reduction at an international level. New instruments such as Destination Earth and Digital Twins hold great promise and can be leveraged to boost our understanding of present and future climate extremes at planetary and local scale.

EU-funded research plays an important role in these efforts by improving our understanding of both extreme events and the consequences of future warming trajectories, and by making this knowledge available for guiding policy responses. Projects are developing innovative models, tools and methods with improved accuracy and more detailed information on weather extremes, but also on vulnerability and resilience. Their outputs are essential to design disaster risk management strategies to protect natural resources, sensitive economic sectors such as agriculture, water or energy, critical infrastructure and civil society. In their work, they are applying the latest digital breakthroughs such as artificial intelligence, machine learning and high-performance computing to enable effective approaches to adaptation.

XAIDA

Project Name:
Xtreme events: Artificial Intelligence for Detection and Attribution

Description:
Heatwaves in Europe remained deadly during several extremely hot summers in the recent past, even after the implementation of adaptation measures. XAIDA unites attribution, artificial intelligence, convection-permitting climate modelling, and a strong interaction with stakeholders to improve climate risk assessment in a timely fashion. Through sustained communication on extremes, and the development of methods to understand extremes, the ambition is to feed impactful climate services.

The project's objectives therefore are:

a. characterize, detect, attribute, and project extreme events with a novel impact-based approach;

b. assess their underlying causal pathways and physical drivers;

c. assess new event types and develop storylines of yet-unseen but physically-plausible events for present and future climates.

In its research programme, XAIDA has a particular focus on developing new data-driven methods to simulate impacts from weather and other factors, thus contributing to IPCC Working Group II's science base.

Project coordinator & participating countries:
Centre National de
la Recherche Scientifique (France)
Switzerland, Netherlands, United Kingdom, Germany, Spain

Total investment / EU contribution:
EUR 5 999 241 / EUR 5 999 241

Start & End dates (Duration):
September 2021 to August 2025 (4 years)

Website:
https://xaida.eu

FIREURISK

Project Name:
Developing a holistic, risk-wise strategy for European wildfire management

Description:
Wildfires constitute a reality affecting a significant part of the European and global populations, causing considerable ecological and atmospheric impacts, with almost one third of the global landmass experiencing recurrent fires. Although wildfires are a natural and even necessary ecosystem process, they may also pose a significant threat, leading to negative consequences and severe damages.

To address the new wildfire risk conditions in Europe it is imperative to focus on improving our understanding of the vulnerability and resilience of communities and countries at a variety of spatial and temporal scales. Such risks comprise human casualties (morbidity and mortality), cultural and economic losses, social disruption, major infrastructure damage, and deterioration of natural capital and biodiversity. The main objective of FIREURISK is therefore to develop, test, and disseminate an integrated, science-based strategy for wildfire risk management in Europe.

Project coordinator & participating countries:
Associação Para O Desenvolvimento Da Aerodinâmica Industrial (Portugal)
Spain, Greece, Italy, Finland, Germany, France, Sweden, Netherlands, United Kingdom, Cyprus, Bulgaria, Ukraine, Israel, Romania, Croatia, Australia, Canada

Total investment / EU contribution:
EUR 10 539 794 / EUR 10 271 044

Start & End dates (Duration):
April 2021 to March 2025 (4 years)

Website:
https://fireurisk.eu/

PROVIDE

Project Name:
Paris Agreement overshooting: reversibility, climate impacts and adaptation needs

Description:
PROVIDE will address a knowledge gap identified in the IPCC Special Report on Global Warming of 1.5°C: the distinct impacts of different overshoot scenarios depending on a) the peak temperature of the overshoot; b) the length of the overshoot period; and c) the rate of change in global temperature over the time period of the overshoot.

The project will use an innovative multi-scenario framework and a risk-threshold-centered approach to assess the impacts and quantify adaptation needs, options and costs, accounting for local socio-economic vulnerabilities, adaptive capacity, sectoral and urban development challenges as well as uncertainty about impact reversibility for a wide range of overshoot pathways. Co-development with local and regional actors will ensure that perspectives of decision-makers and stakeholders are fully incorporated. Overshoot proofing of existing adaptation strategies will establish concrete examples of how to reduce vulnerabilities and enhance adaptation action.

Several researchers funded under the project participated as lead or contributing authors in IPCC reports.

Project coordinator & participating countries:
Humboldt-Universität zu Berlin (Germany)
Switzerland, France, United Kingdom, Belgium, Portugal, Austria, Norway, Pakistan, Canada

Total investment / EU contribution:
EUR 6 019 538 / EUR 5 994 538

Start & End dates (Duration):
September 2021 to August 2024 (3 years)

Website:
https://www.provide-h2020.eu/

ADAPTATION MEASURES and ENABLING SOLUTIONS

REGIONAL and CROSS-CUTTING MEASURES

As underlined in the previous sections, adaptation responses must be tailored to each particular context to be effective. For example, within Europe, the Mediterranean basin will have very different needs than the Atlantic coast, whereas adaptive measures in cities will not be the same as those on agricultural land. The wide range of climate risks, and combinations thereof, call for a diverse portfolio of flexible, scalable and replicable solutions that can be adjusted to local circumstances. This is why cross-fertilisation and exchange of knowledge between all relevant stakeholders about best practices, but also about what doesn't work and for which reasons is so essential if we are to be successful in scaling adaptation efforts rapidly.

As the effects of climate change are becoming ever more intense, the EU Adaptation Strategy emphasises the urgency to step up our efforts by combining soft measures such as awareness raising, governance improvements and conducive policy frameworks with accelerated roll out of breakthrough solutions that include nature-based approaches to reduce the impacts of climate extremes, upgrading our water management systems to better cope with storm overflows and droughts, innovative insurance schemes to hedge against climate risk, early warning systems, advanced climate analytics and many others.

> "The wide range of climate risks call for flexible, scalable and replicable solutions that can be adjusted to local circumstances."

The EU R&I is heavily investing in developing innovative solutions and climate services that help reduce climate risks and increase protection. The EU Mission on Adaptation to Climate Change is at the heart of these efforts. It focuses on building regional adaptation pathways together with designing, testing and deploying place-based solutions to support adaptation at the local level. Some of the examples in this chapter are part of the first projects of the Mission piloting a local approach to Europe-wide climate challenges like water management, food and crop security, or disaster risk resilience. The rationale behind the Mission is to create an inclusive and vibrant community of practice that will share lessons-learnt and join forces to overcome the fragmentation and systemic challenges inherent to the European adaptation landscape by engaging, mobilising and connecting local actors across the continent.

ARSINOE

Project Name:
Climate-resilient regions through systemic solutions and innovations

Description:
ARSINOE seeks to develop actionable solutions and to foster an innovation ecosystem to further climate resilience and enable adaptation to climate change across Europe. The project employs a holistic approach focused around an intelligent, data-driven, multi-system, dynamic modelling framework. This approach integrates technological, digital, economic, social, governance, and environmental aspects with social innovation, building regional adaptation pathways in compliance with the goals of the EU Green Deal and the regional climate impacts highlighted by the IPCC.

Uniquely, ARSINOE connects innovators and end-users in different European regions to create novel innovation packages, business models, and implementation concepts that promote sustainability and growth through European cross-fertilization. Demonstrators are developed and tested for applicability, reproducibility, potential, and effectiveness in nine highly diverse European regions that represent a large spread of vulnerabilities, risks, and adaptation challenges for economic sectors and ecosystems.

Project coordinator & participating countries:
Panepistimio Thessalias (Greece)
United Kingdom, Denmark, France, Germany, Netherlands, Spain, Turkey, Italy, Bulgaria, Cyprus, North Macedonia, Albania, Romania, Belgium

Total investment / EU contribution:
EUR 15 643 021 / EUR 14 834 277

Start & End dates (Duration):
October 2021 to September 2025 (4 years)

Website:
https://www.arsinoe-project.eu

IMPETUS

Project Name:
Dynamic information management approach for the implementation of climate resilient adaptation packages in European regions

Description:
IMPETUS will develop and validate a coherent, multi-scale, multi-level, cross-sectoral climate change adaptation framework to accelerate the transition towards a climate-neutral and sustainable economy. The project's Resilience Knowledge Boosters will build a robust stakeholders' community complemented with reliable data and assessment methods to support decision- and policy-making. Communities will thus be empowered to co-design, assess, deploy, and monitor climate adaptation Innovation Packages.

IMPETUS will span all 7 EU biogeographical regions —continental, coastal, Mediterranean, Atlantic, Arctic, boreal, and mountainous— thus covering all key community systems, climate threats, and multi-level governance. The project will implement and validate specific measures to adapt to and mitigate climate change, like multi-functional wetlands, controlled environmental agriculture, sand dunes restoration, post-fire restoration of forests, heat awareness, or assessment of economic impacts.

Project coordinator & participating countries:
Fundación Eurecat (Spain)
Norway, Germany, Greece, Italy, Netherlands, Latvia, France, Switzerland

Total investment / EU contribution:
EUR 16 224 768 / EUR 14 872 468

Start & End dates (Duration):
October 2021 to September 2025 (4 years)

Website:
https://climate-impetus.eu/

MYRIAD-EU

Project Name:
Multi-hazard and sYstemic framework for enhancing Risk-Informed mAnagement and Decision-making in the EU.

Description:
The objective of MYRIAD-EU is to catalyse the paradigm shift required to move towards a multi-risk, multi-sector, systemic approach to risk management, instead of addressing risks and hazards independently. The project will develop forward-looking disaster risk management and climate adaptation pathways that assess the trade-offs and synergies of various strategies across sectors, scales, and hazards.

The interlinkages between the different hazards and sectors will be studied in 5 pilot projects throughout Europe: Scandinavia, the North Sea, the Canary Islands, the Danube region, and the Veneto region. Each pilot will address at least 3 of the following socio-economic sectors: infrastructure and transport, food and agriculture, ecosystems and forestry, energy, finance, or tourism.

The project will deliver open-source software for multi-hazard multi-risk scenario generation, and policy recommendations.

Project coordinator & participating countries:
Vrije Universiteit Amsterdam (Netherlands)
Italy, Austria, Germany, United Kingdom, Norway, Belgium, Spain, Romania

Total investment / EU contribution:
EUR 4 999 802 / EUR 4 999 802

Start & End dates (Duration):
September 2021 to August 2025 (4 years)

Website:
https://www.myriadproject.eu

BRIGAID

Project Name:
BRIdges the GAp for Innovations in Disaster resilience

Description:
BRIGAID's objective was to bridge the gap for innovations in disaster resilience by providing integral, on-going support for climate adaptation innovations. The project has guided the development of innovations from prototype to commercial deployment by providing methods and tools designed to increase social, technical, and market readiness. The resources developed have also been made available for future innovators, and take the form of three "pillars of support": a) a testing and implementation framework to evaluate and enhance innovations; b) a business development and financing framework for increasing market readiness; c) resources to boost market outreach to end-users and innovators, such as an online innovation sharing platform.

BRIGAID has helped in the development, marketing, and implementation of some of the most promising climate disaster resilience innovations in Europe, leveraging technologies such as drones, 3D printing, blockchain, IT applications, machine learning, and biological systems. Some are still in pre-commercial stage, while others have reached the market and are being implemented.

Project coordinator & participating countries:
Technische Universiteit Delft (Netherlands) Belgium, Italy, Germany, Portugal, United Kingdom, Spain, Israel, Albania, Romania, Greece, Poland

Total investment / EU contribution:
EUR 8 817 445 / EUR 7 739 805

Start & End dates (Duration):
May 2016 to September 2020
(4 years & 5 months)

Website:
https://cordis.europa.eu/project/id/700699

BUILDING CLIMATE-RESILIENCE IN WATER and AGRICULTURE SECTORS

Water is the primary medium through which we experience the effects of climate change, and it will play a pivotal role not only in how the world adapts to, but also how it mitigates rising temperatures given that water availability will limit the range of available options.

Already at the current levels of warming, water availability is becoming less predictable in many places. IPCC warns that, in the future, increases in frequency, intensity and severity of droughts, floods and heatwaves, combined with continued sea-level rise will expose millions of people to acute water and food insecurity with a high risk of triggering conflicts, political instability and refugee crises. In the agri-food systems, water-related risks add to other pressures associated with climate change such as increased vulnerability to crop failure and pest damage.

> "More frequent and intense droughts, floods and heatwaves, combined with sea-level rise, will expose millions to acute water and food insecurity, triggering instability and conflict."

We also know that despite ambitious mitigation efforts, Europe will not be spared from water-related challenges: IPCC cautions that one of the key risks for the continent in the coming decades is water scarcity in southern and western central part of the continent, with significant human, economic and ecological losses. On the other hand, above 3°C warming, coastal flood damage is projected to increase at least 10-fold by the end of the 21st century. In this context, it does not come as a surprise that water gets particular attention in the EU Adaptation Strategy.

Against this backdrop, the EU is taking action to make our water management and agriculture systems more resilient to climate change while fostering synergies with other policy objectives such as climate change mitigation, sustainable land-use and food security. EU-backed projects are developing innovative and cost-effective adaptation measures such as tailor-made climate services, improved early warning systems, solutions to manage and save water as well as more climate-resilient crop varieties and agricultural practices, harnessing the potential of digitalisation and other cutting-edge technologies such as artificial intelligence and precision farming. Water is also one of the key priority sectors in the focus of the EU Mission on Adaptation to Climate Change.

While much of EU-funded research focuses on the specific impacts in Europe, some projects are geared towards supporting adaptation of the most vulnerable populations world-wide, in particular in low-income countries such as those located in Sub-Saharan Africa. These efforts contribute to the international dimension of the EU Adaptation Strategy and the broader EU-Africa partnership.

TRANSFORMAR

Project Name:
Accelerating and upscaling transformational adaptation in Europe: demonstration of water-related innovation packages

Description:
The IPCC Special Report on Global Warming of 1.5°C demonstrates that, even in a best-case scenario of sustained emissions reductions, there will be large stress on agri-food systems, infrastructure, ecosystems, and public health due to unavoidable climate impacts. To reduce climate-related risks, transformational adaptation is needed: TRANSFORMAR's overarching goal is to upscale and accelerate this process.

Building on existing successful initiatives, the project will address water-related risks and impacts of climate change through six lighthouse demonstrator regions and communities that will test solutions. A full-scale socio-economic impact assessment of climate change impacts and adaptation pathways, downscaled to the demonstrator scale, will generate novel insights, especially on water challenges due to climate change.

Project coordinator & participating countries:
University of Antwerp (Belgium)
Italy, France, United Kingdom, Finland, Spain, Germany, Greece, Czechia, Norway, Malta

Total investment / EU contribution:
EUR 12 700 000 / EUR 11 900 000

Start & End dates (Duration):
October 2021 to September 2025 (4 years)

Website:
https://www.transformar.eu

RESCCUE

Project Name:
RESCCUE - RESilience to cope with Climate Change in Urban arEas - a multisectorial approach focusing on water

Description:
RESCCUE aimed at helping cities around the world to become more resilient to physical, social, and economic challenges by focusing on the water sector. The project developed methodologies and tools to support cities in their resilience-building process, focusing on three target cities: Barcelona, Bristol, and Lisbon.

RESCCUE used abundant, extensive, and reliable climate data —both from observations and from climate projections— that were downscaled to local level to feed different hazard models, including complex, cascading, and compound disasters. Hazards were assessed through newly developed sectorial, integrated- or loosely-coupled models of fluvial and tidal floods, which helped in identifying their cascading effects on urban services and critical infrastructures. These results were fed into impact models to perform comprehensive risk assessments —including tangible and intangible damages like socio-economic— and to evaluate the hazard reduction achieved by implementing adaptation strategies

Project coordinator & participating countries:
Aquatec Proyectos para el
Sector del Agua SA (Spain)
United Kingdom, Portugal, Kenya, France

Total investment / EU contribution:
EUR 8 057 266 / EUR 6 896 991

Start & End dates (Duration):
May 2016 to November 2020
(4 years & 7 months)

Website:
https://toolkit.resccue.eu/

MED-GOLD

Project Name:
Turning climate-related information into added value for traditional MEDiterranean Grape, OLive and Durum wheat food systems

Description:
Agriculture is weather-driven and climate-constrained, with expected increased vulnerability to crop failure and pest damage under climate change. In the Mediterranean region, higher than average projected climate change will further threaten an extremely rich and intertwined biological and cultural diversity. The long-term goal of MED-GOLD was to make European and global agriculture and food systems more resilient to climate change through the use of climate services, which it demonstrated through case studies for three major Mediterranean food systems: grapes and wine, olives and olive oil, and durum wheat and pasta.

Main outcomes of MED-GOLD include prototype climate services co-produced and tested with major industrial players of the global food system, using MED-GOLD methods for user engagement, cloud-based processing, and visualization of data. This enabled unprecedented replicability and scalability across regions, sectors, and users, as tested in Colombia for coffee

Project coordinator & participating countries:
Agenzia Nazionale Per Le Nuove Tecnologie, L'energia E Lo Sviluppo Economico Sostenibile (Italy)
United Kingdom, Spain, Belgium, Portugal, Greece, Colombia

Total investment / EU contribution:
EUR 4 990 967 / EUR 4 990 967

Start & End dates (Duration):
December 2017 to May 2022
(4 years & 6 months)

Website:
https://www.med-gold.eu

DOWN2EARTH

Project Name:
Translation of climate information into multilevel decision support for social adaptation, policy development, and resilience to water scarcity in the Horn of Africa Drylands

Description:
DOWN2EARTH is addressing the multi-faceted challenges of water scarcity and food insecurity within the context of climate change in the Horn of Africa Drylands by facilitating community-centred adaptation and resilience. It uses a multidisciplinary, inclusive approach, bringing together local communities, academic experts, novel decision-support tools, multi-level governance structures, regional climate centres, and NGOs. It will deliver state-of-the-art and community-relevant climate services that focus on water scarcity and its consequences for increasingly vulnerable rural populations in the most vulnerable countries (Kenya, Somalia, Ethiopia).

Directly aligned with the IPCC Working Group II, the research activities proposed are aimed at improving regional climate services and promoting adaptation to climate change through new and enhanced decision-support tools, capacity building, citizen science, information dissemination, expansion of data networks, and climate change adaptation policy implementation.

Project coordinator & participating countries:
Cardiff University (United Kingdom)
Kenya, United Kingdom, Netherlands, Belgium, Italy, Germany, Denmark, Ethiopia

Total investment / EU contribution:
EUR 6 645 663 / EUR 6 645 663

Start & End dates (Duration):
September 2020 to August 2024 (4 years)

Website:
https://www.down2earthproject.org

CONFER

Project Name:
Co-production of Climate Services for East Africa

Description:
East Africa is highly vulnerable to the impacts of climate change because climatic factors, especially rainfall, dictate the quantity and quality of water resources in the region. CONFER co-produces new climate services for East Africa —encompassing 11 countries and about 365 million people— focused on water, energy, and food security. The services are co-designed with stakeholders and end-users to enhance their ability to plan for and adapt to seasonal climate fluctuations.

To build capacity, CONFER includes an extensive training programme, building on earlier initiatives and targeting practitioners and journalists. The services will be disseminated to all the national meteorological and hydrological services in the region, which work with boundary organizations to provide tailored support to end-users such as farmers, fishers, dam operators, or watershed managers. Used in the frontline of climate change impacts, the project will build resilience to climate change impacts like crop failures, livestock loss, migration, or famines.

Project coordinator & participating countries:
Norce Norwegian Research Center AS (Norway)
Kenya, United Kingdom, South Africa, Germany

Total investment / EU contribution:
EUR 6 999 177 / EUR 6 999 177

Start & End dates (Duration):
September 2020 to February 2024
(3 years & 6 months)

Website:
https://www.confer-h2020.eu

NATURE-BASED SOLUTIONS FOR ADAPTATION

Examples of nature-based solutions (NBS) for climate resilience include floodplain restoration to reduce inundation risks, coastline stabilisation by means of vegetation such as mangroves or green urban spaces that alleviate heat island effects, improve water storage and discharge capacity. NBS, however, hold significant potential not only to reduce climate risks, but also to mitigate warming through their carbon sink function, while simultaneously improving our lives through other co-benefits such as better health and well-being as well as provision of quality jobs and business opportunities.

These multiple advantages make NBS a "no-regret" option in the policy toolbox and the concept is increasingly recognised and mainstreamed across global and EU policy frameworks. The importance of NBS is also powerfully acknowledged by the IPCC, which asserts that safeguarding and strengthening nature is key to securing a liveable future. This is well reflected in the EU Strategy on adaptation to climate change, which recognises NBS as a key enabler of more systemic approaches to adaptation. However, despite the rapidly expanding knowledge base, the wider deployment of NBS hinges on overcoming barriers related to financing, replicability, but also better accounting of non-market benefits in countries' macro-fiscal policies.

"The importance of NBS is also powerfully acknowledged by the IPCC, which asserts that safeguarding and strengthening nature is key to securing a liveable future."

It is also crucial to recall that while offering a valuable adaptation solution, NBS themselves depend on healthy ecosystems, and so their potential is vulnerable to climate change and may decline in the future. Indeed, the latest IPCC conclusions underscore the importance of the interdependence of climate, biodiversity and human systems and call for more integrated policy approaches that build on insights from natural, social and economic sciences.

To accelerate the deployment of NBS for climate resilience, EU funded R&I investigates the best ways for applying them at scale and for various climate hazards and tackles essential barriers such as valuation of NBS benefits, development of technical standards, innovative business, governance and financing models, or improved understanding of NBS vulnerability to climatic changes, among others. Projects involve stakeholders, co-design tools to increase awareness, build capacity, create societal and political acceptance and drive demand for NBS. In parallel, the Mission on Adaptation to Climate Change will be demonstrating NBS in various contexts to de-risk their large-scale uptake and to make them an essential component of a systemic transformation towards a climate resilient future.

NAIAD

Project Name:
NAture Insurance value: Assessment and Demonstration

Description:
NAIAD's overarching goal was to identify how nature can help reduce the risks from floods and droughts, which are likely to become more frequent and intense due to climate change, through the involvement of the insurance sector as a key actor, thereby contribution to closing the climate protection gap. The project's objectives were:

a. to further our understanding on the insurance value of nature for risk reduction;

b. to develop a series of tools and methods to operationalise natural assurance schemes, showing how a more resilient ecosystem can help adaptation efforts;

c. to identify nature's significantly untapped potential as part of our adaptation options.

NAIAD used rural and urban cases across Europe at different scales: from large basins like the Danube or aquifers like Medina del Campo, through cities like Lodz or Montpellier, to small neighbourhoods in the city of Rotterdam. Several papers published by the consortium were cited in the latest IPCC Working Group II report, and its researchers further contributed as leading or contributing authors.

Project coordinator & participating countries:
Confederación Hidrográfica Del Duero (Spain) France, United Kingdom, Sweden, Denmark, Germany, Netherlands, Slovenia, Romania, Italy, Poland

Total investment / EU contribution:
EUR 5 081 176 / EUR 4 994 370

Start & End dates (Duration):
December 2016 to August 2020
(3 years & 8 months)

Website:
https://www.naiad2020.eu

RECONECT

Project Name:
Regenarating ECOsystems with Nature-based solutions for hydro-meteorological risk rEduCTion

Description:
RECONECT aims at stimulating a new culture of co-creation for land-use planning by linking hydro-meteorological risk reduction with local and regional development objectives in a sustainable and financially viable way. The project will also demonstrate and evaluate the multiple benefits of NBS within a network of cases covering a diverse range of local conditions, geographical characteristics, institutional/governance structures, and socio-cultural settings to successfully upscale NBS throughout Europe and internationally.

RECONECT supports the IPCC Working Group II in several ways:

a. providing knowledge and evidence base on NBS to enhance local, regional, and international policies and to support co-creation, replication, and upscaling of large-scale NBS;

b. developing new approaches for selection, allocation, and design of NBS for hydro-meteorological disaster risk reduction and climate change adaptation;

c. strengthening the capacity of relevant institutions and industry partners in implementing and assessing NBS;

d. mainstreaming NBS in land-use planning, landscaping, and territorial policies by developing holistic ecosystem-based frameworks.

Project coordinator & participating countries:
Stichting IHE Delft Institute for Water Education (Netherlands)
Germany, Italy, Denmark, United Kingdom, Belgium, Austria, Switzerland, Bulgaria, Spain, Serbia, France, Croatia, Sweden, Poland, Thailand, Malaysia, Taiwan

Total investment / EU contribution:
EUR 15 399 379 / EUR 13 520 689

Start & End dates (Duration):
September 2018 to August 2024 (6 years)

Website:
http://www.reconect.eu/

PHUSICOS

Project Name:
According to nature: solutions to reduce risk in mountain landscapes

Description:
PHUSICOS will demonstrate how NBS are effective in reducing the risk posed by extreme weather events on rural mountain landscapes: floodings, landslides, erosion, and snow avalanches. To assess technical innovations, the project developed an assessment framework with indicators relevant for disaster risk reduction that include not only technical feasibility, but also the impact on ecosystems, society, and the local economy.

The project also focuses on social and governance to facilitate NBS interventions, engaging with stakeholders through a co-design approach and promoting multi-scale and cross-sectoral collaboration. This includes novel governance arrangements that cut across organisational responsibilities and sectors, achieving benefits beyond disaster risk reduction.

The PHUSICOS researchers have participated as lead authors in the IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation.

Project coordinator & participating countries:
Stiftelsen Norges Geotekniske Institutt (Norway)
Italy, Germany, Austria, France, Switzerland, Spain

Total investment / EU contribution:
EUR 9 633 000/ EUR 9 472 200

Start & End dates (Duration):
May 2018 to April 2023 (5 years)

Website:
https://www.phusicos.eu

GROW GREEN

Project Name:
Green cities for climate and water resilience, sustainable economic growth, healthy citizens and environments

Description:
GROW GREEN will deliver an easy-to-use, replicable approach to support the development and implementation of NBS strategies in cities, contributing to their deployment at scale across Europe. Three demonstration projects will develop an evidence base to show how NBS in cities provide a cost-effective, sustainable mean of increasing urban climate and water resilience whilst delivering other co-benefits such as improvements in biodiversity, social and economic conditions. The project will also work closely with the Chinese city of Wuhan recognising its role as one of the "Chinese Sponge Cities".

GROW GREEN delivers evidence base that further supports IPCC Working Group II findings that adaptation actions using NBS generate multiple additional benefits around health, wellbeing, and social cohesion. It also promotes coordinated cross-sectoral policies that combine mitigation, adaptation, and sustainable development through the integration of NBS in Climate Change Action Plans, rather than as a free-standing strategy.

Project coordinator & participating countries:
Manchester City Council (United Kingdom)
Poland, Spain, France, Croatia, Italy, China

Total investment / EU contribution:
EUR 11 514 817 / EUR 11 224 058

Start & End dates (Duration):
June 2017 to November 2022
(5 years & 5 months)

Website:
https://www.growgreenproject.eu

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Climate change is one of the greatest threats facing humanity, and the window to take action and secure a liveable future is closing fast. The European Commission presented in 2021 its new EU Strategy on adaptation to climate change, setting out how the EU can adapt to the unavoidable climate impacts. Through the Framework Programmes for Research and Innovation (Horizon 2020 and Horizon Europe), the EU has already made significant contributions to improve our understanding of the changing climate and provide innovative adaptation solutions. Building on the release of the IPCC Working Group II report "Climate Change 2022: Impacts, Adaptation and Vulnerability", this brochure puts a spotlight on and celebrates the contribution of EU-funded projects to pushing the boundaries of world-class adaptation science as a key ingredient towards climate resilient development and just transition for all.

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Science for Climate Action

EU Research Contribution to IPCC Working Group III on Mitigation

Assessing solutions, informing decisions

Research and Innovation

Science for Climate Action: EU Research Contribution to IPCC Working Group III on Mitigation

European Commission
Directorate-General for Research and Innovation
Directorate B — Healthy Planet
Unit B.3 — Climate & Planetary Boundaries

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Manuscript completed in March 2022.
1st edition.

Print	ISBN 978-92-76-49048-7	doi:10.2777/899304	KI-05-22-060-EN-C
PDF	ISBN 978-92-76-49049-4	doi:10.2777/401703	KI-05-22-060-EN-N

Luxembourg: Publications Office of the European Union, 2022

EUROPEAN COMMISSION

Science for Climate Action

EU Research Contribution to IPCC Working Group III on Mitigation

edited by Katarzyna Drabicka and Alfonso Acosta Gonçalves

2022

Directorate-General for Research and Innovation
Horizon 2020

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INTRODUCTION

With the ever-worsening climate crisis unfolding worldwide, rapid and radical action is needed to limit the global temperature rise to well below 2°C in line with the Paris Agreement. The current decade is qualified by scientists as the make-or-break moment in the fight against global warming and its adverse, potentially catastrophic effects. The EU has set very ambitious targets to cut its greenhouse gas (GHG) emissions and make the European Union climate-neutral by 2050, securing a green, fair, and healthy future for all Europeans. This objective is at the heart of the European Green Deal and reflects the EU's commitment to global climate action.

Science, which first brought global warming to worldwide attention, will continue to play a central role in dealing with this existential challenge: its contribution will go well beyond provision of innovative climate-friendly solutions. Crucially, evidence from the research community will be needed, more than ever, to drive ambition, guide policy responses, and clarify the roles of different actors: from governments, through businesses, to local communities. Impartial and transparent science can be very powerful — it has the potential to change the way policymakers and people look at climate change and mobilise action. In this spirit, scientific findings formed the backbone of the Glasgow Pact, expressing more urgency, more alarm, and more concern about climate change and reflecting the principle that policy should follow science.

The year 2022 is a special year for climate science as it brings the finalisation of the milestone Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Reports, with the contributions of Working Groups II[1] and III, and the Synthesis Report. These reports will constitute the most authoritative references on the state of knowledge on climate change for the coming years and their importance cannot be overstated.

The IPCC, consisting of the world's leading climate scientists, plays a unique role within climate science and in informing policy decisions. First convened in 1988 by the United Nations and the World Meteorological Organisation, the IPCC is tasked to provide policymakers with regular, comprehensive, and authoritative scientific assessments on climate science knowledge, building on the work of hundreds of scientists worldwide.

So far, the Panel has produced five assessment reports and its work has been instrumental in creating a broad, evidence-based consensus, not only on the link between human activity and climate change, but also on the associated impacts, future risks, and options for adaptation and mitigation. The consecutive reports have seen an increased confidence on the findings, based on continuous progress in climate science and modelling, and have reinforced the warnings and calls for action. The IPCC reports thus represent an essential source of information for the implementation of the Paris Agreement.

1. https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/

The latest reports from the IPCC 6th Assessment cycle (AR6), consisting of three parts, is part-way through publication: the first instalment, on the physical science of climate change[2], was published in August 2021, delivering the starkest warning so far, described by the UN Secretary-General António Guterres as a "code red for humanity". The second part, focusing on impacts, adaptation and vulnerability did not paint a much brighter picture — it warns that any further delay in climate action "will miss a brief and rapidly closing window of opportunity to secure a liveable and sustainable future for all".

IPCC reports also provide an important guidance for the strategic programming of EU-funded research, helping to focus on the most pressing knowledge gaps and policy-relevant research.

The European Union, through its successive Framework Programmes for Research and Innovation (R&I), is among the top funders of the evidence base underpinning the IPCC reports. More broadly, EU-funded research plays an important role in addressing the key thematic areas the IPCC tackles by filling critical knowledge gaps, thereby increasing the robustness of research findings, and building consensus among the international scientific community. This way, EU-funded projects contribute to improving the effectiveness of both national and international climate policies and processes, including those underpinning the implementation of the Paris Agreement. They also play an important role in building public support for more ambitious climate action.

Coinciding with the approval of the IPCC Working Group III (WG III) report on Mitigation of Climate Change, this brochure puts a spotlight on and celebrates the contribution of EU-funded projects to pushing the boundaries of the underlying science. We provide examples of projects funded by the EU Horizon 2020 Framework Programme for Research and Innovation, specifically within its societal challenge "Climate action, resource efficiency and raw materials", which address issues of direct relevance to the Working Group III.

The highlighted projects address a broad range of topics to inform the transition to climate neutrality: from assessing methods for reducing emissions, enhancing their sinks, and removing GHGs from the atmosphere; through investigating which emissions pathways might be best for avoiding the worst climate outcomes; to advising on whether the proposed mitigation options are technically, economically, and socially feasible. Some explore mitigation options in specific sectors such as energy, agriculture, or transport, while others investigate the role of consumption and behavioural change, innovation, technology, or finance. Synergies and trade-offs with adaptation measures, sustainable development, and equity (within and between countries) are also increasingly important research areas addressed. Where available, information on the contribution to the evidence base referenced by the IPCC reports is also highlighted.

2. https://www.ipcc.ch/report/ar6/wg1/


EU
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SOCIAL ASPECTS
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NEGATIVE EMISSIONS
TRANSITION PATHWAYS
WORLD IMPACT
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SDGs
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SOCIO-ECONOMIC SCENARIOS AND TRANSITION PATHWAYS

The Paris Agreement and the European Green Deal are firmly anchored in scientific evidence. As we move forward with their implementation, it is essential that governments continue to champion science-based responses in line with state-of-art knowledge, to achieve a just and inclusive transition for all.

The European Climate Law commits the EU to become climate-neutral by 2050, in line with the goals set out by the European Green Deal. The law also sets an intermediate target by 2030 to reduce net GHG emissions by at least 55% compared to 1990 levels. In the spirit of evidence-based policymaking, it also provides for the establishment of a European Scientific Advisory Board on Climate Change that will provide independent scientific advice on EU climate measures and their adequacy.

Whereas the end goal is clear, the same is not necessarily true for its implementation given the many possible paths to climate neutrality. Different technological and non-technological choices exist, each implying distinct impacts on societies and ecosystems. Working out which is the best transition path is therefore a key challenge facing policymakers — a challenge that science can help navigate.

There are many scientific methods to investigate transformation pathways, but quantitative models, including "integrated assessment models" (IAMs) play a particularly important role. Such models are used to answer central questions about the green transition: from how the world needs to change to meet the Paris Agreement goals at the lowest cost, through mitigation options, to the implications of countries' pledges to cut emissions. The insights provided by these models are assessed in the IPCC reports and play a central role in the Working Group III assessment, as well as in the Special Report "Global Warming of 1.5°C" (SR1.5).

EU-funded research has been central in supporting the evolution of modelling tools to increase their policy relevance. This includes efforts to broaden the scope of mitigation options beyond the energy sector, like information technology, urban development, or healthier diets, and to better account for uncertainties such as future energy prices and innovation. And, while models are an essential decision-support tool for policymakers, the EU Research and Innovation also extends into other methods to mobilise effective mitigation action, including exploration of most effective governance models, feasibility analysis, and alternative economic paradigms to those based on GDP growth.

NAVIGATE

Project Name:
Next generation of AdVanced InteGrated Assessment modelling to support climaTE policy making.

Description:
IAMs play a central role in the assessment of mitigation pathways by the IPCC. NAVIGATE's overall objective is to develop the next generation of IAMs for informing EU and international climate policies. For the IPCC AR6, NAVIGATE partners contributed through several publications, covering the capabilities and gaps in IAMs; sources of uncertainty in scenarios; improved representation of sectors, inequality, and climate impacts in different models; and on carbon pricing. Our partners submitted global scenarios to the AR6 scenario database, and contributed with illustrative mitigation pathways in Chapter 3 of the report.

As an additional activity, NAVIGATE conducted a new diagnostic model comparison of IAMs, providing an important input for Chapter 3, on Mitigation Pathways Compatible with Long-term Goals, and the Annex on Models and Scenarios. Moreover, several members of the NAVIGATE consortium are authors of the WG III contribution to the AR6.

Project coordinator and participating countries:
Potsdam-Institut für Klimafolgenforschung e.V. (Germany).
Italy, Austria, Netherlands, France, Greece, United Kingdom, Switzerland, Sweden, Norway, Brazil, China, Poland.

Total investment / EU contribution:
EUR 6 998 342 / EUR 6 998 342

Start and End dates (Duration):
September 2019 to August 2023 (4 years)

Website:
www.navigate-h2020.eu

PARIS REINFORCE

Project Name:
Delivering on the Paris Agreement: A demand-driven, integrated assessment modelling approach.

Description:
Fully aligned with the scope of the IPCC Working Group III, PARIS REINFORCE has developed an integrated assessment modelling framework for effectively supporting the design and evaluation of climate mitigation policies, globally and in Europe, with respect to the objectives of the Paris Agreement. This framework is oriented towards enhancing the legitimacy of the scientific processes in support of climate policymaking, by co-creating the modelling exercises and improving the transparency of models, methods, and tools. It also develops novel methods and tailored processes for better-informed models and improved robustness of results against different types of climate and model-related uncertainties.

Based on this integrative scientific paradigm, PARIS REINFORCE has produced over 60 scientific publications, reporting and disseminating project outputs, as well as directly underpinning the majority of WG III chapters, with a focus on mitigation pathways, energy systems, innovation and its transfer, and broader sustainable development. Notably, the project has carried out several model inter-comparison exercises, directly feeding in the WG III scenarios database, with emphasis on trajectories accurately reflecting current policies and Nationally Determined Contributions (NDCs).

Project coordinator and participating countries:
National Technical University of Athens (Greece).
Spain, United Kingdom, France, Italy, Germany, Belgium, Netherlands, Norway, Switzerland.

Total investment / EU contribution:
EUR 7 830 242 / EUR 6 950 548

Start and End dates (Duration):
June 2019 to November 2022 (3 years 6 months)

Website:
www.paris-reinforce.eu

ENGAGE

Project Name:
Exploring National and Global Actions to reduce Greenhouse gas Emissions.

Description:
ENGAGE aims at co-producing knowledge for designing cost-effective, technologically sound, socially and politically feasible pathways that can meet the objectives of the Paris Agreement. It will also quantify avoided climate change impacts at regional and national levels, and identify concrete policy portfolios that maximise co-benefits and minimise trade-offs.

For AR6, national and sectoral model scenarios (on buildings, energy, land, and transport) were also targeted, engaging large portions of the climate research community. These scenarios' data are featured in almost half of the AR6 WG III chapters and the Summary for Policy Makers (SPM) figures, providing information on global emissions reductions, net-zero targets, and temperature outcomes. For example, out of some 1,200 long-term emissions scenarios assessed in Chapter 3, more than 500 were ENGAGE scenarios, and of the 9 Illustrative Pathways featured in the report, 3 are ENGAGE ones. Moreover, for the majority of modelling teams, this represented their first contribution to peer-reviewed results for the IPCC — an excellent example of capacity building.

The full database will be accessible to the public following the release of the SPM, for free download and exploration.

Project coordinator and participating countries:
Internationales Institut für Angewandte Systemanalyse (Austria).
Netherlands, Italy, Germany, Greece, Brazil, India, Hungary, China, Russia, Thailand, Vietnam, Indonesia, Japan, South Korea.

Total investment / EU contribution:
EUR 7 089 831 / EUR 7 089 831

Start and End dates (Duration):
September 2019 to August 2023 (4 years)

Website:
www.engage-climate.org

LOCOMOTION

Project Name:
Low-carbon society: an enhanced modelling tool for the transition to sustainability.

Description:
LOCOMOTION aims at enhancing an existing integrated assessment model, WILIAM, by increasing its capacity to assess the feasibility, effectiveness, costs, and impacts of sustainability policy options to identify the most effective transition pathways towards a low-carbon society. The WILIAM model will contribute to IPCC processes through:

- Diagnosis: evaluating policy impacts on society, economy, and the environment.
- Scenario assessment: assessing different energy transition pathways consistent with the standard scientific climate scenarios, testing and developing policies to implement the Paris Agreement. Alternative storylines such as "post-growth" and scenarios linked to the European Green Deal are also being analysed.
- Quantification of uncertainties.

LOCOMOTION researchers have participated as reviewers of the WG III report.

Project coordinator and participating countries:
Universidad de Valladolid (Spain).
Austria, Belgium, Croatia, Japan, Italy, Greece, Portugal, Norway, Austria, Iceland.

Total investment / EU contribution:
EUR 6 315 865 / EUR 6 315 865

Start and End dates (Duration):
June 2019 to May 2023 (4 years)

Website:
www.locomotion-h2020.eu

4i TRACTION

Project Name:
Innovation, Investment, Infrastructure and sector Integration: TRAnsformative policies for a ClimaTe-neutral European UnION.

Description:
The 4i-TRACTION project analyses what transformative EU climate policy could look like. It has four overarching objectives in support of the IPCC process:

1. a thorough assessment of the effectiveness of mitigation policies across the EU to achieve climate-neutrality;
2. identification of policy instruments capable of delivering transformative change;
3. developing transformation scenarios consistent with climate-neutrality;
4. developing a governance framework for implementing transformative policies.

4i-TRACTION is conducting ex-post evaluations of different policy instruments and how they contribute to transformative change towards climate neutrality. The project draws on the latest IPCC scenarios to understand and quantify the role of the 4 i's (innovation, investment, infrastructure, integration) in the transformation process. In order to translate findings from global scenarios to selected EU countries, 4i-TRACTION employs downscaling techniques to develop scenarios with higher regional and sectoral specificity that will be published and made accessible to the academic community.

Project coordinator and participating countries:
Ecologic Institut gemeinnützige GmbH (Germany).
Belgium, Germany, Netherlands, France, Finland, Poland, Spain.

Total investment / EU contribution:
EUR 3 997 068 / EUR 3 997 068

Start and End dates (Duration):
June 2021 to May 2024 (3 years)

Website:
www.4i-traction.eu

COP21 RIPPLES

Project Name:
COP21: Results and Implications for Pathways and Policies for Low Emissions European Societies.

Description:
COP21 RIPPLES analysed the implications of the post-COP21 global context with an interdisciplinary approach, combining analysis of the evolution of the international climate regime, emerging NDCs, and their socio-economic implications. The project addressed issues closely linked to the scope of IPCC WG III, including the development of evidence on: a) adequacy of the NDCs; b) implications of NDCs and more ambitious mitigation pathways on other European socio-economic objectives; and c) adequacy of the outcomes of COP21 from a governance-perspective.

Overall, the project contributed to clarify the required actions and available pathways to meet the Paris Agreement mitigation goals, as well as strategies that can drive higher ambition at national, EU, and global levels. It provided scientific input to better understand the nature of the ambition gap, and options for addressing it. Several COP21 RIPPLES publications were cited in the WG III report, including papers on social and developmental aspects of mitigation, governance, or the needs for a whole-systems approach to the financial sector.

Project coordinator and participating countries:
Fondation Institut De Recherche Pour Le Developpement Durable Et Les Relations Internationales (IDDRI) (France).
United Kingdom, Belgium, Germany, Italy, Poland, South Africa, Brazil, China, Bulgaria.

Total investment / EU contribution:
EUR 2 986 923 / EUR 2 986 923

Start and End dates (Duration):
December 2016 to January 2020 (3 years 2 months)

Website:
www.cop21ripples.climatestrategies.org

SECTORIAL TRANSFORMATIONS AND TECHNOLOGY TRANSITIONS

The transition to climate neutrality is an immense challenge, demanding deep transformations across all key sectors of the economy. It requires profound changes in energy supply and demand, but also a fundamental restructure of the way land, water, and other resources are managed. However, it is also an opportunity to build a better and more equitable future.

Fossil fuels must be phased out rapidly and replaced by greener technologies and practices in energy generation and storage, buildings, transportation, industry, and agriculture. Renewables will be at the heart of the transformation, working in synergy with increased energy efficiency, electrification, circularity, and sustainable bio-based approaches.

While certain sectors will be relatively easy to decarbonise, others will be much more challenging — if at all possible. Aviation, shipping, and the industrial sector will be particularly complicated due to their heavy reliance on fossil fuels, calling for substantial research and innovation efforts. In turn, agricultural GHG emissions can be reduced, but will be largely unavoidable and will have to be offset with innovative agroforestry and land-use solutions that will also offer co-benefits for biodiversity.

While some transitions are already well underway, many questions remain: Which are the most optimal technology choices, their combinations, their timing? Which are the institutional, economic, or technical enablers and constraints? The EU also needs to take into account the different circumstances and capacities of its Member States — if transitions are not adequately planned, some territories or parts of the society could pay a major economic and social toll for the transformation. It is therefore critical to find a balance between the technical, social, and spatial elements of the transition.

These are important questions for researchers and underscore the vital role of research and innovation in guiding the transition process, managing the tensions between different sectors and parts of the society, and developing the necessary technological and socio-economic solutions. EU-funded projects are contributing critical knowledge, models, and tools to help policymakers and stakeholders navigate this complex landscape of low-carbon pathways and technologies. Building on this evidence base, the EU can lead the way by investing into critical technologies and aligning action in key areas such as industrial policy or finance, while ensuring a fair and just transition for all.

EUCALC

Project Name:
EU Calculator: trade-offs and pathways towards sustainable and low-carbon European Societies.

Description:
EUCalc aimed to provide decision makers with an accessible and user-friendly modelling solution to provide real-time policy support underpinned by comprehensive analysis of trade-offs. It took a multi-sector approach based on co-design with scientific and societal actors. The EUCalc model relates emission reductions with human lifestyles, the state of natural resources, job creation, energy production, agriculture, costs, and other factors in one highly integrated tool.

EUCalc captured over 50 sectors, estimating impacts of changes in single sectors, their combinations, and/or effects of behavioural changes on emissions/energy demand for Europe as a whole or for selected countries. The scenarios were cross-tested against existing EU scenarios, allowing policy and decision makers to determine whether their choices are compatible with predefined mitigation goals, and identifying trade-offs with other policy objectives such as carbon leakage or land use.

Project coordinator and participating countries:
Potsdam-Institut für Klimafolgenforschung e.V. (Germany).
United Kingdom, Belgium, Bosnia and Herzegovina, Netherlands, Austria, Italy, Denmark, Hungary, Switzerland.

Total investment / EU contribution:
EUR 5 875 173 / EUR 5 283 351

Start and End dates (Duration):
November 2016 to February 2020 (3 years 4 months)

Website:
www.european-calculator.eu

INNOPATHS

Project Name:
Innovation pathways, strategies and policies for the Low-Carbon Transition in Europe.

Description:
INNOPATHS had five overarching goals in support of the IPCC assessments: a) understanding the challenges of decarbonisation and the innovations needed to address them; b) a detailed assessment of low-carbon technologies, their uncertainties, prospects, and system characteristics; c) proposing policy and innovation system reforms to help the EU and its Member States meet their GHG emission reduction targets; d) creating new deep decarbonisation pathways with a focus on low-carbon technology development; and e) exploring the social, economic, and environmental dimensions of the low-carbon transition and how they can be managed.

The project characterised a wide range of innovative low-carbon technologies, analysing employment, and distributional and financial implications of their deployment. Four different narratives of deep decarbonisation were created through a process of co-design with stakeholders. Online tools were developed for users to explore in more detail selected issues studied by INNOPATHS.

Given the focus on technology innovation, modelling, innovation systems, and innovation policy evaluation, the project's work in these areas supported the roles of INNOPATHS scientists as lead/ contributing authors of WG III, Chapter 16 on "Innovation, Technology Development and Transfer". INNOPATHS also contributed to the WG III report through peer-reviewed publications.

Project coordinator and participating countries:
University College London (United Kingdom).
Italy, Germany, Greece, France, Netherlands, Poland, Finland, Switzerland.

Total investment / EU contribution:
EUR 6 345 578 / EUR 5 996 716

Start and End dates (Duration):
December 2016 to July 2021 (4 years 8 months)

Website:
www.innopaths.eu

REINVENT

Project Name:
Realising Innovation in Transitions for Decarbonisation.

Description:
REINVENT focused on meat and dairy, paper, plastics, and steel—four industrial sectors where low-carbon transitions are still relatively unexplored. Their entire value chains were studied to gain a broader understanding of the possibilities for transition, including non-technical aspects. The project started shortly after the adoption of the Paris Agreement, which provided a new context for its research on future industrial development. The REINVENT team contributed to facilitating the transformation process through wide engagement with societal actors and through its contributions to policy and scientific assessments. This includes participation as authors in the work of the IPCC AR6 WG III, specifically contributing to Chapter 3 on Mitigation pathways compatible with long-term gals, and Chapter 11 on Industry.

Project coordinator and participating countries:
Lunds Universitet (Sweden).
Netherlands, Germany, United Kingdom.

Total investment / EU contribution:
EUR 4 500 000 / EUR 4 500 000

Start and End dates (Duration):
December 2016 to November 2020 (4 years)

Website:
www.reinvent-project.eu

NDC ASPECTS

Project Name:
Assessing Sectoral Perspectives on Climate Transitions to support the Global Stocktake and subsequent NDCs.

Description:
NDC ASPECTS will provide inputs to the Global Stocktake under the Paris Agreement and support the development of NDCs for the post-2030 period. It focuses on advancing transformations in four GHG emission-intensive sectors that have made only limited progress in decarbonisation to date: transport, emission intensive industries, buildings, and agriculture, forestry and land-use.

For each of these sectors, NDC ASPECTS will co-create evidence-based narratives with experts and stakeholders, drawing on the latest science assessed by the IPCC, experiences with the implementation of previous NDCs and model-based analyses. These narratives can then be translated into global pathways informing the Global Stocktake, as well as national pathways. NDC ASPECTS will also aim at identifying options to improve international governance to facilitate sectoral transformations.

Project coordinator and participating countries:
Wuppertal Institut für Klima, Umwelt, Energie gGmbh (Germany).
France, Greece, Spain, Belgium, Finland, United States, South Africa, India, China, Russia, Indonesia.

Total investment / EU contribution:
EUR 4 999 375 / EUR 4 999 375

Start and End dates (Duration):
May 2021 to April 2024 (3 years)

Website:
www.ndc-aspects.eu

SOCIAL ASPECTS OF MITIGATION

Climate neutrality can only be achieved with everybody's support: governments, business, and citizens. Consumers play a crucial role in the fight against climate change by altering their consumption choices and habits to avoid or reduce their carbon footprint, what is called "demand-side mitigation".

Production and use of household goods and services is responsible for ~60% of global emissions, mainly through food, mobility, and housing decisions. However, differences in emissions mirror income inequalities between and within countries, and thus not everybody contributes in equal measure. In addition, there are many drivers of lifestyle choices — political, economic, societal, and technological — and it is important to understand these factors better to be able to steer the transition towards more climate friendly and sustainable behaviours. Responses can come from all levels: from individual citizens through increased uptake of recycling, plant-based diets, and public transport; from municipalities by improving waste management or land use planning; and from governments by facilitating the deployment of technologies and infrastructures that are needed to empower such transformations. Citizen awareness about the emissions caused by their choices also plays a crucial role in supporting GHG reduction policies, particularly when accompanied by information on how to implement and upscale effective changes.

The EU supports research to better understand the role of lifestyles in mitigation pathways, while establishing how behavioural changes can contribute to a just and inclusive transition that leaves no one behind, as enshrined in the European Green Deal. Projects develop knowledge, recommendations, and tools to accelerate the adoption of low-carbon lifestyles, exploring their scalability, barriers, and enablers. The insights gained will be used to shape policies that empower consumers and help them make better-informed choices that bring the world closer to reaching the objectives of the Paris Agreement.

EU 1.5 LIFESTYLES

Project Name:
EU 1.5° Lifestyles: Policies and tools for mainstreaming 1.5° Lifestyles.

Description:
The IPCC concludes in its Special Report on Global Warming of 1.5°C that limiting global temperature increasingly requires demand-side actions and lifestyle changes. Such changes are particularly urgent in the resource-intensive consumption areas of mobility, housing, food, and leisure. Against this background, EU 1.5° Lifestyles aims at promoting the mainstreaming of lifestyles compatible with the 1.5° objective of the Paris Agreement. With regard to the IPCC AR6 WG III, the project combines an analysis of individual lifestyle perspectives with an increased emphasis on the investigation of structural drivers of lifestyle choices — political, economic, societal, and technological — and their impacts. On this basis, it develops recommendations and tools for political decision-makers, households, and other actors. To this end, EU 1.5° Lifestyles quantifies lifestyle options and identifies necessary changes in relevant structures to enable their effective implementation. The project started only recently and will provide valuable insights for future IPCC reports.

Project coordinator and participating countries:
Westfaelische Wilhelms-Universitaet Muenster (Germany).
Sweden, Hungary, Netherlands, Germany, Spain, Latvia, Finland.

Total investment / EU contribution:
EUR 4 945 241 / EUR 4 945 241

Start and End dates (Duration):
May 2021 to April 2025 (4 years)

Website:
www.onepointfivelifestyles.eu

CAMPAIGNERS

Project Name:
Citizens Acting on Mitigation Pathways through Active Implementation of a Goal-setting Network.

Description:
The CAMPAIGNers project focuses on mitigating climate change by motivating low-carbon lifestyles with a goal-setting network co-created with the active participation of citizens and municipalities. The project will examine critically the lifestyle transformation potentials, associated barriers, and enablers across 5 continents and 16 major cities with over 20 million residents.

The analysis of existing scientific data on carbon-emitting lifestyle behaviours and policy assessments will support the development of feasible GHG mitigation pathways for citizens around the globe. The empirically validated pathways will then be applied to principal integrated modelling tools used in the EU to provide robust insights into the system-level impacts of large-scale lifestyle transformations.

Overall, the project will support the development of climate change mitigation pathways and policy approaches from a socio-economic perspective. It will develop effective multi-level policy and strategy support that fosters the GHG-mitigation potential of citizens, involving local, national, and EU policy-makers to determine policy targets.

Project coordinator and participating countries:
Energieinstitut an der Johannes Kepler Universität Linz Verein (Austria).
Germany, Norway, Greece, Ireland, Belgium, Switzerland, South Africa, Turkey, Finland, Italy, Sweden, Azerbaijan, Austria, France, Peru, Lithuania.

Total investment / EU contribution:
EUR 4 999 670 / EUR 4 999 670

Start and End dates (Duration):
May 2021 to April 2024 (3 years)

Website:
www.climate-campaigners.com

FULFILL

Project Name:
Fundamental Decarbonisation Through Sufficiency By Lifestyle Changes.

Description:
FULFILL takes up the concept of sufficiency to study the contribution of lifestyle changes to decarbonising Europe and fulfilling the objectives of the Paris Agreement. The project explores the social, infrastructural, and regulatory conditions for changing individual and collective practices in a way that reduces GHG emissions and simultaneously contributes to societal wellbeing. It thereby links strongly to Chapter 5 of IPCC WG III on demand-side measures.

FULFILL's research engages in a dialogue between social sciences and humanities as well as techno-economic energy and climate studies. At the project's core is empirical fieldwork in 5 EU and 1 non-EU countries combining qualitative and quantitative methods. FULFILL will provide an in-depth analysis of sufficiency lifestyles covering: a) their intended and unintended consequences such as rebound and spillover effects; b) enablers and barriers, including incentives and structures; and c) impacts on micro (individual and household), meso (community and municipal), and macro (economy wide) levels, and including on aspects such as health and gender. Building on this, FULFILL will evaluate the potential for upscaling and its findings will inform the development of policy recommendations, supporting National Energy and Climate Plans.

Project coordinator and participating countries:
Fraunhofer Institute for Systems and Innovation Research ISI, part of the Fraunhofer Gesellschaft (Germany).
France, Italy, Denmark, Latvia.

Total investment / EU contribution:
EUR 3 210 085 / EUR 3 210 085

Start and End dates (Duration):
October 2021 to September 2024 (3 years)

Website:
www.fulfill-sufficiency.eu

NEGATIVE EMISSIONS

The IPCC Special Report on Global Warming of 1.5°C acknowledged that limiting warming to within that range will require the use of negative emissions technologies — methods that remove carbon dioxide from the atmosphere. The recent contribution of IPCC Working Group I to the Sixth Assessment Report confirms these findings. The overshoot of temperature targets is one specific scenario where the role of negative emissions would become critical: "The larger and longer an overshoot, the greater the reliance on practices that remove CO2 from the atmosphere."

The European Climate Law underlines the importance of removals in reaching the EU targets by compensating for residual emissions and to deliver net-negative emissions beyond 2050. As announced in the Communication on Sustainable Carbon Cycles, by the end of 2022 the Commission will propose a regulatory framework for the certification of carbon removals to support scaling up of carbon farming and industrial solutions removing carbon from the atmosphere. However, the Climate Law also acknowledges that negative emissions must not delay or replace mitigation measures — as Vice-President Timmermans put it: "Our climate action must first and foremost reduce human-made emissions".

Negative emissions can take two forms: those enhancing natural processes that remove carbon from the atmosphere like reforestation or afforestation, or those that are technology-based like direct air capture and storage. The different solutions vary widely in their degree of availability, maturity, potential for widespread deployment, and permanence. They also imply diverse side effects, co-benefits and trade-offs, notably with bioenergy, food production, and biodiversity. Some may face public perception and acceptance problems. All these issues must be accounted for in climate policy-making.

The scale of negative emissions to be delivered is an important policy choice within mitigation pathways. It depends on many factors such as the rate of progress in emissions reductions in other parts of the world, the acceptance of temporarily 'overshooting' temperature targets, as well as the interpretation of the principle of "common but differentiated responsibilities" in the global climate action context. R&I is crucial to tackle these complex questions to guide policy decisions, and to develop new approaches and solutions that optimise the contribution of negative emissions to effective climate action.

NEGEM

Project Name:
Quantifying and Deploying Responsible Negative Emissions in Climate Resilient Pathways.

Description:
There has been increasing focus in the climate debate on negative emission technologies and practices (NETPs) to reduce atmospheric CO2 emissions. Essential quantitative scientific knowledge about the efficiency, effectiveness, impacts, and potential of NETPs is not well appraised, particularly within the relevant disciplines of sustainability, sociopolitical, and socio-economic sciences. This lack of understanding is a major challenge for decision-making and recommendations from policymakers and assessment bodies, such as the IPCC.

Based on real-world, multi-disciplinary assessments, NEGEM will quantify the potential for NETPs deployment in a socially, environmentally, and economically conscious manner by creating a comprehensive, quantitative analytical framework. The framework will identify concrete pathways, with their underlying conditions and governance structures, that can contribute to achieving climate neutrality as laid out in the Paris Agreement and within the context of key UN Sustainable Development Goals.

Project coordinator and participating countries:
VTT Technical Research Centre of Finland Ltd (Finland).
United Kingdom, Germany, Belgium, Switzerland, Italy, Norway, Netherlands, France, Sweden.

Total investment / EU contribution:
EUR 5 817 835 / EUR 5 817 835

Start and End dates (Duration):
June 2020 to May 2024 (4 years)

Website:
www.negemproject.eu

OCEANNETS

Project Name:

Ocean-based Negative Emission Technologies: analyzing the feasibility, risks, and co-benefits of ocean-based negative emission technologies for stabilizing the climate.

Description:

Carbon dioxide removal (CDR) is increasingly being evaluated by the IPCC. OceanNETs is determining to what extent and under what conditions large-scale deployment of ocean-based CDR technologies could contribute to realistic and effective pathways to achieve climate neutrality and the Paris Agreement goals. OceanNETs aims to identify and prioritise options with the most potential for CO_2 mitigation, taking into account their environmental impact, risks, co-benefits, technical feasibility, cost effectiveness, and political and societal acceptance. While the IPCC has so far mainly focused on land-based CDR approaches, there are many factors suggesting that ocean-based CDR could have at least as much CDR potential, making them increasingly important as a subject of scientific inquiry. Researchers funded by the OceanNETs project have provided their expertise on ocean-based CDR as contributing authors to IPCC AR6 WG I and WG III reports.

Project coordinator and participating countries:

GEOMAR Helmholtz Centre for Ocean Research Kiel (Germany).
Norway, United Kingdom, Finland, Spain, Australia.

Total investment / EU contribution:

EUR 7 310 895 / EUR 7 310 895

Start and End dates (Duration):

July 2020 to June 2025 (5 years)

Website:

www.oceannets.eu

LANDMARC

Project Name:
LAND-use based MitigAtion for Resilient Climate pathways.

Description:
LANDMARC is improving the understanding of how and where Land-based Mitigation Technologies (LMTs) — technologies and techniques that mitigate emissions or sequester atmospheric carbon within biomass and soils — can be most effectively deployed.

The project brings together stakeholders (e.g., land use managers, farmers, forest managers), earth observation technology, and computer modeling to estimate national and global realistic potential of the Earth's land surface in absorbing emissions from the atmosphere.

LANDMARC develops innovative methods that will improve the accuracy and reliability of national GHG inventory reporting, particularly in the case-study countries. In addition, the project will develop tools and services based on new methodologies that will allow interested parties, including IPCC WG III, to assess the suitability of different LMTs portfolios at national and continental levels, and to estimate the carbon, economic, and social impacts of their deployment at scale.

Project coordinator and participating countries:
Technische Universiteit Delft (Netherlands).
Germany, Switzerland, Spain, Sweden, Portugal, United Kingdom, Colombia, Venezuela, Indonesia, Nepal, Kenya, South Africa, Burkina Faso, Vietnam and Canada.

Total investment / EU contribution:
EUR 7 062 988 / EUR 6 999 988

Start and End dates (Duration):
July 2020 to June 2024 (4 years)

Website:
www.landmarc2020.eu

MITIGATION IN THE BROADER CONTEXT

The European Green Deal represents a nexus approach with all EU policies and programmes mobilised to address climate change and environmental degradation. The challenges are complex and interlinked, but the approach offers a blueprint for successful policies — integrated, effective, coherent, complementary, and fair.

Achieving the transformative Sustainable Development Goals (SDGs) and addressing climate change must go hand-in-hand. In this respect, the UN 2030 Agenda for Sustainable Development calls for action to promote prosperity while protecting the planet, recognising that ending poverty must go hand in hand with strategies that build economic growth and deliver on social needs while tackling climate change and environmental crises. Given the complexity of the challenges at stake, it is paramount to identify the interdependencies, and manage conflicts and tensions between climate action and other SDGs. Policies must be designed to work together to promote convergence and reduce trade-offs with coherence across Nationally Determined Contributions and Long-term Strategies, National Development and Adaptation Plans and other programmes. For example, energy transitions are key for lowering GHG emissions, but also hold potential for eradicating poverty, creating jobs, improving health, and conserving ecosystems. Similar synergies are also possible around actions that aim at more sustainable food and industrial systems as well as those targeting more responsible and less wasteful patterns of consumption and production. Strong links also exist between climate change and the biodiversity crisis, as emphasised in the contribution of the IPCC Working Group II to the Sixth Assessment Report. It stresses that climate-related impacts on ecosystems and biodiversity loss increase the vulnerability of people and reduce their ability to both mitigate and adapt to climate change, and that some human activities — such as unsustainable use of natural resources and pollution — exacerbate ecosystems' vulnerability to climate change, undermining the services on which the world's prosperity and wellbeing depends.

This underscores the importance and urgency of thinking more strategically about combining adaptation and mitigation actions with sustainable development, and working in a more integrated, inclusive and equitable way. Science, research, and innovation are key in guiding such convergence. EU-funded projects contribute to this shift, by improving the understanding of the relationships and interdependencies between different policy objectives, by identifying ways to ease the underlying tensions and trade-offs and by promoting more holistic approaches in climate policy design and implementation.

CD-LINKS

Project Name:
Linking Climate and Development Policies — Leveraging International Networks and Knowledge Sharing.

Description:
CD-LINKS explored the complex interplay between climate action and sustainable development to support the design of complementary and effective policies. It developed the next generation of globally consistent, national low-carbon development pathways and established a research network and capacity building platform to leverage knowledge exchange among institutions.

Following the contribution of CD-LINKS scenario analyses to the IPCC Special Report on Global Warming of 1.5°C, the project also played a substantial role in informing the WG III AR6, in particular on the interplay between climate action and sustainable development through both global and national perspectives. Specifically, CD-LINKS provided:

1. about 40 global IAM scenarios in IPCC AR6 scenarios database.
2. more than 50 national scenarios for seven major-emitting countries and regions.
3. analyses of SDGs co-benefits and trade-offs of climate change mitigation, providing key data and insights to SDGs in Chapter 3.
4. global and national scenarios that underpinned the assessment of aggregate emissions outcomes of current policies and NDCs for 2030, presented in Chapter 4.

Project coordinator and participating countries:
Internationales Institut für Angewandte Systemanalyse (Austria).
Italy, Germany, Netherlands, Greece, Brazil, Russia, India, China, United Kingdom, France, Japan.

Total investment / EU contribution:
EUR 5 212 962 / EUR 5 037 962

Start and End dates (Duration):
September 2015 to September 2019 (4 years 1 month)

Website:
www.cd-links.org

MAGIC

Project Name:
Moving Towards Adaptive Governance in Complexity: Informing Nexus Security.

Description:
MAGIC contributed to the implementation of the Europe 2020 Strategy for smart, sustainable, and inclusive growth by testing the robustness and quality of policy and innovation narratives in the water, energy, food, and environment Nexus domain in Europe. This included a critical review of proposed solutions, reducing uncertainties about their opportunities and limitations to address climate change.

The project outcomes showed that the feasible scale of the assessed technological and policy solutions (including biofuels, electric vehicles, shale gas extraction, and green bonds) will not suffice to meet the targets of the Paris Agreement. It concluded that the EU cannot achieve carbon neutrality through technological change alone: a transformative shift in social practices and demands is needed. The project has also highlighted the challenges of policy integration and the need for more holistic approaches in climate policy development and implementation.

Project coordinator and participating countries:
Universitat Autonoma de Barcelona (Spain).
Netherlands, Germany, Italy, United Kingdom, Spain, Norway, EC.

Total investment / EU contribution:
EUR 7 457 761 / EUR 7 457 761

Start and End dates (Duration):
June 2016 to September 2020 (4 years 4 months)

Website:
www.magic-nexus.eu and
www.uncomfortableknowledge.com

SIM4NEXUS

Project Name:
Sustainable Integrated Management FOR the NEXUS of water-land-food-energy-climate for a resource-efficient Europe.

Description:
SIM4NEXUS improved the understanding of interlinkages between water, land, energy, food, and climate to promote more coherent policies, management of resource conflicts, and creating synergies in natural resource use.

Through 12 case studies, SIM4NEXUS researched the potential of Nature-based Solutions, like a transboundary basin study across Germany–Czech Republic–Slovakia, which identified restoration of landscapes as a key measure to improve rainwater retention and abatement of local heatwaves, and creating synergies with climate mitigation and adaptation, water, biodiversity, health, and tourism.

Project coordinator and participating countries:
Stichting Wageningen Research (Netherlands).
United Kingdom, Sweden, Greece, Netherlands, Germany, France, Malta, Spain, Denmark, Austria, Italy, Japan, Latvia, Belgium, Czechia, Slovakia.

Total investment / EU contribution:
EUR 7 895 657 / EUR 7 895 657

Start and End dates (Duration):
June 2016 to June 2020 (4 years 1 months)

Website:
www.sim4nexus.eu

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EU LAW AND RELATED DOCUMENTS

For access to legal information from the EU, including all EU law since 1952 in all the official language versions, go to EUR-Lex at: **http://eur-lex.europa.eu**

OPEN DATA FROM THE EU

The EU Open Data Portal (**http://data.europa.eu/euodp/en**) provides access to datasets from the EU. Data can be downloaded and reused for free, for both commercial and non-commercial purposes.

The European Union is among the top funders of the evidence base underpinning the IPCC reports, contributing to improving the effectiveness of both national and international climate policies and processes, and building public support for more ambitious climate action.

Coinciding with the approval of the IPCC Working Group III report on Mitigation of Climate Change, this brochure puts a spotlight on and celebrates the contribution of EU-funded projects to pushing the boundaries of the underlying science. It provides examples of projects funded by Horizon 2020 — the EU Framework Programme for Research and Innovation — which provide the evidence-base for guiding the transition to climate neutrality in Europe and across the globe.

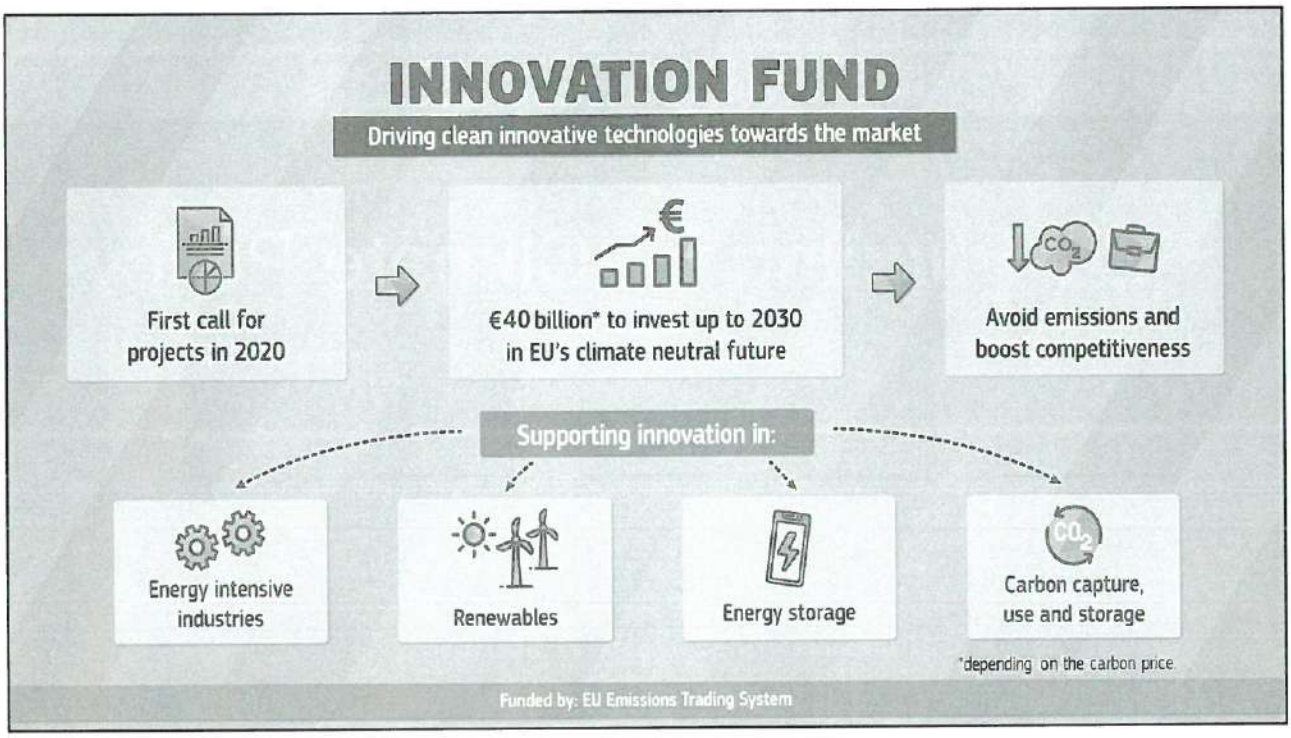
Studies and reports

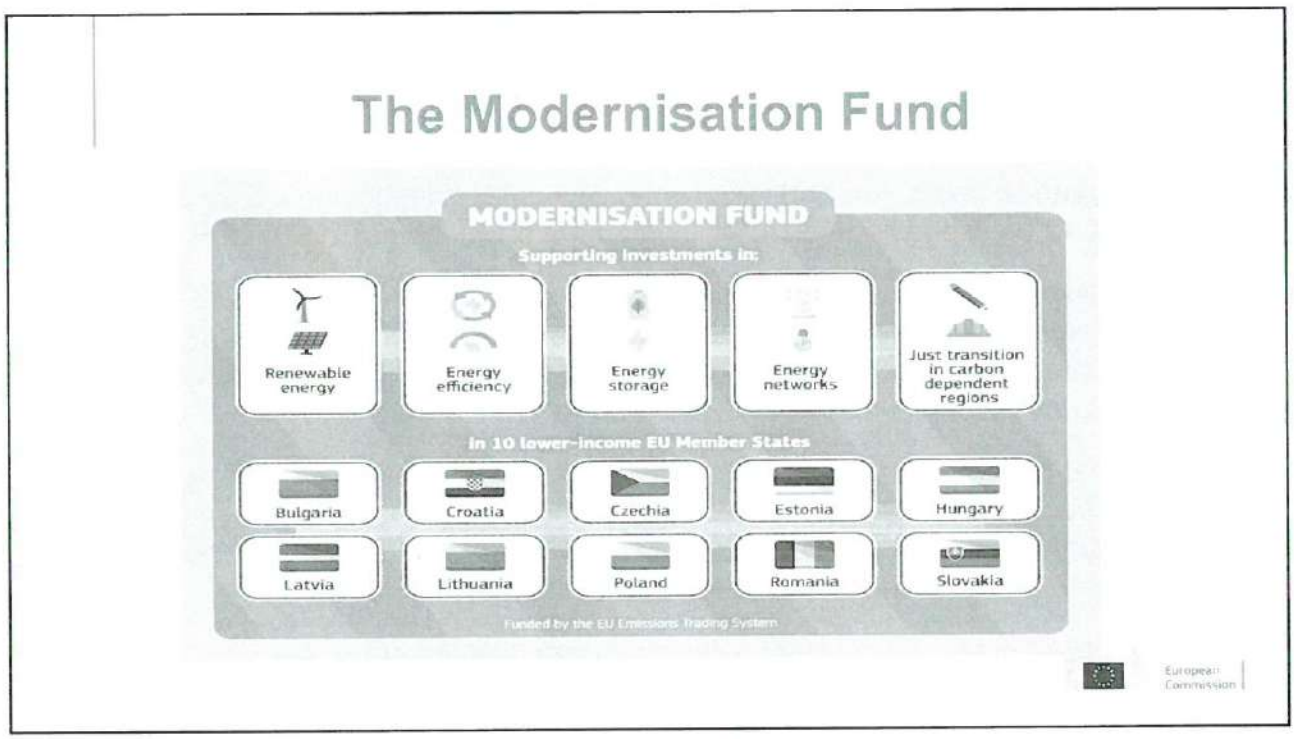
Publications Office
of the European Union

EU Funding for Climate Policy

Revenues from the EU Emissions Trading System

- **Innovation Fund:** supports innovative low-carbon technologies; an estimated EUR 40 bn available until 2030; investment since start in 2020: EUR 3 bn
- **Modernisation Fund:** supports ten lower-income Member States to modernise their energy systems & improve energy efficiency; 3 more MS to join after ETS Directive revision; an estimated of EUR 56 bn available until 2030; investment since 2021: EUR 5 bn
- **Social Climate Fund:** supports vulnerable households, micro-enterprises and transport users that are particularly affected by energy & transport poverty; EUR 86.7 bn available between 2026-2032 (EUR 65 bn from ETS II revenues+ 25% national contributions from Member States)
- Application of the **Do-No-Significant-Harm (DNSH) principle**


INNOVATION FUND
Driving clean innovative technologies towards the market
First call for projects in 2020
€40 billion* to invest up to 2030 in EU's climate neutral future
Avoid emissions and boost competitiveness
Supporting innovation in:
Energy intensive industries
Renewables
Energy storage
Carbon capture, use and storage
*depending on the carbon price
Funded by: EU Emissions Trading System


The Modernisation Fund
MODERNISATION FUND
Supporting investments in:
Renewable energy
Energy efficiency
Energy storage
Energy networks
Just transition in carbon dependent regions
In 10 lower-income EU Member States
Bulgaria
Croatia
Czechia
Estonia
Hungary
Latvia
Lithuania
Poland
Romania
Slovakia
Funded by the EU Emissions Trading System
European Commission

The EU's Multiannual Financial Framework 2021-2027 and New Generation EU (NGEU)

- **The EU's Multiannual Financial Framework 2021-2027:** EUR 1.2 trillion
- **NGEU:** up to EUR 806.9 billion; in particular the '**Recovery and Resilience Facility**' (composed of grants (EUR 338 bn) and loans (EUR 385.8 bn) and **'REPowerEU'**
- **Minimum climate spending target**: at least 30% of MFF & NGEU combined (potentially over EUR 670 bn) must be spent on climate policy objectives
- **Specific spending programmes** under MFF 2021-2027 have their own climate spending targets: e.g. the European Regional Development Fund (ERDF) (30%), 'InvestEU' (30%), 'Horizon Europe' (35%), the 'Cohesion Fund' (37%), the 'Connecting Europe Facility' (60%), 'LIFE' (61%) and the 'Just Transition Fund' (100%)
- Application of the **Do-No-Significant-Harm (DNSH) principle**

European Commission

Thank you

European Commission

Umwelt Bundesamt

DEHSt
Deutsche Emissionshandelsstelle

Taiwanese-German Exchange on climate policy, carbon pricing and ETS Berlin 3 March 2023

Welcome

Dr Jürgen Landgrebe

Head of Division V - Climate Protection, Energy, German Emissions Trading Authority (DEHSt)

Cooperation Taiwan – UBA/DEHSt

- Nov 2008 Visit from delegation of the MOEA Taiwan to UBA/DEHSt
- Sep 2010 Mr. Chung-Ding Wu, CPC Taiwan on UBA/DEHSt visit
- Feb 2011 Visit from the Energy Minister, S.E. Mr. Chi-Yuan LIANG to Germany
- Sep 2014 Visit from Minister Dr. Kuo-Yen Wei to Germany
- Apr 2015 “International Conference & Workshop on Ecology, Environment & Energy (3E) – Pursue as First Steps on the Road to Sustainability” in Taipei
- Jun 2015 Visit of Taiwan EPA delegation to UBA/DEHSt
- Jun 2015 “International Conference on Carbon Reduction” in Taipei
- Sep 2015 Visit from Minister Prof. Dr. Kuo-Yen Wei and delegation to Berlin

Cooperation Taiwan – UBA/DEHSt

- Jul 2016 „International Workshop on Climate Change: Regional Carbon Market Capacity Building" in Taipei, Meeting with Dr. Ying-Yuan Lee, Minister, Environmental Protection Administration, R.O.C.
- May 2017 ETS Capacity Building Study Visit to UBA/DEHSt
- Oct 2017 "Carbon Market Capacity Building Workshop" in Taipei
- Apr 2018 Joint Declaration of Intent on cooperation in emissions trading between the Taipei Representative Office in the Federal Republic of Germany and the German Institute Taipei
- Nov 2018 Taiwan CORSIA Capacity Building Workshop, Taipei
- Jun 2019 Taiwan ETS Capacity Building Study Tour, Deputy Minister Dr. Shen to UBA/DEHSt
- Dec 2020 Taiwanese-German online workshop on climate policy, carbon pricing and EU ETS

Agenda

13.00 - 13.30	Welcome and Round of Introduction
13.30 - 14.15	**Current developments in Taiwan**
14.15 – 14.30	Q&A
14.30 - 14.45	Coffee break
14.45 – 15.30	**Current developments in EU and Germany** • Fit for 55 from the ETS Perspective (e.g. CBAM) • German national ETS and EU Fuel ETS
15.30 - 15.45	Q&A
15.45 – 16.00	Wrap up /next steps

Thank you for your attention!

Dr Jürgen Landgrebe

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Umwelt Bundesamt

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Deutsche Emissionshandelsstelle

Fit for 55 in a nut shell

Visit of delegation from Taiwan, 03.03.2023

The fit for 55 program in a nut shell

Claudia Gibis, Hans Zschüttig

Berlin, 03/03/2023

Umwelt Bundesamt

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Deutsche Emissionshandelsstelle

The „Fit for 55“ legislation package from 14 July, 2021 – state of play

- **Set of legislative proposals and strategies**: broad range of policies for energy supply, industry, transport, households, and LULUCF.
- Aligning energy and climate policy with the new EU climate policy goal for 2030 (at least minus 55 % in GHG emissions compared to 1990).
- An political agreement on the ETS dossiers was reached in the Trialogue on 17/18 December 2023.
- Formal adoption by Council an EP is ongoing; entry into force is expected for April 2023.
- Implementation in the various fields of action is now taking place gradually.

source: EU KOM

Overview on the ETS Dossiers under the Fit for 55 Package

Substantial reform of exiting the EU ETS and significant extension of the scope

Separate presentation

Carbon Leakage Protection

Introduction of a CBAM

Reform of free allocation

Ambition

Cap reduction

Market Stability Reserve (MSR)

Funds and revenue recycling

100 % of revenues utilized for climate and social purposes

Strengthening of exiting and creation of new EU funds

Aviation

Scope remains for intra EWR flights

Phase out of free allocation

Maritime

Stepwise inclusion in the EU ETS 1

EU fuel ETS

Creation of a new upstream ETS for fuel emissions (EU ETS 2)

Separate presentation

Ambition rising and market stabilisation in EU ETS 1

Cap and Market stability Reserve (MSR)

- Emission reduction target for 2030 is significantly raised from currently -43 % to -62 % compared to 2005.
- Implementation over adjusted linear reduction factor and two on off reductions
- Reduction of the cap is essential to prevent structural surplus and to bring the EU ETS in line with EU's overall reduction target of min. 55%.
- Parameters of the MSR are unchanged, but the temporary adjustment of the doubled intake rate (24%) remains.
- Annual cancellation of allowances in the MSR above the limit of 400 million tons.
- Further review of the MSR in 2026.

Aviation and Maritime

Raising ambition level for aviation and inclusion of maritime

- Phase out of free allocation for **aviation** by 2026
- Scope remains restricted to intra EWR flights; CORSIA for all flights from an to third countries
- Revision of the scope in 2026
- Monitoring and reporting of non-CO2-effects as data base for a potential surrendering obligation
- ETS 1 scope is excluded to **maritime** by 2025:
  - Activities in EWR and 50 % of activities to and from third countries
  - Ships above 5,000 GT
- Phase-in of surrendering obligation (40 % in 2025, 70 % in 2026 and 100 % in 2027).

Strengthening emissions trading as a key instrument

- Status of emissions trading as EU's **central climate protection instrument** is underlined by the reform package.
- A significant **reduction of the cap** is essential to prevent structural surplus and to bring the EU ETS in line with the overall target of min. 55 %.
- With maritime and ETS 2 the **scope of emissions trading is expanded significantly.**
- **CBAM** provides for Carbon Leakage protection and is the key to phase out free allocation and to strengthen the incentives for transformation in the industry.
- DEHSt is now preparing for the **implementation** of the new ETS tasks and obligations.

➢ **With the latest reform, ETS will make a significant contribution to climate neutrality**

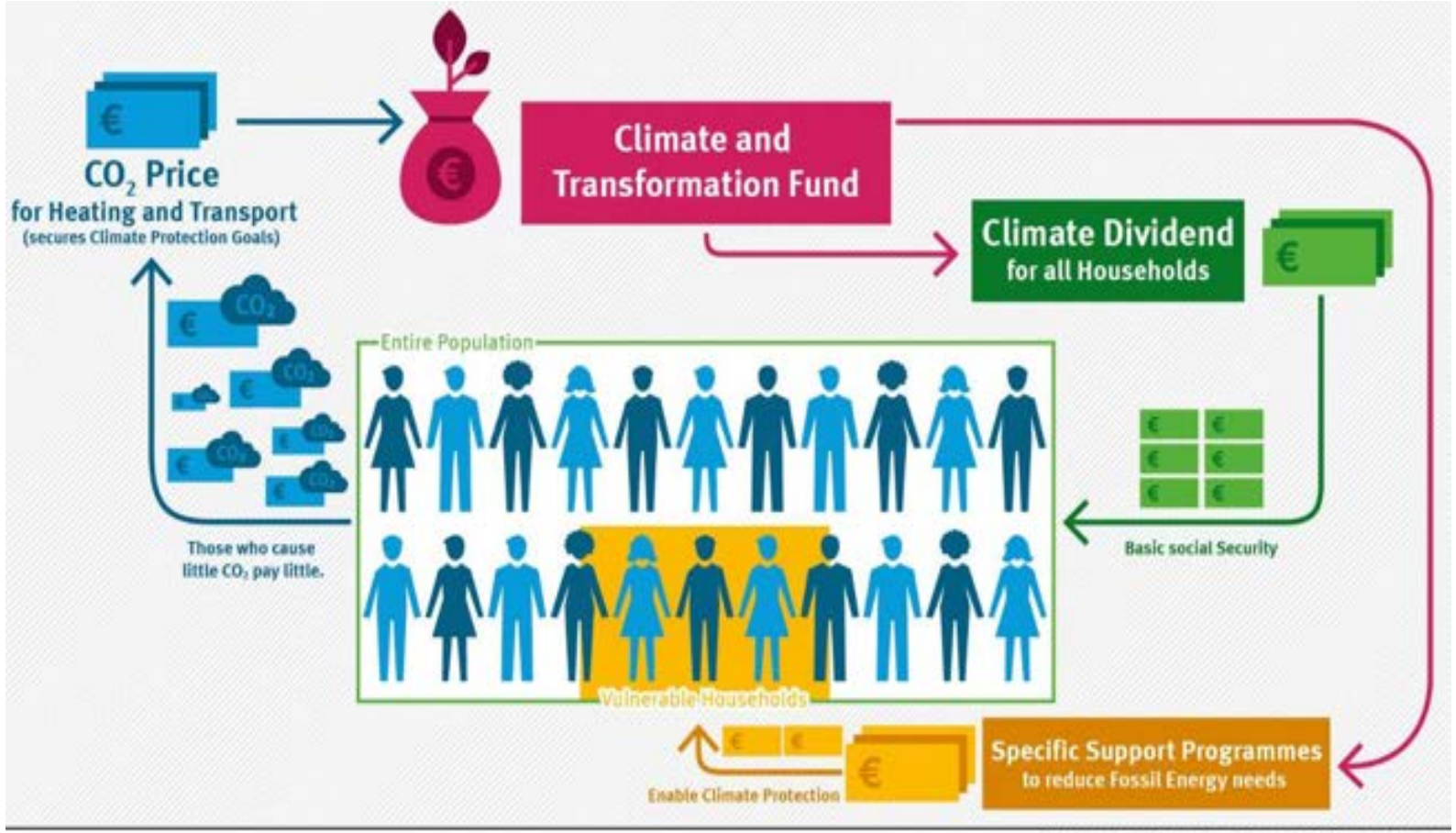
Funds and revenue recycling

Both elements are strengthened under the reform

- Member States have to utilize 100 % of **national revenues** from auctions for climate protection measures or social balance (50 % under old legislation).
- Extension and creation of new **European funds**:
  - **Innovation fund** (min: 500 mln EUA): renewables, CCS/CCU, industry decarbonization, buildings, transport
  - **Modernization fund** (min 440 mln EUA plus national funds): transformation of energy system in 10 lower income EU Member States
  - Creation of **Social Climate Fund** (65 bln Euro plus EU Member States' own contributions)

UBA's policy mix concept for socially balanced CO_2 pricing

- Social hardship in ETS 2 sectors must be avoided
- UBA suggests a policy mix containing:
  - A climate dividend
  - Supplementary support programs for vulnerable households
- This ensures social justice and public acceptance



Source: own illustration, German Environment Agency

Thank you for your attention!

Claudia Gibis, Hans Zschüttig

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Introduction of a Carbon border adjustment mechanism (CBAM) in EU

Visit of delegation from Taiwan, 03.03.2023

Introduction of a Carbon border adjustment mechanism (CBAM) in EU

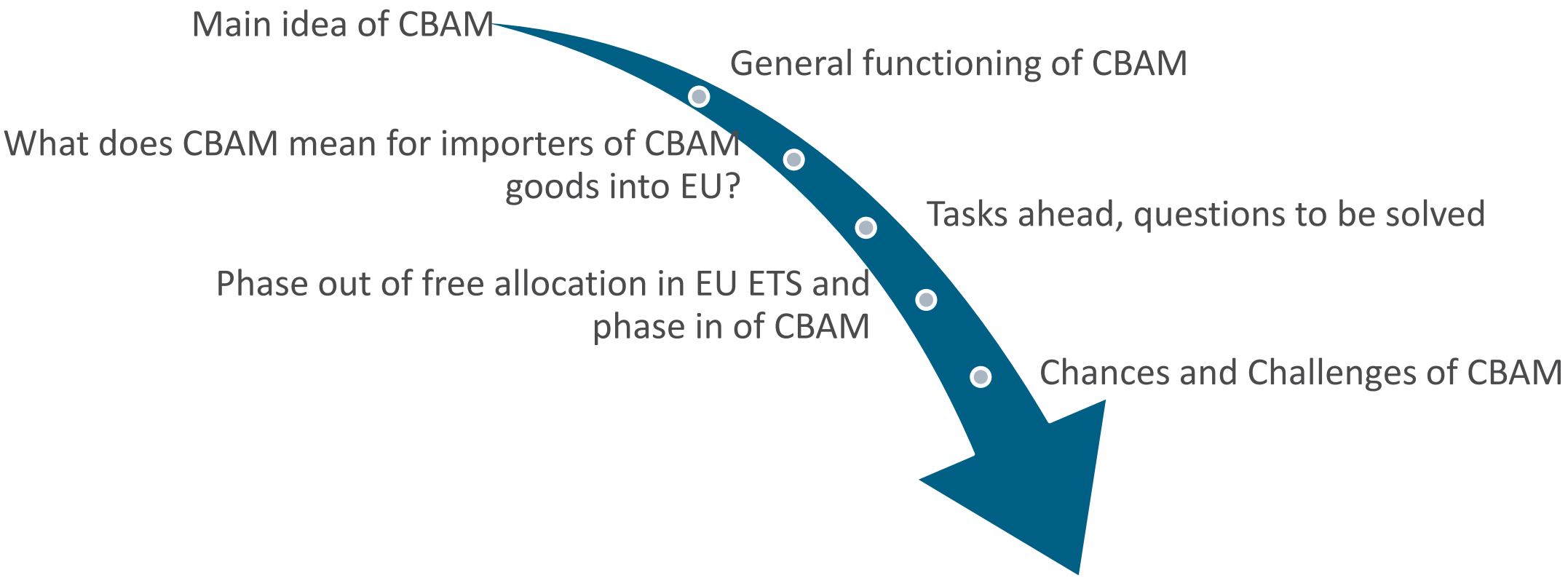
Claudia Gibis und Inga Budde

Berlin, 03/03/2023

Umwelt Bundesamt
DEHSt
Deutsche Emissionshandelsstelle

Introduction of CBAM in EU

Overview



The idea: Combining carbon leakage protection and effective CO_2 pricing

Equal CO_2 price for imported and EU-manufactured products (basic industrial materials)

Political agreement on 13/12/2022
Approval in Committee on 08/02/2023
Formal adoption in plenary and Council planned for April 2023

Protection against Carbon Leakage (CL)

Incentives for Climate Change Mitigation

Replacing free allocation as instrument for carbon leakage protection:

✓ Reducing competitive disadvantages vis-à-vis third countries and thus

✓ Avoiding relocation of industrial production.

Gradual phasing out of free allocation in EU:

✓ Rising auction revenues

✓ Passing on the CO_2 price signal

Incentives for third countries:

✓ Introducing CO_2 pricing for industry

✓ Strengthening GHG MRV capacities

CBAM: General functioning

- Electricity
- Cement and clinker
- Products of iron and steel
- Aluminium products
- Fertilizer
- Hydrogen

- Importers („Declarants“): Annual submission of a declaration on embedded emissions of imported goods
- In the beginning only direct emissions and emissions from heat/cooling, indirect emissions from electricity consumption only for cement / fertilizers
- Purchase + Submission of CBAM certificates
- CBAM obligation is reduced by free allocation in EU ETS
- CBAM obligation is reduced by carbon price paid in third countries

1.10.2023: Reporting Obligation → **1.1.2026:** Obligation for Reporting and Submission of CBAM Certificates → Phase-out of free allocation in EU ETS (bis 2034) → Expansion of coverage (indirect emissions/other products)

CBAM: What does it mean for importers of CBAM goods into EU?

2023 — **2026** — **2034**

Transitional Period

- Regulated entity is the importer located in EU
- Quarterly reporting of embedded direct + indirect emissions to EU Commission (common platform), no verification
- Customs authorities report amounts and types of imported CBAM goods, importers and country of origin to EU Commission
- nCAs implement correction procedure in case of non-compliance (after notification by the EU Commission)

Full Operation of CBAM

- Importers of CBAM goods have to be authorized as CBAM Declarants
- Annual submission of CBAM declaration and CBAM certificates (31/05)
  - Verified embedded emissions of imported goods
  - Minus free allocation in EU ETS
  - Minus carbon price paid in third country => no double pricing!
  - Copy of verification report

Free allocation is phased out

=> Full carbon price is charged.

Tasks ahead, questions to be solved

1 implementing act	Rules for calculating embedded emissions and reporting	Technical and political exchange with third countries		Availability of IT-based platform for reporting		
		before the start of the transitional period (10/2023)				
		Information for importers in EU and for producers/service providers in third countries				
		12 implementing acts + 3 delegated acts	Rules for accounting of free allocation and carbon prices in third countries	Evaluation of pilot phase, possibly: scope extension		Building MRV capacities: accreditation of verifiers
				before the start of the regular operation (01/2026)		
				Building MRV capacities in third countries: trainings for operators, new service providers		

Phase-out of free allocation in EU ETS corresponds to phase-in of CBAM

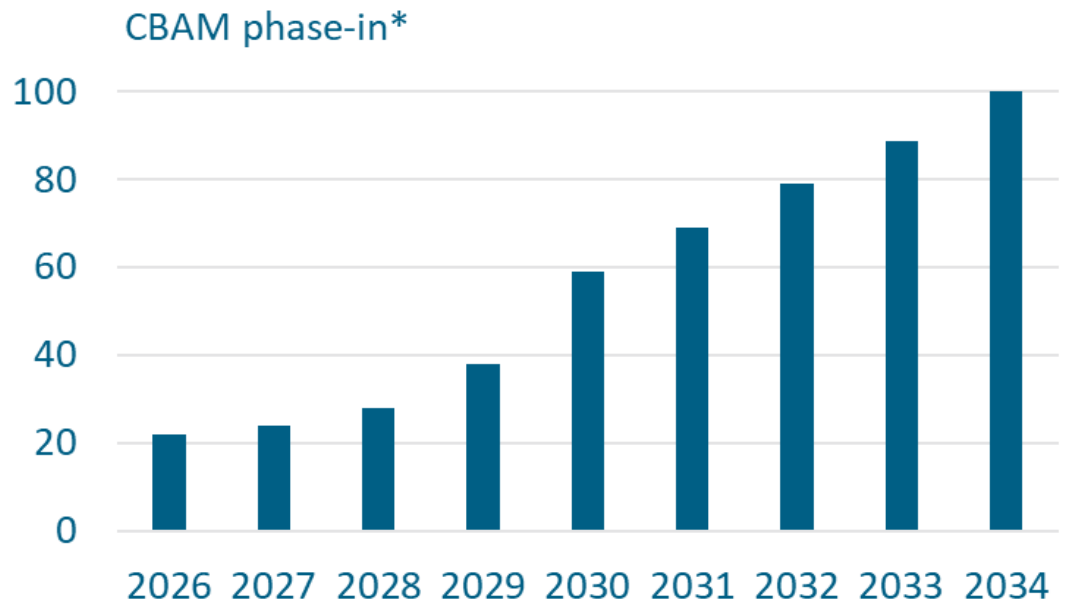
Free allocation in EU ETS is based on benchmarks
ratio free allocation/emissions in industry: approx. 80 % in Germany

Phase out of free allocation in EU ETS by applying a CBAM factor to the benchmark allocation

2026	2027	2028	2029	2030	2031	2032	2033	2034
97.5	95	90	77.5	51.5	39	26.5	14	0

From 2034 on, EU producers of CBAM goods have to buy EU allowances for 100% of their emissions => no more free allocation

CBAM Obligation:
100% of embedded emissions
minus free allocation in EU ETS
minus no. of certificates for which carbon price was already paid
multiplied with average carbon price in EU ETS



* estimated average share of emissions for which CBAM certificates or EU allowances have to be purchased (assumed that emissions are not reduced)

Chances and challenges of CBAM

Chances for climate protection:

- End of free allocation within Europe
- Pass on the carbon price along the value chain
- Incentive to lower CO2 and other relevant emissions during the production process worldwide
- Enhance transparency on embedded emissions of goods, basis for international agreements on MRV of embedded emissions

Building of robust governance structures and processes:
to ensure a fair and equal treatment

Overcoming international critique and resistance:
with cooperation and communication , Capacity Building ➔ **climate club**

Challenges:

- Time pressure (transitional phase starts already in October 2023, full system running by January 2026)
- Building of robust MRV systems and structures difficult within such a short timeperiod
- Trade-offs between effective carbon leakage protection, administrative burden and strain of international trade relations

Thanks for your attention!

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Taiwan EPA Delegation - Visit to DEHSt/Germany

Introduction to the German national ETS (nEHS) and the EU Fuel ETS

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Berlin, 3 March 2023

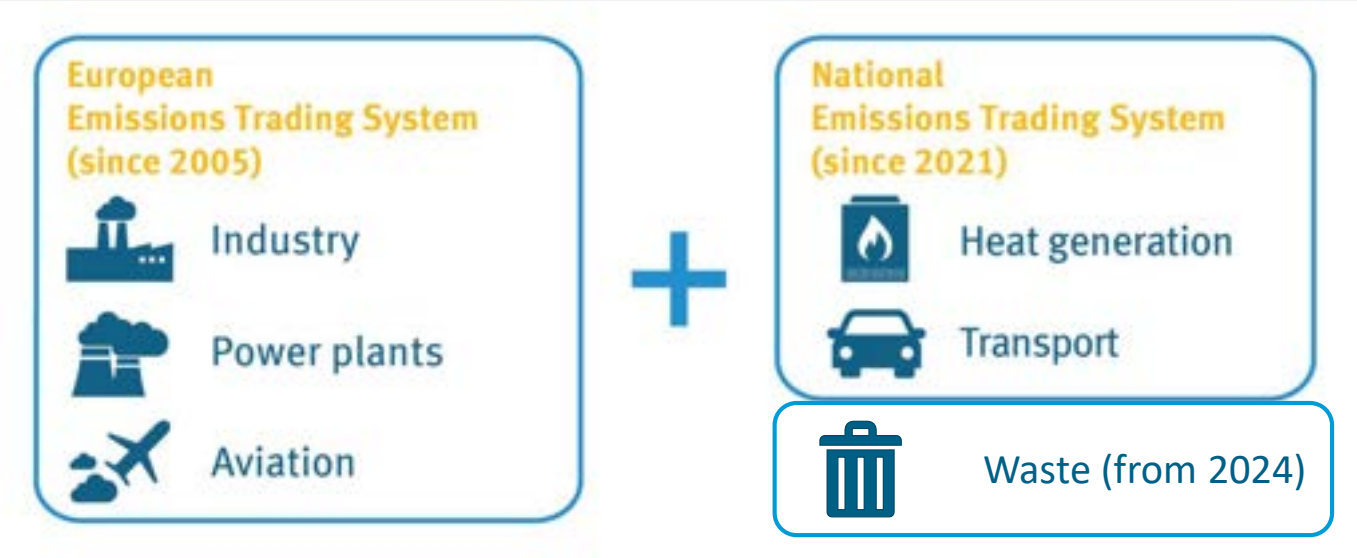
Outline

1. Basics of the **German national ETS (nEHS)**
2. How do EU ETS and nEHS differ?
3. Overlaps between nEHS and EU ETS
4. Basics of the **EU Fuel ETS**
5. Difference between nEHS and EU Fuel ETS
6. Challenges in implementing EU Fuel ETS

1. Basics of the German national ETS (nEHS)

1.1 Scope of the nEHS

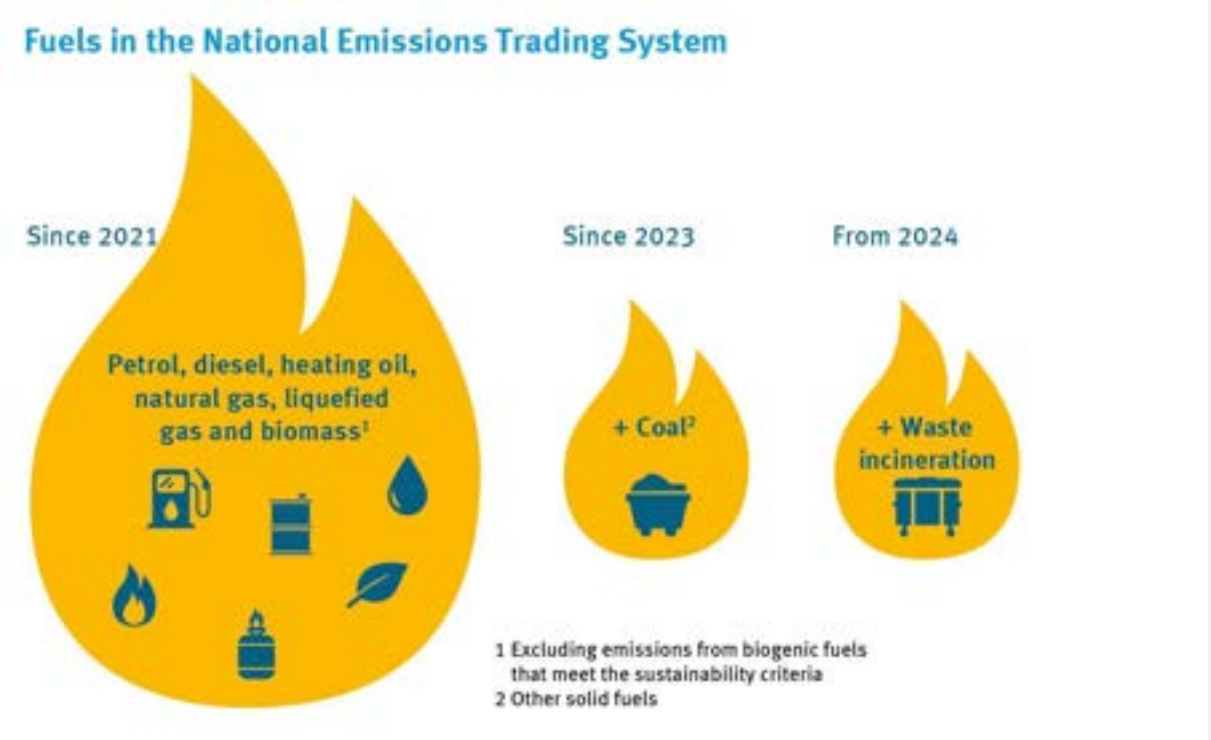
- December 2019: the **Emissions Trading Act for Fuels (BEHG)** implementing the nEHS came into force
- **The goal is to introduce certificate trading for fuel emissions**
- Scope includes mainly emissions of the **heating/building and transport sectors**
- **(Small) industries** outside the EU ETS scope are also included
- From 2024 **waste incineration** will be covered



1. Basics of the German national ETS (nEHS)

1.2 Scope of the nEHS: What fuels are subject to BEHG?

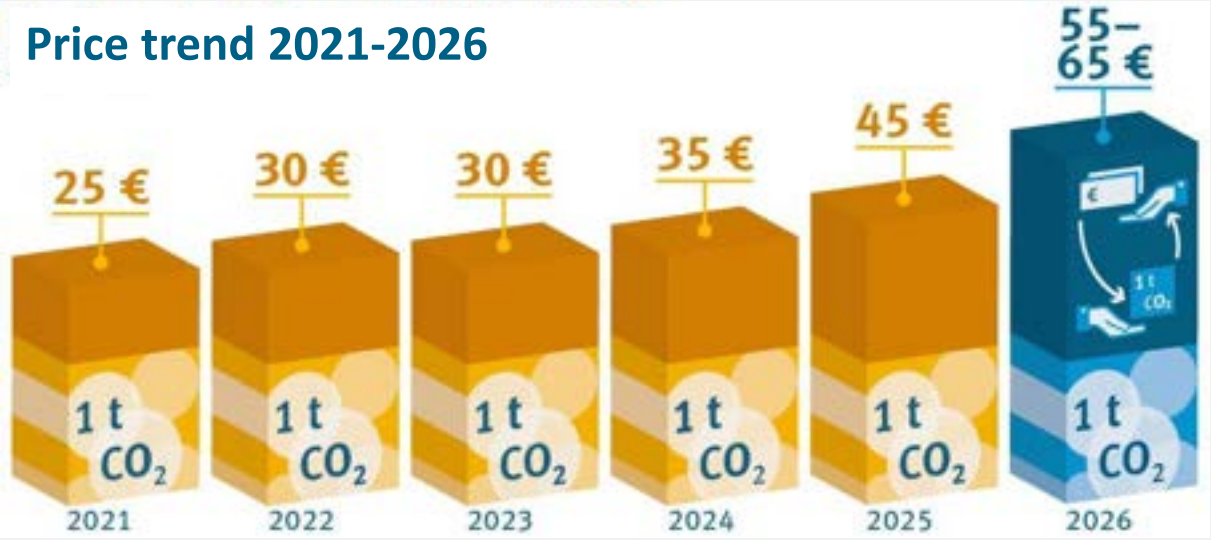
- BEHG applies to fuels distributed as listed in Annex 1 of the Emissions Trading Act for Fuels (BEHG)
  - **All fuels** whose combustion **have the potential to cause CO_2 emissions**
  - Corresponds to energy products pursuant to Energy Tax Act (EnergieStG)
- Fuels covered
  - from 2021: E.g. petrol, diesel, heating oil, liquefied gas, natural gas, biofuels that do not meet the sustainability criteria;
  - from 2023: coal and other fuels
  - from 2024: waste incineration



1. Basics of the German national ETS (nEHS)

1.3 What is the CO2 price in the nEHS?

- From fixed price to free price formation on the market (from 2027 onwards)
  - Allocation via sale/auctioning of all allowances by the government; no free allocation
  - Fixed prices in the introduction phase (2021 – 2025)
  - 2026: regulated price formation within a price corridor
  - From 2027: Price formation on the market with a fixed volume of greenhouse gases all participants combined are permitted to emit (→ emissions cap)

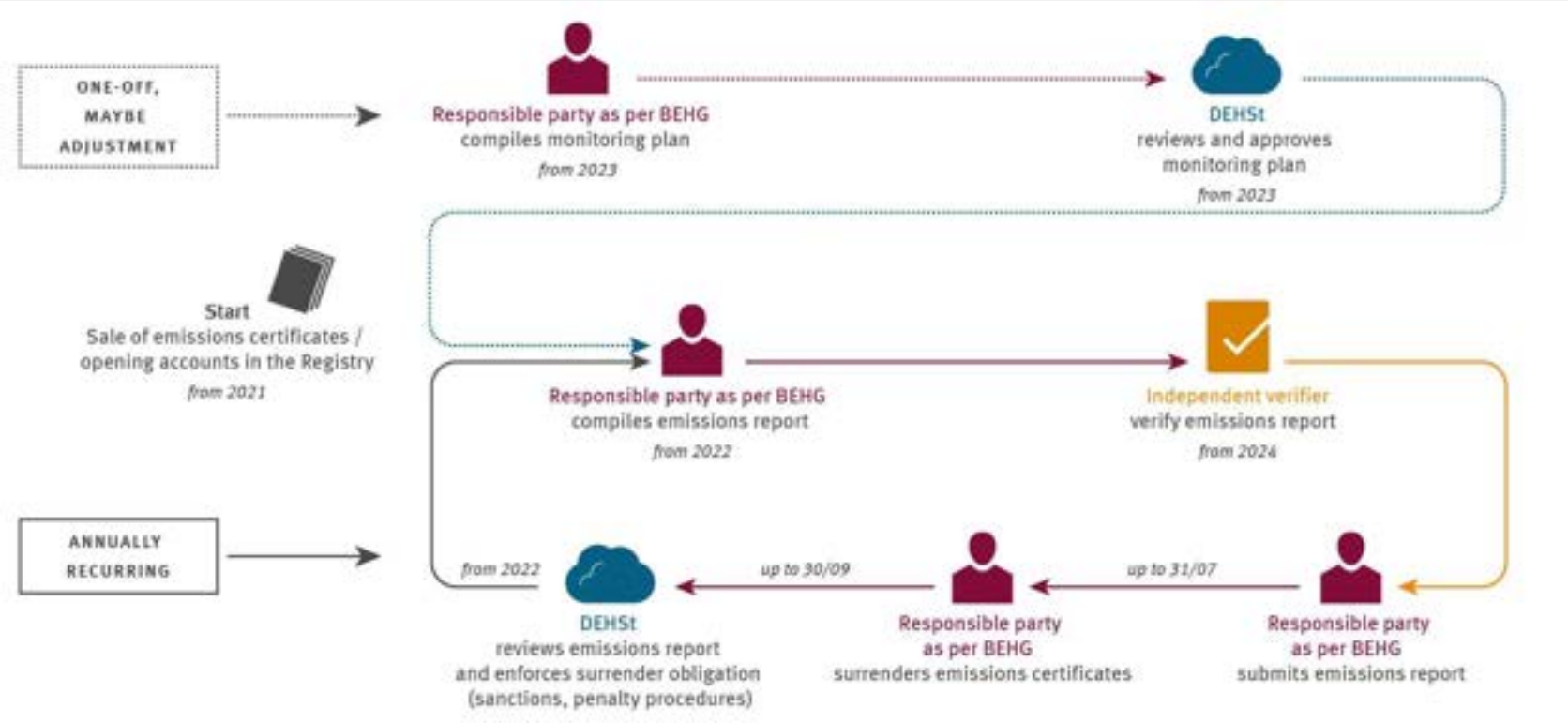


- The cap is determined by a political decision and will be based on the German emissions' share of the covered sectors as laid down in the EU Effort Sharing Regulation

1. Basics of the German national ETS (nEHS)

1.4 Compliance cycle

- Simplified reporting obligations for selected fuels

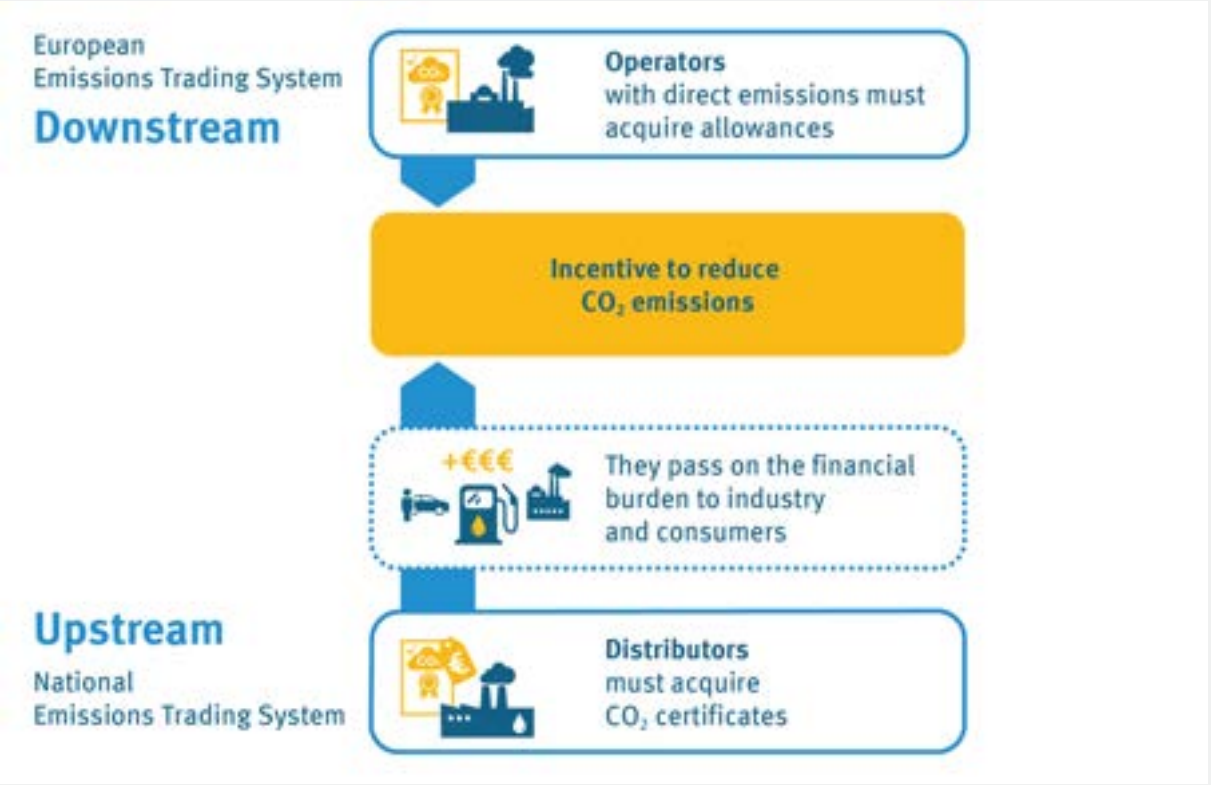


2. How do EU ETS and nEHS differ?

- With regard to fuel distributors BEHG considers
  - → **potential emissions** and **not** the **actual emissions** that occur at a later time when the fuels are used (upstream).

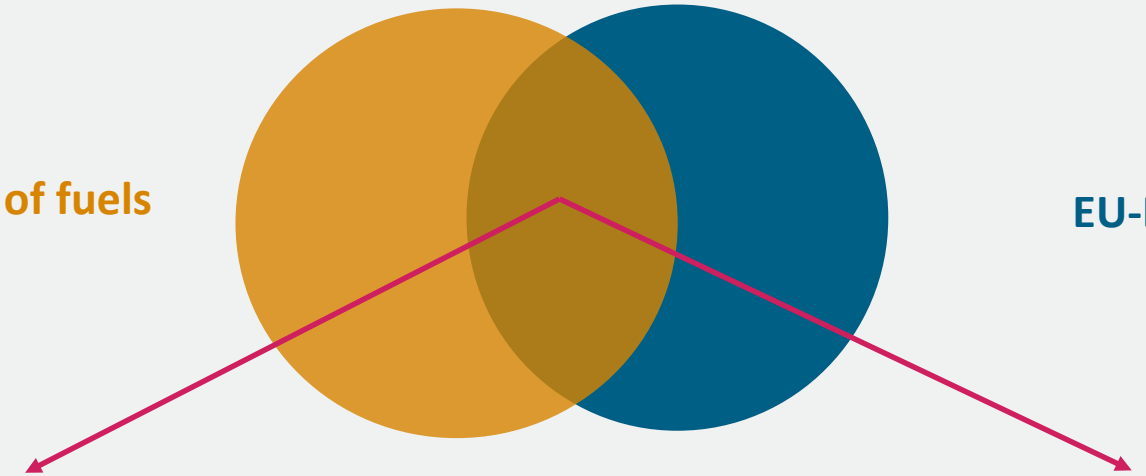
- Linking emissions to actual emitters is not practically possible in the heat and transport sectors due to the large number of emitters.

- Therefore: distributors passing on the costs along the value chain to final customers



3. Overlaps between nEHS and EU ETS

nEHS: Distribution of fuels



EU-ETS: Use/combustion of fuels

Avoiding double charging through the avoidance of costs in advance (ex ante) § 7 (5) BEHG

Application:
The distributor (the obligated party as per BEHG) gets a *confirmation of use* by the EU ETS Installation,
→ Fuels can be delivered without the costs for nEHS certificates

Refunding by a subsequent compensation of the fuels, which have been charged twice (ex post) §11 (2) BEHG

Application:
The avoidance of costs in advance was not possible (e.g. due to multiple intermediaries)
→ The costs for nEHS certificates have been transferred to an EU ETS Installation

In both cases, the acquisition of data takes place in the emissions report of the EU ETS

5. Basics of EU Fuel ETS

5.1 Introduction of the system

- Direct emissions of buildings and road transport are responsible for 30% of total greenhouse gas emissions and for more than half of emissions under the EU Effort Sharing Regulation (ESR)
- In both sectors **emissions have increased** between 2014 and 2019:
  - buildings sector by 2%
  - road transport sector by 7%
- Decision to introduce a **new and separate ETS for buildings, road transport and additional sectors on EU level (EU Fuel ETS)** that contributes to around 42% emission reductions in road transport and buildings sector in 2030 compared to 2005
- **Start of system**:
  - Monitoring/reporting based on historical emissions in 2024 (emissions report by 30 April 2025)
  - Monitoring/reporting based on actual emissions in 2025 and 2026

  } No surrender of allowances

  - **From 2027**: Monitoring and reporting **with compliance obligations**/surrender of allowances in 2028

5. Basics of EU Fuel ETS

5.2 Scope and coverage, avoiding double counting

- **Upstream system**, regulating the fuel suppliers/distributors who have to acquire CO2 certificates and not the end-consumers
  - Compliance obligation: releasing of a fuel on the market for combustion in the sectors concerned
- Corresponds to energy products pursuant to EU Excise Duty Directive
- **Emissions** will be determined **indirectly** via the fuel quantities put on the market
- **Covered sectors**:
  - Building/heating
  - Road transport
  - Industry and energy outside EU ETS (largely process heating)
- **Opt-in of additional sectors** possible on Member State level
- Excluded/outside scope: Fuel use in agriculture sector, remaining transport sector, EU ETS installations
- Mechanism to **avoid double counting** of CO2 emissions in EU ETS/EU Fuel ETS and other sectors outside scope of EU Fuel ETS

5. Basics of EU Fuel ETS

5.3 Cap, allocation, price stability, revenue use

- Cap and Linear Reduction Factor (LRF) from 2027 to allow a **smooth start** of the system and deliver a **clear signal about the reduction trajectory needed until 2030**
  - LRF of 5.1% (2024-2027), 5.38% (from 2028)
- Allocation of allowances only through **auctioning**, no free allocation
  - **Front-loading** in 2027 of additional 30% of 2027 auction volumes
- Price increase-based mechanism to release allowance from the Market Stability Reserve to **counter risks of excessive price fluctuation;** trigger at **45 EUR**
- **Additional safeguards**: one year emergency brake if very high energy prices; reporting + follow up on carbon price cost pass-on
- Member State **auction revenues** to be spent for **climate-and energy-related purposes,** incl. social aspects
- New **Social Climate Fund** to address the social impacts from the EU Fuel ETS on vulnerable groups in the EU
  - From revenues in EU ETS and EU Fuel ETS

6. Difference between nEHS and EU Fuel ETS

- Main differences in ETS design

	nEHS	EU Fuel ETS
Scope	Covers all fuels pursuant to energy tax	• Excludes fuel use in remaining transport sector, agriculture sector as well as waste incineration • Opt-in possible

MRV	• Compliance deadlines:
	  • Reporting 31.07.
	  • Surrender allowances 30.09.
		• Compliance deadlines:
		  • Reporting 30.04.
		  • Surrender allowances 31.05.
		• Identification of final consumers/end use sectors of fuels

Price formation	• Fixed price phase 2021-2025	• No fixed price phase, price formation on the market • Safeguards to counter risks of excessive price fluctuation
Compensations /double counting	• Carbon Leakage compensation • Mechansims to avoid double counting with EU ETS	• Carbon Leakage compensation only in opt-in sectors • Mechansims to avoid double counting with EU ETS and other sectors outside EU Fuel ETS

7. Challenges in implementing EU Fuel ETS in Germany

- Generally, **transfer of nEHS** into **EU Fuel ETS** → goal not to have two parallel systems
  - Deviations from nEHS-provisions/approaches possible when implementing EU Fuel ETS regulations (e.g. regarding MRV)
- **Identification of final consumers**/end use sectors necessary in EU Fuel ETS to ensure fuel use in respective sectors covered under the system and for reporting purposes
  - Additional administrative efforts for both covered entities and competent authority
  - Different methods (with different levels of accuracy) necessary to identify final consumers
- **Short timeline** for adoption of regulations/delegated and implementing acts on MRV, compensation mechanisms, auctioning, registry

Thank you for your attention!

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