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Chapter 5 | Policymaking and governance

National-level carbon dioxide removal (CDR) policy has made some progress in supporting scientific research and demonstration for novel CDR. But there is less development in other areas where policy plays a guiding role.

Key insights

- CDR policy gained momentum in 2023, but important policy and governance ambiguities (e.g. on residual emissions) remain.
- At the international level, CDR received considerable attention at the sidelines of the COP28 negotiation process (side events, reports, launch of new cooperation); however, its presence in official negotiations was limited.
- National and subnational policies have progressed towards regulating and establishing incentives for initial novel CDR deployment projects, as well as to funding research and development.
- Safeguards against harms from improper deployment need more focus in future CDR governance.
- Case studies on Canada, China, Japan and Saudi Arabia show that CDR is embedded in broader policy landscapes (e.g. agricultural or industrial policy) which address some CDR policy needs but that dedicated CDR policies are also needed.
- A better understanding of specific national contexts can help inform and instigate new initiatives and provide opportunities for future cross-sectoral and cross-country collaborations and alliances.

The IPCC has highlighted three main roles for CDR in mitigation strategies: to reduce net emissions in the near term, to counterbalance residual emissions in the medium term, and to achieve net-negative emissions in the longer term (see Chapter 1 – Introduction). To effectively perform these functions, dedicated policies and innovative governance will be required.[133–135]

This chapter discusses both policy and governance. Governance, as defined by the United Nations Development Programme, is "the system of values, policies and institutions by which a society manages its economic, political and social affairs through interactions within and among the state, civil society and private sector".[136] Policy, by contrast, refers

to specific procedures and protocols, regulations, laws, voluntary actions and other instruments enacted to achieve social goals.

5.1 The state of dedicated CDR policy

Progress is being made in the governance of research and development for novel CDR, but further policy to safeguard against potential harmful deployment and to enable public participation would be required to meet the expectations of stakeholders.

The diffusion of net zero pledges and targets in the past few years has lent momentum to CDR. But scaling up CDR will require the implementation of dedicated and actionable policy sequencing that translates this momentum into development and deployment strategies, as well as systematic integration of CDR into climate, land-use, agriculture, biodiversity, energy and industrial policy.[137–141] To become an element of ambitious mitigation strategies, it is essential that CDR policy ambitions are supported by monitoring, reporting and verification (MRV); actionable deployment incentives; transparent approaches for designating residual emissions; market integration; and near-term targets.[142–145]

Functions of governance for CDR

As important as innovation and upscaling are, effective CDR policy needs to focus on more than just those goals. Policy and governance discussions need to reflect on what this governance does for CDR and other social goals and on how this governance is embedded and linked to other governance structures in climate change mitigation and other policy areas. In particular, four functions of governance for CDR stand out: (1) enabling policy, which may include supporting CDR research and development or creating standards for MRV; (2) regulatory policy on emissions, requiring that emissions be compensated by removals; (3) policy that restricts harmful deployment, which may involve limiting fraudulent activities related to CDR or creating regulatory safeguards to protect communities and ecosystems; and (4) policy that improves decision-making, such as facilitating public deliberation or community assessment.

Current progress in these functional areas is uneven, as analysed in this chapter. The most progress is being made in support of research and innovation for novel CDR and in new initiatives to establish standards for MRV for both novel and conventional CDR. The other functions are often sidelined or ignored in new CDR initiatives at all levels of governance: international, supranational, national and, in some countries, subnational.

International CDR governance

CDR policy gained momentum in 2023 at both the international and regional scale. At the international level, CDR received considerable attention at the sidelines of the official COP28 negotiation process (side events, reports, launch of new cooperation); however, its presence in official negotiations was limited. CDR was addressed in negotiations on the guidance on carbon crediting methodologies and greenhouse gas removals under Article 6.4 of the Paris Agreement, the mechanism for voluntary cooperation based on carbon

credits. The discussion included topics such as the social and environmental safeguards for removals and details of carbon accounting practices (see Chapter 10 – Monitoring, reporting and verification) and will have to be continued at future UNFCCC meetings. The failure to agree on a guidance document is a reminder of the politics inherent in multilateral CDR governance – conventional CDR having long been a highly contentious issue in the UNFCCC negotiations.[146] The final global stocktake text called for the acceleration of zero- and low-emission technologies, including a short and rather vague subparagraph on "abatement and removal technologies such as carbon capture and utilization and storage".[147]

Despite the limited progress in official UNFCCC negotiations, there are many examples of progress within the CDR landscape:

- The end-to-end integrity guidance framework from standard setters in the voluntary carbon market, which discusses the use of carbon credits to compensate for residual emissions[148]
- Mission Innovation's CDR Mission, launched in 2021 and co-led by Canada, Saudi Arabia and the US, which continues undertaking technical work on "biomass carbon removal and storage" and on "enhanced mineralization"[149,150]
- The Group of Negative Emitters, launched at COP28 by founding members Denmark, Finland and Panama, with the goal that group member countries will remove more carbon dioxide than they emit[151]
- Private sector efforts by corporate entities and registries (e.g. creating standards), which can be seen as a form of CDR governance (see Chapter 10 – Monitoring, reporting and verification)

However, when it comes to policy by governments, commitments to CDR remain vague. The official documents submitted by countries to the UNFCCC, such as long-term strategies and nationally determined contributions (NDCs), include – sometimes explicitly, sometimes implicitly – pledges or expectations for CDR.[152] Those expectations for conventional CDR have been criticized for betting too much on land and ignoring the negative impacts of using land for mitigation.[153–155] For novel CDR, the pledges are very limited, with only a few countries explicitly providing a vision and/or scope for these CDR methods (see Chapter 9 – The CDR gap). Not only are these commitments often vague, but strategies to operationalize them in national policies are often lacking. Analysis specific to a country's political, social and ecological landscape that incorporates potential policy pathways will need to be developed.

CDR policies in countries

National and EU policies have, overall, progressed towards regulating and establishing incentives for initial CDR deployment projects, as well as to funding research and development. Australia, Canada, the EU, Japan, Norway, the UK and the US have government funding programmes for CDR demonstration projects (see Chapter 3

– Demonstration and upscaling). The EU has been focused on setting up governance frameworks for CDR. One prominent development is the progress made towards the EU's Carbon Removal Certification Framework. This certification will initially be voluntary but could potentially be a tool for integrating removals into the existing climate policy architecture.[156] In the US, the focus has been on innovation and demonstration projects, for which some of the funding appropriated in prior infrastructure legislation has been released, such as $1.2 billion out of an eventual $3.5 billion for direct air capture hubs (see Chapter 3 – Demonstration and upscaling, Box 3.1). Box 5.1 contains specific updates on the country case studies included in *The State of Carbon Dioxide Removal* 1st edition.

Countries are also working out how to integrate removals into carbon market plans and policies. In India, for example, there are plans to include both removals and reductions in the planned carbon credit trading scheme, which has both compliance and voluntary elements.[157] Other countries, like China and New Zealand, have already gained some experience with trading of afforestation credits in their compliance or voluntary carbon markets. Some governments are also planning to pilot test the trading of removals between countries; for example, Sweden and Switzerland signed a declaration of intent to test how a symbolic amount of removals can be transferred.[158] This transfer will provide valuable information on how removals can be exchanged within a Paris-compliant framework.

Thus far, tangible policy progress at the national level has been mostly in funding research, development and demonstration (RD&D); most other considerations are merely at a discussion level, especially for novel CDR methods. Part of the reason for the limited progress is the complexity created by the number of sectors and technologies involved, from the ocean, soils and forest to agriculture, energy, industry and more. CDR-related policies, therefore, have to cross boundaries: between regions, between institutions, between policy objectives (e.g. food, security, adaptation, biodiversity), and more. Depending on the governance architecture in place, this cross-boundary nature can lead to synergies, but it can also lead to risks, such as political conflicts from other policy areas spilling into climate policymaking. A key example is soil carbon sequestration: Initiatives in this area could potentially lead to more sustainable agriculture or forestry. However, initiatives aiming to do so will have to deal with both climate and agricultural politics, potentially increasing the risk of backlash.

Despite this complexity, CDR is moving up the policy agenda in many countries, and actors in research, business, NGOs and advocacy are increasing their efforts to track CDR policies. While these efforts help to map the current CDR policy landscape, it should be recognized that CDR policy does not start from scratch but already exists implicitly, for example in the governance of the forestry or agriculture sectors. CDR policy is therefore developed in relation to existing policy frameworks and builds on path dependencies within other policy areas. Although there are overarching trends in policy development (several of which are discussed in this chapter), CDR policy initiatives are, by their very nature and like all mitigation policymaking, context specific. Qualitative case studies that provide insights into these specificities are therefore an important complement to exploring the state of CDR (see Chapter 9 – The CDR gap).

Ambiguity in CDR policy

More than 150 countries have proposed net zero emission targets since the adoption of the Paris Agreement.[159] It is widely recognized that achieving these targets will require scaling up CDR, supported by dedicated policy strategies, alongside reducing emissions. However, despite policy experimentation and an increase in discussions of CDR policy, important policy-related ambiguities remain. Fundamentally, the role of CDR is often not consistently specified; in other words, it is unclear whether it is intended to contribute to net emission reduction, counterbalance residual emissions, or contribute to eventually reaching net-negative emissions (see Chapter 1 – Introduction).[143] For example, there is often conflation between carbon removals and carbon offsets in both policy and corporate strategies aimed at reducing net emissions in the short term. Policy debates also often overlook the crucial difference between carbon dioxide (CO_2) sources (fossil versus biogenic or atmospheric).[25,160] While countries like Germany and Sweden, as well as the EU, are developing strategies related to residual emissions,[161–165] this is not common. The amount and type of residual emissions that need to be counterbalanced by CDR to achieve and maintain net zero emissions are still ambiguous in most countries.[143]

Without greater clarity from governments on the role of CDR in mitigation strategies, there is a risk of greenwashing or obstruction of emission reduction – a dynamic in which a promised CDR scale-up obstructs the reduction of gross greenhouse gas emissions at the rates required to achieve climate goals. Many civil society groups and academics continue to raise concerns about this risk.[166–169] If CDR is treated simply the same as a carbon offset, or if policies are not put in place to ensure that CDR is used to counterbalance only "legitimate" residual emissions,[160] CDR capacity will be used to delay abating emissions that could be addressed at their source. The current lack of specification in many strategies therefore decreases the credibility and legitimacy of CDR efforts and could hinder the most critical factor in climate change mitigation: the reduction of gross emissions.

Some jurisdictions are moving to confront the risk of greenwashing or the obstruction of phasing out fossil fuel infrastructure. For example, California's recently passed law AB 1305, Voluntary Carbon Market Disclosures, requires any carbon offsets and removals that are exchanged to specify methodologies and verification information to back up their removal claims. Another approach is to separate mitigation targets into CDR targets and gross greenhouse gas emission reduction targets. While such a separation would effectively address the issues raised above, the actual implementation would be challenging. For example, in the EU, only a limited amount of net removals from the land use, land-use change and forestry (LULUCF) sector can contribute to the achievement of the 2030 abatement target (up to 225 $MtCO_2e$). However, capping the contribution of net removals from the LULUCF sector to achieve the abatement target does not address the share of gross emissions and removals. A similar target design is being discussed for 2040,[163] which again shows that the idea of separate targets is gaining traction, but the actual implementation and clear differentiation of separate targets is both politically and administratively challenging. Such efforts tackle some of the concerns about CDR being mobilized as an offset for emission reduction, but this risk needs to be addressed at all levels and stages of policymaking, target setting, MRV schemes, deployment incentives and

market integration, and within the wider policy landscape.

5.2 Tracking emerging CDR policy

As CDR policy moves from concepts and pledges to deployments on the ground, there is an opportunity to understand how CDR policies impact real-world developments and explore links with other policy domains.

An effective assessment of the current state of CDR policy needs to recognize that the policy space is rapidly evolving and that many ambiguities remain. Merely counting explicit CDR initiatives and pledges would not provide sufficient information; the assessment needs to also identify policy gaps, the politics of including CDR as part of mitigation strategies, and adverse effects that could stem from the policy's implementation.

This chapter assesses CDR policies and governance in relation to three key dimensions: (1) the overarching CDR policy architecture, (2) innovation and scaling policies, and (3) safeguards and links with other policy domains.

Overarching CDR policy architecture

Since the adoption of net zero targets, discussions about explicit CDR policy have entered the climate policy arena. Implicit CDR policy for conventional CDR, such as forestry, has been part of climate policy architectures before, but explicit CDR policy requires an overarching governance structure that defines the function of CDR in mitigation strategies. Such a structure would specify the role of removals in mitigation strategies to counterbalance residual emissions (e.g. through separate targets). In addition, it would require robust MRV schemes as well as liability mechanisms to deter the reversal of removed carbon and to ensure transparency.

Innovation and scaling policies

Given the very different technology readiness levels of CDR methods, the specific design and focus of innovation and scaling policies will differ considerably for novel and conventional CDR. Key elements in such policies will be initiatives and funding schemes for research and development, deployment incentives, and public or private procurement, as well as market integration into voluntary and/or compliance carbon markets.

Safeguards and links with other policy domains

Policy objectives beyond the carbon removed are going to shape how CDR is deployed. CDR policy intersects with many social goals: safety, environmental health, energy security, food security and more. CDR policy may thus involve policies to ensure worker or community safety, standards for environmental integrity, or policies to maximize co-benefits. It is also critical to consider that other policies (e.g. regulations concerning parts of process chains like CO_2 injection or transport infrastructure, or regulations on biodiversity protection and restoration) may shape, and are being shaped by, the output and outcome of CDR policy initiatives.

5.3 Case studies

Countries differ substantially in how and the degree to which they are turning their pledges into actionable incentives for CDR deployment – and in how they address other functions of CDR governance.

The State of Carbon Dioxide Removal 1st edition looked at the country case studies of Brazil, the EU, the UK and the US (see Box 5.1 for key updates on these countries). This edition extends the scope of the country case studies to include Canada, China, Japan and Saudi Arabia – countries that have received very little attention in the academic literature on CDR policy and governance. By systematically gathering information on the overarching CDR policy architecture, the innovation and scaling policies, and the broader policy landscape within a country, this report identifies the role of CDR in the case study country and the similarities and differences between countries in how CDR is approached as an element of climate policy. In addition, the report looks at the existing institutional architecture and policies for CDR, how they shape current CDR policy development and how they are expected to shape future CDR policy initiatives. These case studies provide snapshots of CDR policy in selected countries in early 2024, an important starting point for identifying current trends and future challenges.

Box 5.1 Case study updates from The State of Carbon Dioxide Removal 1st edition (Brazil, EU, UK, US)

The State of Carbon Dioxide Removal 1st edition looked at four case studies: Brazil, the EU, the US and the UK. This box summarizes key policy initiatives in these countries since the publication of the first edition in January 2023:

Brazil. Since the change of government in 2023 and its new emphasis on climate ambition in general, conventional CDR together with pledges to reduce deforestation have received more attention. Initiatives include the recommitment to restore 12 million hectares of land by 2030, the Tropical Forest Forever Facility launched at COP28,[170] and the Arc of Restoration programme, aimed at ecological restoration and carbon storage.[171] In addition to these developments relating to conventional CDR, possible bioenergy with carbon capture and storage applications in ethanol production are being discussed and tested as novel CDR.[172,173]

EU. CDR has continued to climb up the political agenda in the EU. In addition to the Carbon Removal Certification Framework (see Section 5.1), CDR played a key role in the recommendation for the new 2040 climate target.[163] In a strategy on industrial carbon management, the European Commission highlighted the importance of novel CDR methods.[174] More concrete steps building on this strategy, including consideration of how CDR could be accounted for and covered under the EU Emissions Trading System,[175–178] will be facilitated by the next Commission, starting in late 2024.

UK. The UK government has taken several next steps on a broad portfolio of CDR methods[179] as well as in the Developing the UK Emissions Trading Scheme consultation – an initiative that confirmed a "carbon contracts for

difference" approach for novel CDR, plus integration into the UK Emissions Trading Scheme cap. Furthermore, the government aims to develop an MRV standard.[179,180] Further steps were taken to incentivize the implementation of the much-discussed bioenergy with carbon capture and storage capacity at the Drax Power Station,[181] and CDR projects can now apply to access CO_2 transport and storage networks.[182] Efforts to trial ocean alkalinity enhancement, a method the government shows less interest in, through a project funded by philanthropy in UK waters has caused local protest.[183]

US. The US has started implementing funds that were authorized in the 2021 Bipartisan Infrastructure Law and the 2022 Inflation Reduction Act, which included selecting projects for the first $1.2 billion of the $3.5 billion Regional Direct Air Capture Hubs programme, as well as releasing funds for programmes that support soil carbon sequestration and ecosystem restoration in a way that would also enhance land-based removals. In relation to CDR specifically, $24 million for marine CDR research was funded through the National Oceanographic Partnership Program in 2023. The US also announced the $35 million CDR Purchase Pilot Prize programme, enabling the purchase of CDR credits from four removal methods: direct air capture, biomass carbon removal and storage, enhanced rock weathering, and planned and managed sinks. In February 2024, the Department of Energy announced up to $100 million for CDR pilot projects and testing facilities.

Canada

Like other countries, Canada has set a target of net zero greenhouse gas emissions by 2050 and enshrined it into law.[184] Canada is exploring the roles that novel and conventional CDR methods may play in reaching net zero, with methods including bioenergy with carbon capture and storage (BECCS), direct air carbon capture and storage (DACCS), and CDR in the LULUCF sector being explicitly considered.[185] Overall, CDR has received increasing attention in the country in recent years, with several related policies and strategies currently under development or published, including Canada's Carbon Management Strategy,[186] Canada's Greenhouse Gas Offset Credit System,[187] and the Natural Climate Solutions Fund.[188]

Credits generated under Canada's Greenhouse Gas Offset Credit System can be used to meet compliance requirements under the country's Output-Based Pricing System, which places prices on greenhouse gas emissions, or to reach voluntary climate goals.[189] While the credit system covers both emission reductions and removals, specific protocols are to be developed for several conventional and novel CDR methods, including forest management, enhanced soil carbon sequestration and DACCS.[190]

A variety of conventional CDR methods are targeted by the country's Natural Climate Solutions Fund, consisting of the 2 Billion Trees Program, the Nature Smart Climate Solutions Fund, and the Agricultural Climate Solutions Program.[188] While the 2 Billion Trees Program, among other co-benefits, aims to contribute to climate targets via afforestation, reforestation and restoration of forest habitat,[191] the Nature Smart Climate Solutions Fund provides funding for the protection, restoration and improved management of a variety of ecosystems storing carbon, including wetlands, peatlands, grasslands and forests.[192]

In addition to these policies with a larger focus on CDR, CDR is finding its way into other parts of Canada's climate-related strategies and policies. These include Canada's Defence Climate and Sustainability Strategy 2023–2027, which states that residual emissions of real property are to be addressed using permanent CDR to meet the country's net zero goal by 2050, and Canada's 2024 budget, which highlights that the achievement of the climate goals of the country's Low-carbon Fuel Procurement Program may be aided through the procurement of CDR.

Canada is further aiding CDR scale-up by funding both research and development and pilot applications of CDR.[193] To encourage early investment in CDR, a carbon capture and utilization (CCU) and carbon capture and storage (CCS) investment tax credit is currently under development, from which CDR methods with permanent storage are expected to benefit.[193] In addition to national measures, Canada is part of international innovation initiatives relevant to CDR, including Mission Innovation, whose CDR Mission is co-led by Canada, and the Carbon Management Challenge, which is focused on accelerating the deployment of carbon management measures.[194]

Canada is also in the process of improving its regulatory framework surrounding CCS, with many of the considered measures (some of which are already published) having high relevance for CDR.[193] Among these measures is the development of relevant regulatory frameworks for carbon storage. Three of Canada's provinces have already introduced policies regulating geological CO_2 storage, addressing aspects such as liability and MRV, and further provinces are currently developing their respective regulatory frameworks for CO_2 storage,[193] usually with a focus on fossil CCS applications. By 2030, Canada's CO_2 capture capacity is projected to reach 16 Mt annually, with further increases in capture and storage capacities needed for the country to achieve its net zero target by 2050.[193]

China

As the largest emitter of current annual emissions, China plays a critical role in global climate change mitigation efforts. Its pledge to achieve carbon neutrality by 2060 has attracted considerable attention and, as in other countries, raised the profile of CDR. However, the degree to which novel and conventional CDR methods are addressed by public policy differs considerably.

Conventional CDR has already had a relatively high profile in climate policy in China. China has a long history of afforestation/reforestation programmes and efforts to enhance the carbon sink in the LULUCF sector. Although CDR has not always been the main motive for these initiatives (they may have aimed to prevent, for example, desertification),[195] recent pledges and initiatives indicate that CDR's mitigation effects are becoming more important. These projects that enhance conventional removals tend to be shaped by top-down, command-and-control regulations[196] and can have local adverse effects on ecosystems and communities.[197] New initiatives to address conventional CDR methods are linked with agriculture policy and politics.[195]

China has committed in its NDC to increase forest stock by 6 billion cubic metres from 2005 levels and mentions enhancing carbon sink capacity as one of its "Ten Key Actions for Peaking Carbon Emissions".[198] The NDC also includes a reference to "blue carbon"

and mentions that in the future "carbon sink trading will be integrated into the national carbon emission trading market".[198] However, as in other countries, ensuring the quality of certificates is a challenge, especially for non-permanent CDR methods like afforestation.[199]

With respect to novel CDR, there is a large number of patents for these methods in China (see Chapter 2 – Research and development) but no systematic support or incentive system. BECCS and DACCS methods are mostly discussed in expert communities, and there are no CDR-specific policy initiatives for novel CDR. A key element of the expert debate is the increasing attention on novel CDR in national modelling.[200,201] The national government is gradually promoting the RD&D and application of CCU and CCS, mainly through the development of pilot projects, as announced in the 14th Five-Year Plan.[202,203] The country's NDC includes these technologies in a list of "carbon peak pilots".[198] To date, however, existing CCS and CCU projects are mostly associated with fossil CO_2 sources, with most projects reinjecting CO_2 for enhanced oil recovery, and therefore are not CDR projects.[204,205] In preparation for the fifth "National Key Low Carbon Technologies List", BECCS and DACCS, as well as conventional CDR and monitoring technologies, are part of the five key areas for which the government is seeking proposals.[206]

Although no specific funding for BECCS or DACCS demonstration plants could be identified in China, reports from national studies on the status of CCU and CCS indicate that innovation in DACCS and BECCS is coming to the attention of decision makers.[201,203,207,208] For example, direct air capture is mentioned in the bilateral declaration between China and the US,[209] an initiative that further raises the profile of novel CDR methods. With regard to other CDR options, biochar has been addressed in multiple research projects,[210] and different marine CDR approaches are being researched.

Japan

Japan has announced its goal of reaching net zero greenhouse gas emissions by 2050[211] and has amended the Act on Promotion of Global Warming Countermeasures accordingly. In its long-term strategy, the country identified the application of both conventional and novel CDR methods as essential to tackling unavoidable greenhouse gas emissions and reaching net zero.[212] A multi-model study suggests a CDR of approximately 100 $MtCO_2$ per year by 2050 would be necessary for a cost-effective net zero policy.[213] While the issue of carbon management is rising in Japan's policy agenda, the most prominent focus is on "carbon recycling" (i.e. CCU).[214] Rather than permanent storage of carbon or CDR specifically, the processing of captured carbon into products would be the focal point, though parts of this carbon recycling agenda are expected to be directly or indirectly beneficial for CDR.

In its NDC, Japan estimates that overall greenhouse gas removals will reach nearly 50 Mt per year by 2030. This quantity, however, represents roughly the same level of CDR as in 2013, the reference year for Japan's 2030 emission reduction target. Japan further intends to secure international emission reductions and removals cumulatively totalling 100 $MtCO_2$ by 2030 via the country's Joint Crediting Mechanism.[215] While removal quantities per CDR method are not yet specified in the country's NDC or long-term strategy, Japan

anticipates the need for measures to enhance the forest, cropland, natural environment, and coastal and ocean carbon sinks, together with the promotion of urban revegetation and steps to further the development of DACCS.[212]

Like other countries, Japan has developed crediting schemes relevant to CDR. Both the government-managed J-Credit Scheme and the voluntary J-Blue Credit Scheme allow for the creation of CDR credits for the application of conventional CDR methods such as forest management, afforestation and coastal wetland restoration,[216–218] with the J-Credit Scheme also covering greenhouse gas emission reductions.[217,218] Credits issued under these schemes can be traded and used for offsetting purposes.[217] A methodology is now being developed for including direct air capture in the J-Credit Scheme.[219,220] In April 2024, it was announced that Japan's national emissions trading system will allow for the inclusion of CO_2 removals as eligible carbon credits in the system's voluntary first phase. The category of eligible carbon credits will include CCU, coastal wetland restoration, BECCS and DACCS.

Japan also provides funds for research and development as well as for innovation activities. CDR pilot projects can receive funding from the Green Innovation Fund, and further funding for research and development as well as pilot projects is provided via the cabinet-level Moonshot Research and Development Program,[194,221,222] whose target technologies include direct air capture, enhanced rock weathering and coastal wetland restoration.[222] As a core mission member, Japan collaborates with other countries on Mission Innovation's CDR Mission and aims to accelerate the introduction of carbon management measures under the Carbon Management Challenge.[194,223] Japan's government has also sponsored CDR road map reports through the Innovation for Cool Earth Forum, focusing on CDR methods such as DACCS, enhanced rock weathering, coastal wetland restoration and BECCS, among other themes.[224]

In recent years, Japan has also been developing CCU and CCS strategies and policies, many of which are relevant to CDR methods that rely on CCS technologies (e.g. BECCS, DACCS). However, the share of CDR-related CO_2 storage has yet to be determined for either annual or 2050 CO_2 storage targets. To address gaps and ambiguities in Japan's current legal framework surrounding CCS, the country is developing the CCS Business Act, which is expected to cover the stages of capture, transportation and storage of CO_2 and to tackle issues of storage rights, liability, monitoring and export of CO_2.[225]

Saudi Arabia

Saudi Arabia has announced its ambition to achieve net zero greenhouse gas emissions by 2060. As a major producer of fossil fuels, it has emphasized in several international forums the importance of a circular carbon economy, in which removal is one of the four key principles: reduce, reuse, recycle, remove.[226] Although the country currently has no legally binding or separate target for CDR, the government is developing a CDR strategy to prepare for the next steps in CDR policymaking.

Recent modelling suggests that a large amount of CDR would be required to achieve net zero greenhouse gas emissions: 250–371 Mt per year by 2060.[227] In addition to these modelling studies, work is under way to identify optimal locations for DACCS clusters in

the country and to conduct feasibility studies for various CDR methods (notably DACCS and energy-from-waste with CCS). Recent work by the King Abdullah University of Science and Technology has evaluated the availability and suitability of CO_2 geological storage across Saudi Arabia, including in saline aquifers and depleted oil and gas fields.[228]

Some CDR-related pilot projects have emerged in the private sector, including for direct air capture. The State-owned oil and gas company Saudi Aramco, in collaboration with others, is developing the Climatree technology, a direct air carbon-capturing microalgae photobioreactor integrated with a patented CO_2 scrubber;[229] the prototype was installed at Al-Qurrayah in 2022.[230] In addition, Aramco is collaborating with Siemens Energy to develop a direct air capture test unit in Dhahran. The test facility, to be completed in 2024, will demonstrate the removal and storage of 12 tons per year of CO_2. It is expected that this will pave the way for a larger pilot plant with an annual CO_2 capture capacity of 1,250 tons.[231] In addition, Aramco and the King Abdullah University of Science and Technology are working on a CO_2 storage method, converting CO_2 into carbonate rocks.

Overall, Saudi Arabia considers DACCS the CDR option with the highest potential, and research is under way to determine its potential in the country. Saudi Arabia is one of the co-founders of the Mission Innovation CDR Mission, launched in 2021, and together with Australia is leading the development of the 2023–2026 Work Plan for the Enhanced Mineralization Technical Track, launched at COP28, covering both enhanced rock weathering as a CDR method and CO_2 injection in rock formations, which could be used for both atmospheric and fossil CO_2.[149]

In terms of conventional CDR, the Saudi Green Initiative commits to planting 10 billion trees and rehabilitating 40 million hectares of land by 2060. The National Center for Vegetation Development and Combating Desertification has been established to facilitate the tree planting. In 2023, Saudi Arabia introduced the Greenhouse Gas Crediting and Offsetting Mechanism (GCOM). It aims to allow companies and organizations to offset their emissions by purchasing credits and certificates from projects that voluntarily reduce or remove greenhouse gas emissions. The GCOM guidance acknowledges the importance of CDR and addresses the topic of permanence. Like with other accounting and offsetting schemes (see Section 5.1 on the EU Carbon Removal Certification Framework, for example), the quality of the certificates and the use cases will be important to the credibility of the scheme.

Under the GCOM framework, accounting issues for CDR methodologies would be addressed by establishing requirements and specifications for the quantification, MRV and registration of project-based emission reductions and CDR, including issues of permanence and reversal of removals. According to the government's plans, the GCOM will adapt to future changes and developments at the national and international levels, including alignment with Article 6 of the Paris Agreement.

Saudi Aramco is actively engaged in CCS and CCU projects, with fossil CO_2 sources used for enhanced oil recovery. Current work commissioned by the government includes a feasibility study for a CCS hub in the Gulf Cooperation Council countries. Saudi Arabia's target is to capture and permanently store 9 $MtCO_2$ per year by 2027, rising to 44 $MtCO_2$ per year by 2035. This capacity, built for fossil CCU or CCS, could potentially enable CDR

upscaling. However, as with the other case studies, the current targets do not focus on CDR. To qualify as CDR targets, they would need to cover permanent removal from the atmosphere.

5.4 Synthesis

Conventional and novel CDR are often embedded in broader sectoral policy initiatives, but dedicated CDR policy is also needed to address both deployment and other functions of governance.

The case studies illustrated a strong focus on enabling policies for CDR, especially for research and development. Several case studies also demonstrated preparations for systems intended to facilitate the tradability of CDR credits, as well as early attempts to establish trading of conventional CDR credits. However, these credits typically represent CDR that is being used *instead of* emission reductions rather than CDR that is being used to *counterbalance* residual emissions. The case studies also show that both conventional and novel CDR are embedded in other policy fields and economic sectors. Table 5.1 summarizes the key messages from the case studies within the three dimensions outlined in Section 5.2 (overarching CDR policy architecture; innovation and scaling policies; safeguards and links with other policy domains).

	Overarching CDR policy architecture	Innovation and scaling policies	Safeguards and links with other policy domains
Canada	To reach its net zero target, Canada has recognized the need for deployment of both conventional and novel CDR. Explicit removal targets in terms of tons of CO_2 removed do not yet exist.	The government supports research and development as well as pilot CDR applications. It is currently developing CDR methodologies for its Greenhouse Gas Offset Credit System and preparing incentives including an investment tax credit and funding contracts for differences in carbon markets. Canada co-leads the Mission Innovation CDR Mission.	Conventional CDR is being tackled in policies focused on wider ecosystems, which also consider further, non-carbon benefits. Novel CDR is expected to benefit from several policies aimed at CCS and CCU, whose safeguards will also affect CDR.
China	Conventional CDR methods already have a relatively high profile, including through quantified targets and policy initiatives. The policy landscape for novel CDR is much less developed.	BECCS and DACCS are considered in the modelled pathways, but policy support for RD&D is still in its infancy and often focused on fossil CCU or CCS applications.	Large-scale afforestation, a well-established strategy, may have negative impacts on ecosystems and local communities. Conventional CDR in general is closely linked to agricultural policy and politics.

	Overarching CDR policy architecture	Innovation and scaling policies	Safeguards and links with other policy domains
Japan	So far, Japan's focus has been on conventional CDR and applying voluntary rather than compliance measures to further CDR development.	While Japan is supporting national and international CDR innovation initiatives, it is currently lacking policies targeting CDR deployment.	Japan's carbon management approach currently prioritizes carbon recycling (CCU) over CDR and CCS.
Saudi Arabia	Quantified targets and deployment initiatives exist for conventional CDR methods. A new crediting and offsetting scheme that considers novel and conventional CDR was launched in 2023. But policy for novel CDR is in the early stages.	Saudi Arabia has addressed CDR as part of its circular economy initiatives. Some pilot projects on novel CDR methods have been started in the private sector. Saudi Arabia co-leads the Mission Innovation CDR Mission.	The initiatives in novel CDR innovation are closely linked to the energy company Saudi Aramco, and research is being conducted by institutes and universities.

Table 5.1 *Key findings from case studies providing snapshots of carbon dioxide removal (CDR) policy in selected countries in early 2024.*

For conventional CDR, path dependencies, political and stakeholder networks, and the political economy of agriculture and forestry will shape the future of CDR policy. A key risk associated with the rise of conventional CDR as part of climate change mitigation strategies, as observed in the case studies, is – in addition to reversibility risks – the potential adverse impacts of its large-scale deployment on biodiversity, food security and local communities.

For novel CDR, the recent initiatives included in the case studies are closely linked to fossil CCS and CCU applications and initiatives. The emerging policies on carbon management – an umbrella term for all kinds of CCS and CCU applications, including those with fossil CCS – will shape future CDR policy. Early initiatives in the countries analysed here indicate that it will be a challenge to make sure that CCS and CCU infrastructure become an enabling factor for future large-scale CDR. The surge in CDR policy announcements and commitments and their effects on climate policy will need to be carefully assessed in the coming years. In addition to the direct risk of obstructing emission reductions, embedding CDR in wider carbon management policy initiatives poses indirect risks of confusing the different roles that these mitigation approaches can play in achieving net zero and net-negative emissions.

As CDR deployment progresses, CDR policy will continue to emerge within and be shaped by an existing landscape that includes climate, energy, industrial, agricultural, forestry, ocean and innovation policy. Each of these domains exerts an influence on what CDR policy is and will become. For example, climate policy and the existing context of policy around forestry and land use and around carbon offsets is fundamental to how markets for removals evolve. Energy policy may influence the development of particular CDR

methods, such as BECCS or approaches that co-produce hydrogen. CDR policy is also linked with CCS and CCU policy in some jurisdictions. Even though the roles of CDR, CCS and CCU within a climate action portfolio differ, there can be regulatory overlap in terms of regulating geological storage, and there is often overlap in the public mind. Approaches such as soil carbon sequestration are situated within existing policy infrastructure that incentivizes conservation agriculture, marine CDR is situated within existing policies that regulate ocean activities, and so on. And policies that incentivize scientific research interact with all CDR techniques. These landscapes address some of the needs of CDR policy, but dedicated CDR policy is also required – not only for deployment but also for the other functions of governance.

Some of these governance functions – research and innovation policy, regulation that enables CDR, social safeguards, support for public deliberation and involvement in decision-making – fit better into the existing policy landscape than others. Policy focused on increasing soil carbon sequestration, for example, may further the development of MRV technologies and farmer adoption of carbon sequestering practices, but it is unlikely to address social safeguards or procurement for CDR broadly. Similarly, policy that provides public funding for direct air capture demonstration projects, which falls under industrial RD&D, tends to be dealt with in a project-level, industrial demonstration box. While direct air capture is supported by governments in this way, this leaves out governance that would deal with impacts on communities should the technology successfully scale or with how to involve the public in questions of how large a role CDR should play in responding to climate change. Dedicated CDR policy at wider scales would address these and other CDR-specific needs. And some dedicated CDR policy *is* starting to evolve in close connection with existing national mitigation strategies, as illustrated in the case studies.

Box 5.2 Limitations and knowledge gaps

This report has identified areas on which future assessments can build, including:

There is limited research that maps out how sectoral policies in areas such as agriculture, industrial decarbonization, forestry, buildings and power interact with CDR development. Future assessments could systematically map this out with empirical studies.

While there have been many recent studies calling into question the efficacy of carbon offsets, there is an opportunity for further research into:

How markets for removals (rather than avoided emissions) would have similar or different challenges (around issues such as additionality, permanence, fraud, over-crediting or dispossession of communities).

Whether removals-only markets can avoid some of the challenges plaguing carbon markets.

What design features removals markets need for the best chance of success.

As technologies move from concept to demonstration to deployment, there is an opportunity to conduct comparative studies of how policy support helps companies move through the cycle and of when policy support is not the decisive factor. There is also an opportunity to conduct comparative studies of how social safeguards and public engagement – or the lack thereof – have shaped projects. Future assessments could profile cases and synthesize knowledge from them.

The emerging dedicated CDR policy landscape provides new opportunities to empirically study the political economy of CDR in international, supranational and national climate policies, in particular distributional effects, burden sharing in CDR ramp-up policies, and new forms of cooperation and alliances.

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