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）

「日本碳捕捉後封存(CCS)政策交流」出國報告

服務機關：環境部氣候變遷署

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派赴國家/地區：日本/東京及北海道

出國期間：114年8月26日至8月30日

報告日期：114年11月24日

摘　要

為達 2050 淨零排放目標，「碳捕捉、利用與封存 (CCUS)」已成為全球邁向淨零排放不可或缺的一環，在淨零轉型路徑中，對於發電業及鋼鐵、石化、水泥等難以減排(hard-to-abate)的產業而言，必須結合 CCUS 達成淨零目標。日本在全球 CCUS 領域扮演領先角色，其經濟產業省(METI)自 2016 年起已於北海道的「苫小牧 CCS 計畫」累積注入 30 萬噸二氧化碳，其展示出從煉油廠捕獲二氧化碳並將其注入離岸地下儲層之安全性和可靠性，並設立了廣泛的監測系統，並於 2018 年北海道地震期間，相關設施也未受損，獲選為日本國家級「先進 CCS 計畫」9 個入選區域之一，其從場址探勘、技術驗證、環境監測、法規建立至社會溝通的完整經驗，對我國極具參考價值。

此外，日本政府已明確將 CCS 定位為實現能源安全、經濟增長與脫碳目標的必要工具，並在「CCS 長期路線圖」中，設定 2050 年達成每年 1.2 億至 2.4 億噸封存量的宏大目標。為此，日本國會於 2024 年 5 月正式頒布《CCS 事業法》，為私部門投資創建了穩定的法律框架與商業環境。

為汲取其成功經驗，加速我國 CCS 價值鏈的建構，本次於 2025 年 8 月 26 日至 30 日赴日本與日本 CCS 相關主管機關、研發法人及指標性企業進行交流，並實地參訪北海道苫小牧 CCS 示範場域。期望透過本次考察，深入瞭解日本從政策頂層設計、法規制定、商業模式、環境監管到社會溝通的完整策略，作為我國研修 CCS 管理辦法、推動政策環評及完善產業配套措施之重要依據，確保我國 CCS 發展路徑穩健可行。

目　錄

「日本碳捕捉後封存(CCS)政策交流」出國報告

一、目的

為因應國際淨零排放趨勢，臺灣於 2022 年公布「2050 淨零排放路徑及策略」，總統府於本(2025)年 1 月 23 日「國家氣候變遷對策委員會第 3 次委員會議」提出國家減碳新目標草案及臺灣總體減碳行動計畫，除各部會由下而上自主優化提出 80 項減碳行動計畫外，並由上而下聚焦六大部門 20 項減碳旗艦行動計畫，以強化減碳力道，其中本部研提之「碳捕捉利用與封存(CCUS)減碳旗艦行動計畫」即為其中一項關鍵策略，行政院並於 114 年 10 月 3 日核定；延續「碳捕捉利用及封存(CCUS)關鍵戰略計畫」規劃及分工，由環境部與經濟部、國科會及金管會共同合作，從法制面、產業面、科技面及金融面逐步建立我國 CCUS 產業價值鏈，環境部負責二氧化碳捕捉後封存(CCS)法規制度的建置，目標 2035 年達到 600 萬公噸 CO_2e 的減碳目標。

由於日本與臺灣同樣位於環太平洋地震帶，地質條件相似，都是地震頻繁的海島國家，兩國產業型態高度相近，並且同樣高度仰賴能源進口，在推動能源轉型與淨零策略上面臨相似的挑戰，也使得在淨零目標達成上，CCS 的推動成為兩國重要的課題之一，期能透過此技術協助電力、鋼鐵、石化等難減排產業邁向淨零。

日本在全球 CCUS 領域扮演領先角色之一，從 2016 年推動北海道「苫小牧（Tomakomai）CCS 示範計畫」後，已經安全封存 30 萬噸二氧化碳，成功展示了完整的 CCUS 鏈（從捕捉到儲存）的可行性與安全性，並與當地居民建立了良好的溝通機制，為此，日本於 2024 年通過的《CCS 事業法》明確界定了碳封存責任、監管程序與公眾參與機制，形成政府與事業機構緊密合作的體系。

本次赴日交流深入瞭解日本碳捕捉與封存（CCS）的推動經驗，聚焦討探日本 CCS 國家戰略、法規框架、公私協力模式、財務支持機制、CCUS 核心技術、商業實績與應用，此外，借鏡日本苫小牧 CCS 場址營運、環境監測與在地社會溝通及環境教育等實務經驗，以期為我國 CCS 發展尋求穩健可行之路徑。

二、過程

（一）行程表

2025 年 8 月 26 日（二）至 8 月 30 日（六）前往日本，行程如下：

日期	行程	住宿地點
8 月 26 日 (二)	●上午搭機前往日本東京 ●於日台交流協會拜會經濟產業省(METI)與日本能源金屬礦物資源機構(JOGMEC)	日本東京
8 月 27 日 (三)	●拜會三菱重工(MHI) GX Solutions ●拜會新能源產業技術綜合開發機構(NEDO)	日本東京
8 月 28 日 (四)	●上午從東京搭機前往北海道 ●拜會日本 CCS 調查株式會社(JCCS) ●參訪苫小牧 CCS 示範場域	日本北海道
8 月 29 日 (五)	●上午搭機從北海道返回東京 ●於日台交流協會拜會日本環境省(MOE)	日本東京
8 月 30 日 (六)	●日本返回臺灣	-

（二）行程內容摘述

本次交流行程由本署蔡玲儀署長率隊，在駐日代表處鄭淳尹秘書陪同下，本署團員包括梁喬凱科長、許值蓉特約環境技術師、我方智庫包括國立臺灣大學劉雅瑄教授、王興睿助理教授、施秀靜博士後研究、以及財團法人台灣綜合研究院蘇漢邦副院長及林祐生主任等人拜會相關單位，說明如下：

1、拜會經濟產業省(METI)及日本能源金屬礦物資源機構(JOGMEC)

經濟產業省(METI)為日本負責制定國家能源政策、產業技術發展、資源戰略等多個重要領域之核心部會，在 CCS 領域主導政策規劃、法規制定與商業模式建構等，本次拜會由 METI 資源能源廳政策課國際資源戰略室長 長谷川 洋代表出席。另日本能源金屬礦物資源機構(JOGMEC)為 METI 轄下的獨立行政法人，負

責確保日本能源與礦物資源的穩定供應，在 CCS 領域，JOGMEC 接受政府撥款，執行全國性地質調查、評估潛在封存場址、促進國際與產業合作，並管理與推動「先進 CCS 計畫」。本次參與交流人員包括能源業務本部 高梨 真澄（CCS 企劃課長）、小山 泰平（CCS 企劃課課長代理）、加藤 文人（担当審議役）、加藤 亮一（CCS 技術課担当調査役）等人，交流內容如下：

(1) 日本為達成 2050 碳中和目標所制定的 CCS 國家戰略、法規框架及專案進展。日本政府視 CCS 為創造新產業基礎的國家級機會，其推動策略展現了高度的戰略決心與務實的政策設計。METI 制定的「CCS 長期路線圖」已為日本 CCS 發展提供了清晰方向，明訂 2030 年進入商業化、2050 年達成每年 1.2 億至 2.4 億噸 CO_2e 封存目標。

(2) 為落實 CCS 長期路線圖，METI 與 JOGMEC 建立了緊密的公私協力模式，METI 負責制定日本 CCS 的法律框架、長期目標、監管標準，及政府對商業化的支持機制，例如 CCS 專案的勘探、封存許可制度、CO_2 管線運輸相關業務和安全法規；而 JOGMEC 則是在 METI 框架下，負責執行政府財政支持項目（接受撥款），進行全國性、大範圍的初步地質調查，以尋找合適的潛力區域。政府並啟動「先進 CCS 計畫」（Advanced CCS Projects），選定 9 個具代表性的專案，涵蓋日本國內和海外的 CO_2 運輸與封存，於可行性研究階段提供 100%的資金支持（2025 年度預算高達 320 億日圓），由政府承擔前期探勘的高風險，待專案進入商業化階段，則將採用「差價合約(CfD)」模式，補助 CCS 成本與市場碳價之間的差額，為企業提供長期穩定的投資預期，在專案後期負責接收和管理已完成注入的封存設施，此一完整的財務支持體系，是驅動產業投入高成本 CCS 專案的關鍵誘因。

(3) 法制方面，2024 年 5 月公布的《CCS 事業法》是關鍵的里程碑，該法建立了由政府和民間緊密合作的雙向流程，從場址的探勘、鑽井、封存到關閉後的監管與責任移交，皆有明確規範。此法不僅保障了業者的權益，也透過跨部會共管機制，確保了專案的安全性與環境可持續性。依據《CCS 事業法》，

METI 負責指定潛在封存的特定區域，以鼓勵申請人勘探鑽井，於 2024 年 2 月 21 日，METI 大臣即指定了苫小牧市海域作為第一個特定區域。

(4) 針對臺灣與日本同為地震頻繁地區的共通挑戰，日方分享其以「科學實證」與「資訊透明」為核心的溝通策略。透過「苫小牧示範計畫」的長期監測，已證實 CO_2 注入與自然地震無因果關係，且在強震後並無洩漏風險。這些科學數據，皆透過地方政府與多元媒體管道向民眾公開說明，有效化解社會疑慮。

圖 1 拜會經濟產業省(METI)及日本能源金屬礦物資源機構(JOGMEC)合照

2、拜會三菱重工(MHI) GX Solutions

三菱重工(MHI)是全球碳捕捉技術的領導者，其與關西電力共同開發的胺基溶劑捕獲技術(KM CDR Process®)在全球商轉市場佔有率超過七成，擁有豐富的實廠應用經驗，該機構參與交流人員包括 MHI GX Solutions 業務部 Hidekazu Shibuya 業務經費、Takashi Hirata 副理、Wataru Tokuzumi 經理、Yuya Yamamoto 副理，交流內容如下：

(1) MHI 作為全球商轉實績最豐富的碳捕捉技術提供商，其發展歷程與公部門的緊密合作息息相關，自 1990 年起，MHI 即與關西電力公司(KEPCO)共同開發其核心技術—胺基溶劑捕獲技術(KM CDR Process®)。其獨家專利溶劑

(KS-1/KS-21)相較於傳統技術，其關鍵在於獨家專利的胺基溶劑相較於傳統的 MEA 溶劑，KS-1 溶劑所需蒸汽量降低約 20%，貧溶劑流量減少約 25% ，大幅提升了商業運轉的經濟性，奠定其市場領先地位。

(2) MHI 已累積許多實績，已在全球 18 個商業化廠房中得到驗證，展現其高度的技術成熟度與適應性，包括全球最大的商業規模電廠（美國 Petra Nova 燃煤電廠），每日捕捉量近 5,000 噸，延伸至英國 Drax 電廠的生質能與碳捕捉結合(BECCS)、美國的液化天然氣(LNG)廠，再到日本國內的水泥廠與垃圾焚化發電廠，證明其技術能有效應對不同工業製程產生的煙氣。

(3) 我方關切不同煙氣來源的技術差異，MHI 說明其胺基技術適用於 CO_2 濃度 3-25%的煙氣，僅需依據煙氣特性（如雜質成分）調整吸收塔規模與前處理流程，技術通用性高 。針對捕捉後的 CO_2 純度，MHI 指出 99.9%的高純度通常用於化學品生產，而用於地質封存的管線運輸，純度或可降低至 95-99%，但海運則可能因雜質潛在問題而需要更高的純度 。日本政府仍在與利害關係人討論相關規範，預計 1-2 年內提出決策 。

(4) MHI 預估一個大型 CCS 專案從可行性研究到商轉約需 5 至 7 年，並強調此類高成本技術的推動，離不開與政府的緊密合作。日本政府在專案初期提供的全額研發補助，以及後續為彌補碳價與 CCS 成本差距的政策支持，是促成技術商業化的關鍵驅動力。MHI 的經驗表明，一個成功的 CCS 產業，需要頂尖的私部門技術與前瞻性的公部門政策相互配合，共同創造市場誘因。

3、拜會新能源產業技術綜合開發機構(NEDO)

NEDO 為日本最大的公立研發管理機構，是 METI 旗下的資助機構，負責加速技術研發和商業化，在 CCS 領域，NEDO 專注於前瞻技術的研發與實證，以促使成本降低的目標。該機構參與交流人員包括 NEDO 循環經濟部 布川 信 組長、大城 昌晃 組長、國谷 昌浩 課長等 5 員，交流內容如下：

(1) NEDO 橫跨能源、環境、工業技術等領域，其年度初始預算約為 10 億美元，NEDO 的 CCUS 專案涵蓋捕捉、運輸、注入、封存、監測以及碳循環技術

(CCU/CDR)，NEDO 在日本 CCS 生態系中，扮演著專注於「技術開發以降低成本」的關鍵角色，與主導政策及商業化的 METI、JOGMEC 形成明確分工，其研發成果旨在為下一階段的大規模商業化鋪路。

(2) NEDO 的合作模式主要是透過公開徵案，並運用其管理的「綠色創新基金（GI 基金）」，補助企業與學術單位進行前瞻技術的研發與示範 。目前的研發重點涵蓋了價值鏈的各個環節，除了設立 2030 年各項碳捕捉技術的成本下降趨勢及目標，更包括開發「低能耗固體吸收劑捕獲技術」、全球首艘「低溫低壓液化 CO_2運輸船」，以及可用於「即時偵測地層變化的高精度光纖監測技術」等 。

(3) 針對苫小牧專案，NEDO 坦言其作為試驗計畫，單位成本極高，但成功驗證了技術在地震頻繁地區的安全性 ，此專案的經驗也凸顯了商業化的挑戰，包含高昂成本以及「全生命週期」淨減碳效益尚待量化的問題，後者影響了對 CCS 技術真實環保成效的判斷 ；此外，NEDO 提出一個重要的策略觀點：儘管日本擁有龐大的近海封存潛力，但初期開發成本高昂，相較之下，利用海外已開發的枯竭油氣田進行封存，在現階段更具經濟可行性，亦解釋為何多數日本民間企業提出的計畫皆傾向於國際合作與海外封存，借由日本在「國內、海外封存並行」的務實思維，為我國在規劃整體封存佈局時，提供了跳脫單一選項的重要啟示。

圖 2 我方團員與新能源產業技術綜合開發機構(NEDO)經驗交流情況

4、拜會日本 CCS 調查株式會社(JCCS)及參訪苫小牧 CCS 示範場域

苫小牧 CCS 示範場域是日本首個完整涵蓋捕捉、注入、封存的 CCS 大規模實證計畫，由日本 CCS 調查株式會社(JCCS)負責營運。該計畫自 2016 年起，成功將 30 萬噸 CO_2 封存於北海道苫小牧市外海的海床下地層，本次拜會日本 CCS 調查株式會社(JCCS)，參與交流人員包括 田中 次郎（担当部長）、田瀬 大治（担当部長），交流與參訪內容如下：

(1) 苫小牧 CCS 示範專案（Tomakomai CCS Demonstration Project）其專案資金 100%皆來自日本政府，計畫目標係展示從捕捉到封存完整 CCS 灌注系統的可行性、安全性和可靠性；其 CO_2 來自鄰近煉油廠，捕捉來的 CO_2 灌注至離岸的儲集層；其專案的特色為世界上第一個位於大型城市港口附近的離岸 CCS 專案，並採用兩個高傾角定向鑽井（highly deviated injection wells）從岸上鑽井至離岸儲集層，避免了對海洋環境、港口和漁業活動的干擾，同時節省了鑽井成本。

(2) 該示範計畫為監測 CO_2 封存、地震活動和海洋環境，所設置的監測系統包括注入井感測器、觀察井、海底電纜 (OBC)、海底地震儀 (OBS)、陸上地震站和多種地震調查（2D/3D/Mini-3D）等，於 2018 年 9 月 6 日發生 6.6 級地震，震央距離苫小牧約 148 km，設施未受損。故 JCCS 確認 CO_2 注入與地震之間沒有關係，且沒有 CO_2 洩漏。

(3) 本次實地參訪苫小牧示範場域，不僅在於觀摩其技術操作，更在於學習其社會溝通的成功之道。JCCS 作為由多家民間企業合資成立的專案公司，其運作體現了緊密的產官合作。專案經費主要來自 METI 的補助，而 JCCS 則負責專案的執行、技術驗證與在地溝通。JCCS 專家強調，苫小牧專案成功的基石，是與在地社區，特別是漁民，建立了「長期且良好的溝通和信賴關係」。其關鍵作法如：

A. 十年深耕：早在計畫啟動前十年，團隊便已開始與地方密集溝通，透明地分享所有資訊。

B. 尊重在地：將在地漁民視為專案的「地主」，而非僅是利益相關者，充分尊重其意見。

C. 科學實證：2018 年北海道膽振東部地震發生後，專案團隊立即暫停注入，並提出科學數據證明地震與 CO_2 注入無關，且封存未受影響。此一「非預期的壓力測試」反而成為最有力的安全證明，大幅強化了公眾信任。

(4) 對於 CCS 專案，「公眾接受度」與「技術開發」同等重要，甚至更為關鍵。目前雖然注入作業已完成，但後續的監測工作仍在持續，這也展現了對地方的長期承諾。

圖 3 我方團員參訪苫小牧 CCS 示範場域並與 JCSS 意見進行交流

5、拜會日本環境省(MOE)

日本環境省(MOE)是負責國土環境保護的最高主管機關，在 CCS 治理中，其職責為監督海洋環境、審查環境影響評估，並在《CCS 事業法》的框架下，與 METI 共同對海上 CCS 專案進行許可。本次拜會由環境省(MOE)水・大氣環境局 水谷好洋課長、武井 宏樹 課長輔佐等 4 位人員出席，交流內容如下：

(1) 環境省詳細說明了其在 CCS 治理中的雙重角色：依法監督與獨立驗證。在《CCS 事業法》的框架下，環境省與經濟產業省建立了權責分明又緊密合作的共管模式。任何海上封存專案的許可，METI 都必須諮詢並獲得 MOE 的同意。業者必須提交包含環境影響評估的實施計畫與監測計畫，而 MOE 則依據《倫敦議定書》等國際標準進行審查，肩負海洋環境保護的最終把關責任

(2) 為確保監管的客觀性與公信力，環境省採取了「雙重監測機制」，除了依法要求業者執行並公開監測數據外，MOE 自身也委託第三方在苫小牧周邊海域進行獨立的長期環境調查，監測項目涵蓋水質、沉積物及海洋生態系統的調查（如重要漁獲「北寄貝」的生態狀況），藉此證明 CCS 的安全性。所有調查結果均對外公開，環境省表示，此舉已有效提升在地漁民的信任感，證明以科學數據為基礎的透明化策略，是化解社會疑慮、促進 CCS 順利推動的基石。此合作模式，展現了政府部門間如何協力，共同為大型基礎建設的環境與社會效益把關。

三、心得及建議

（一）心得

1、**完備的法規與財務框架是產業發展的基石**：日本於 2024 年公布《CCS 事業法》，透過單一專法明確界定政府與業者之權責，並整合經濟發展（METI 主責）與環境保護（MOE 主責）的跨部會共管機制，為產業提供了從探勘到封存後責任移轉的完整法律保障。在財務上，日本「政府承擔前期風險、後期差價合約補貼」的

模式，有效降低了企業的投資不確定性，是驅動私部門投入高成本 CCS 專案的關鍵，借鏡日本經驗，規劃設計符合我國產業現況的投資抵減或補助方案，以吸引國營事業與民間企業共同投資，加速我國 CCS 產業鏈的形成。

2、**成熟的商業化技術是減碳的務實選項**：三菱重工(MHI)的案例證明，高效、低耗能的胺基溶劑碳捕捉技術已在全球超過 18 個商轉廠房得到驗證，並可廣泛應用於發電、鋼鐵、水泥、石化等多個「難減排」產業。採納已獲市場驗證的成熟技術，可大幅縮短我國產業的技術評估與學習曲線，加速減碳進程。

3、**社會信任的建立優先於技術的推動**：苫小牧 CCS 示範專案，其驗證 CCS 在每一環節中（特別是地震頻發的島國）是安全可靠，惟苫小牧可成功的經驗，最關鍵因素在於長達十年的在地溝通，其將在地漁民視為「地主」而非對立者，並透過「業者監測」與「政府獨立監測」並行的雙重機制，將所有科學數據透明公開，甚至在經歷強震後以科學實證化解公眾對安全性的疑慮，最終贏得了深厚的社會信任。此經驗證明，社會溝通是比工程技術更需耐心經營的環節與 NEDO 的交流，釐清了政府在 CCS 生態系中不同單位的角色分工。其務實的成本考量與「國內、海外封存並行」的策略思維，為我國在規劃整體封存佈局時，提供了跳脫單一選項的重要啟示。技術的領先與成本的降低，是 CCS 能否大規模普及的關鍵，NEDO 在此扮演了不可或缺的推手角色。

4、**清晰的治理分工是高效推動的保障**：日本政府內部針對 CCS 的推動，有著明確的角色分工：METI 主導政策與商業模式、JOGMEC 負責前期地質調查與專案管理、NEDO 專注於前瞻技術研發以降低成本、MOE 則嚴守環境保護的關卡。此一權責分明的治理架構，使政策、技術、資金與監管能高效協作，共同打造健全的 CCS 生態系。

5、**務實的商業佈局是兼顧理想與現實的策略**：NEDO 提出儘管日本擁有龐大近海封存潛力，但初期開發成本高昂，故現階段多數民間企業傾向與海外合作，利用既有枯竭油氣田進行封存，更具經濟可行性。此「國內、海外封存並行」的務實思維，為我國在規劃長期封存策略時，提供了兼顧經濟效益與能源安全的多元選項。

（二）建議

1、加速建構我國 CCS 法制與治理體系：為因應我國淨零轉型之迫切性，建議本署應偕同經濟部等相關部會，加速完備《二氧化碳捕捉後封存管理辦法》，並借鏡日本《CCS 事業法》之精神，明確劃分各主管機關在場址開發、環境監測與產業推動上之權責，建立高效的跨部會協調與審查機制。

2、研擬具體財務獎勵措施以引導產業投資：我國即將開徵碳費，然初期費率與高昂的 CCS 成本存在巨大落差，難以形成足夠的投資誘因。建議應積極研擬符合我國產業現況的財務支持方案，可參考日本補助「CCS 成本與碳成本差額」之精神，規劃投資抵減或前期經費補助，以鼓勵國營事業與私部門共同投入，加速我國 CCS 產業鏈的形成政策與法制面建議。

3、**建立以科學為本、資訊透明的社會溝通機制：**社會信任是 CCS 專案能否落地的關鍵。建議本署應在政策環評階段，即主導建立常設的、多方的社會溝通平台，並師法日本環境省，建立獨立的第三方環境監督機制，將所有監測數據以公眾易於理解的方式透明公開。應主動與場址周邊的漁會、地方社區及環保團體建立制度化的溝通管道，將其疑慮納入風險。

4、**研擬本土化的環境監測與預警系統規範**：建議汲取日本環境省「雙重監測」與 METI「紅綠燈預警系統」的經驗，盡速研訂我國 CCS 場址的環境監測技術指引與緊急應變計畫規範。除要求業者提報監測計畫外，主管機關應建立獨立的第三方查核與環境監測機制，並將監測數據透明公開，以建立公信力。

5、**建立 CCUS 價值鏈技術標準與生命週期評估方法學**：為促進產業鏈整合，建議邀集產、官、學、研成立工作小組，研擬我國 CCUS 價值鏈的技術標準。討論議題應包含不同應用場景下的 CO_2純度要求、管線與儲槽的材料規範等 。同時，透過委託學研機構針對我國主要 CCUS 路徑，進行全面的生命週期評估(LCA)，以科學化數據釐清各方案的真實淨減碳效益，作為政策優先順序與資源分配的依據。

四、附錄

(一) 日本經濟產業省(METI)簡報資料

(二) 日本環境省(MOE)簡報資料

(三) 日本新能源產業技術綜合開發機構(NEDO)簡報資料

(四) 日本 CCS 調查株式會社(JCCS)簡報資料

(五) 我國碳捕捉利用與封存 CCUS 減碳旗艦計畫簡報資料

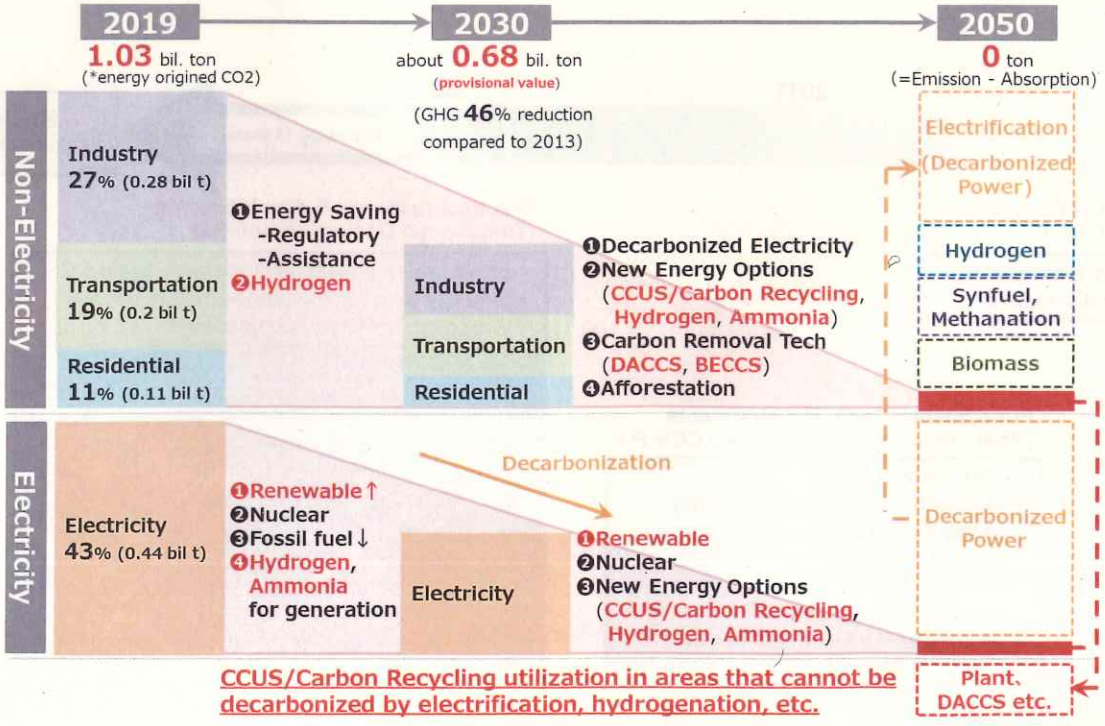
Ministry of Economy, Trade and Industry

Japan's CCUS policy Update

August 2025

Agency for Natural Resources and Energy, METI

Japan's pathway toward Carbon Neutrality by 2050



The 7th Strategic Energy Plan (February,2025)

6. Expansion of Decarbonized Power Sources and Grid Development

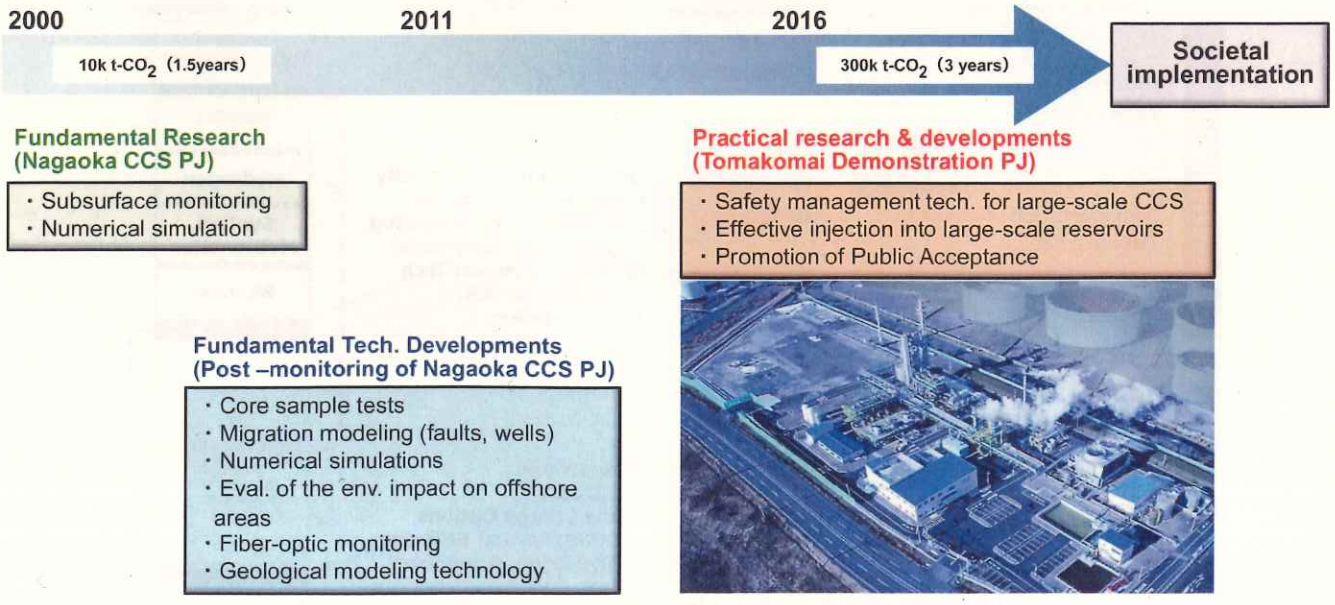
<Thermal power>

- While the current supply and demand of electricity remains unpredictable, we **will maintain and secure the generation capacity (kW) necessary for a stable supply of** thermal power as a whole, **while reducing the amount of electricity generated (kWh), mainly from inefficient coal-fired power**. Specifically, we will **secure LNG-fired power** as a means of **transition**, promote the **decarbonization of thermal power** by utilizing hydrogen, ammonia, CCUS, etc., and give ongoing consideration to measures such as a **Reserve Power Plants system**.

9. CCUS/CDR

- CCUS can **achieve decarbonization in areas that are difficult to decarbonize through electrification and a shift to non-fossil sources using hydrogen and its derivatives**. Therefore, CCUS is indispensable for simultaneously achieving energy security, economic growth, and decarbonization. We will **consider support systems to encourage investment** in CCS projects, **develop technologies to reduce costs**, **develop suitable sites**, etc.
- CDR is necessary as a means to offset residual emissions.We will work to improve the environment, create markets, and accelerate technology development.

History of Japanese CCS Projects



Japan's "CCS Long-Term Roadmap"

[Basic principles]

To implement CCS systematically and rationally to promote the sound development of CCS business in Japan with minimal social costs, thereby contributing to the development of Japan's economy and industry, securing a stable energy supply, and the achievement of carbon neutrality.

[Objectives]

A business environment for commencement shall be prepared by 2030, involving cost reduction, public understanding, overseas CCS promotion, and CCS Business Act legislation, **based on the rough estimation of enabling CO_2 storage of about 120 to 240 million tons as of 2050, and full-scale CCS business shall deploy after 2030**.

[Examples of Specific actions]

- Development of the CCS Business Act
- Government support for CCS business
- Efforts for reducing CCS costs
- Promotion of overseas CCS business

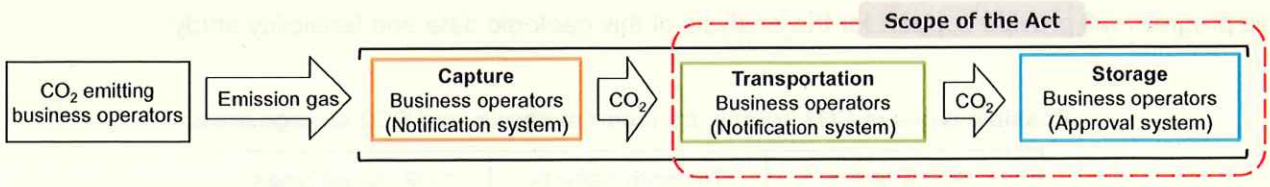
CCS Business Act (accepted on 24th May, 2024)

Purpose

◆Ensuring adequate business environment and public safety for CCS business in Japan

Scope

◆**Regulations for** business operators of **pipeline transportation** and **storage**
*Including **not only safety regulation** but **also economic regulation***
*Regulations for Carbon capture will be considered in the future



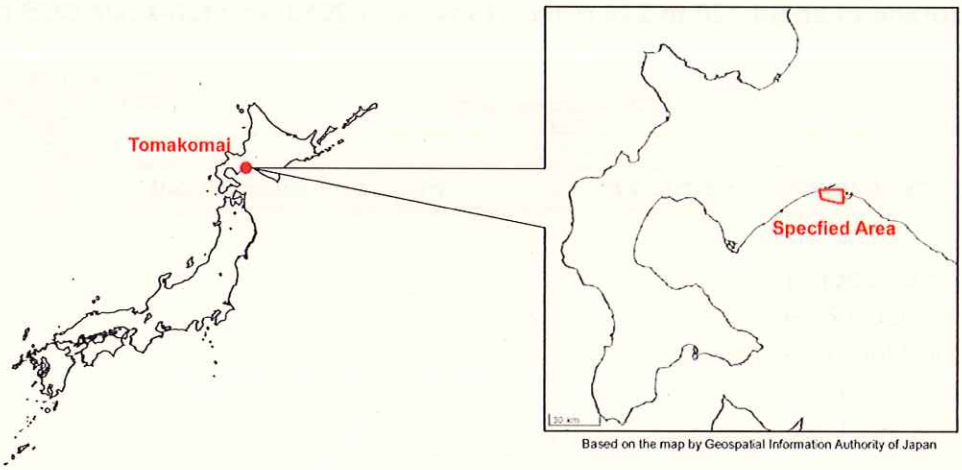
London Protocol

◆ **Japan is the contracting parties to the London Protocol 1996.**

◆ Together with CCS business Act, **acceptance of the amendment of London Protocol was approved** by the National Diet on this May which **enable Japan to export CO2.**

Designation of Specified Area under CCS Business Act

- The CCS Business Act stipulates that when the METI Minister finds it necessary to have businesses **conduct exploratory drilling of an area where reservoirs exist or may potentially exist** as an effort to promote public interest by storing carbon dioxide storage in the area, **the METI Minister may designate the area as a specified area and grant a license to the businesses evaluated as most capable of conducting the drilling in the specified area** after accepting applications for the license for such drilling from businesses.
- On February 21, 2025, the Minister of Economy, Trade and Industry (METI), **designated a sea area offshore Tomakomai City, Hokkaido Prefecture, as a specified area** under the CCS Business Act.
- METI started the acceptance of applications for a license for exploratory drilling in the specified area.



Based on the map by Geospatial Information Authority of Japan

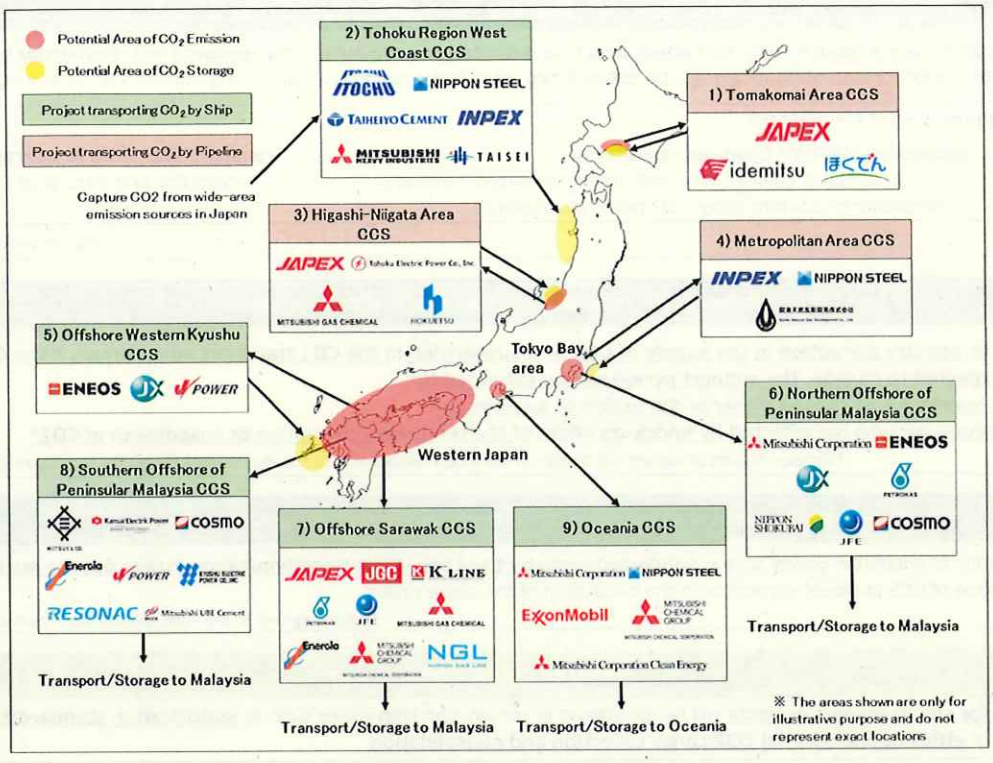
Government Support: "Advanced CCS Program"

- To secure annual storage of 120-240 million tons of CO2 by 2050, A business model for CCS that can cross-sectoral should be established at an early stage. Thus, Japanese government selected "Advanced CCS projects" led by operators and will actively support them.
- This supporting program will establish various CCS business models by **supporting projects with different combinations of CO2 source, transportation methods and CO2 storage areas**. Furthermore, it **aims to secure 6-12 million tons of CO2 storage per year by 2030**.
- This program will provide support for the analysis of this geologic data and feasibility study.

Possible types of CO2 source, transport methods, and CO2 storage areas

CO2 sources	Transport methods	CO2 storage areas
Thermal power plant Steel plant Chemical plant Cement plant Paper plant Hydrogen plant etc.	Pipeline Ship	Onshore Near shore Offshore

Advanced Efforts for Commercialization of CCS
- JOGMEC selects Nine projects as Japanese Advanced CCS Projects -



CCS Business (Pipeline Project) Support Scheme: Outline of Interim Review (1/2)

Support Scheme

- Support will be focused on **cost difference** between **CCS costs** and **costs borne by the emitter to implement CO2 measures**, over the **mid-to-long term (Considering the timeline that those costs are reversed)**

Cost difference = Strike price − Reference price

<Strike price>

Separation/capture cost [/CO2t] (**CAPEX & OPEX** for Separation/capture, set for each separation/capture business operator)

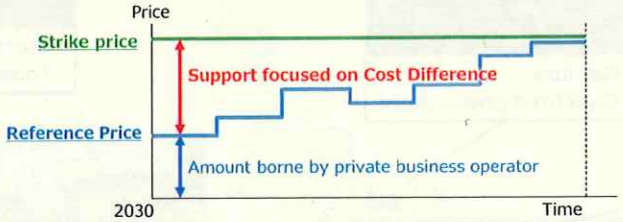
+

Transport and storage charges [/CO2t] (**CAPEX & OPEX** for Transport & Storage, **determined by auction**)

<Reference price>

Determined every year by referring the previous fiscal year's **carbon price** in carbon pricing systems

*The carbon pricing benchmarks that should be adopted will require adjustment in accordance with upcoming GX-ETS system design



- To achieve the establishment of a series of CCS businesses in the early 2030s, projects will be selected about **once per year; over multiple years**.
- The CO2 storage capacity to be selected for each fiscal year will be set in advance.
- Selections will be based on an **overall evaluation of the entire business plan** and **transport and storage charges auction** (Successful bidding in the auction will be positioned as one of the necessary items in the evaluation).

CCS Business (Pipeline Project) Support Scheme: Outline of Interim Review (2/2)

Mechanisms for Promoting Autonomy after the Support Period (Business Continuity Obligations)

- As a measure **to continuously reduce costs and enhancing CCS business to have autonomy (Become self-sustaining business without subsidy)**, the **business continuity obligations will be established after the support period,** during at most the same length as the support period.

Obligations after the support

Separation/capture business operators:
- CCS at the level equivalent to that during the support period / Substituting CCS with other CO2 reduction measure

Transport and storage operators :
- Acceptance and storage of CO2

*Support period & Obligation period are TBD

Measures for Temporary Suspension and Cross-Chain Risks

- In the event of a **temporary disruption in the supply of CO2 or a suspension in the CO2 transport and storage, if the total amount of support is not expected to change, the support period will be extended for**
  - A) **the business operator who caused either of disruption or suspension**
  - B) **the business operator who are affected by knock-on effect of the temporary disruption or suspension of CO2***

*In case (B), part of support will be paid in advance if needed to continue the business during the temporary disruption or suspension period

Relationship with the Long-Term Decarbonization Power Source Auction

- To prevent duplication of support in power sector, **supported costs by the Long-Term Decarbonization Power Source Auction* will not be included** in the scope of CCS business support or in the calculation of the strike prices.

*Bidding system to promote new investments in decarbonization power sources

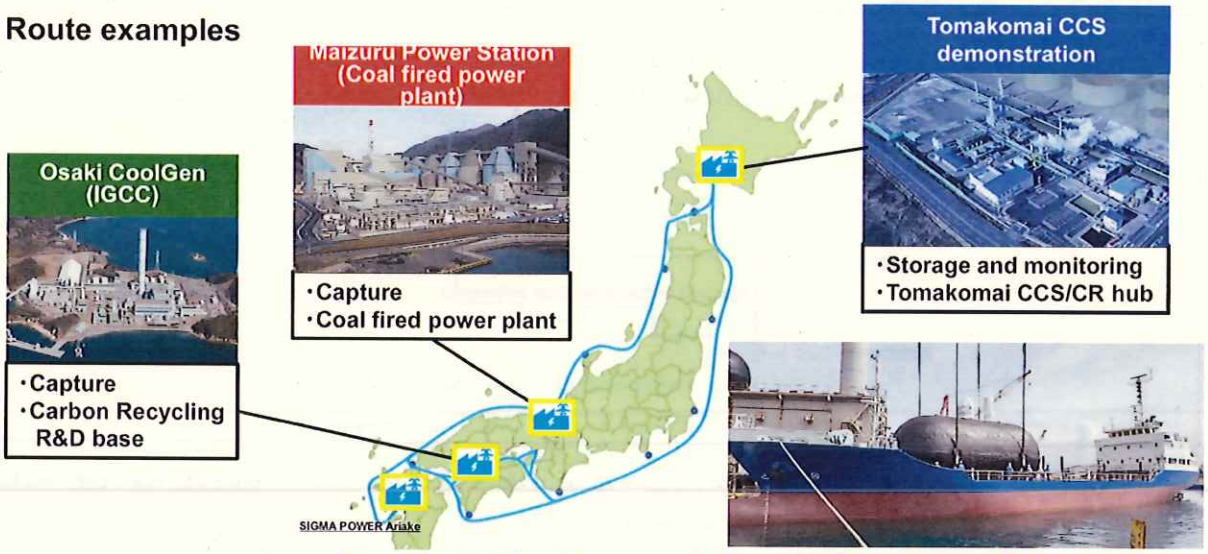
Items for Future Consideration

- **Support scheme for ship transport projects** will be considered in conjunction with issues such as **specification standardization of LCO2 Carrier** and consideration of **efficient and optimal CO2 cargo collection and consolidation**.

Cost reduction effort: Liquefied CO2 Shipping Demonstration Project

A demonstration project for long-haul transportation from emission sources to places suitable for storage will be carried out to establish liquefied CO2 shipping techniques.
Through this project, LCO2 carrier will be expanded to LNG carrier (around 60K ton class).

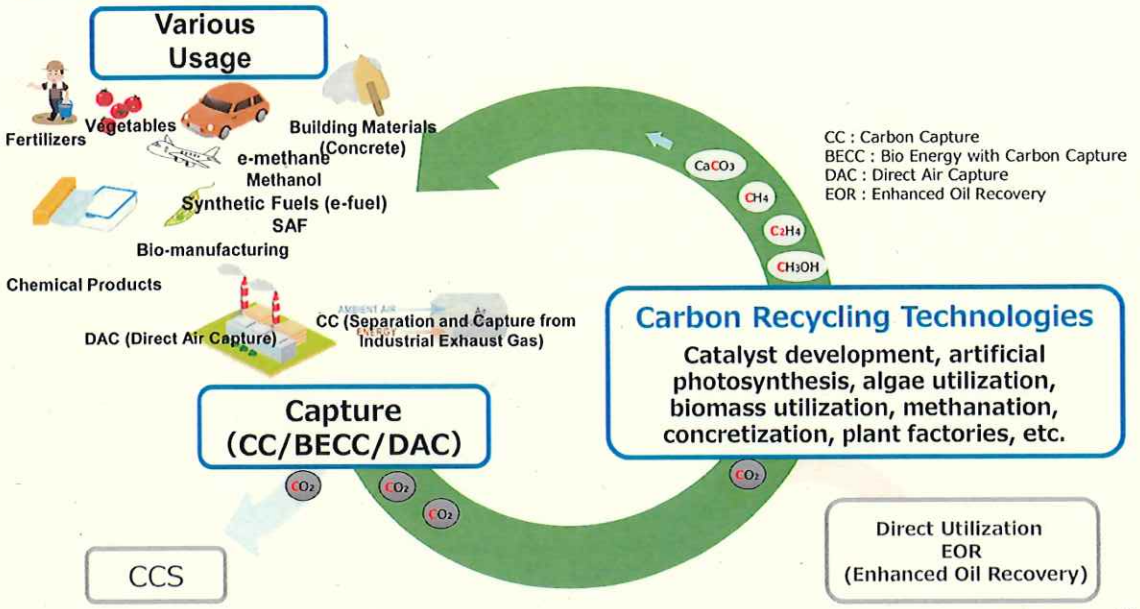
Route examples



Demonstration transportation of CO2 started from 2024

Concept of Carbon Management (CCU - Carbon Recycling/CCS/CDR)

Carbon Management: Cyclical use and reduction of CO2 through Carbon Dioxide Removal (CDR) and CO2 Capture, Utilization and Storage (CCUS)



環境省

環境省説明資料

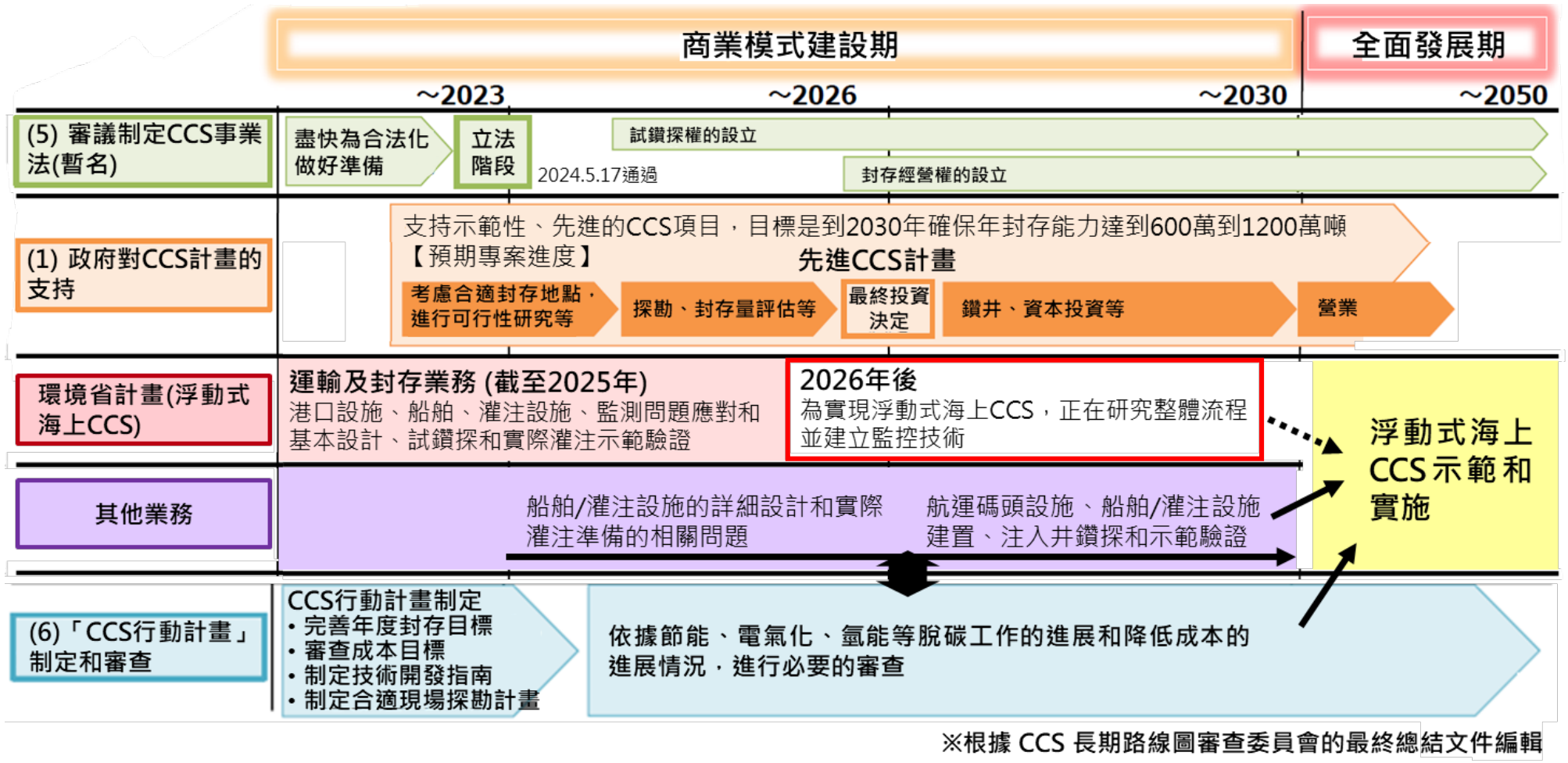
令和７年８月〇日

環境省

地球環境局 地球温暖化対策事業室、水・大氣環境局 海洋環境課

實現CCS長期路線圖

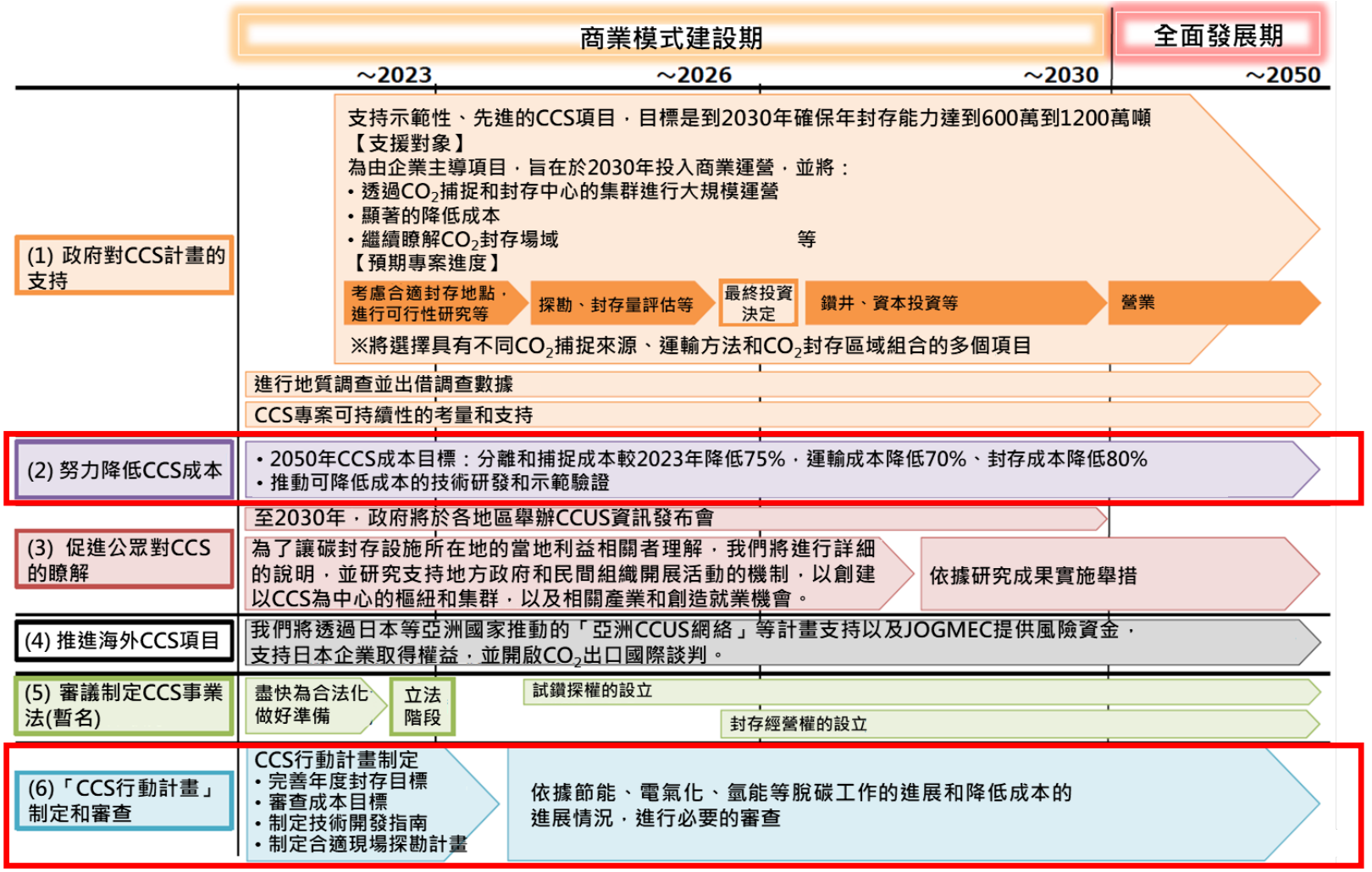
浮動式海上CCS的定位 (與CCS長期路線圖的關係)



※根據 CCS 長期路線圖審查委員會的最終總結文件編輯

(參考)CCS長期路線圖

■ (5) 除了考慮制定CCS事業法之外，環境省的CO_2運輸和封存計畫的成果還將有助於 (2) 降低CCS成本的努力和 (6)「CCS行動計畫」的製定和審查。



資料來源：CCS長期路線圖審查委員會最終總結

浮動式海上灌注法

- 日本碳封存潛力大部分存在於其周邊海域，但**透過管道運輸二氧化碳，尤其是海上管道運輸，難度和成本較高**，原因包括從陸地鋪設管道時，管道長度將隨離岸距離而增加；且淺水區有限，與歐美相比水深較大；海床因礁石等因素而較不平坦。
- 透過從船舶等**海上設施向海底注入CO_2**，即可於上述難鋪設管道地區進行注入和封存，並**有效利用適合CCS之海上地質構造**。
- 採用海上注入方式，即使注入過程中達到注入極限而**需改變注入點，也可靈活應對而無需重新鋪設管道**。
- **海上注入技術於全球尚屬首次**。由於亞洲及世界其他地區地形陡峭，日本率先將這項技術投入實際應用，**預期將可擴展至海外運用**。

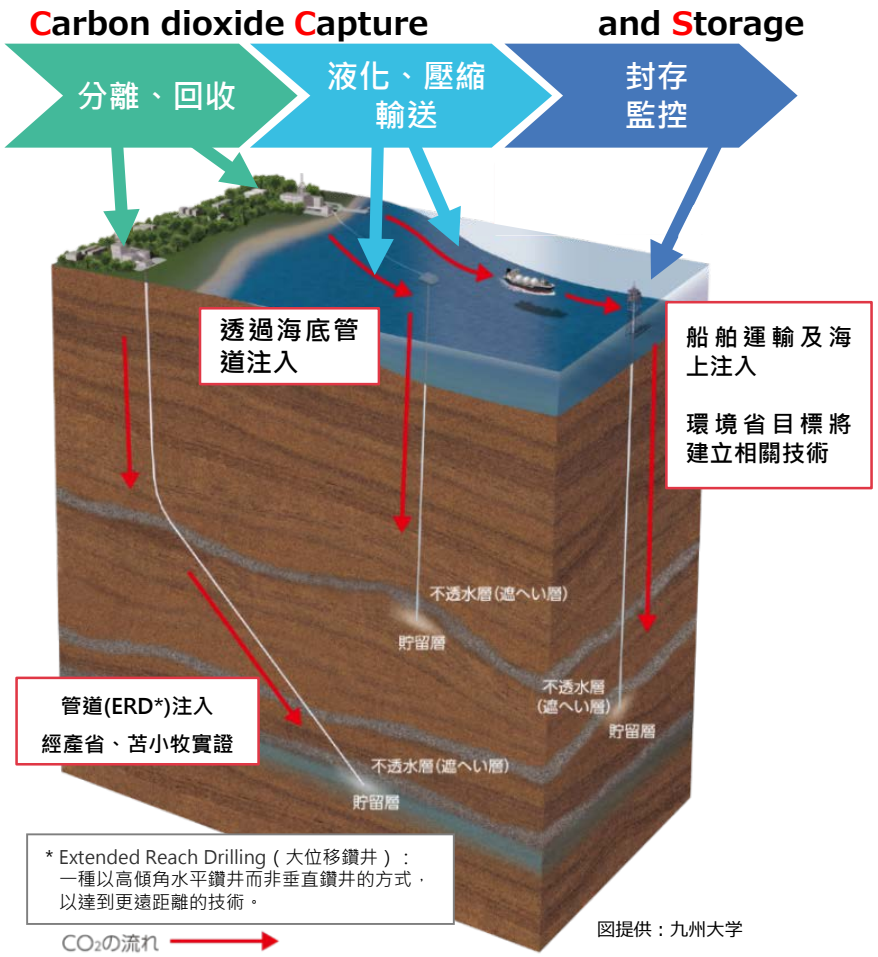
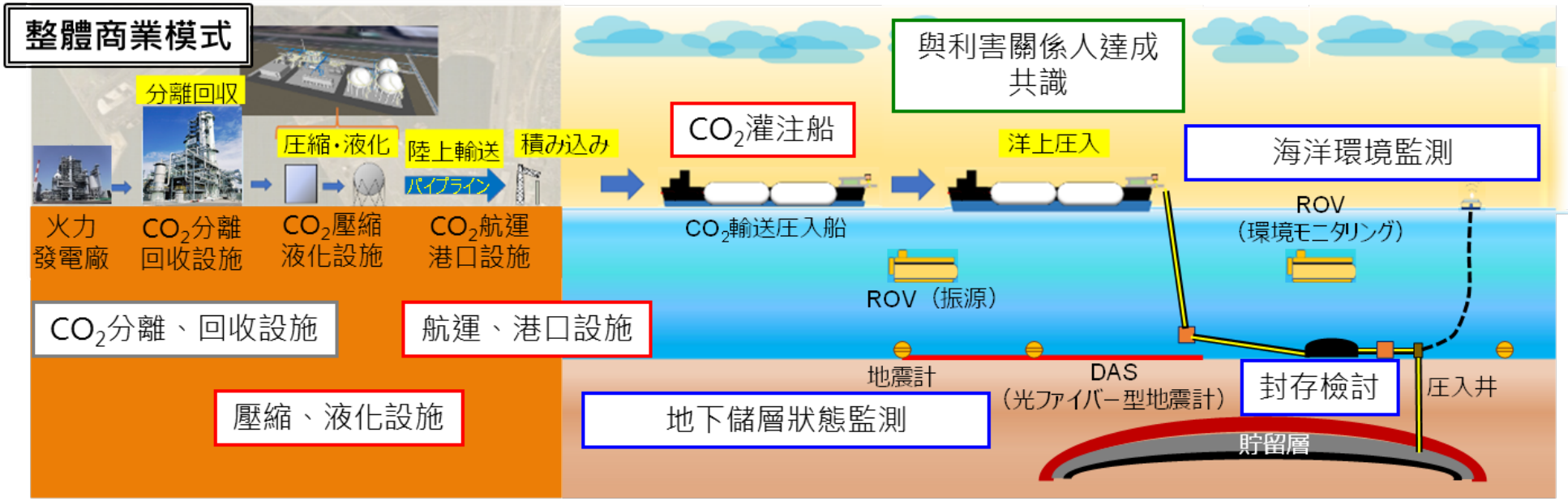


圖 將CO_2注入海底的方法
可透過從陸地直接注入、海底管道注入及海上注入共三種方式

CO_2運輸和封存業務

■ **本計畫旨在進行技術研究，以實施海上CCS計畫。此計畫利用CO_2運輸船將CO_2運送至海底封存點，然後從浮式海上結構體注入並封存CO_2，同時兼顧環境效益。此外，本計畫也旨在累積 CCS 順利商業化所需的知識。**

- **運輸**：關於碳捕捉設施捕捉的CO_2經壓縮液化後，裝運、運輸、注入CO_2封存場域的技術研究。
- **封存與監測**：國內碳封存技術研究，包括建立適用於地下碳封存與海洋環境的監測技術。
- **順利實施方法**：從順利實施CCUS的角度，我們將綜合考慮CCUS的經濟和環境效益及風險，並與利害關係人達成共識。



CO_2運輸和封存業務(海上CCS潛力及成本估算)

■ 透過海上CCS可以進一步發揮封存潛力。

■ 據估計，一旦離岸運輸距離超過約53公里，海上注入CO_2單位重量成本將低於管道輸送方式。

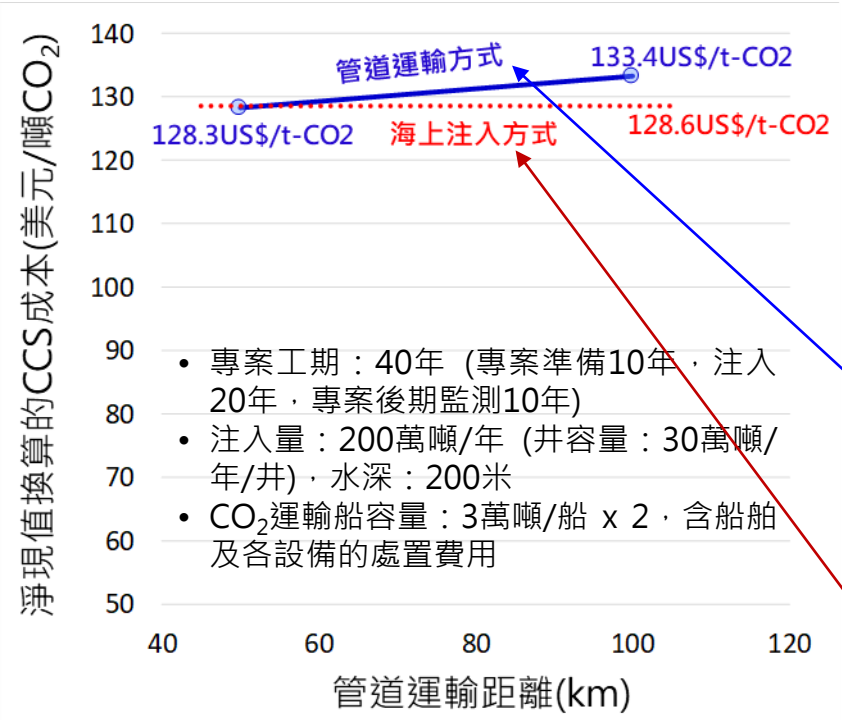
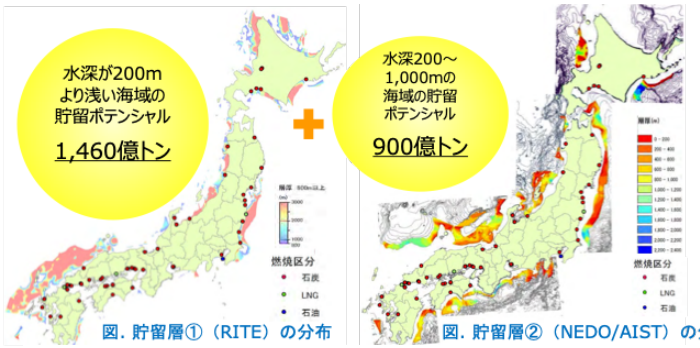
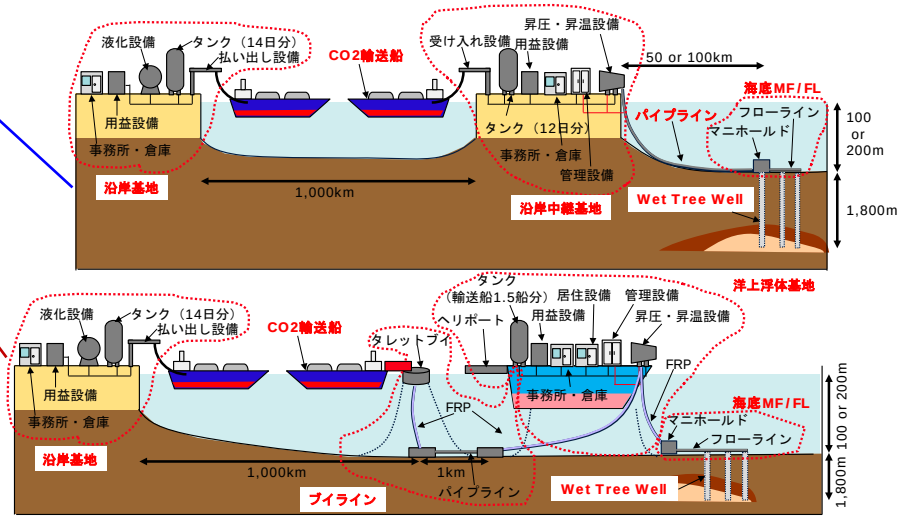


圖 CCS成本相對於管道運輸距離的變化



水下200 m封存潛力

摘自第三屆早期社會實施會議（2021年8月3日）



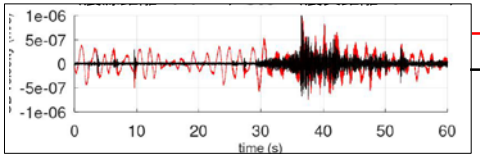
CO_2運輸和封存業務(CO_2監測)

■ 我們將研究監測地下和海洋CO_2和儲層穩定性的各種技術和方法。

➢ 建立連續海洋監測系統：開發結合光纖感測技術(DAS)的新型連續監測技術，以估計注入地下的CO_2的擴散(瞭解CO_2的行為並確認其穩定性)。

➢ CO_2海洋環境監測方法研究：利用多波束聲納(MBES)在200公尺深處進行探測CO_2洩漏試驗。

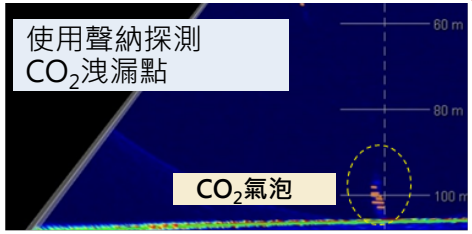
透過從地震儀觀測結果中消除海浪的影響來觀測微地震。



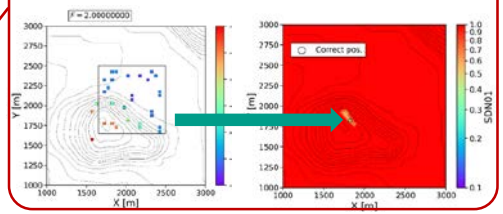
考慮對海洋生物影響的小型揚聲器型地震源

地震勘探、光纖
彈性波勘探

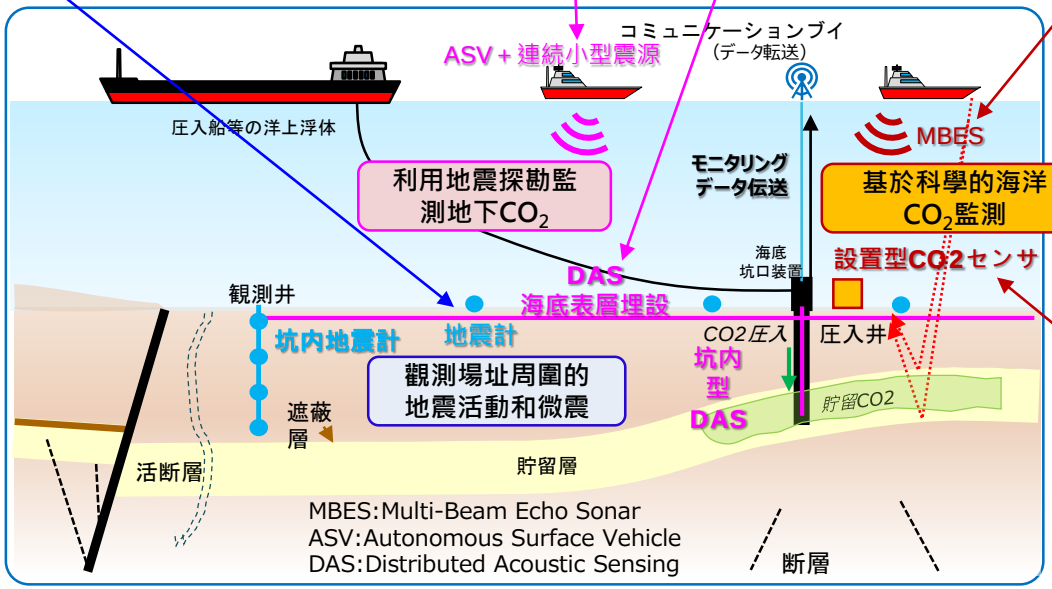
使用聲納探測
CO_2洩漏點



透過數值模擬，根據觀測結果識別洩漏點。



本專案開發了pCO_2感測器PCS-19。



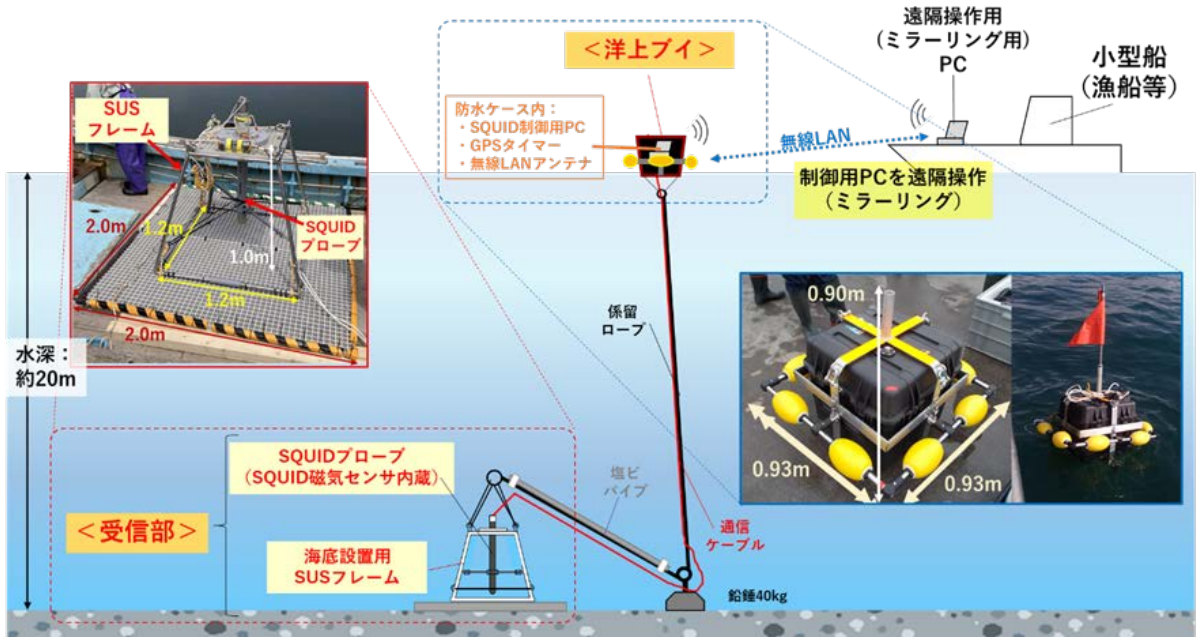
海洋及地下CO_2監測運輸與封存技術示範計畫概述

（參考）關於環境省監測技術審查

○海底CCS計畫監測方法探討

目前，海底封存的CO_2監測主要採用地震探勘法，即使用氣槍或其他裝置人工產生彈性波(地震波)，並測量和分析其在地下的傳播情況，從而評估地質構造。然而，人們仍然擔心氣槍的巨大噪音會對海洋生物造成影響，因此需要開發新的、環保的海底CO_2監測技術。

此外，我們將收集和整理海外封存CO_2監測的最新成果，開發優化、降低成本並提高環保監測方法品質的技術，以了解海底CO_2封存狀況。為此，我們將進行實際海上試驗，以探討電磁勘探系統相關的海洋觀測方法並將其商業化，建立評估方法並公開結果。



○電磁勘探系統示意圖

環境影響評估

《防止海洋污染及特定CO_2海底自然處置(CCS)法》相關規定

- 環境省根據《防止海洋污染法》負責監管碳捕獲和儲存(CCS)，該法以防止海洋污染的國際條約(如《倫敦議定書》)為基礎。

1．原則上禁止在海底傾倒廢物

除非獲得環境大臣許可，否則禁止在海底處置廢物。

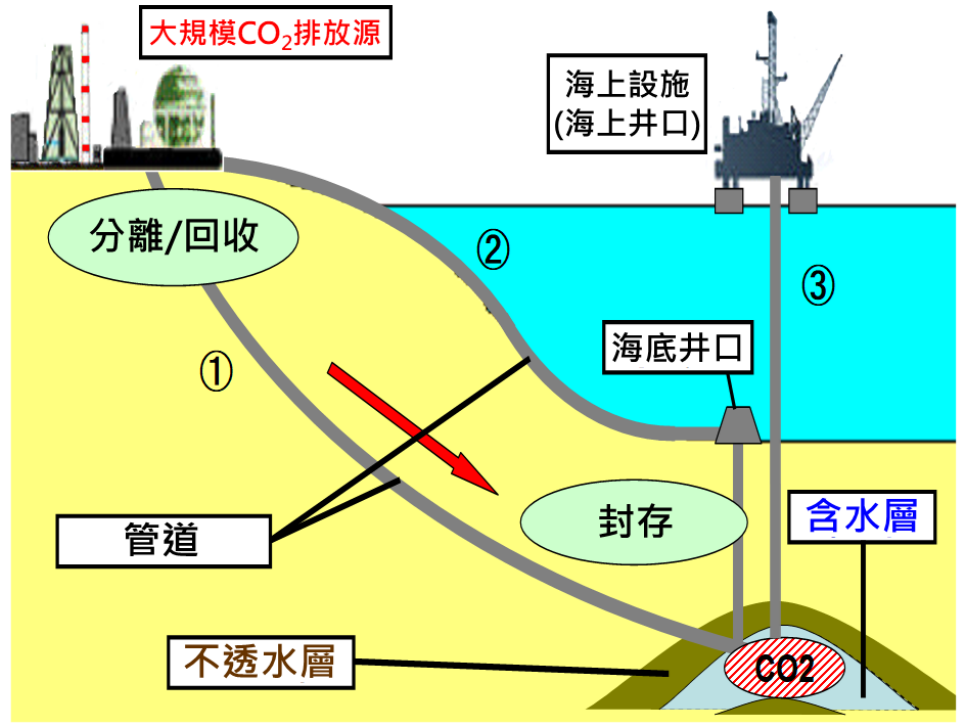
2．CO_2海底處置許可證制度

1) 任何打算在海床下處置CO_2 (包括打算在陸地上處置CO_2)的人，必須獲得**環境大臣許可**。

2) 任何打算獲得**環境大臣許可**的人，必須進行環境影響評估。

3) 任何獲得許可在海床下處置CO_2的人，必須以不損害海洋環境保護的方式進行處置，並且必須**監測海洋環境**。

海底地質碳封存示意圖



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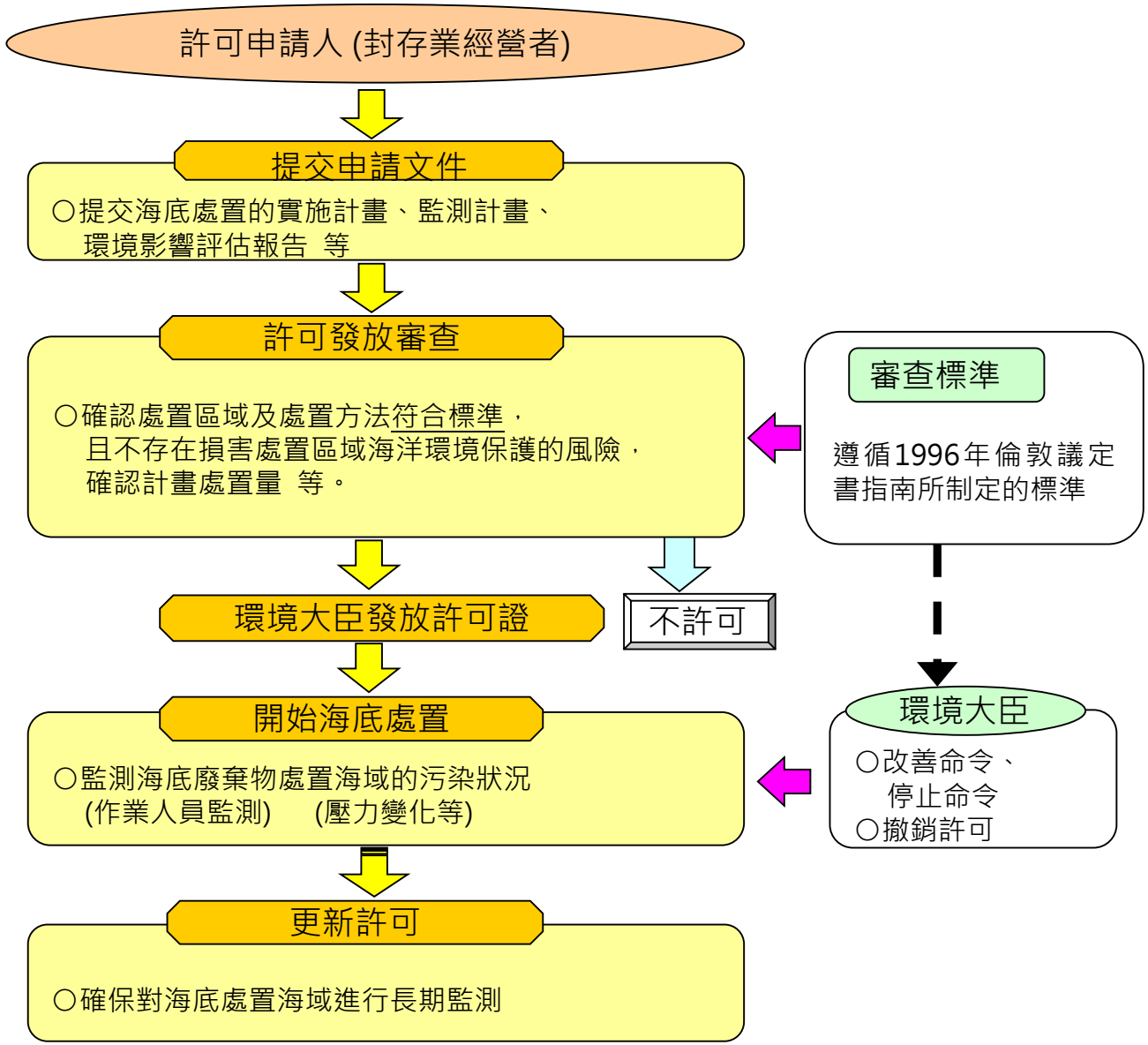
海底特定二氧化碳氣體處置許可證制度流程



落實CCS商業法
與經濟產業省的職責分工

《二氧化碳封存業務法》(CCS 業務法)概述

環境省

令和6年5月通過，公布後2年以內全面實施
※ 分階段部分實施

背景和法規概述

- ✓ 隨著我們朝著**2050年實現碳中和**的目標邁進，未來的挑戰是如何在難以脫碳的領域實現GX。為了在這些領域推動使用**化石燃料和原料後的脫碳**，**引入CCS** (碳捕捉與封存)**至關重要**，CCS是指捕捉CO_2並將其封存在地下的技術。
- ✓ **日本決定在2030年前營造允許民間企業啟動CCS計畫的商業環境**(GX推進策略，2023年7月內閣決定)，並將**建立封存計畫許可制度**等必要措施，在維護公共安全和保護海洋環境的同時，營造這樣的商業環境。

1. 建立勘探和封存專案許可製度，制定封存專案相關業務和安全法規

(1) 建立勘探和封存項目許可制度

- **經濟產業大臣**將指定※可能存在儲層的區域為「**特定區域**」。隨後，他將**招募**申請人在這些區域進行**勘探和碳封存項目**，並向被認為**最適合這些任務的申請人**頒發許可※。

※ 在指定海上特定區域並批准儲存項目時，必須諮詢環境大臣並獲得其許可。

- 獲得上述許可者將被授予**鑽探權** (開挖地質構造以確定其是否符合儲層條件的權利)和**封存權**(將CO_2封存在儲層中的權利)。

(2) 針對封存業者的規定

- **勘探鑽井和封存作業的具體「實施計畫」必須經經濟產業大臣(※)批准**。

※ 對於海上封存作業，則需要經經濟產業大臣和環境大臣批准。

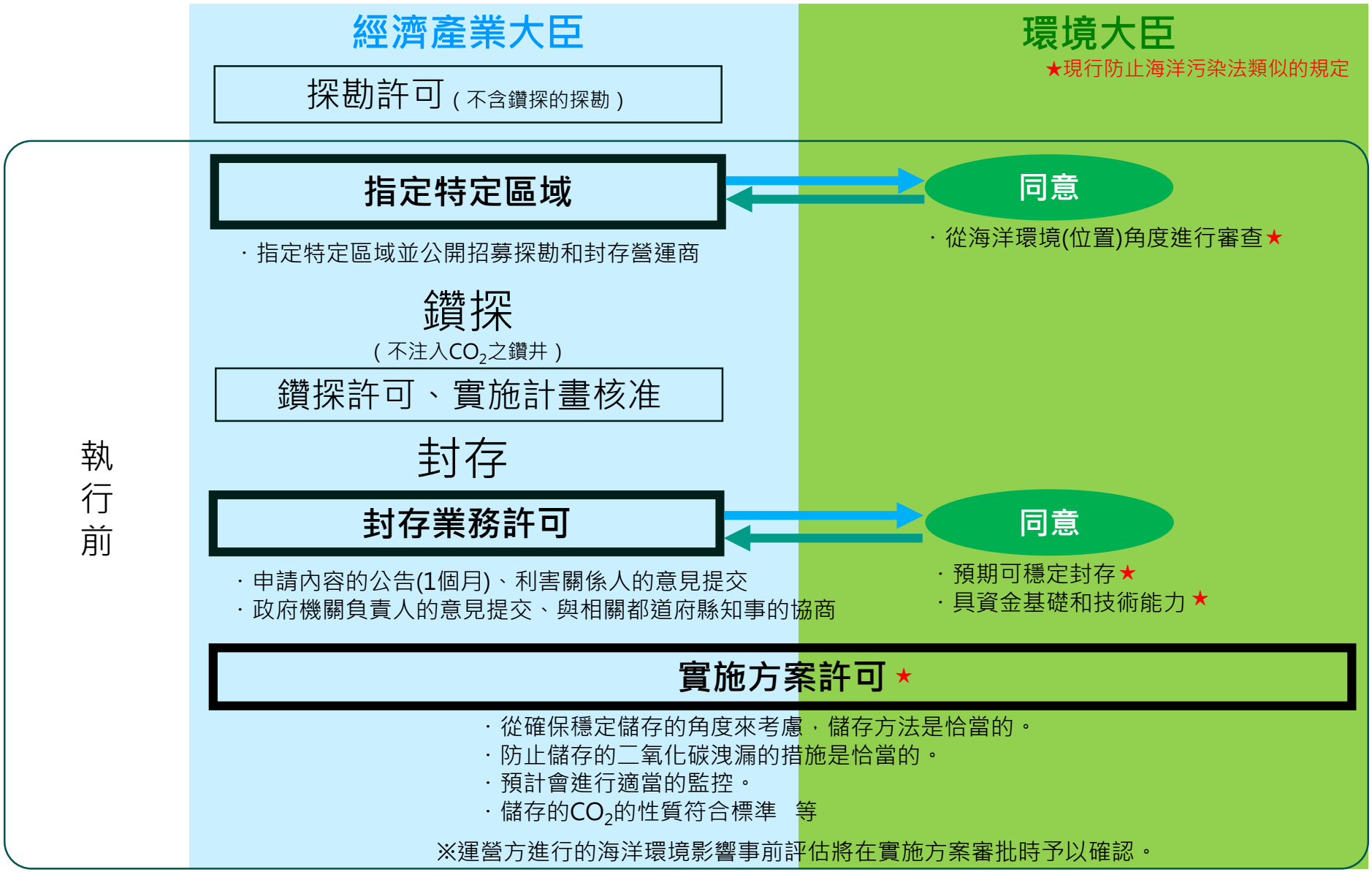
- 必須**監測儲層的溫度和壓力**，以確認封存的二氧化碳是否有洩漏。
- 為了確保**封存結束後監控營運所需的資金**，必須留出**儲備金**。
- 如果滿足某些要求，例如封存**CO_2的穩定性**，**封存設施的管理(包括監測)可能會移交給日本能源金屬國家機構(JOGMEC)**※。此外，封存業者需要繳納費用，以**確保移交後JOGMEC營運所需的資金**。

※ 轉移需要獲得經濟產業大臣的批准，如果是海上儲存作業，則需要與環境大臣協商並獲得同意。

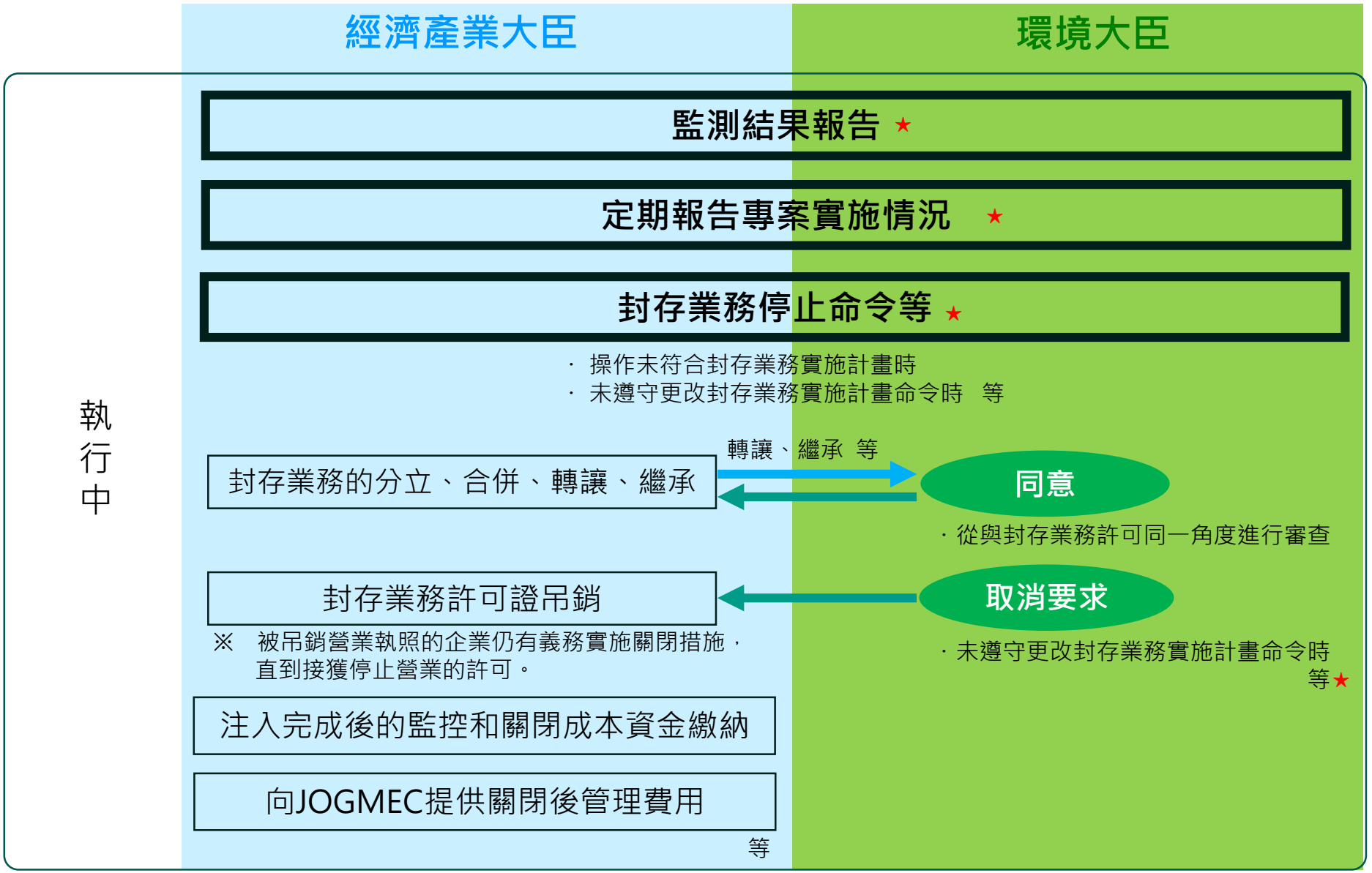
2. 制定與CO_2管線運輸業務相關的業務和安全規章制度

※本法案將統一海洋污染防止法中關於海底CO2處置的許可制度，環境大臣將從保護海洋環境的角度(紅色標記)共同監督所需的任何措施。

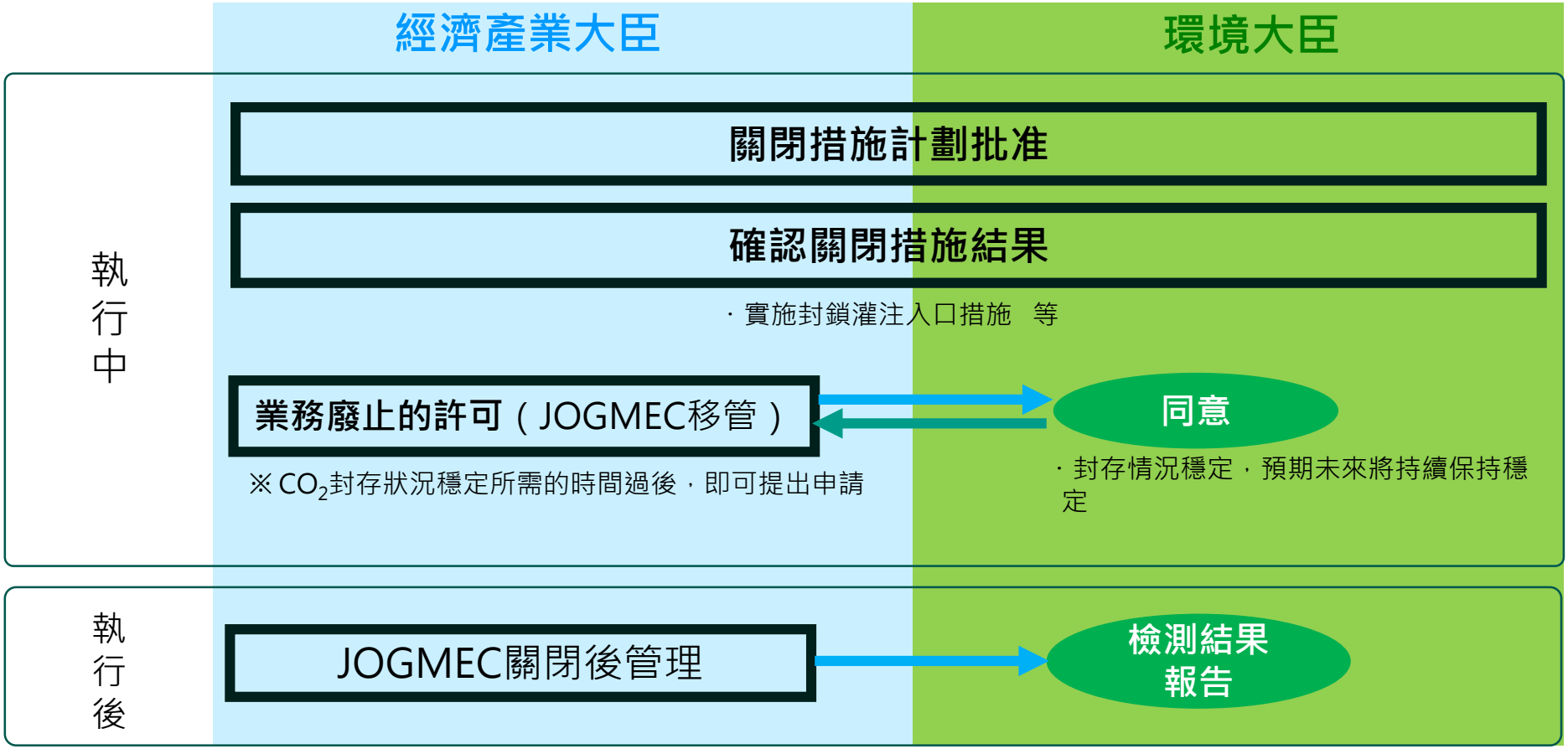
CCS商業法案中的海洋環境保護①



CCS商業法案中的海洋環境保護②

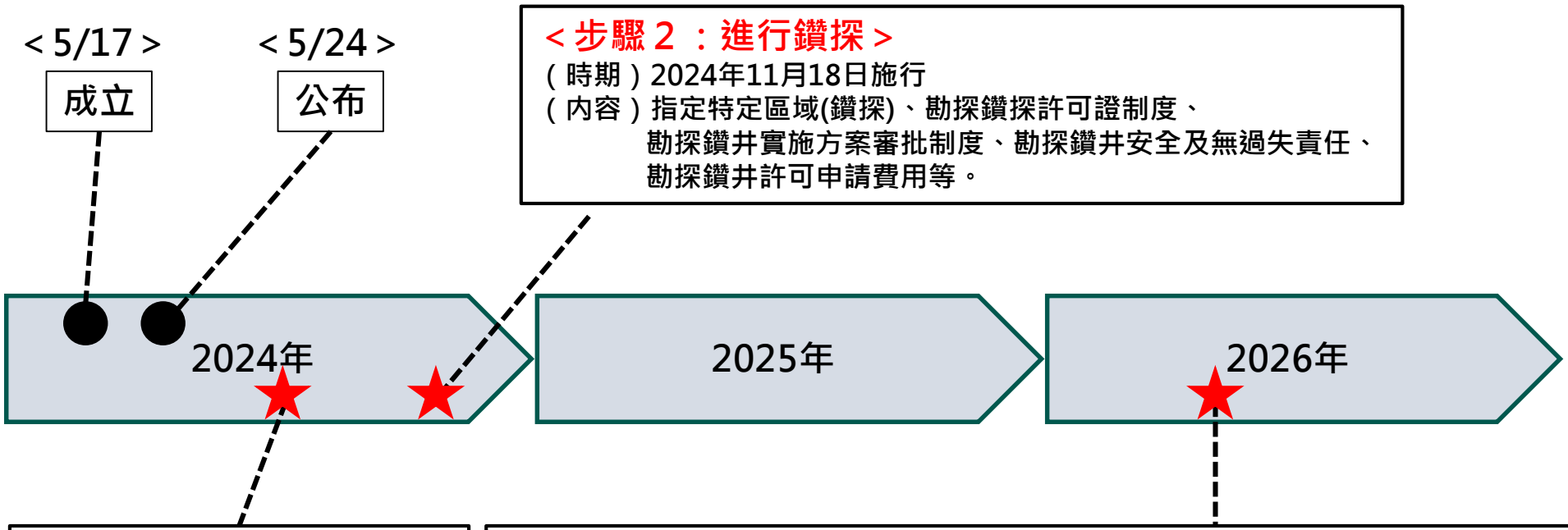


CCS商業法案中的海洋環境保護③



※　陸域封存業務由經濟產業大臣管轄
※　與公共安全和其他安全事務及管道運輸業務有關事務由經濟產業大臣管轄。
※　未來將透過政府法令和其他措施解決以下具體事項：
- 執行前海洋環境評估
- 執行期間海洋環境監測
- 關閉期間的具體措施

CCS專案總體進度安排



＜步驟２：進行鑽探＞

（時期）2024年11月18日施行

（内容）指定特定區域(鑽探)、勘探鑽探許可證制度、勘探鑽井實施方案審批制度、勘探鑽井安全及無過失責任、勘探鑽井許可申請費用等。

＜步驟１：進行探勘＞

（時期）2024年８月５日施行

（内容）探勘許可證制度(限制探勘方法、申請程序等)

＜步驟３：進行封存和管道運輸項目＞

（時期）法規公布後2年以內 (截至2026年５月23日)

（内容）指定特定區域（封存項目）、封存項目許可製度、封存項目實施計劃審批制度、封存項目監測、安全和無過失責任、移交給JOGMEC、管道運輸項目通報制度、管道運輸項目安全、封存項目和管道運輸項目第三方准入等。

與公眾溝通

與公眾溝通

- 提升對CCS理解
  - ✓ 經濟產業省(METI)和環境部(MOE)在其官方網站和報告中解釋了CCS的必要性和安全性。
- 建立CCS透明度
  - ✓ 北海道苫小牧CCS示範計畫涵蓋了多場計畫前期簡報會、現場參觀和公眾意見徵詢會。
  - ✓ 監測數據皆公布並告知利害關係人。
  - ✓ 與當地政府、漁業合作社和其他利害關係人進行意見交流。
- 挑戰
  - ✓ 有人指出，會議常包含大量專業術語，公眾難以理解。
  - ✓ 為了獲得全國性的理解和支持，有必要建立一個雙向、長期的討論平台。

苫小牧示範計畫中業者監控措施

初次許可證之監測計畫(2016年4月至2021年3月)(含CO_2注入)	目前許可證之監測計畫(2021年4月至2026年3月)(無CO_2注入)
①【特定二氧化碳氣體處理情形】	
• 特定CO_2氣體量 ：實施 1次/年	• 特定CO_2氣體量 ：未實施
• CO_2濃度、有害物無濃度 ：實施 1次/年	• CO_2濃度、有害物無濃度 ：未實施
• 注入壓力、速率、溫度 ：實施 1次/年	• 注入壓力、速率、溫度 ：未實施
②【海域狀況】	
A. 地層內部壓力與溫度的變化	
• 地層內部壓力、溫度 ：實施 1次/年※ ※監測為持續性，每年報告一次	• 地層內部壓力、溫度 ：實施 1次/年※
地層地質狀況、具體CO_2氣體的位置及範圍等	
• 彈性波探查 ：實施 1次/年	• 彈性波探查 ：實施 1次/年
B. 海水化學性質	
• 水質調查 ：實施 4次/年	• 水質調查 ：實施 4次/年
• 底質調查 ：實施 4次/年	• 底質調查 ：未實施
C.海洋生物和生態系統以及海洋利用現狀	
• 底棲生物 ：實施 4次/年	• 海蚌調查 ：實施 1次/年
	• 動植物和浮游生物 ：實施 4次/年

・在與公眾溝通方面，有公開通知和公眾檢查的規定 (基於《倫敦議定書》的規定)

環境省對苫小牧離岸CCS計畫的調查

■ 除了對業者進行調查外，環境省還進行了內部調查，以確認苫小牧海岸CCS示範計畫的環境保護。

【環境省獨立海洋調查概況】

自計畫啟動以來，環境省除了業者的調查外，還進行了自主調查，確認不存在任何海洋環境保護的擔憂。

〇調查區域：苫小牧海域，約10公里 x 8公里
〇四季調查(春、夏、秋、冬)

①海水化學性質調查

- 在9個測量點進行了水體取樣和分析。

②底質沉積物調查

- 除了9個測量點的海水化學性質調查外，還在注入井末端附近的3個測量點進行了調查。

③海洋生態系評估調查

- 在12個測量點使用水下攝影機對淺灘蛤(北寄貝)的棲息地和底棲生物進行了調查。

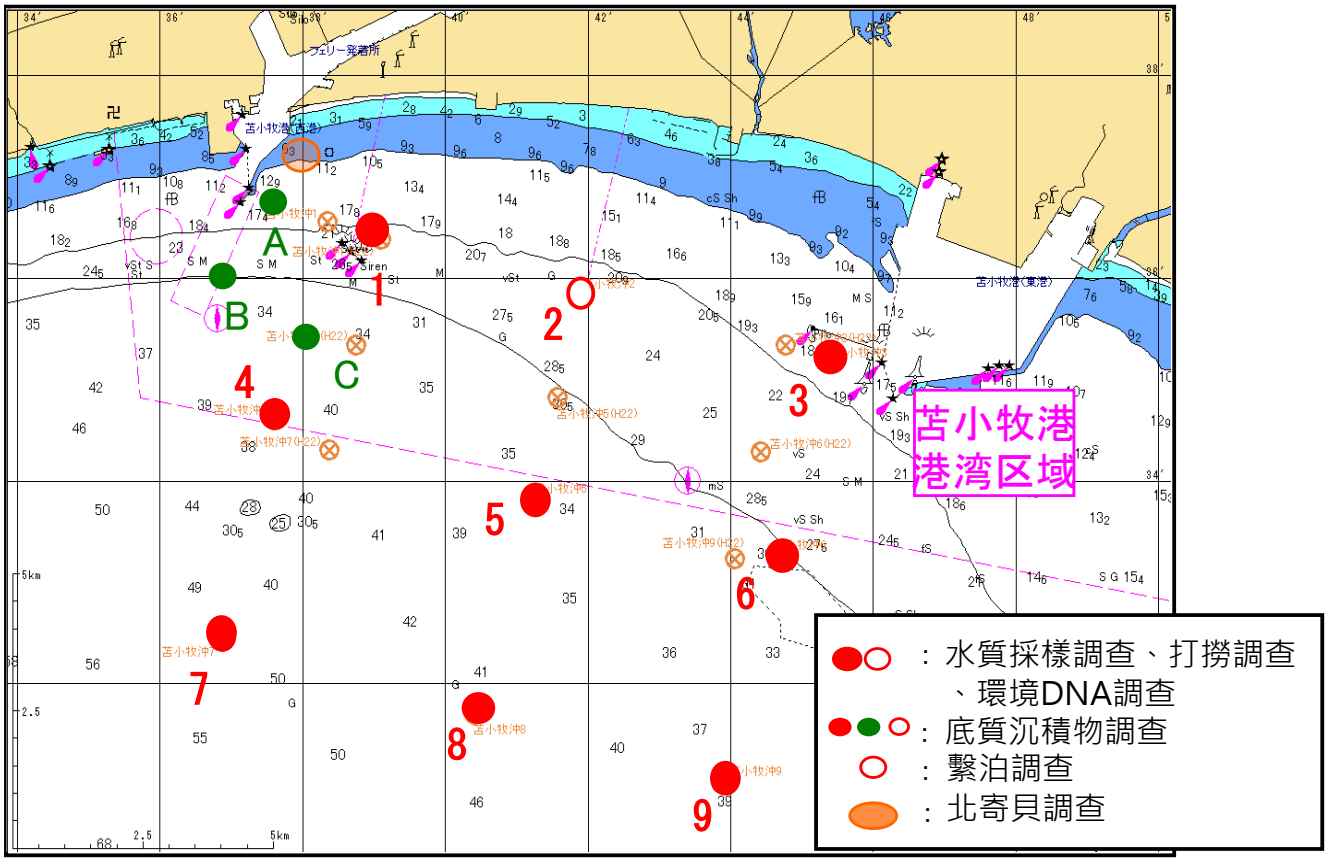
※在計畫實施之前，也於2011年至2015年進行了五年的海洋調查。

打撈調查收集大型底棲生物

使用「 ROV」 進行海洋生態系調查

苫小牧沿海海洋調查（2024年冬季調查）結果摘要

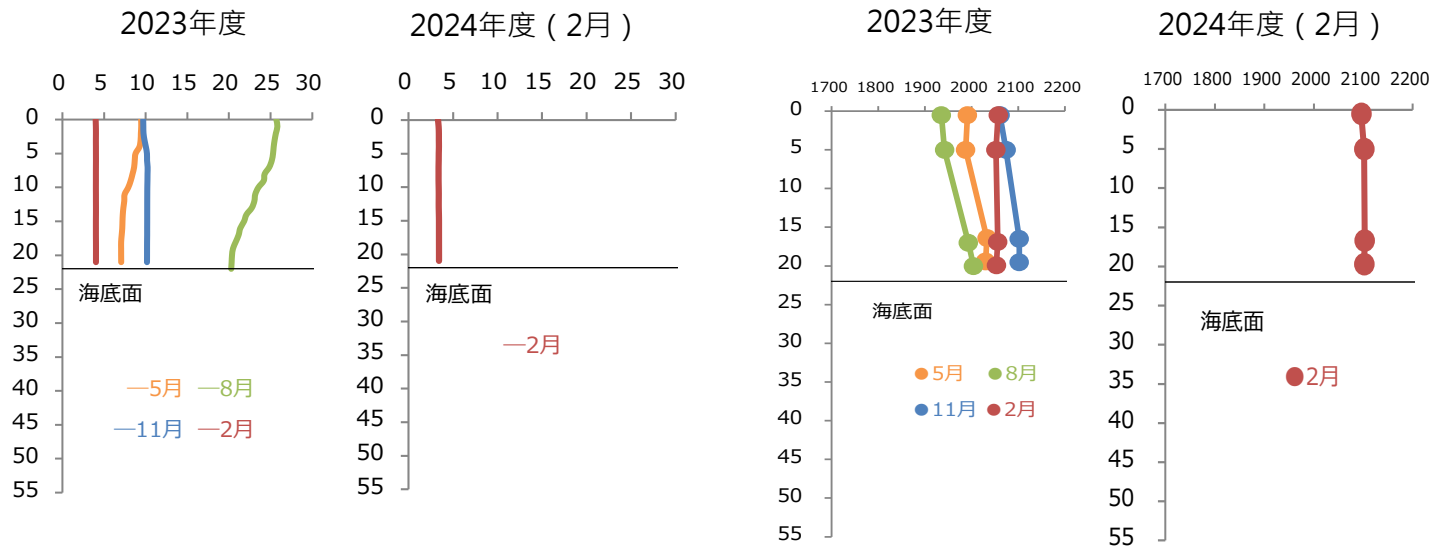
日本經濟產業省於2016年度在苫小牧沿岸地區啟動了海底CCS示範計畫。為確保示範計畫能夠妥善實施，且不會對海洋環境產生負面影響，環境省作為監管機構，正在對苫小牧沿岸地區的海洋環境進行監測，以了解其情況，並製定出在海底CCS項目中應用適當監測技術的方法。



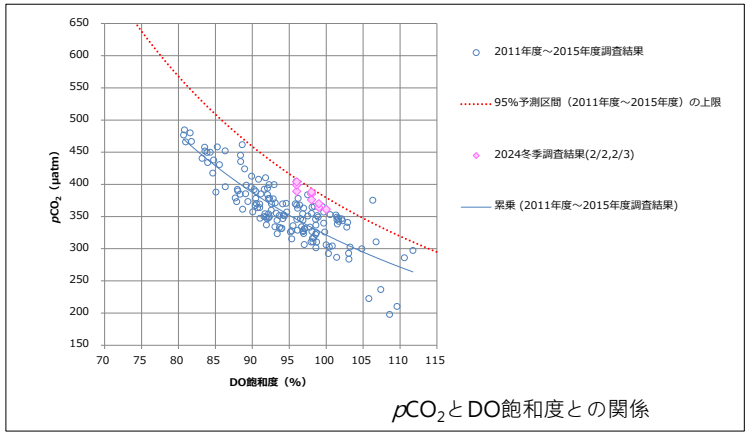
（苫小牧近海調查區域及調查點）

苫小牧外海海洋調査結果(2024年冬季調査)：海水中CO_2總量

（水質調査結果；2024年度　調査測點1）



St. 5、6、8、9所有層位、St. 3上層及底層、St. 7表層及上層海水中二氧化碳含量均高於以往調查結果，其他調查點及層位未見大的變化。

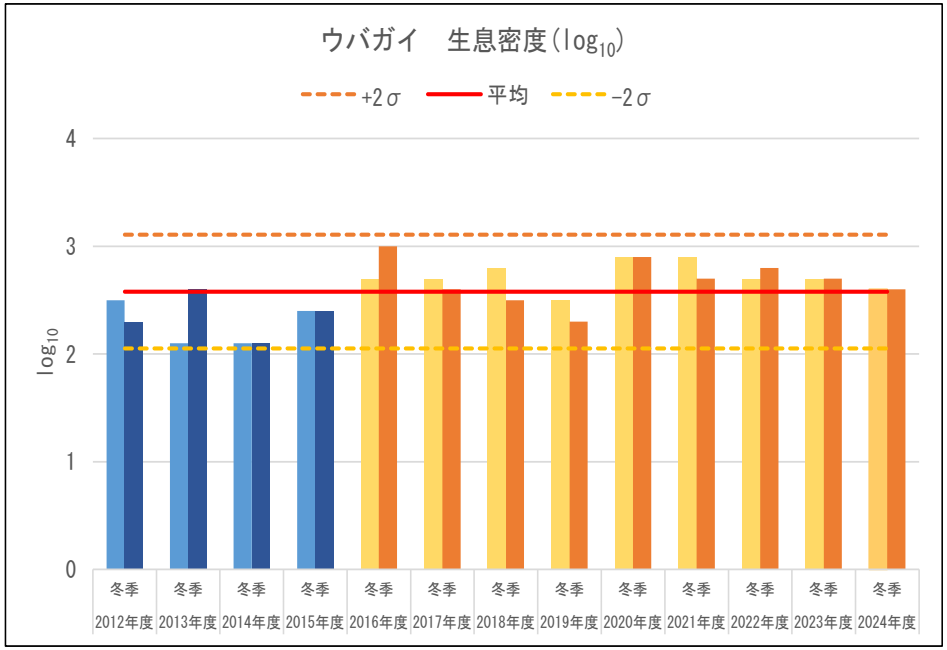


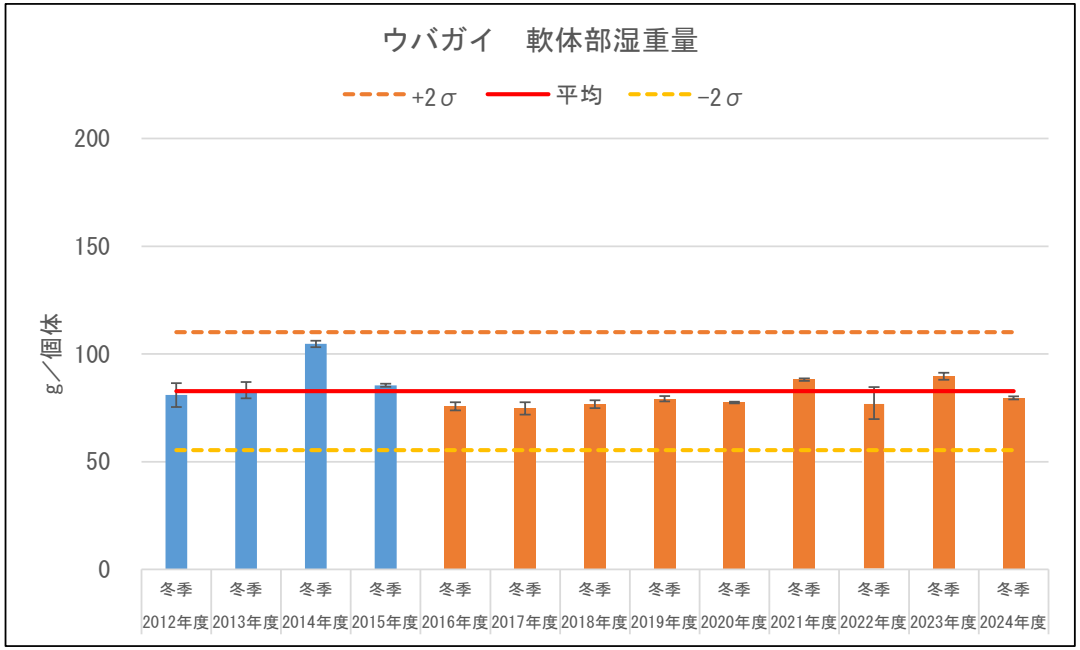
pCO_2とDO飽和度との関係

沒有發現超過 95% 預測區間上限的數據，即沒有發現引起對CO_2洩漏擔憂的數據。

苫小牧近海海洋調査(2024年冬季調査)結果：海貝棲地状況

CCS示範計畫啟動前後沒有發現顯著變化。





NEDO's RD&D Activities in CCUS Field

August, 2025

New Energy and Industrial Technology Development Organization
Circular Economy Department

http://www.nedo.go.jp/english/index.html

What's NEDO?

- Funding agency under METI
- **$1** billion/year + **$64** billion in funds
- **71** projects currently underway
- **Energy** and **Environment**
- Technology to **Market**

1US$=140

Activity Areas

Annual initial budget; 146.4 billion JPY (approx. 1 billion USD)

Energy Systems

- System provision technology
- Energy technology such as batteries
- Technology related to hydrogen production, storage, transport, and use
- Renewable energy technology

Industrial Technology

- Robot and AI technology
- IoT, electronics, and information technology
- Manufacturing technology
- Materials and nanotechnology
- Biotechnology

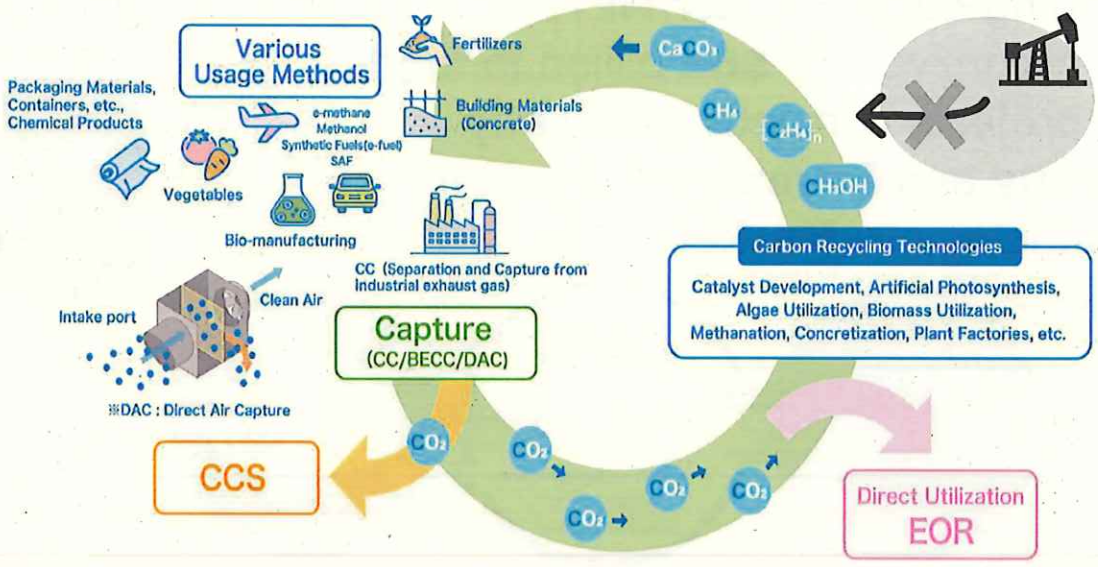
Energy Conservation & Environment

- Technology to harness unutilized thermal energy
- Environmentally-friendly steel manufacturing technology
- Development of high-efficiency coal-fired power generation technology
- CO_2 capture, utilization and storage
- Fluorocarbon recovery technology
- 3R technology, including resource screening and metal refining technology
- International demonstrations, Joint Crediting Mechanism activities, and others

New Industry Creation & Discovery of Technology Seeds

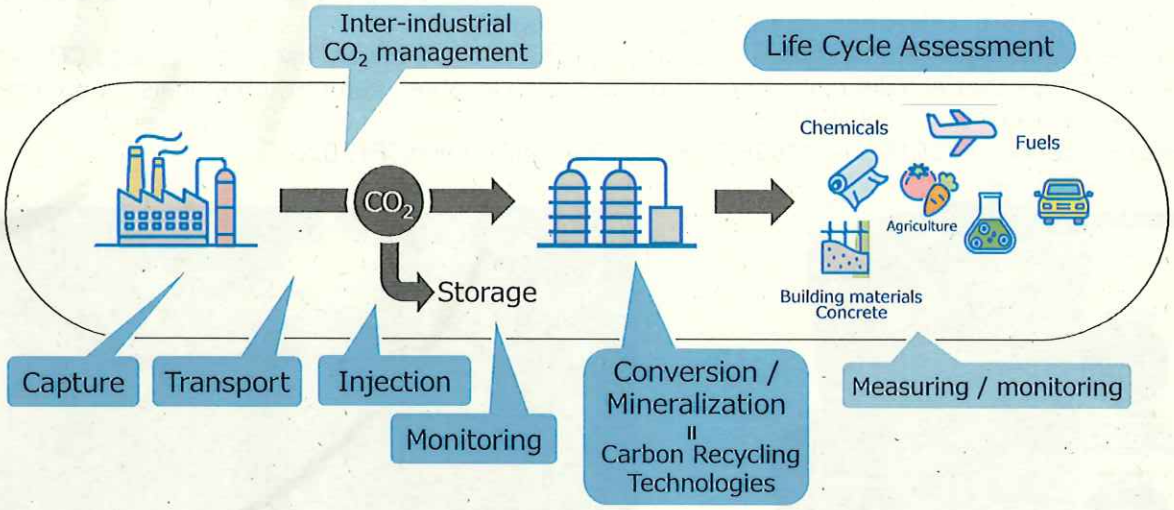
- Fostering technology-based startups
- Promotion of open innovation

CCUS and Carbon Recycling



Source: prepared by NEDO based on "Carbon Recycling Roadmap" by METI (2023)

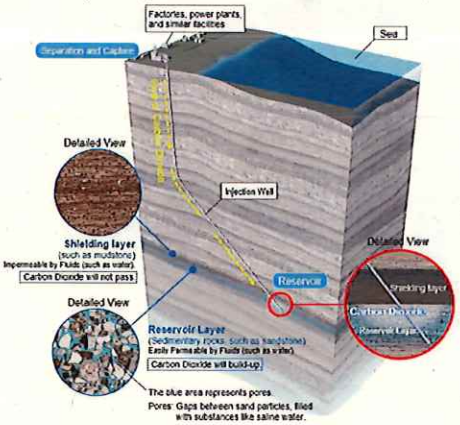
Range of NEDO's CCUS Programs



Research, Development and Demonstration of CCUS Technology

Research, Development and Demonstration of CCUS Technology

- To help achieve carbon neutrality by 2050, NEDO is promoting the development of CCUS (Carbon dioxide Capture, Utilization and Storage) technologies.
- These technologies are designed to capture, transport, effectively use, and storage CO_2 emitted from sectors that are difficult to decarbonize - such as steel, cement, chemicals, and oil refining - as well as from power plants.
- Project period: FY2018 to FY2026, budget: 7.47 billion yen (FY2025)



CCS Conceptual Diagram

LIQUEFIED CO_2 CARRIER "EXCOOL"

The R&D items and output goals

R&D Items	Key R&D themes	Output Goal
Large-scale CCUS demonstration testing at Tomakomai	・Operation of CO_2 separation and capture equipment ・Injection and storage of CO_2 at a scale of 100,000 tons per year	・Achievement of CO_2 storage at a scale of 100,000 tons per year
	・Monitoring of stored CO_2	・Confirming through monitoring that there is no leakage of CO_2
Demonstration Test on CO_2 Transportation	・Development of a business model for long-distance and large-scale maritime transport of liquefied CO_2 ・Demonstration of integrated maritime transport of liquefied CO_2	・Establishment of low-temperature, low-pressure maritime transport technology for large-scale and low-cost CO_2 transportation ・Establishment of safety management methods related to CO_2 maritime transport, including vessel operation and cargo handling
R&D of CO_2 storage technologies to safely carry out CCS operations	・Development of CO_2 injection and monitoring technologies ・Development of monitoring technologies using optical fibers, etc. ・Characterization targeting diverse storage reservoirs	・Establishment of safety management technologies for reducing CO_2 injection and storage costs, and development of methods to improve storage performance and economic efficiency
	・Demonstration tests at domestic and overseas sites	・Establishment of risk assessment technologies for leakage and other hazards
Research related to CCUS Technologies	・Cost analysis, and investigation of domestic and international trends	・Identification and analysis of challenges associated with CCUS technologies

CCS Projects in Japan

2027 2030

NEDO Project :
Research, Development and Demonstration of CCUS Technology

Commercialization
Establish technologies that lead to the launch of CCS projects, considering social acceptance of CCUS

Outcome Goals
- Establish and disseminate CCUS-related technologies that contribute to achieving carbon neutrality
- Expand the introduction of storage sites and CO_2 transport systems to achieve CO_2 storage of 120–240 million tons/year
- Promote internationally safe, secure, and low-cost CCS, CO_2 transport, and storage management technologies

JOGMEC Project :
Advanced CCS Projects
(Financial support for exploration projects of suitable CCS sites in domestic land areas)

Start of CCS Projects

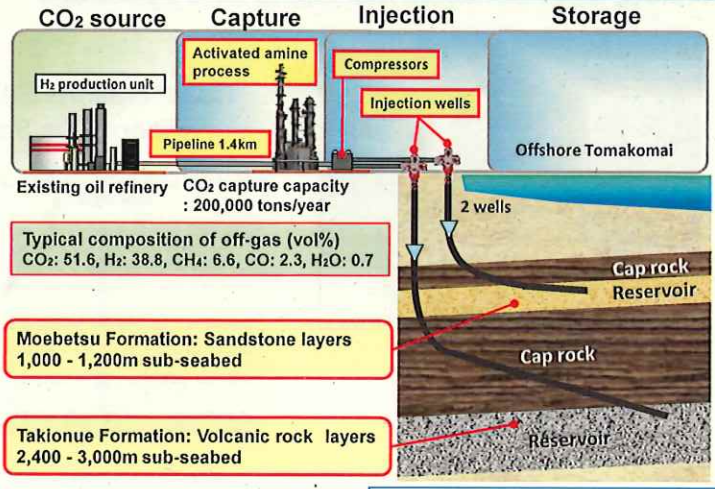
METI :
- Investigation and evaluation of CO_2 storage potential
- Geological structure surveys of domestic CCS candidate sites
- Development of CCS business Act

Tomakomai CCS Demonstration Project

The project objective is to demonstrate the viability of a full CCS system, from CO_2 capture to injection and storage on a practical scale in the Tomakomai port area of Hokkaido.

Construction of the facilities was completed in FY2015, and from FY2016 until FY2019, a total of 300,000 tons or more of CO_2 were injected and stored in offshore saline aquifers.

Marine environmental surveys and monitoring of the distribution of the injected CO_2 are being conducted in compliance with a domestic law by which sub-seabed geological storage of CO_2 is regulated.

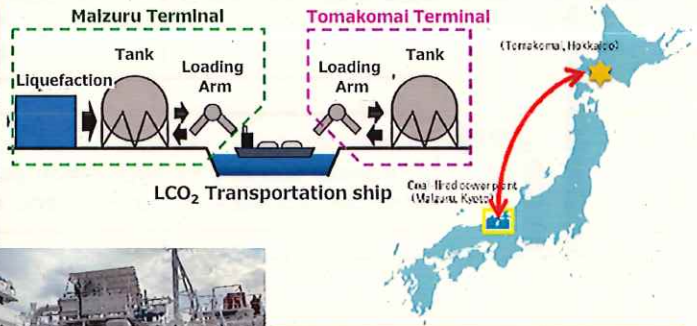


< Period > April 2018 - March 2027
< Contractors > Japan CCS Co., Ltd.

Source: Japan CCS HP https://www.japanccs.com/en/business/demonstration/whole.php

CO_2 Ship Transportation

- For the safe and efficient transportation of CO_2 captured at factories and/or thermal power plants, etc., for carbon recycle or CCS, NEDO has started development of the integrated maritime transportation system.
- To confirm technical issues through demonstration, a demonstration ship capable of transporting approximately 850 tons of liquefied CO_2 will be arranged and operated.

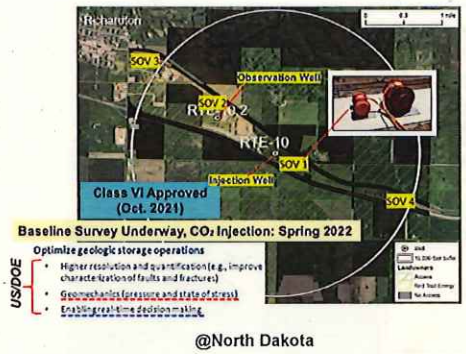


< **Period** > August 2021 - March 2027
< **Contractors** > Japan CCS Co., Ltd., Engineering Advancement Association of Japan, ITOCHU Corporation, Nippon Steel Corporation, Nippon Gas Line Co., Ltd.

10

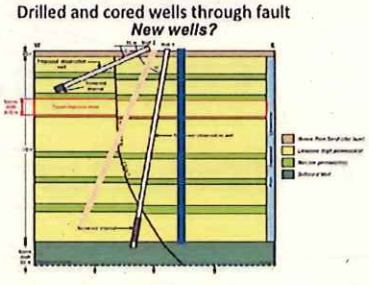
CO_2 Storage Technology

Fiber Optic Sensing for Multi-purpose Data Acquisition (DTS,DAS,DSS) and Permanent Monitoring for CO_2 Storage

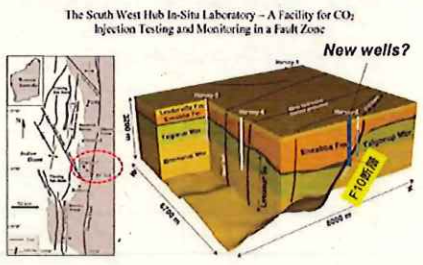


@North Dakota

Collaborations Between RITE-CISRO & RITE-CO2CRC
Fiber Optic Sensing for Fault Integrity Monitoring



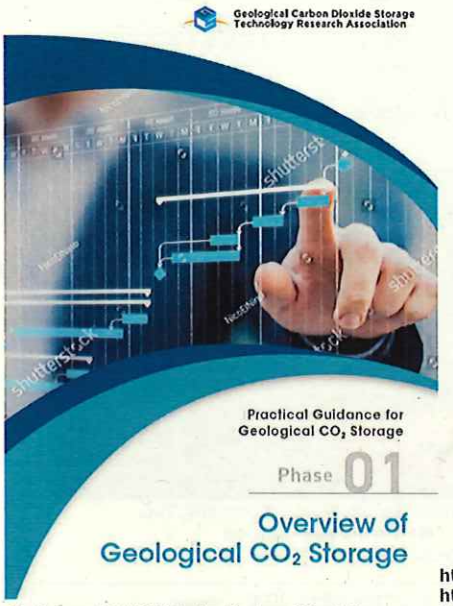
RITE-CO2CRC @Otway



RITE-CSIRO @SW Hub In-Situ Lab

< **Period** > April 2018 - March 2027
< **Contractors** > Geological Carbon Dioxide Storage Technology Research Association

CO_2 Storage Guideline



Publication Schedule

Phase 01-03: Released
Phases 04-08: FY2025

https://www.co2choryu-kumiai.or.jp/cms/wp-content/uploads/2021/10/practical-guidance-01-e.pdf
https://www.co2choryu-kumiai.or.jp/cms/wp-content/uploads/2021/10/practical-guidance-02-e.pdf
https://www.co2choryu-kumiai.or.jp/cms/wp-content/uploads/2021/10/practical-guidance-03-e.pdf

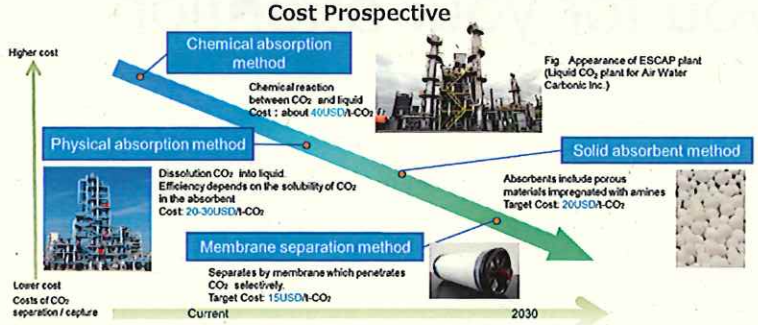
General idea on CO_2 Capturing Technology

- Find out ideal combination depending on "CO_2 concentration" and "gas pressure" of the treated gas
- Technical challenge: Improving system energy efficiency (e.g. heat use), including material developments (solvent, sorbent, membrane) for lowering CO_2 releasing energy

Character of treated gases (example)

	Thermal power			Industry
	Coal-fired	Gas-fired	Gasification	Steel making
CO_2 concentration	10~15%	4~6%	40~50%	20~30%
Exhaust gas pressure	atmospheric	atmospheric	2.5~4.0 MPa	atmospheric

Cost Prospective



Source: Prepared by NEDO based on the Technology Road Map for Next-Generation Thermal Power Generation, Technical Reference Materials (METI)

CO_2 Capturing Technology

- Practical Research and Development of Solid Sorbents -

- NEDO aimed to lower costs and expand scale by developing a massive synthesis method for materials and conducting a bench-scale test using a moving-bed system.
- Through a pilot-scale test at pulverized coal fired power plant, NEDO aims to put technology for capturing CO_2 with solid sorbents into practical use.

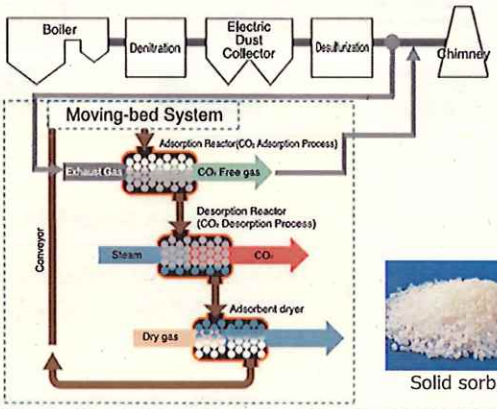
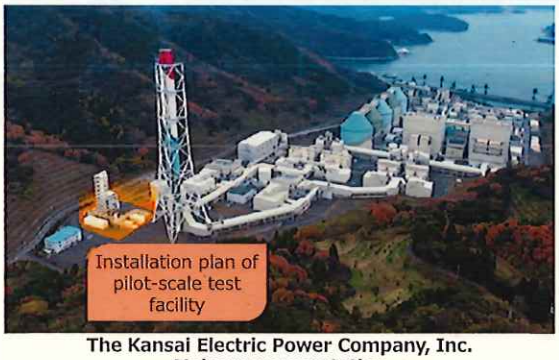


Image of a moving-bed system for coal thermal power

Solid sorbent



The Kansai Electric Power Company, Inc.
Maizuru power station
(Source: The Kansai Electric Power Company, Inc.)

< Period > 2018- March 2026
< Contractors > Kawasaki Heavy Industries, RITE

Thank you for your attention.

http://www.nedo.go.jp/english/index.html

Agenda

13:30－14:20 Presentation

- Tomakomai CCS Demonstration Project
- R&D and Demonstration of CO_2 Ship Transportation (video)

14:20－14:40 View of the entire plant and the injection point from the roof of the control building (photos allowed)

14:40－14:45 Tour of the facility (by car; no photos allowed)

14:45－15:00 Visit to the injection wellhead (photos allowed)

15:00－15:30 Q&A

15:30 End of tour

- Jiro Tanaka Associate General Manager of International Affairs of JCCS
- Daiji Tanase Associate General Manager of International Affairs of JCCS

Outline of Presentation

- Tomakomai CCS Demonstration Project
  - Video of the project
  - Overview
  - Reservoirs and facilities
  - Key results
  - Public Outreach
  - Summary
- R&D and Demonstration of CO_2 Ship Transportation (video)

JCCS company profile and project framework

Company Profile

Date of Incorporation: May 26, 2008
Capital: 242.5 million JPY
Capital reserve: 242.5 million JPY
Shareholders: 33 companies
Electric power, city gas, petroleum, plant design/construction, trading, etc.

Business Description:
Implementation of surveys, research and development, feasibility studies, demonstration projects pertaining to CO_2 capture, utilization, transportation and storage (CCUS) technologies.

No. of Employees: 106 (as of April 1, 2025)

Commissioned Projects/Project Framework

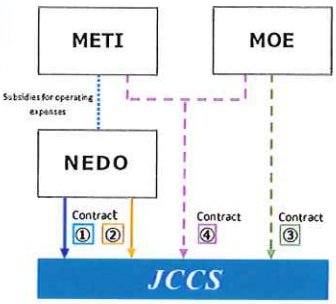
① Tomakomai CCUS Demonstration Project (FY2012~)
Consignor: New Energy and Industrial Technology Development Organization (NEDO)

② R&D and Demonstration of CO_2 Ship Transportation Project (FY2021~) ※4 co. consortium
Consignor: New Energy and Industrial Technology Development Organization (NEDO)

(Previous Commissioned Projects)

③ Project to Promote the Creation of Circular Carbon Society Model through CO_2 Recycling (FY2021~FY2024)
※6 co. consortium
Consignor: MOE (Ministry of the Environment)

④ Investigation of Potential CO_2 Storage Sites (FY2014~FY2023)
Consignors: METI (Ministry of Economy, Trade and Industry) ・ MOE (Ministry of the Environment)

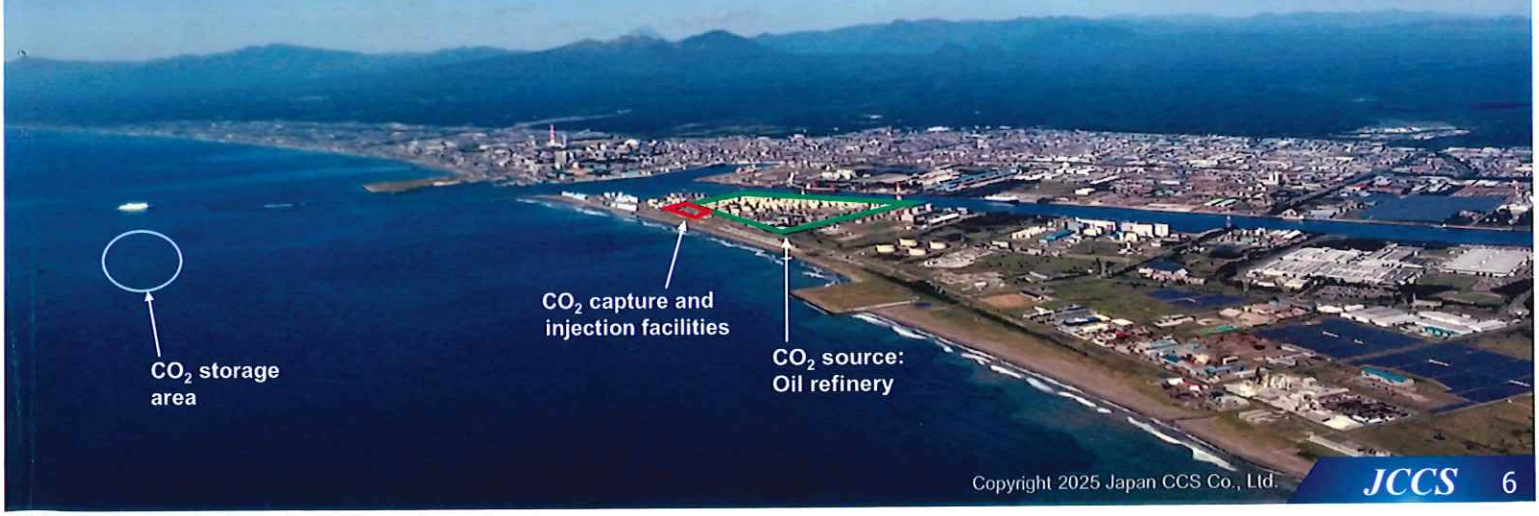


※Each project is conducted by establishing an expert committee comprised of experts in each field which provides advice and technical guidance.

■ Video

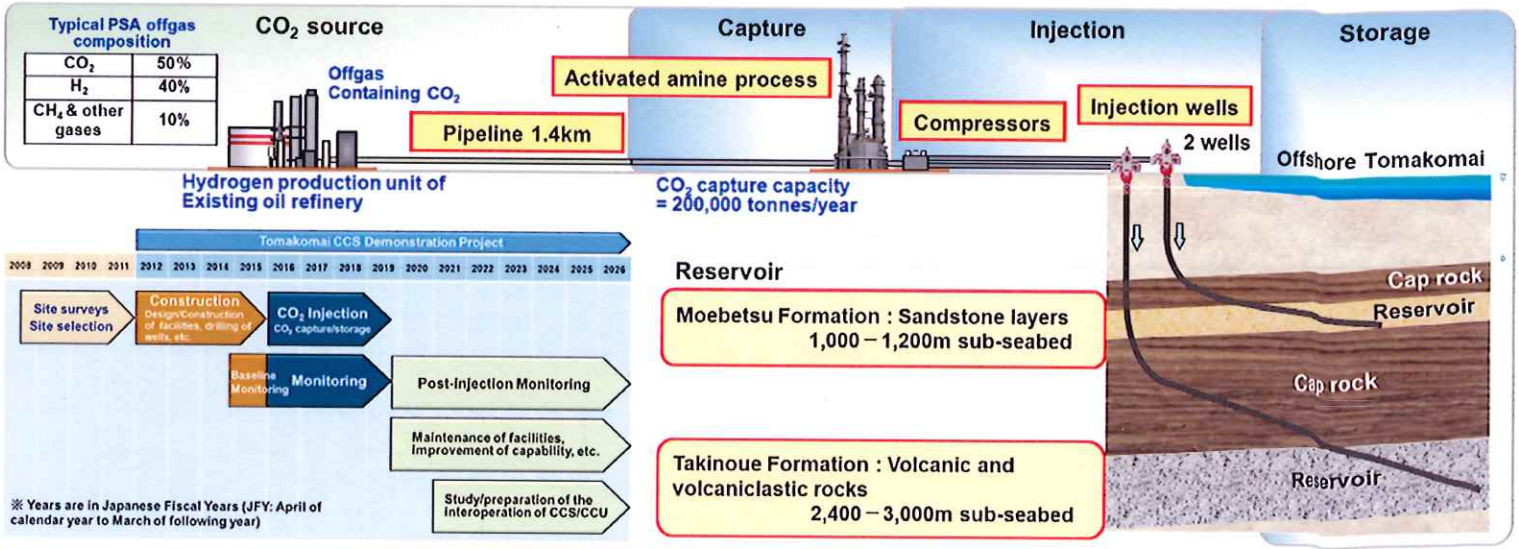
➢ Overview of the project

- First large-scale CCS demonstration project in Japan
- Location: Tomakomai City, Hokkaido Prefecture
- Commissioned by: METI, NEDO
- Contractor: JCCS



Project scheme and schedule

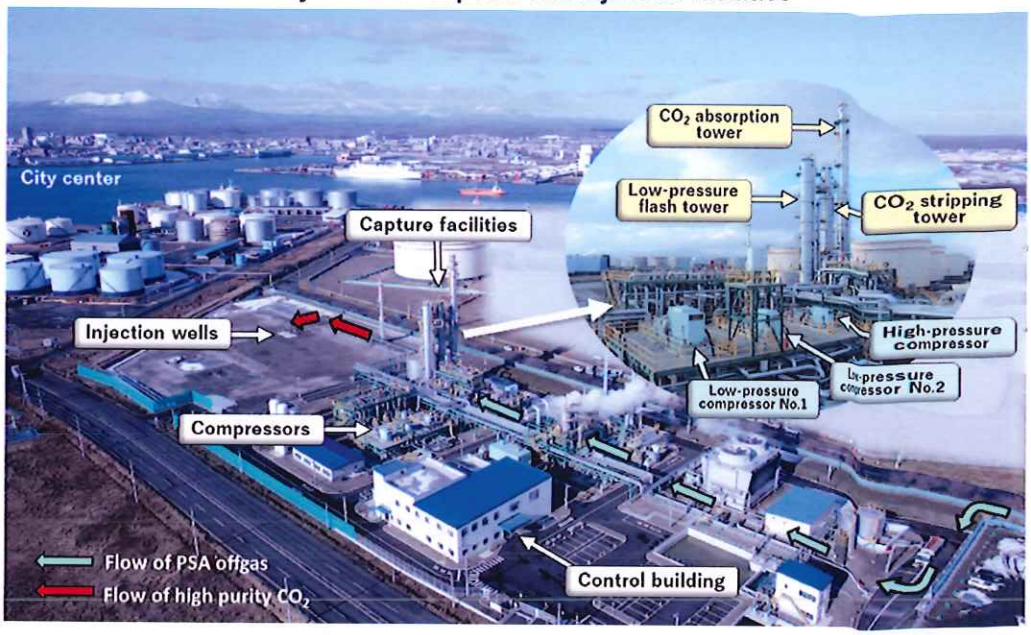
- The CO_2 source is a hydrogen production unit of an oil refinery.
- A portion of PSA (Pressure Swing Adsorption) offgas containing approximately 50% CO_2 generated by a hydrogen production unit is transported by 1.4 km pipeline to the CO_2 capture facility.
- After CO_2 capture and compression, the CO_2 is injected into two offshore subsurface reservoirs.



Main features of Tomakomai CCS Demonstration Project

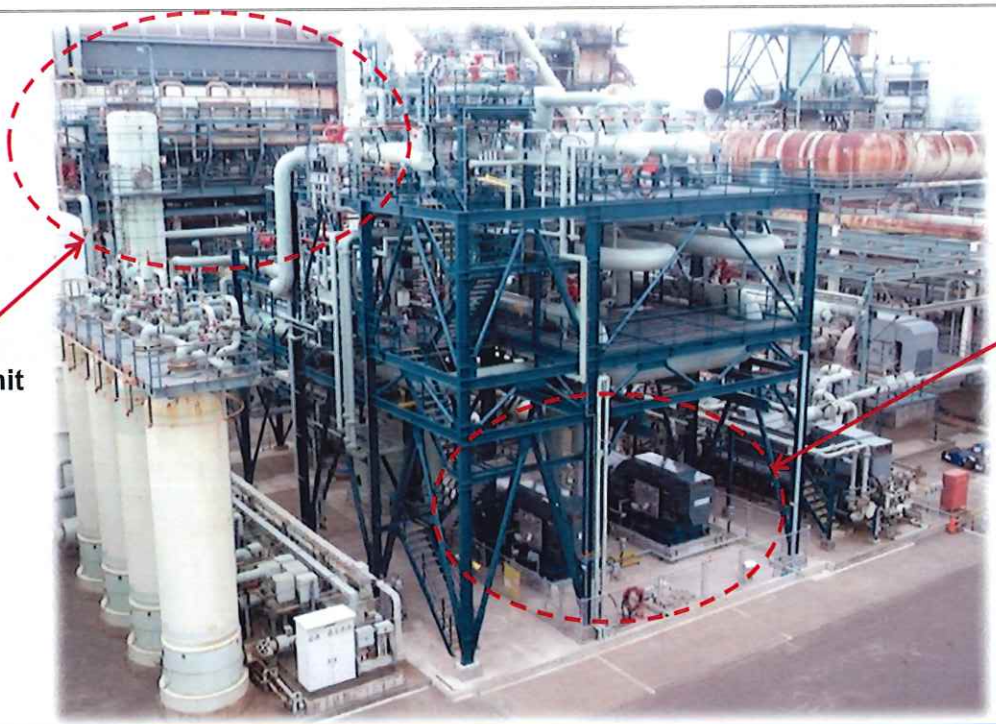
- World first offshore CCS project in a busy port area of large city
- CO_2 storage governed by Japanese law reflecting the London Protocol 1996
- Energy efficient CO_2 capture process
- Two highly deviated injection wells drilled from onshore targeting two separate sub-seabed reservoirs with injection intervals exceeding 1,100m
- Extensive onshore and offshore monitoring system for observation of CO_2 behavior in the reservoirs, micro seismicity and natural earthquakes
- Marine environmental surveys conducted each season

Bird's eye view of capture and injection facilities



➢ Reservoirs and facilities

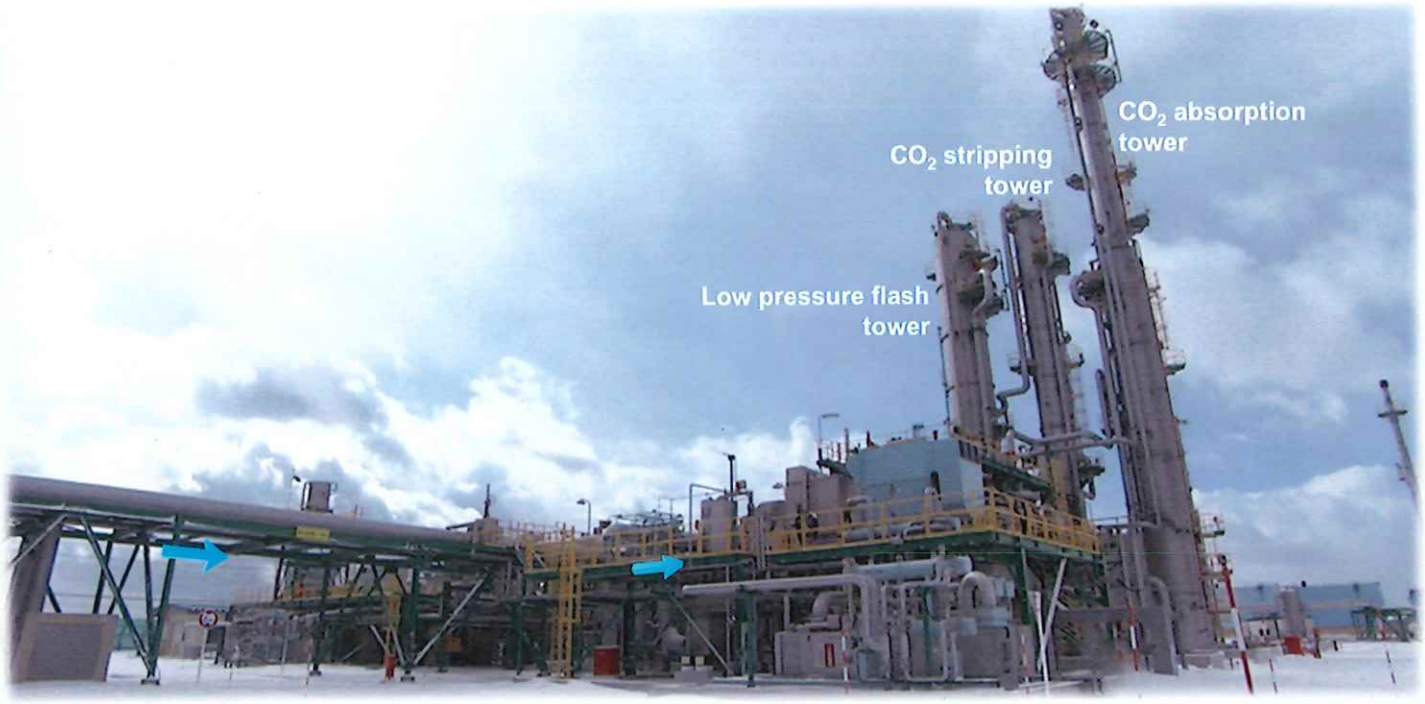
CO_2 Source: Hydrogen production unit and PSA offgas blower



PSA offgas pipeline

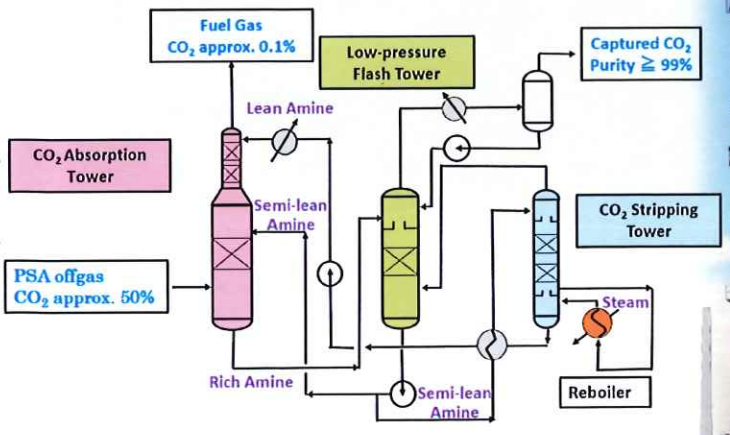
PSA offgas pipeline

PSA offgas compressor and CO_2 capture facility



CO_2 capture process

◆ Two-stage absorption process

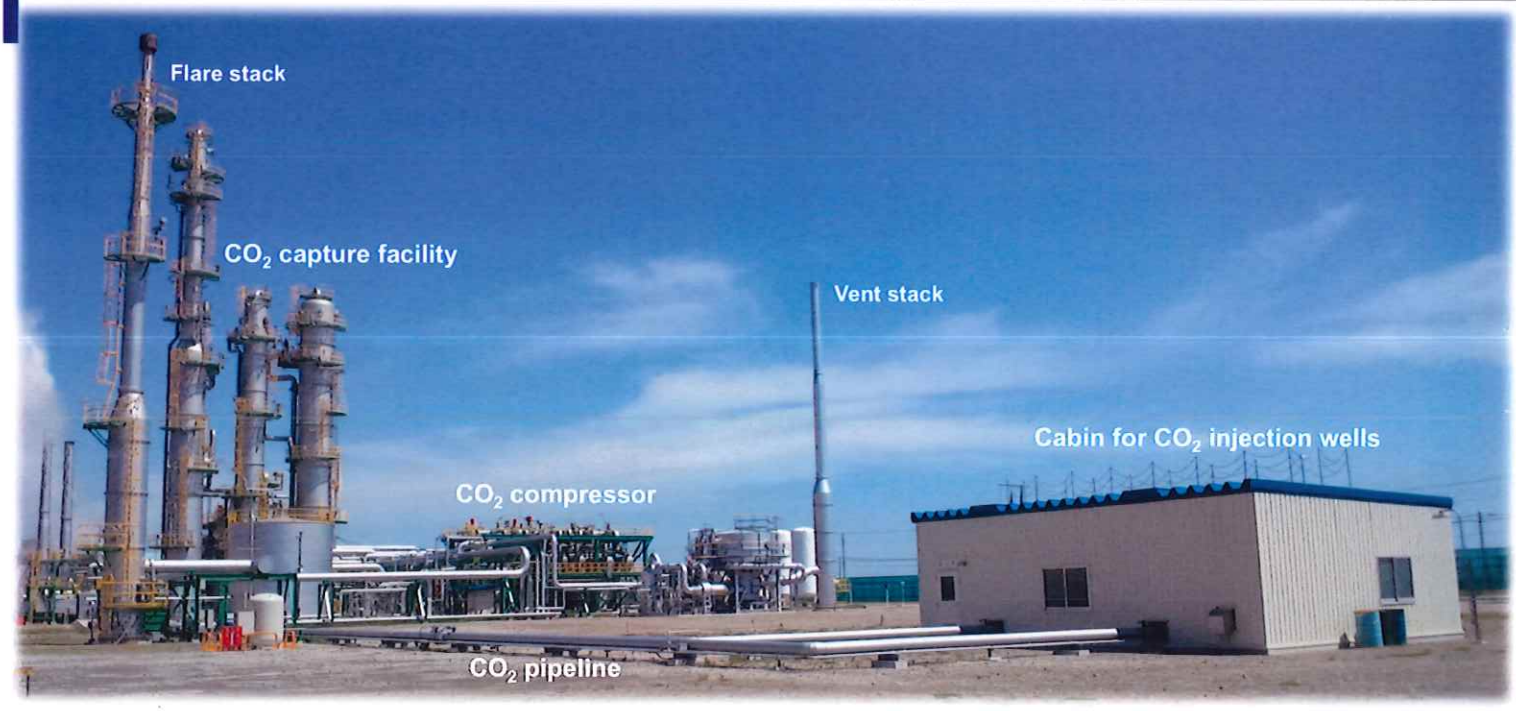


◆ CO_2 Capture Results

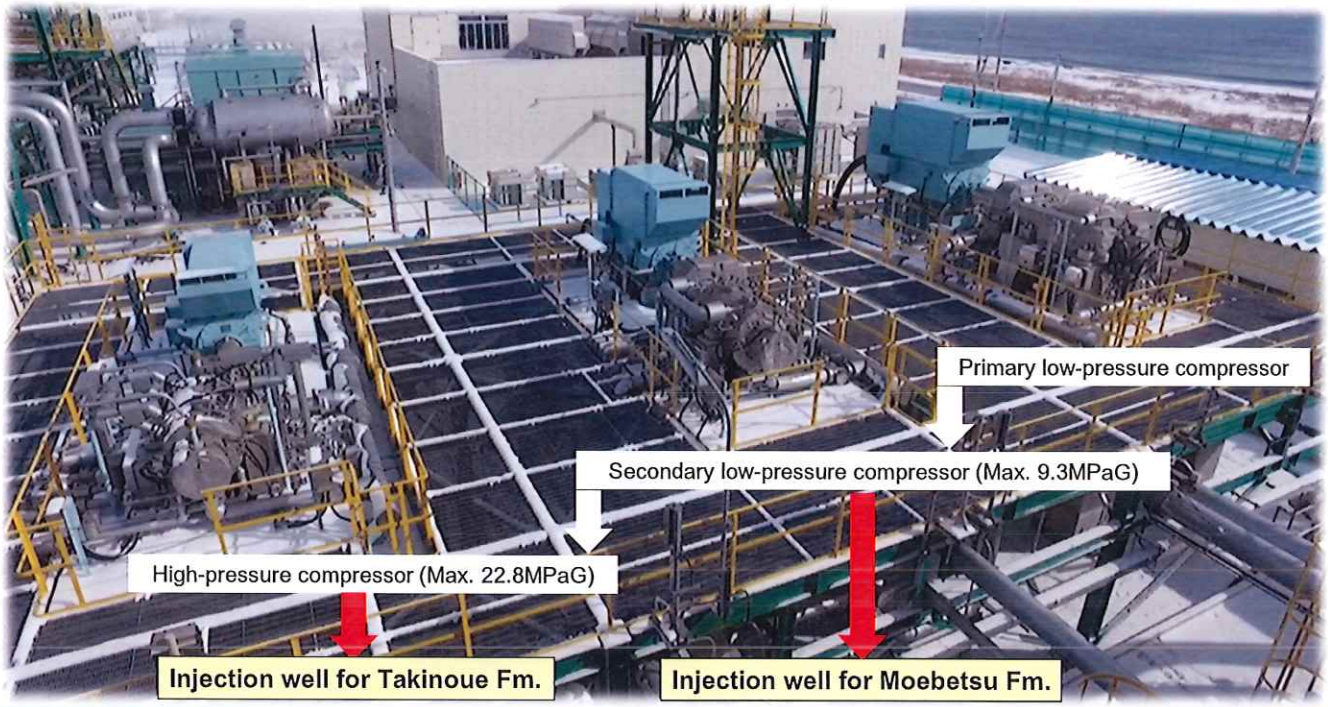
	FY2016	FY2017	FY2019
CO_2 recovery (t/h)	25.3	24.3	26.4
Reboiler duty (GJ/t-CO_2)	0.923	0.882	0.915

- Achieved reboiler duty of 0.882 - 0.923GJ/t-CO_2; (1/2 to 1/3 of conventional one stage absorption process)

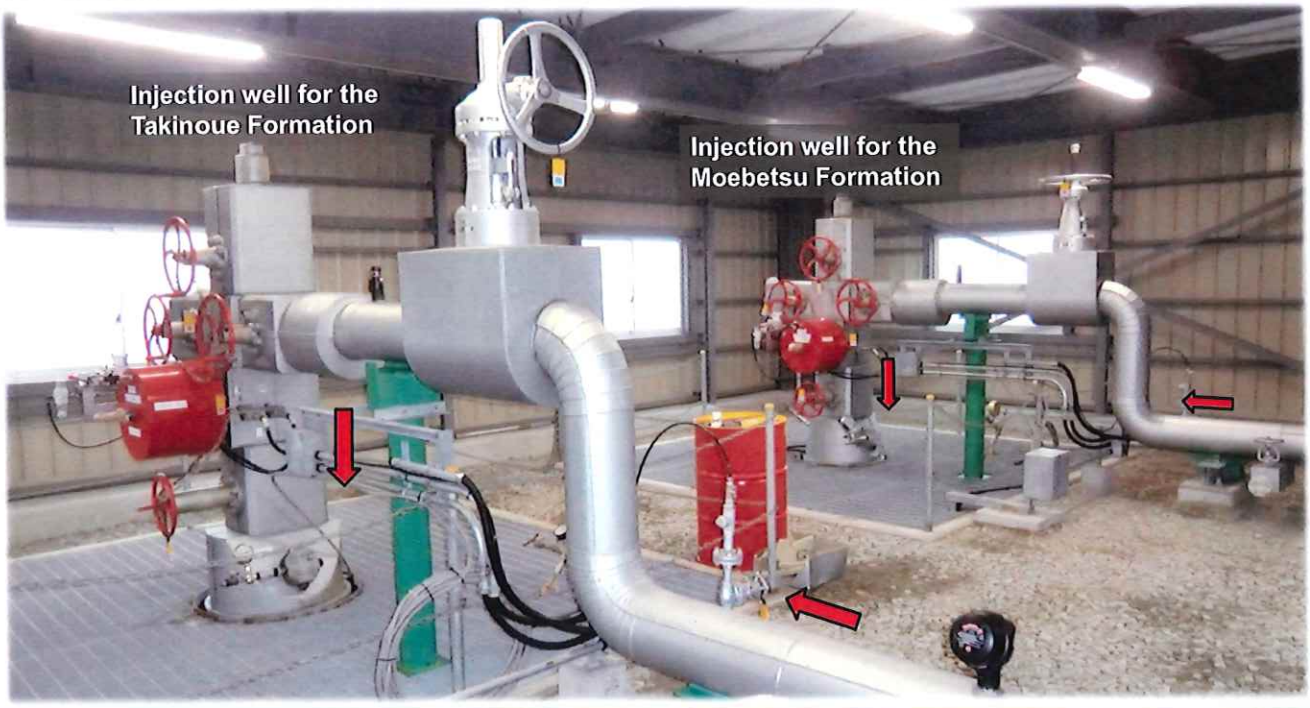
Cabin for CO_2 injection wells



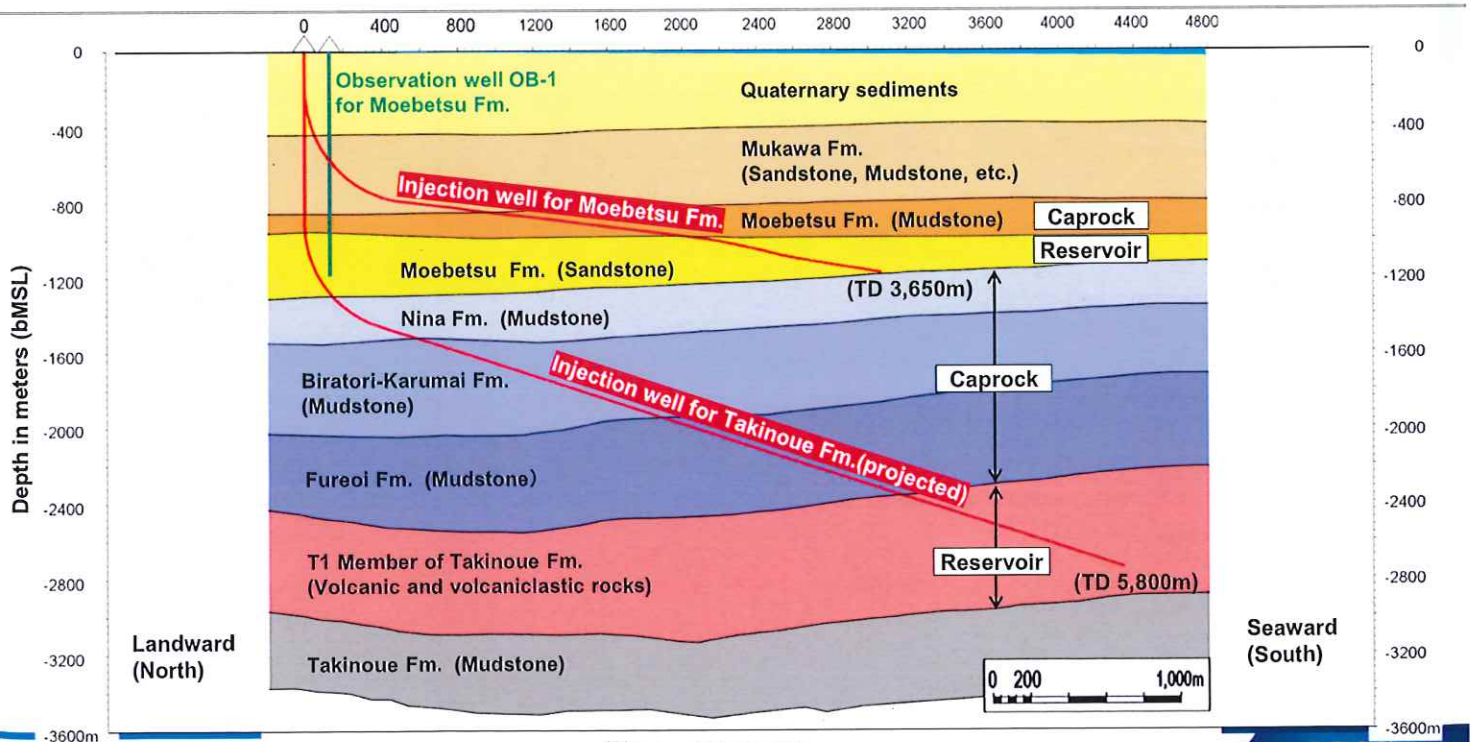
CO_2 compressors



CO_2 injection wells



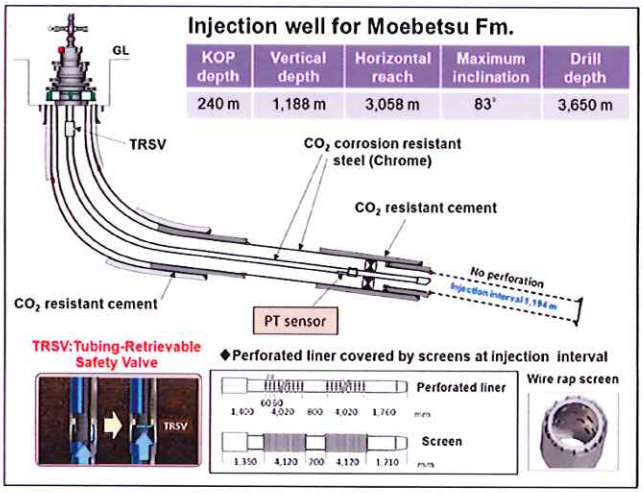
Geological cross section

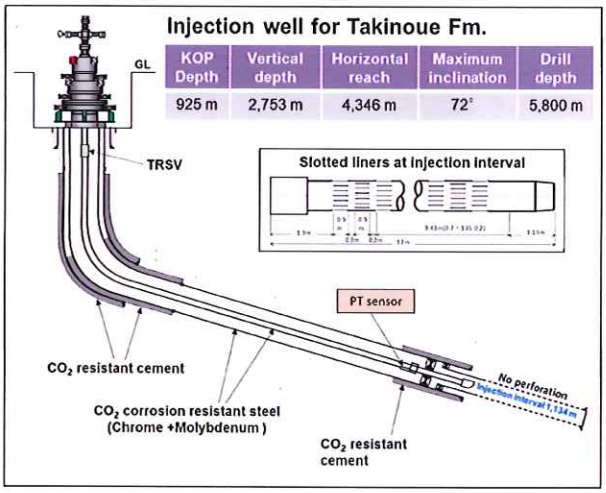


※Aspect Ratio=1:1

Schematic diagram of injection wells

- The captured CO_2 is compressed and stored 3-4km offshore in two sub-seabed reservoirs at different depths – Moebetsu and Takinoue formations by two independent injection wells.
- Deviated CO_2 injection wells drilled from onshore to offshore sub-seabed
  - Cost reduction of drilling, operation and maintenance
  - No disturbance on marine environment and harbor operation
- Injection interval length exceeding 1,100m to enhance injection efficiency

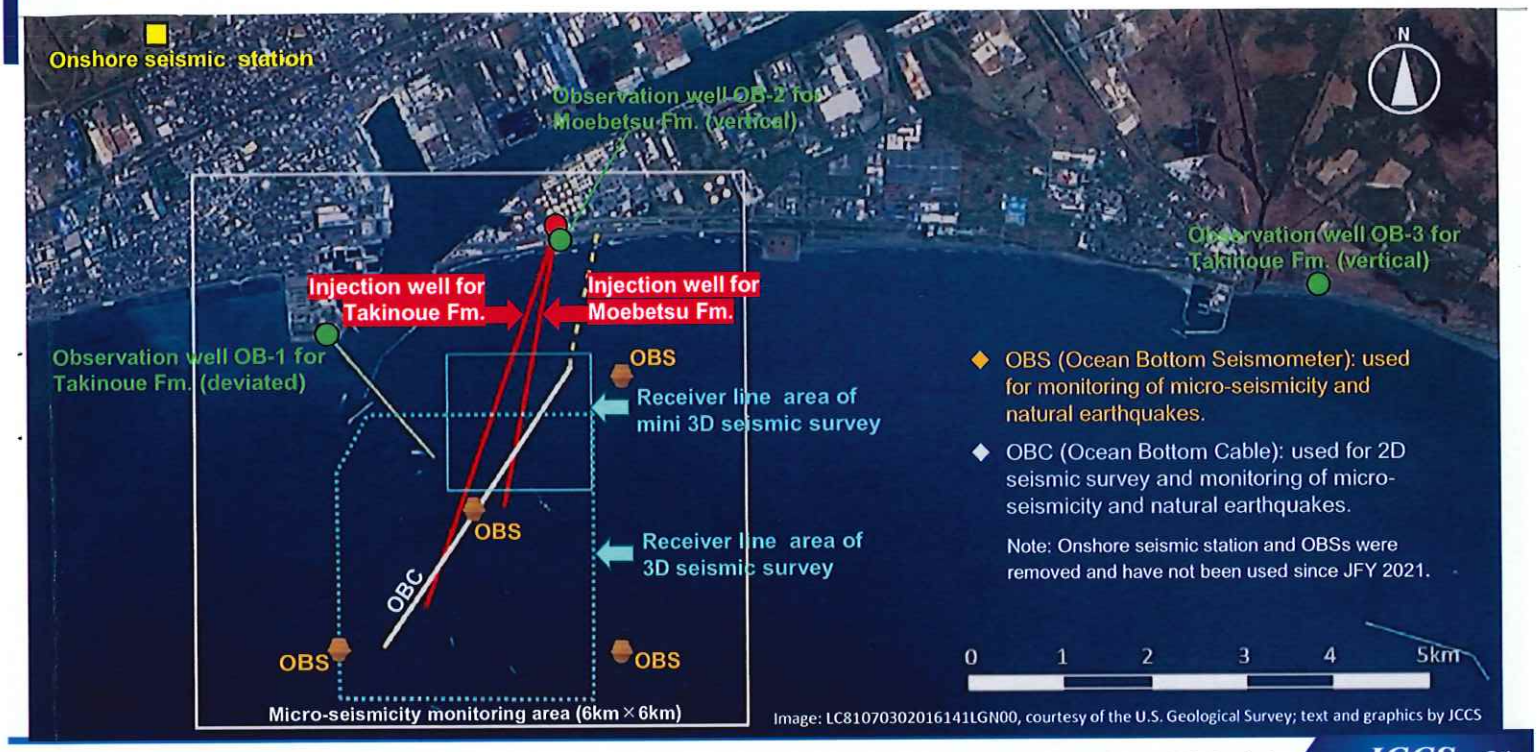




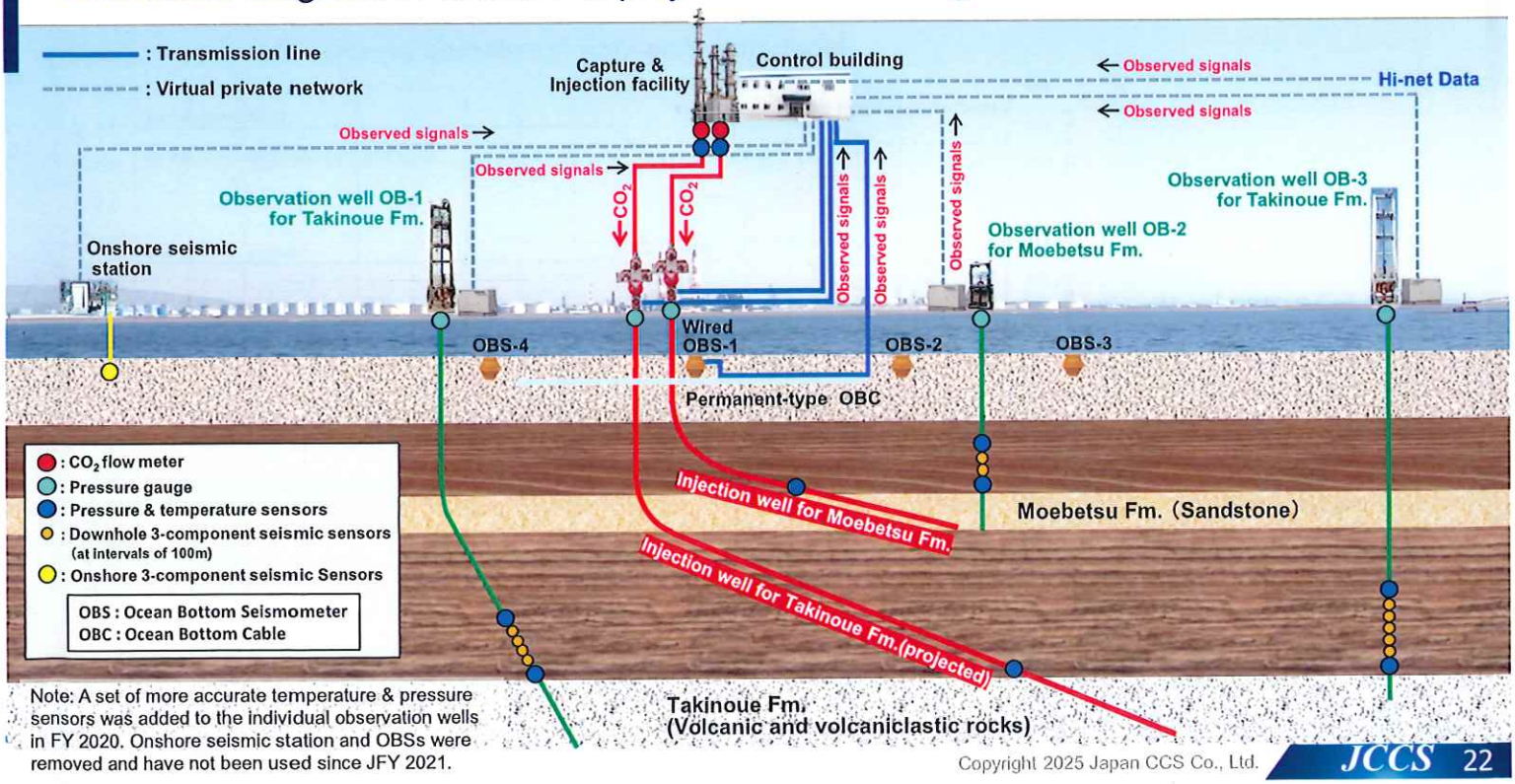
Monitoring equipment/work and monitored items

Equipment/Work	Monitored Items
Sensors in injection facility Injection wells •Well head pressure gauge •Downhole pressure/temperature sensor	Temperature, pressure, injection rate Pressure Pressure, temperature
Observation wells •Downhole pressure/temperature sensor •Seismic sensor	Pressure, temperature Seismicity
Ocean bottom cable (OBC)	Seismicity, receiver for 2D seismic survey
Ocean bottom seismometer (OBS)	Seismicity
Onshore seismic station	Seismicity
2D seismic survey 3D seismic survey 2D seismic survey plus mini-3D survey Mini-3D survey	Distribution of CO_2 in reservoir
Marine environmental survey	Marine data (physical and chemical properties, biological habitat, etc.)

Layout of monitoring system



Schematic diagram of sensors deployed for monitoring

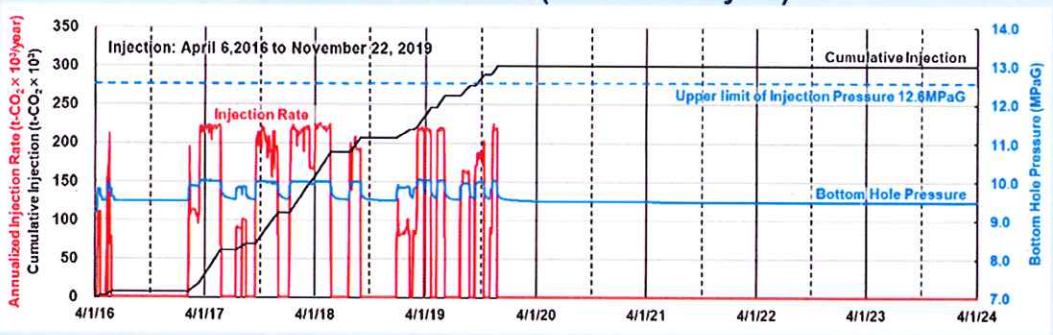


Note: A set of more accurate temperature & pressure sensors was added to the individual observation wells in FY 2020. Onshore seismic station and OBSs were removed and have not been used since JFY 2021.

➢ Key results

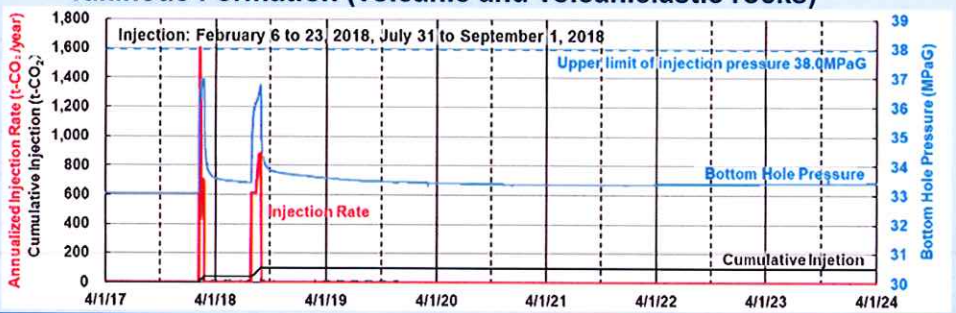
CO_2 injection record

Moebetsu formation (sandstone layers)



- Achieved 300,110 tonnes cumulative CO_2 injection into two reservoirs
  - ➢ Moebetsu Fm. 300,012 t
  - ➢ Takinoue Fm. 98 t

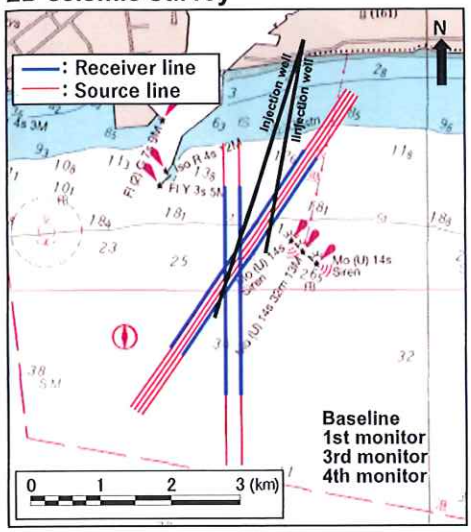
Takinoue Formation (volcanic and volcaniclastic rocks)



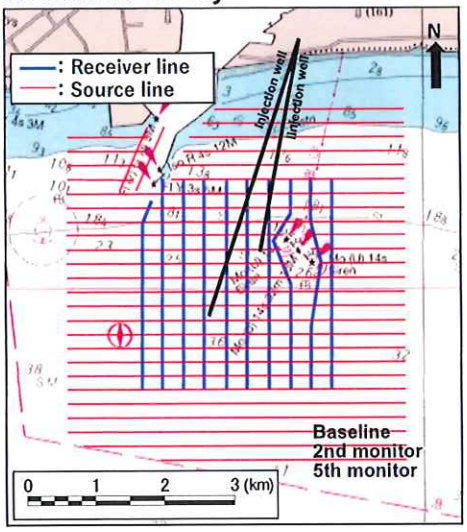
Seismic surveys: Data acquisition geometry (Schematic)

- 2D survey crosses injection intervals of the Moebetsu Formation and Takinoue Formation.
- 3D survey covers injection intervals of the Moebetsu Formation and Takinoue Formation.
- Mini 3D survey covers only injection intervals of the Moebetsu Formation.

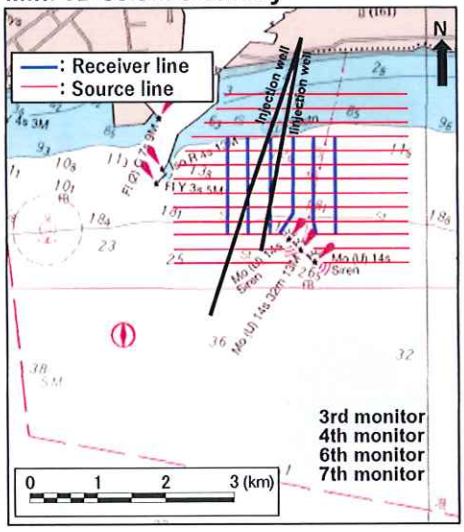
2D seismic survey



3D seismic survey



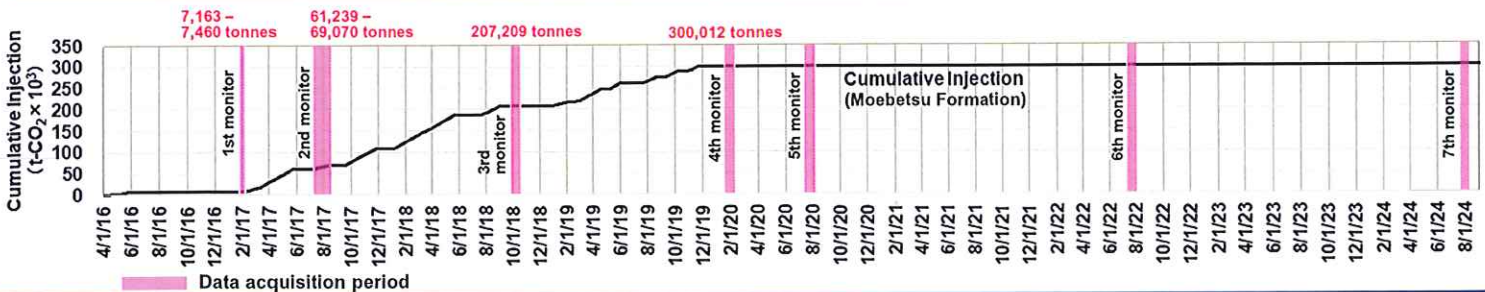
Mini 3D seismic survey



Seismic surveys: Implementation record

- Following the baseline 2D and 3D surveys, seven monitor seismic surveys have been carried out, which are a combination of 2D, 3D and 2D plus mini-3D surveys.

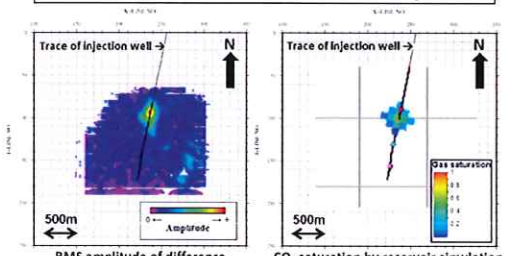
Type of survey		Fiscal year	Data acquisition period	Cumulative injection		Results	
				Moebetsu	Takinoue	Moebetsu	Takinoue
Baseline	3D	JFY 2009	October – December 2009	0 tonnes	0 tonnes		
Baseline	2D	JFY 2013	August 2013	0 tonnes	0 tonnes		
1st monitor	2D	JFY 2016	January 25 – February 6, 2017	7,163 – 7,460 tonnes	0 tonnes	Anomalies were detected	No anomalies
2nd monitor	3D	JFY 2017	July 9 – August 17, 2017	61,239 – 69,070 tonnes	0 tonnes	Anomalies were detected	No anomalies
3rd monitor	2D + mini-3D	JFY 2018	September 26 – October 18, 2018	207,209 tonnes	98 tonnes	Anomalies were detected	No anomalies
4th monitor	2D + mini-3D	JFY 2019	January 19 – February 9, 2020	300,012 tonnes	98 tonnes	Anomalies were detected	No anomalies
5th monitor	3D	JFY 2020	July 13 – August 6, 2020	300,012 tonnes	98 tonnes	Anomalies were detected	No anomalies
6th monitor	mini-3D	JFY 2022	July 11 – 21, 2022	300,012 tonnes	98 tonnes	Anomalies were detected	
7th monitor	mini-3D	JFY 2024	July 14 – 21, 2024	300,012 tonnes	98 tonnes	Under data processing	



3D seismic survey results and CO_2 saturation simulated by reservoir model

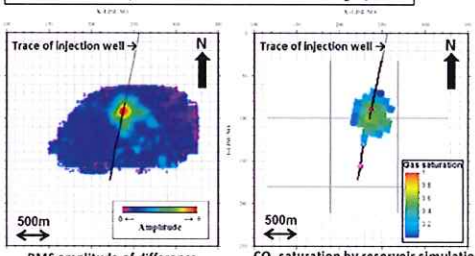
- 3D seismic surveys at cumulative CO2 injection of approx. 65,000, 207,000 and 300,000 tonnes into the Moebetsu Formation detected anomalies, indicating evolution of the CO2 plume. CO2 saturation distributions by reservoir simulation show a similar trend.

2nd monitor survey: About 65,000 tonnes cumulative CO_2 injection



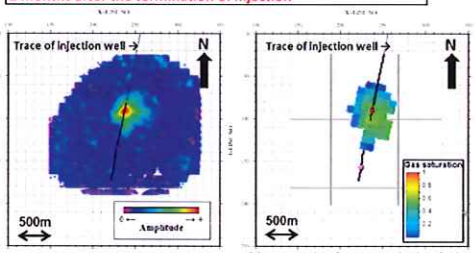
RMS amplitude of difference (plan view) | CO_2 saturation by reservoir simulation (plan view)

3rd monitor survey: 207,209 tonnes cumulative CO_2 injection



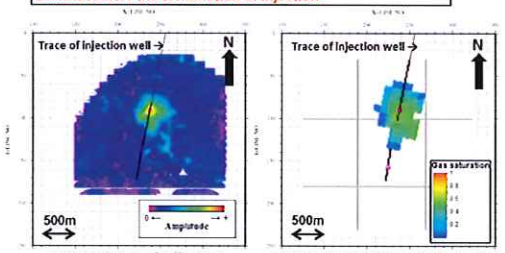
RMS amplitude of difference (plan view) | CO_2 saturation by reservoir simulation (plan view)

4th monitor survey: 300,012 tonnes cumulative CO_2 injection
2 months after the termination of injection



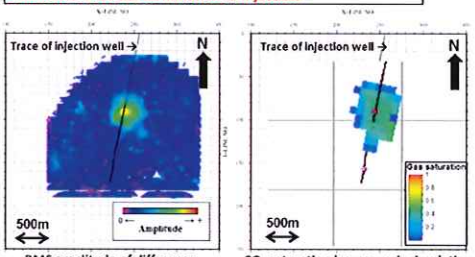
RMS amplitude of difference (plan view) | CO_2 saturation by reservoir simulation (plan view)

5th monitor survey: 300,012 tonnes cumulative CO_2 injection
8 months after the termination of injection



RMS amplitude of difference (plan view) | CO_2 saturation by reservoir simulation (plan view)

6th monitor survey: 300,012 tonnes cumulative CO_2 injection
32 months after the termination of injection

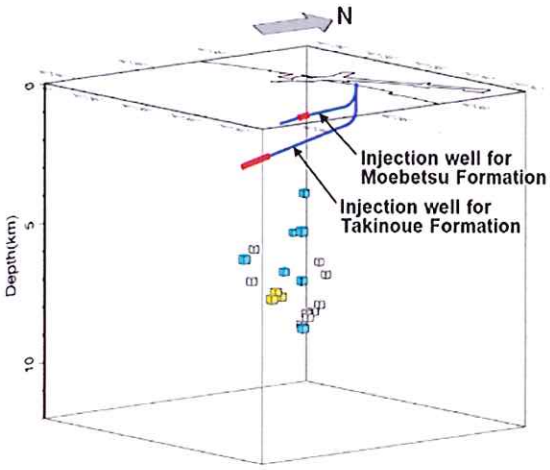


RMS amplitude of difference (plan view) | CO_2 saturation by reservoir simulation (plan view)

RMS (Root Mean Square) amplitude of difference of monitor survey and baseline survey at the depth of the reservoir (970 to 1050 msec)

Results of micro-seismicity monitoring

3D view of hypocenters of events



- Pre-injection events
- Events during injection
- Post-injection events

※Detectability: Mw ≥ - 0.5

List of events

Pre-injection events

No.	Date	Estimated Depth	Mw
1	4/09/2015 15:03	6.64 km	0.14
2	4/13/2015 14:00	5.97 km	0.14
3	4/17/2015 07:06	8.17 km	0.20
4	4/17/2015 07:09	8.19 km	0.19
5	4/17/2015 07:13	8.33 km	0.28
6	4/17/2015 07:18	7.57 km	0.17
7	5/10/2015 08:27	8.59 km	-0.04
8	8/10/2015 19:08	6.76 km	0.23
9	8/20/2015 23:20	8.18 km	0.44

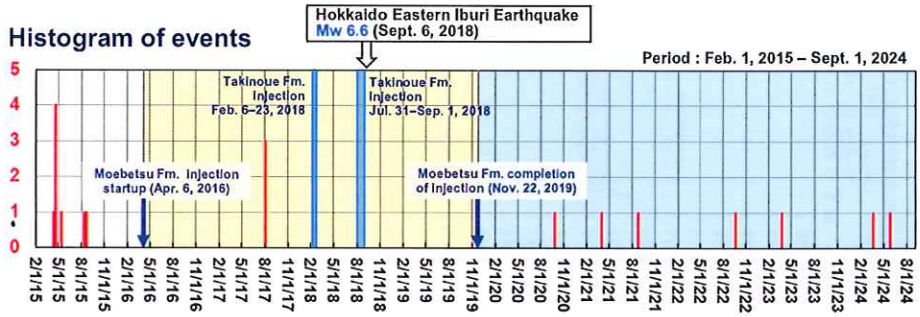
Events during injection

No.	Date	Estimated Depth	Mw
10	8/02/2017 13:35	7.80 km	0.50
11	8/02/2017 13:36	7.78 km	0.33
12	8/02/2017 13:55	7.70 km	0.33

Post-injection events

No.	Date	Estimated Depth	Mw
13	9/24/2020 11:53	5.86 km	0.59
14	4/01/2021 04:23	7.45 km	0.23
15	8/24/2021 16:03	6.50 km	0.13
16	9/18/2022 14:04	4.35 km	0.12
17	3/22/2023 10:26	8.37 km	0.43
18	3/20/2024 22:43	5.15 km	0.59
19	5/27/2024 23:04	5.73 km	- 0.35

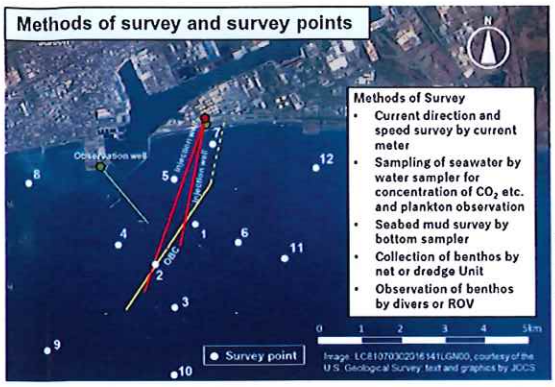
Histogram of events



Marine environmental surveys according to the monitoring plan submitted to MOE

◆ Marine environmental surveys have been conducted under the five-year injection permit (FY2016–2020 and FY2021–2025) from Ministry of the Environment (MOE) which requires the implementation of a "monitoring plan" approved by MOE.

Methods of survey and survey points

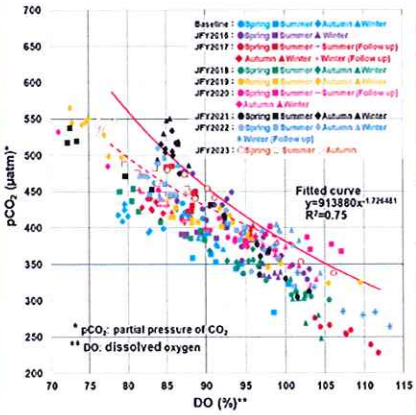



Water sampler


Bottom sampler


ROV

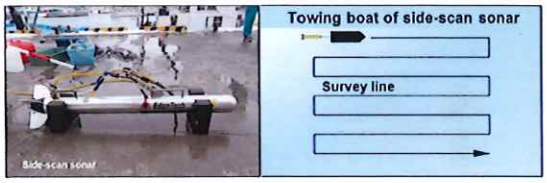
Threshold line: Upper limit of 95% prediction interval



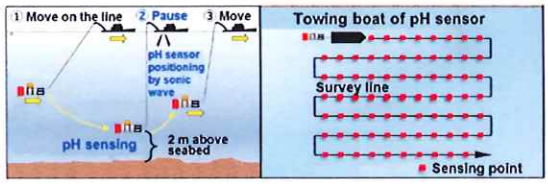
Initial threshold line using baseline data

Current threshold line using data of baseline and Feb. 2017 to Feb. 2018

Follow-up surveys: in case of exceedance over the threshold line



Side-scan sonar survey

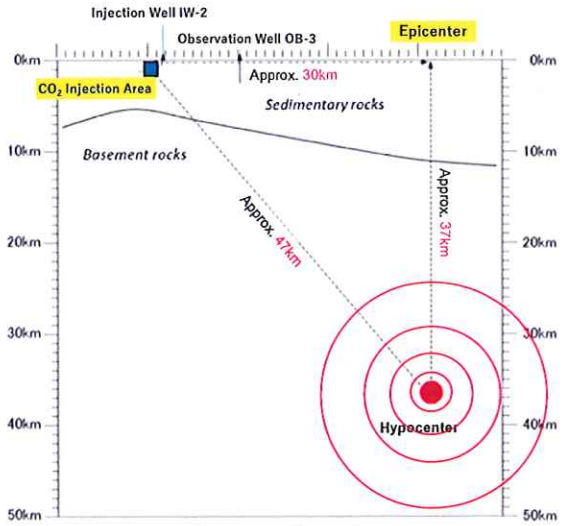


Towed pH sensor survey

2018 Hokkaido Eastern Iburi Earthquake

◆ At 3:07am Sept. 6, 2018, a moment magnitude 6.6 earthquake at 37km depth occurred in central eastern part of Iburi region of Hokkaido. Acceleration of 158 gal was observed at Tomakomai CCS demonstration center; no damage was incurred by facilities.

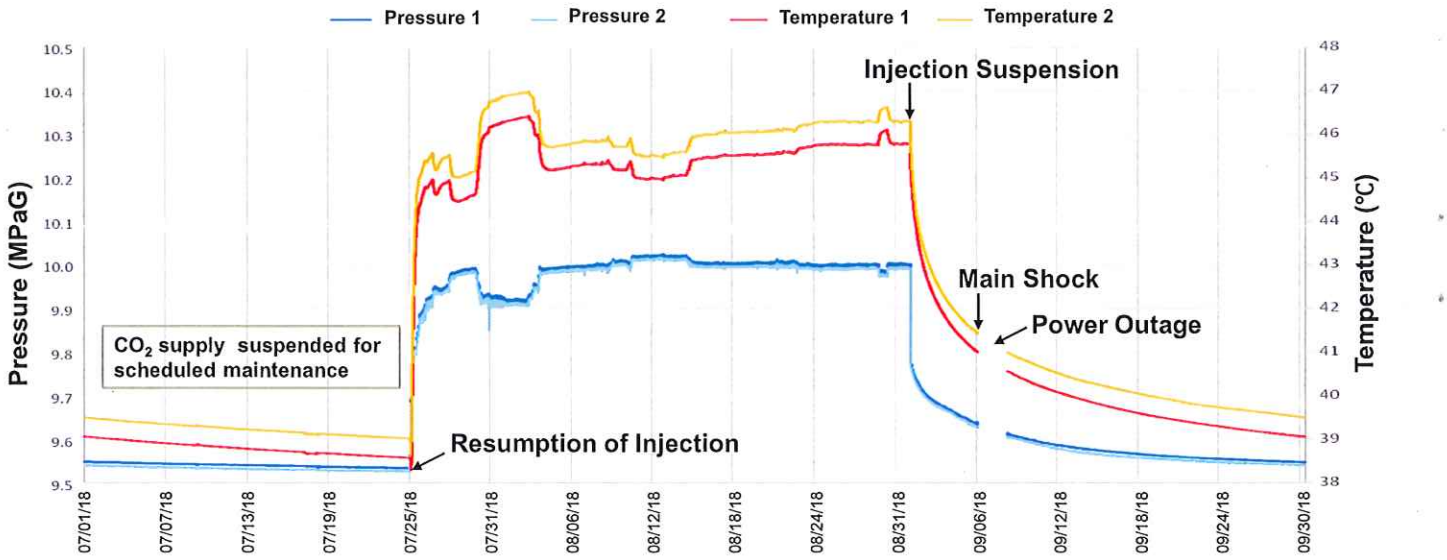
Plan view



Cross section view

2018 Hokkaido Eastern Iburi Earthquake

◆ Bottom hole pressures, temperatures of Moebetsu Formation injection well before/after earthquake



Measures taken by JCCS after the Hokkaido Eastern Iburi Earthquake

- 6th Sept. 2018: Moment Magnitude 6.6 earthquake occurred
- 12th Sept 2018: Posted JCCS's views on JCCS on HP
- 19th Oct. 2018: Convened an expert review meeting
- 21st Nov. 2018: Posted summary of review meeting on HP

Key points on JCCS HP:

1. **No relationship between CO_2 injection and earthquake**
2. **No CO_2 leakage**

※ Report on Expert Review Meeting:
(https://www.japanccs.com/wp/wp-content/uploads/2019/09/Research-Report-on-Impacts-of-Hokkaido-Eastern-Iburi-Earthquake-on-CO2-Reservoir_2nd-edition.pdf)

Key principles to minimize concerns of local community and general public:

- *Respond quickly*
- *Include technical explanation*

Public Outreach

Public Outreach Activities

Voice of Tomakomai Citizens

1. Information Disclosure
Thorough disclosure should be made

2. Safety/CO_2 leakage
Want more detailed information on risk of CO_2 leakage

3. Dissemination to Young Generation
Should consider efforts to involve young generation

Outreach Activities

Monitoring & Disclosure Plan

1. Site Tours
2. Panel/Booth Exhibitions
3. CCS Forum for Tomakomai Citizens
4. Information Disclosure System
5. Seminars for students
6. Kids' lab classes/site tours

Cumulative Outreach Activities (2012-2024)

1. Site Visitors: 19,088 people
   16,291 from Japan
   2,797 from overseas
2. Panel/Booth Exhibitions: 185 times
3. CCS Forums: 11 times
4. Information Disclosure System: Ongoing
5. Seminars: 256 times
6. Kids' lab classes: 43 times

2,3,5,6: in Japan

Project being conducted with understanding and support of local community

Outreach Activities:


Panel Exhibition in Tomakomai


Kids' lab class


Site Tours


Information disclosure system in Tomakomai City Hall

Summary

Summary

Results and Lessons Learned

- Operation of **full chain CCS system from capture to storage conducted successfully, target of 300,000 tonnes of CO_2 injection achieved.** Monitoring operations being continued.
- CO_2 capture process comprising two-stage absorption system with low pressure flash tower achieved **significantly lower capture energy than conventional system**
- Deviated injection wells from onshore site into offshore reservoirs saved drilling cost, avoided disturbance of marine environment and harbor operation
- Safety and reliability of CCS system demonstrated
- Concerns about **earthquakes and induced seismicity** addressed
  - Natural earthquakes have not caused damage to reservoirs; no data suggesting connection between CO_2 storage and earthquakes
  - Important to respond as quickly as possible, and to include technical data to minimize concerns.
- Project being conducted with **understanding and support of local community**
  - Importance of information disclosure and diligent efforts to secure understanding of local stakeholders

Thank you for your attention

This presentation is based on results obtained from a project commissioned by the New Energy and Industrial Development Organization (NEDO).

Japan CCS gave the following papers on the Tomakomai Project at GHGT-16 and GHGT-17 which are available on SSRN.
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4285926
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5071127

JCCS
Japan CCS Co., Ltd.
http://www.japanccs.com/

NEDO (New Energy and Industrial Technology Development Organization) Project

R&D and Demonstration of CO_2 Ship Transportation

Japan CCS Co., Ltd

■ Video

Objectives, Project Framework and Project Schedule

◆ Objectives

R&D and demonstration of technologies for CO_2 liquefaction, storage, loading, unloading, and marine transportation under optimal temperature and pressure conditions for safe, low-cost and large-volume transportation.

◆ Project Framework (as of April 2025)

NEDO (New Energy and Industrial Technology Development Organization)

◆ recommissioned company

- **Japan CCS Co., Ltd**
  - ◆ Mitsui O.S.K. Lines, Ltd.
  - ◆ Kanden Power-Tech Corp.
- **Engineering Advancement Association of Japan**
  - ◆ Ochanomizu University
- **Nippon Gas Line Co., Ltd.**
  - ◆ Kawasaki Kisen Kaisha, Ltd.
- **Itochu Corporation**

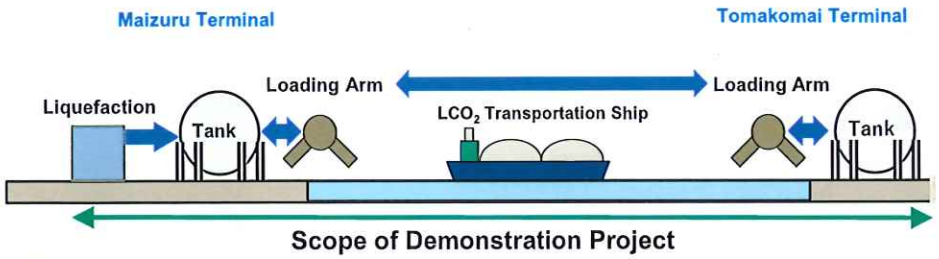
◆ Project Schedule :

June 2021 – March 2027

Overview of Project

- Liquefied CO_2 demonstration ship "EXCOOL", incorporating CO_2 marine cargo tank system developed in project, will repeat transport of CO_2 mainly between Maizuru and Tomakomai terminals, changing CO_2 temperature, pressure, etc. on each trip.
- By evaluating functionality of cargo handling facilities and storage tanks at onshore terminals and identifying the optimal CO_2 transportation conditions, project will lead to development of mass transportation technology.

Project Scope



Source: METI, NEDO

CO_2 transportation ships for industry

- Industrial CO_2 is transported by small ships under medium-temperature, medium-pressure conditions

Vessel Name	FROYA	EMBLA	GERDA	HELLE	DEJIN 26
Navigation Area	Europe	Europe	Europe	Europe	China
Gross Tonnage	2,506 t	2,506 t	2,506 t	1,825 t	Under survey
Cargo Tank Capacity	1,800m^3	1,800m^3	1,800m^3	1,250m^3	Under survey
Cargo Temperature (lowest)	-30℃	-30℃	-30℃	-40℃	Under survey
Maximum Pressure	19.0 bar (1.9 MPa)	19.0 bar (1.9 MPa)	19.0 bar (1.9 MPa)	18.0 bar (1.8 MPa)	Under survey
					

Edited from https://www.japanccs.com/wp/wp-content/uploads/2021/10/Part-1-Speaker-2_JCCS_Toshitsugu-Nozawa.pdf
https://splash247.com/landmark-carbon-capture-pilot-completed-in-china/

CO_2 transportation ships for CCS

Early 2023

https://www.energy.gov/sites/default/files/2023-07/8c%20Greensand%20Phase%202%20-%20Pilot%20Project%20and%20Research.pdf

CO_2 ship transportation by tank containers for Greensand pilot project in Denmark

Nov. 2023

Demonstration ship EXCOOL was completed in Nov. 2023 in Japan.

Cargo tank capacity : 1,450m³
Length : ~72m
Beam : ~12.5m
Cargo transport conditions
Maximum pressure : 1.9MPaG
Minimum temperature : -50℃

Nov. 2024

https://www.kline.co.jp/ja/news/liquefied_gas/liquefied_gas-20241126.html

NORTHERN PIONEER for Northern Lights was completed in Nov. 2024 in China.

Cargo tank capacity : 7,500m³
Length : 130m
Beam : 21m
Cargo transport conditions
Maximum pressure : 1.9MPaG
Minimum temperature : -35℃

Dec. 2024

https://www.kline.co.jp/ja/news/liquefied_gas/liquefied_gas-20250130.html

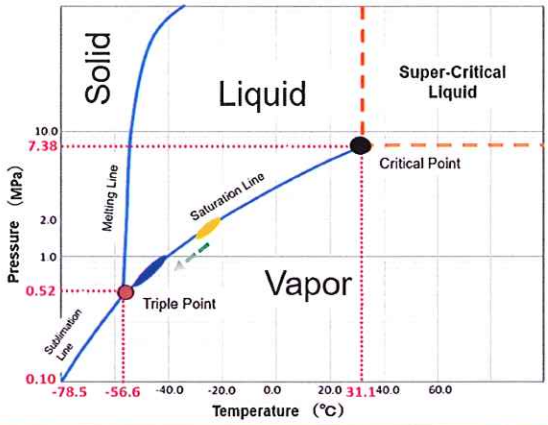
NORTHERN PATHFINDER for Northern Lights was completed in Dec. 2024 in China.

Key Points of R&D (Temperature and Pressure)

- To achieve low-cost and large-volume CO_2 transportation, it is desirable to transport at low-temperature and low-pressure, which allows for thinner tank steel plates and larger capacities
- There is concern that low temperatures and low pressures will result in nearing the Triple Point, which could lead to dry icing, an operational and safety risk
- The project will develop technology for LCO_2 ship transportation at low-temperature and low-pressure to manage this risk appropriately

Condition	T, P	Special notes
Medium T & P	-30℃~-20℃ 1.5MPa ~2.0MPa	Current LCO_2 transportation and storage conditions
Low T & P	-55℃~-40℃ 0.5MPa ~1.0MPa	Conditions expected for large-volume transportation Close to Triple Point
Triple Point	-56.6℃ 0.52MPa	Conditions for dry icing

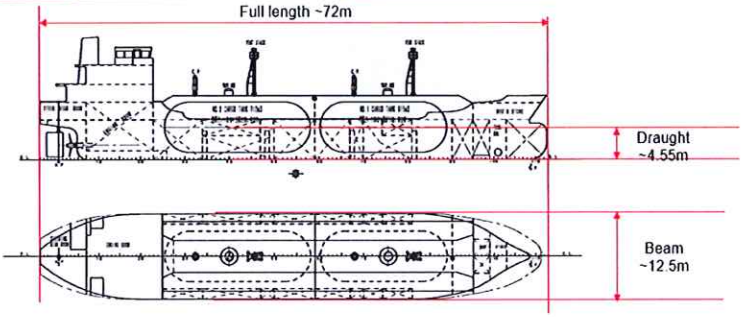
Source of T & P: ZEP



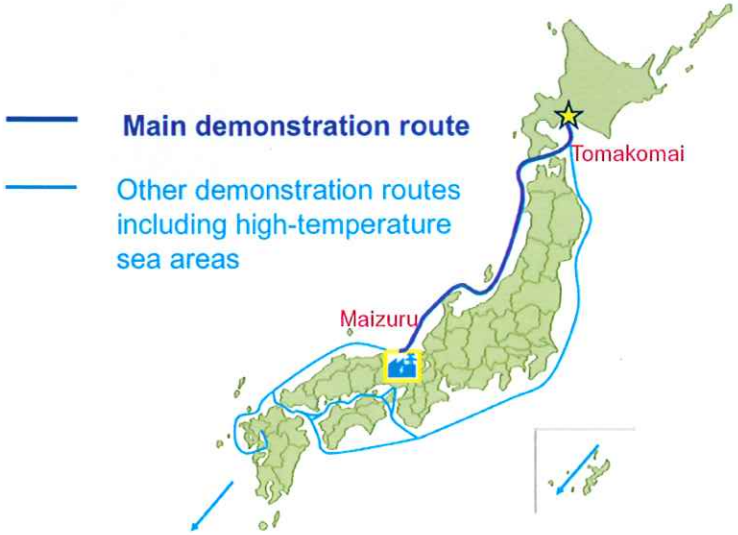
Overview of Demonstration Ship "EXCOOL"

Specifications of LCO_2 Demonstration Ship	
Type of vessel	Liquefied gas carrier
Navigation area	Greater coastal area Non-international waters
Classification	ClassNK
Principal dimensions	Full length ~72.0m Beam ~12.5m Draught ~4.55m
Tank	Independent –Type C

Design Conditions for Marine Cargo Tank		
Volume (m³)	1,450	
Temperature (℃)	-20	-50
Pressure (MPaG)	1.9 (Pressure valve max)	
Liquid density (kg/L)	1.030	1.154

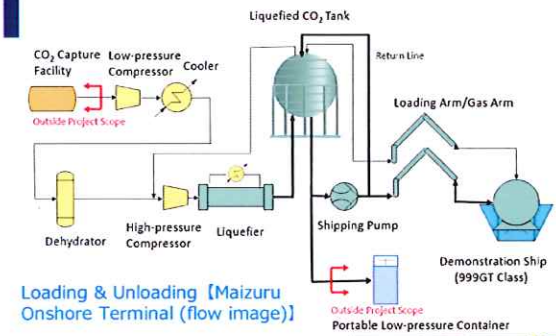


Demonstration Routes



Demonstration ship "EXCOOL"

Onshore Terminal Facilities

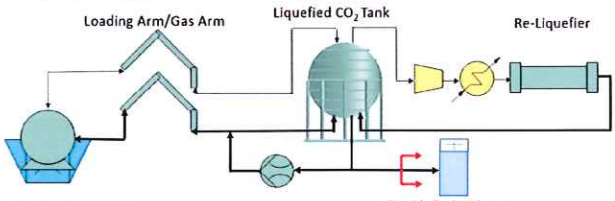


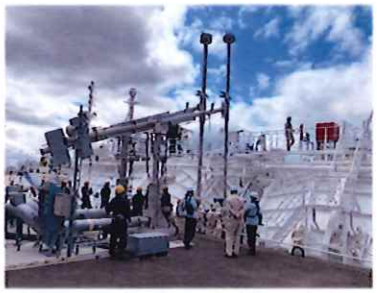
Loading & Unloading【Maizuru Onshore Terminal (flow image)】

Maizuru Terminal
Premises of The Kansai Electric Power Co., Inc. Maizuru Power Plant

Tomakomai Terminal
Premises of Hokkaido Electric Power Co., Inc. Tomakomai Power Plant

Loading & Unloading【Tomakomai Onshore Terminal (flow image)】





Thank you for your attention

This presentation is based on results obtained from a project commissioned by the New Energy and Industrial Technology Development Organization (NEDO)

JCCS
Japan CCS Co., Ltd.
http://www.japanccs.com/

Carbon Capture, Utilization and Storage (CCUS)
Carbon Reduction Flagship Action Plan

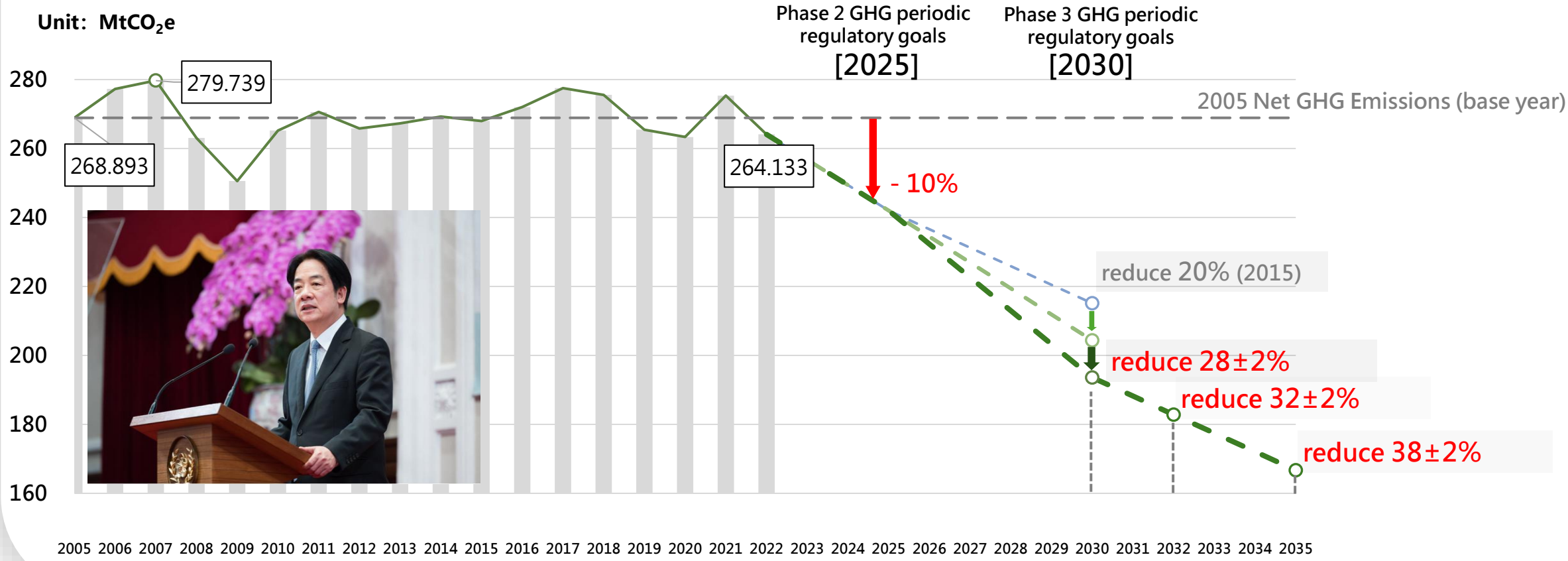
環境部氣候變遷署
Climate Change Administration
Ministry of Environment

2025/08/27

Setting Carbon Reduction targets

- Taiwan promulgated an amendment to the "Climate Change Response Act " in 2023, initiating the implementation of net zero emissions.
- President Lai proposed a draft proposal on 23 Jan. 2025, setting Taiwan's new 2035 NDC targets at emissions reductions of 38±2%, compared with 2005, to keep up with the global NDCs 3.0 submission trend.

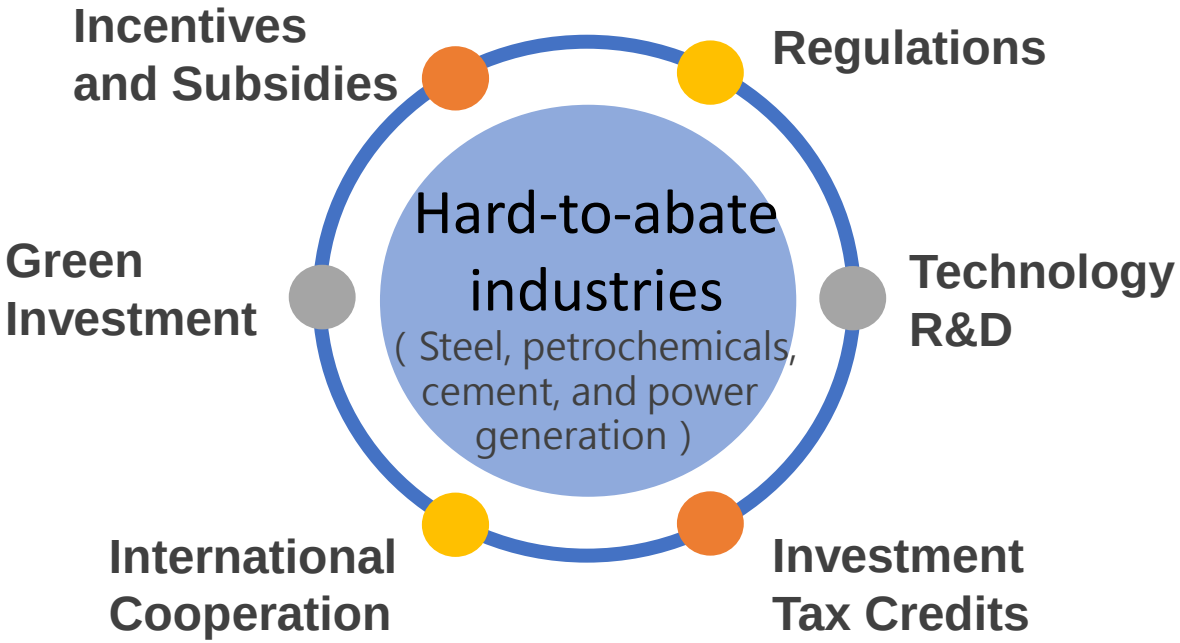
Net GHG Emissions



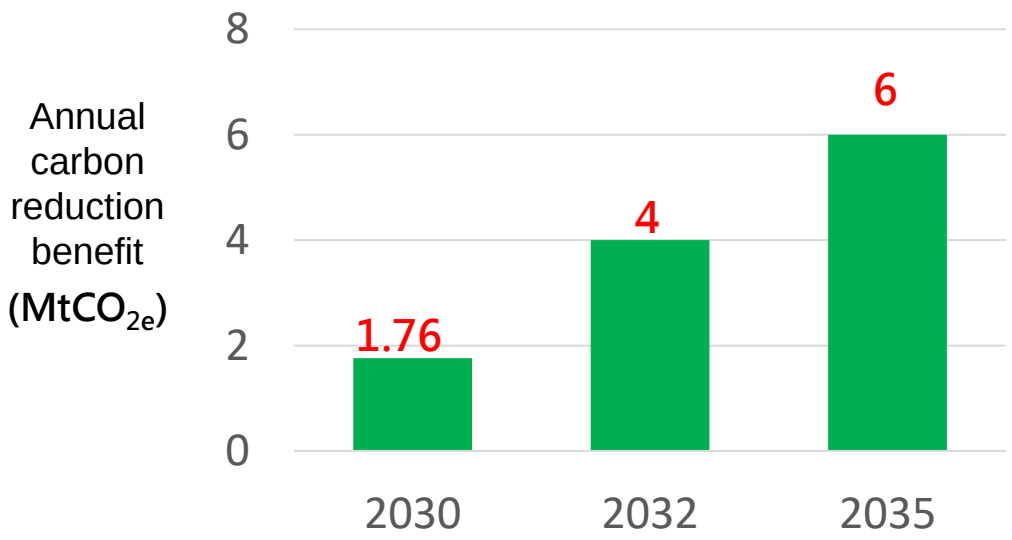
CCUS Carbon Reduction Goals

- According to the International Energy Agency's (IEA) "Net Zero Roadmap 2023" Note 1, CCUS can contribute 8% of global carbon reduction by 2050.
- CCUS can help hard-to-abate industries accelerate carbon reduction and is considered an indispensable part of global carbon reduction strategies.

✓ Policy Tools



✓ Carbon reduction targets



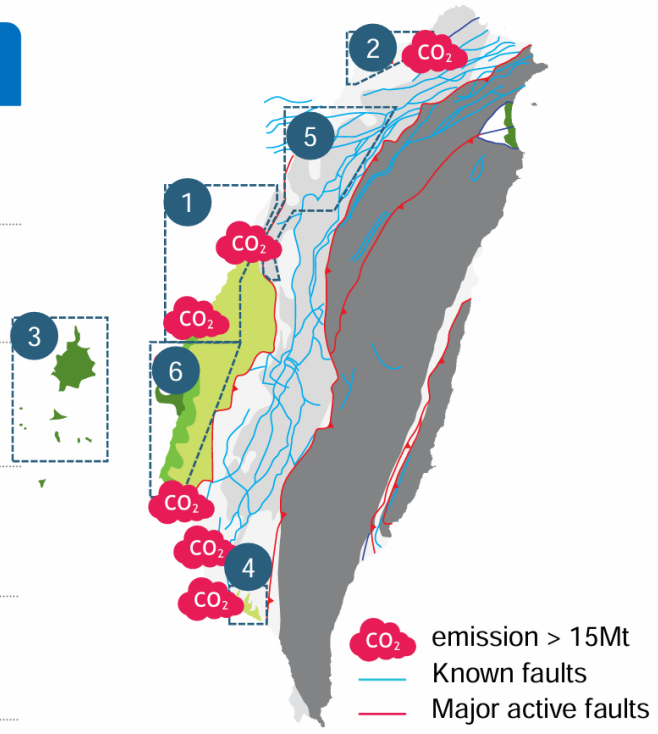
（Note 1：IEA, 2023update. Net Zero Roadmap: A Global Pathway to Keep the 1.5℃ Goal in Reach.）

Opportunities in Taiwan

Assessment of potential sites

Candidate site	Storage type	Depth	Preliminary assessment
1 **Coast of central region**	Saline aquifer	0.8-3.0 km	✓ No active structure and limited earthquake ✓ Close to large emission source
2 **Coast of Taoyuan-Linkou**	Saline aquifer	0.8-3.0 km	✓ No active structure and limited earthquake ✓ Close to large emission source
3 **Penghu Islands**	Basalt & saline aquifer	0.2-2.0 km	✓ No active structure and limited earthquake ! Higher transportation cost
4 **Pingtung coast**	Saline aquifer	0.8-2.0 km	✓ No active structure and earthquake ! Limited capped formations
5 **Taoyuan and Hsinchu area**	Trap structure	0.8-3.0 km	✓ Sufficient geology background ! Risk of fault reactivation
6 **Coast of Chiayi and Tainan**	Saline aquifer	0.8-2.0 km	! Active structure and seismic zone

Low feasibility High feasibility



Potential capacity

- Saline aquifer > 40 Gton
- Trap structure > 2 Gton
- Basalt > 0.4 Gton

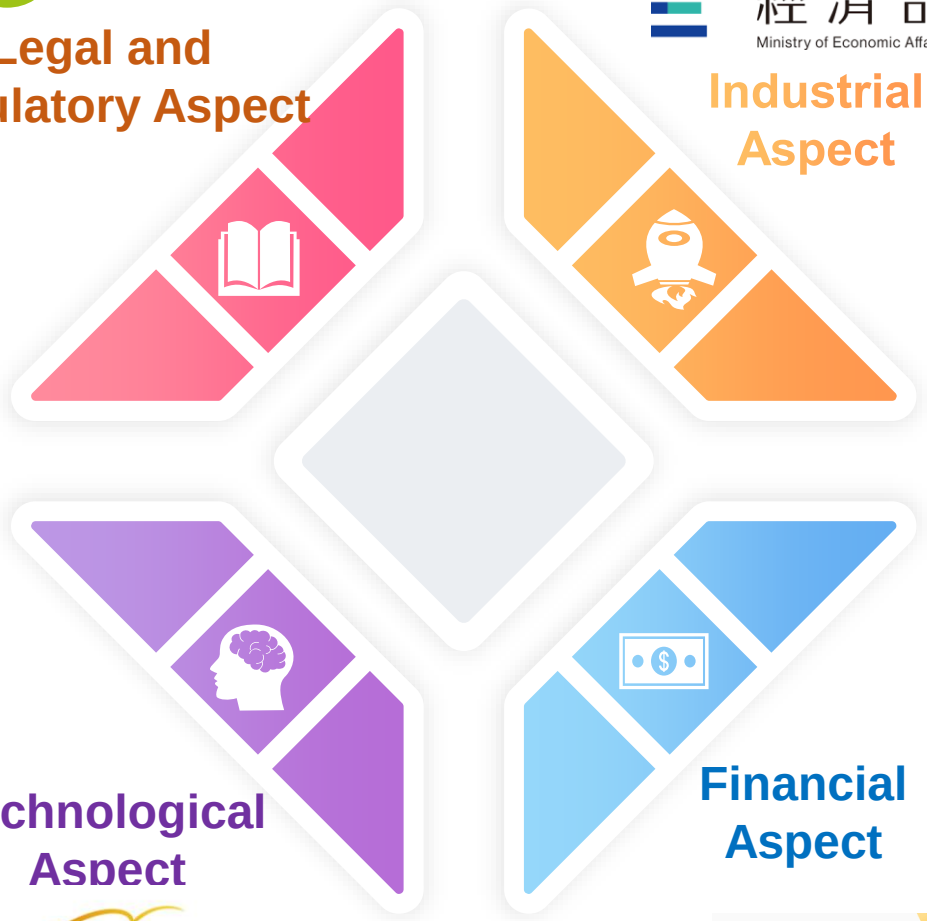
Promotion Strategies and Plan Content (3/3)

Legal and Regulatory Aspect

- **Regulations Formulate**
  CCS management regulations and relevant guidelines
- **Strategic EIA**
  Conduct policy environmental impact assessments and formulate case-by-case EIA review principles
- **Supporting measures**
  Social communication platform, CCS risk management, environmental monitoring, carbon reduction benefit assessment, CCS regional zoning

Industrial Aspect

- **Promote carbon storage projects**
  Building a 10,000-ton pilot test site
- **Promote CCS Hubs**
  Integrate carbon emission sources and, in conjunction with Taiwan's potential carbon storage areas, develop commercial CCS hubs
- **Construct utilization business models**
  Build CCUS business models for key industries



Technological Aspect

- **Technology R&D, International cooperation**
  Apply low-energy-consumption carbon capture technology, develop CCU green products, transportation and storage technology, and CCS geological exploration, drilling, injection, and monitoring technology
- **Risk assessment**
  Develop Taiwan's CCS safety assessment technology and models
- **Capacity building**
  Inject resources to cultivate relevant talent and promote a green job market

Financial Aspect

- **Green investment and financing environment**
  Continue to promote "Reference Guidelines for Sustainable Economic Activities" to guide funds into supportive economic activities such as CCUS
- **Investment Tax Credit, Incentive mechanisms**
  Encourage corporate investment in carbon capture and storage, and reduce financial risks through carbon price incentives, subsidies, or national investment funds

CCS Promotion schedule

Key Initiatives

- Enact Carbon Dioxide Capture and Storage (CCS) Management Regulation
- Conduct Strategic Environmental Assessment (SEA) for Carbon Dioxide Capture and Storage (CCS)

Performance Goals

2026	2027	2028	2029	2030
• Promulgate CCS Management Regulation • Submit the CCS SEA Report for Review • Announce CCS Development Blocks	Initiate CCS Drilling Operation Applications	Establish CCS Risk Assessment Methodology	• Establish CCS Carbon Reduction Benefit Assessment Methodology	Initiate CCS Storage Applications

Conclusion

- CCUS can help hard-to-abate industries accelerate carbon reduction and is one of the important strategies for net-zero emissions. This plan, by promoting the CCUS industry value chain, aims to achieve a carbon reduction target of 6 million tons of carbon dioxide by 2035.
- The short-term main carbon reduction performance of this plan will come from the promotion of CCU, while the medium-to-long-term (after 2030) carbon reduction performance of carbon capture and storage CCS will gradually emerge.
  - Short-term (2025 ~ 2030): Accelerate R&D of carbon capture technology and actively promote the application of CCU technology in industries. Complete CCS management measures, initiate exploration, environmental impact assessment, and approve at least one storage permit by 2030.
  - Medium-to-long-term (2030 ~ 2035): Continue to promote the CCU business model, initiate the operation of carbon capture and storage hubs, the injection at CCS sites, and the CCUS industry value chain business model.
- This plan extends the framework of the CCUS key strategic action plan, dividing it into four major aspects—legal, industrial, technological, and financial—to accelerate the promotion of relevant strategies and plans.

Question 💡 & Answer 🔑

Thank You !