IETA

Geostorage and Crediting Version 2.0
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GEOSTORAGE AND CARBON CREDITING V2.0

A COMPREHENSIVE HANDBOOK ON METHODOLOGICAL DESIGN, SAFEGUARDING AND ACCOUNTING

CARBON COUNTS

PREPARED WITH THE SUPPORT OF:
CARBON COUNTS.

SINCE 1999 IETA HAS BEEN THE LEADING VOICE OF BUSINESS ON AMBITIOUS MARKET-BASED CLIMATE CHANGE SOLUTIONS AND DRIVING NET ZERO. IETA ADVOCATES FOR TRADING SYSTEMS FOR EMISSIONS REDUCTIONS AND REMOVALS THAT ARE ENVIRONMENTALLY ROBUST, FAIR, OPEN, EFFICIENT, ACCOUNTABLE AND CONSISTENT ACROSS NATIONAL BOUNDARIES. REPRESENTING MORE THAN 300 LEADING INTERNATIONAL ORGANISATIONS, IETA IS A TRUSTED PARTNER IN DEVELOPING INTERNATIONAL POLICIES AND MARKET FRAMEWORKS TO REDUCE GREENHOUSE GAS EMISSIONS AT THE LOWEST COST WHILE BUILDING A CREDIBLE PATH TO NET ZERO EMISSIONS. SEE WWW.IETA.ORG FOR MORE INFORMATION.

DESIGN: HITMAN CREATIVE MEDIA INC.

EXECUTIVE SUMMARY

IN 2021, IETA WITH PARTNERS SET OUT TO DEVELOP BEST PRACTICE GUIDANCE FOR CREDITING GEOLOGICAL CARBON DIOXIDE (CO2) STORAGE (GCS) ACTIVITIES WITHIN CARBON MARKETS. TO INFORM THE PROGRAMME, EXPERIENCES WITH CARBON CAPTURE AND STORAGE (CCS) AND ENGINEERED CARBON REMOVALS (ECDR) IN CARBON MARKETS WERE REVIEWED AND SYNTHESIZED. ANALYSIS THEREIN PROVIDED THE FOUNDATIONAL BASE FOR IETA'S FLAGSHIP CARBON MANAGEMENT PUBLICATION: HIGH-LEVEL CRITERIA FOR CARBON GEOSTORAGE ACTIVITIES, LAUNCHED IN DECEMBER 2022.

In follow up, in April 2024 IETA published a methodologies and safeguards synthesis paper in the form of IETA's Handbook for Geostorage and Carbon Crediting (version 1.0).[1] Since that time, new methodologies and updates to existing methodologies have been produced, and new issues and methodological concerns are being tackled. This prompted IETA and its members to implement a refresh of the original handbook.

This new edition—the Handbook for Geostorage and Carbon Crediting 2.0—provides an up-to-date go-to reference source for practitioners and policymakers seeking to understand current practices, commonalities and differences in scope, expectations and approaches for methodological design, safeguards, measurement, reporting and verification (MRV) and accounting for CCS and eCDR technologies.

Methodologies and protocols under these standards are assessed and synthesized in the following contexts:

- **Applicability conditions**
- **Project boundary**
- **Baseline scenario and baseline emissions**
- **Determination of additionality**
- **Project and leakage emissions**
- **Non-permanence and carbon reversal, covering:**
- **Upfront quality assurance and quality control**
- **Liability for short-term (operational) and longer-term (post-injection) leaks**
- **Environmental and social impacts and sustainability.**

A summary table highlighting the scope, coverage and approaches within the current GCS standards ecosystem is provided.

Safeguarding and accounting principles, precedents and practice for GCS established under the UNFCCC, Kyoto Protocol and the Paris Agreement are also reviewed and assessed.

The Handbook highlights important linkages between methodologies, safeguards and accounting for GCS operations and the origination and trading of credits in the era of the Paris Agreement.

GEOSTORAGE CREDITING BUILDS ON STANDARDS FROM LEADING PROGRAMMES—INDEPENDENT, DOMESTIC, AND INTERNATIONAL—TO ENSURE INTEGRITY, SAFEGUARDS, AND CONSISTENCY ACROSS CARBON MARKETS.

Methodologies and/or protocols from the following standard setters are reviewed:[2]

01. Independent crediting programmes (ICPs)	02. Domestic crediting or certification programmes	03. International crediting & accounting methodologies
• ACR • Verra/Verified Carbon Standard (VCS) • Global Carbon Council (GCC) • Gold Standard • Puro.earth • Isometric	• Environment and Climate Change Canada (ECCC) • Alberta Emissions Offset System • British Columbia Emissions Offset • European Union (EU) Carbon Removal and Carbon Farming certification (CRCF) • British Standards Institute (BSI; with input from UK Government, Department of Net Zero and Energy Security)	• UNFCCC Clean Development Mechanism (CDM) • 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC)

TECHNICAL SUMMARY

BACKGROUND

In 2021, IETA alongside key partners, policymakers and stakeholders set out to develop best practice guidance for crediting geological carbon dioxide (CO_2) storage (GCS) activities within carbon markets.

Development of the principles and criteria was structured around the following questions:

1. How do existing protocols address various methodological aspects relating to GCS?
2. What priorities could be established through common principles for crediting of GCS activities?
3. What additional safeguards are needed in GCS methodologies relative to other types of crediting standards?
4. What high-level criteria can guide the development of these safeguards?

To inform the programme, experiences with carbon capture and storage (CCS) and engineered carbon removals (eCDR) in carbon markets were reviewed and synthesized. Analysis therein provided the foundational base for IETA's flagship carbon management publication: High-Level Criteria for Carbon Geostorage Activities, launched in December 2022.

In follow up, in April 2024, IETA published a methodologies and safeguards synthesis paper in the form of IETA's Handbook for Geostorage and Carbon Crediting (version 1.0).[3]

Since then, new methodologies, updates to existing methodologies and new methodological topics have emerged in discourses around CCS (fossil CO_2 capture and geological storage) and eCDR (bioenergy with CO_2 capture and geological storage; BECCS, and direct air capture with geological storage; DACCS). In particular, key areas of the BECCS and DACCS supply chains have been subject to closer methodological scrutiny. These developments prompted IETA and its members to embark on a round of updates to the Handbook for Geostorage Crediting 1.0.

This new edition—the Handbook for Geostorage and Carbon Crediting 2.0—seeks to capture and assess the current state of play for methodologies and protocols applicable to crediting and quantifying/certifying GCS project activities. The review encompasses 13 standard setters (see above) and at least 30 methodologies, protocols and related documents.

In keeping with the first handbook (v1.0), two core parts are presented: (i) a synthesis of current methodologies and protocols (Section 3); and (ii) a review of safeguarding and accounting principles, precedents and practice for methodological design and MRV under the UNFCCC and Paris Agreement, including under Article 6, the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and in accounting towards nationally determined contributions (NDCs; Section 4). A summary of principles and design features for GCS crediting and accounting is also included (Section 2).

METHODOLOGIES AND PROTOCOLS: A SYNTHESIS

The current suite of methodologies and protocols share many design similarities but also contain subtle differences and some divergences in approaches.

Only minor differences exist across methodological components such as baseline and additionality, and few if any unique issues are posed for GCS technologies in these respects.

Conversely, wider differences can be seen in technical scopes and applicability conditions, the spatial and temporal accounting boundaries (including leakage effects), and the approaches taken to manage the risk of carbon reversals, especially over the longer-term. These main differences relate to: (i) the types of GCS activities that may apply the methodology; (ii) the locations in which an eligible GCS project activity may be developed, operated and closed; (iii) the sources of emissions and removals that should be accounted for within the methodological framework; and (iv) the approach to quality assurance and quality control (QA/QC) and the legal, regulatory and technical requirements applied to GCS site development, operation, closure, post-injection and over the longer term.

TECHNICAL SCOPE: BOUNDARY, BASELINE AND ADDITIONALITY

ACR (v1.1.) is unique in covering fossil CCS, DAC, and currently only storage in conjunction with active injection of CO_2 for enhanced oil recovery (EOR).[4] The Global Carbon Council (GCC) methodology also applies to the capture of a variety of potential CO_2 sources (fossil, bio, DAC), although it excludes storage via EOR. Verra/VCS takes a modular approach that aims to cover a wide suite of GCS technologies, but has so far only published modules for DAC, CO_2 capture from bioenergy (BEC), and storage in saline aquifers and depleted hydrocarbon reservoirs. Isometric also uses modules to account for different eCDR and GCS configurations including BEC and DAC and various storage options including saline aquifers.

Gold Standard, Puro.earth, Isometric, Environment and Climate Change Canada (ECCC), the European Union (EU) and the British Standards Institute (BSI) all apply exclusively to carbon removal and eCDR (either or both of BECCS and DACCS). Verra/VCS, alongside Puro.earth, GCC and EU are the only methodologies that explicitly encompass CO_2 capture from waste-to-energy facilities (WtECCS). Alberta and British Columbia offset protocols are fairly agnostic to the source of CO_2 streams sent to GCS, suggesting wide applicability.

THE HANDBOOK FOR GEOSTORAGE AND CARBON CREDITING 2.0 CAPTURES THE CURRENT STATE OF PLAY ACROSS 13 STANDARD SETTERS AND MORE THAN 30 METHODOLOGIES, SETTING OUT PRINCIPLES FOR CREDIBLE GCS CREDITING AND ACCOUNTING.

METHODOLOGIES DIVERGE WIDELY ON ELIGIBLE CO2 STORAGE TYPES — WITH SOME INCLUDING SALINE AQUIFERS AND DEPLETED RESERVOIRS, WHILE OTHERS EXPLICITLY EXCLUDE EOR OR SEABED STORAGE.

Variations exist in the scope of CO2 storage types covered. ACR (v1.1) applies only to EOR. All other methodologies include saline aquifer storage and, with the exception of Isometric, storage in depleted hydrocarbon reservoirs. Only Puro.earth and Isometric are explicit in covering GCS via in situ mineralisation,[5] whereas the approach may be implicitly eligible under others (e.g. Gold Standard, Verra/VCS, EU or BSI). Alberta Environment and Protected Areas (AEPA), lead ministry for Alberta's Emissions Offset System, applies two separate methodologies: one for EOR and one for saline aquifer storage. GCC, Gold Standard, Puro.earth, Isometric, ECCC and EU all explicitly exclude EOR, while Gold Standard is an exception in explicitly not accepting GCS under the seabed.

Broad technical applicability can pose higher complexity for boundary setting and baseline considerations. In the case of fossil CCS, the wide array of potential alternative technologies that could be used to deliver the same underlying service means more baseline approaches can be relevant. In these respects, both ACR and GCC apply either performance- or standards-based approaches to baseline emissions, reflecting the wide set of CO2 capture situations that are covered. Conversely, Verra/VCS, Puro.earth, Isometric, EU and BSI—with their limitation to eCDR—generally assume that all captured and stored CO2 (i.e. removed) is additional and therefore apply a baseline of zero (i.e. there would be no removals in the absence of the registered activity). Most methodologies covering BECCS encompass the additional complexity of addressing upstream emissions associated with the source of the biomass (especially the leakage risk posed by land use change; see below). Methodologies covering DACCS similarly consider the upstream emissions and leakage risks of low carbon or renewable energy procurement (see below). For both BECCS and fossil CCS, the scope of emissions to be counted as project emissions depends on whether the baseline scenario is an existing facility (i.e. retrofit of CO2 capture) or a new build (i.e. greenfield site). The methodologies from Verra/VCS, GCC, Puro.earth and Isometric all consider that, for retrofits, some of the same emissions sources will exist in the baseline scenario and therefore may be excluded from project emissions.

Nearly all methodologies require additionality demonstration. Most use variations upon the regulatory surplus test, financial additionality test and the common practice test, drawing from methodological approaches developed under the CDM. Some refer directly to existing CDM tools (e.g. GCC, Gold Standard). Some also apply a performance standard (e.g. ACR, Isometric).

TECHNICAL SCOPE: WIDER BOUNDARIES AND LEAKAGE MITIGATION FOR ECDR SUPPLY CHAINS

Growing demands to credit or certify only the net removals or net negativity of eCDR activities has pushed standard setters towards full lifecycle emissions accounting, widening activity accounting boundaries and enhancing methods to mitigate leakage effects.

The boundary of eCDR methodologies from Puro.earth, Isometric, ECCC, EU and BSI incorporate a wide range of spatial and temporal emissions, variously including emissions associated with materials supply, plant/facility construction, facility decommissioning and monitoring emissions. Gold Standard, Puro.earth and BSI require land use change emissions from project site development to be considered, while Isometric includes a 'counterfactual storage' scenario in the baseline that could encompass land use change emissions. Puro.earth, Isometric and ECCC require the emissions from project monitoring to be included.

Some standards applicable to fossil CCS also take lifecycle emissions into account. GCC and Alberta include materials consumption and upstream emissions from fuel production. Alberta includes emissions from well drilling, but not other construction emissions (as does ECCC for DACCS). ACR (v2.0) will adopt an inclusive approach towards relevant up- and downstream emissions sources.

Emissions and leakage effects driven by the demand for materials and energy to run eCDR facilities are also increasingly featured in methodologies. Particular attention has been on (i) the sustainability of the biomass used for BECCS (given concerns over activity shifting and direct and indirect land use change (dLUC/iLUC) effects); and, (ii) the carbon intensity of electricity and heat used to power DAC facility (including the potential displacement of previous users of low carbon intensity or renewable electricity and heat, i.e. market leakage).

GROWING DEMANDS FOR INTEGRITY IN ECDR CREDITING ARE DRIVING FULL LIFECYCLE ACCOUNTING, WITH STRICTER BOUNDARIES TO CAPTURE UPSTREAM EMISSIONS, LAND USE CHANGE, AND LEAKAGE RISKS.

Methodologies and protocols from Verra/VCS, Gold Standard, Puro.earth, Isometric, ECCC, EU and BSI all consider these factors in similar ways according to the following:

- BECCS: requirements to check or otherwise certify the sustainability and traceability of the biomass used and only allow removals to be counted when specified criteria are fulfilled.[6]
- DACCS: requirements to count the carbon intensity of electricity used at a DAC facility using a relevant emission factor (e.g. electricity grid average or marginal factor) unless it can be shown to be generated from low- or zero-emissions power plants that are: (i) located on-site (behind-the-meter); and/or (ii) acquired from offsite, procured under either a 'green' power purchase agreement or a wheeling agreement. The 'spatial correlation',[7] 'temporal correlation'[8] and 'additionality'[9] of power procurement are also emerging methodological features. The use of waste heat is also a typical pre-requisite.

Isometric and Verra/VCS also consider market leakage effects of materials used for CO2 capture (e.g. chemicals and other raw materials to capture CO2).

CARBON REMOVALS, GEOSTORAGE AND REVERSAL RISKS

Most types of climate mitigation actions permanently prevent the formation and atmospheric release of CO2. In contrast, CCS and CDR respectively avoid atmospheric CO2 emissions from point sources or remove CO2 that is already in the atmosphere by capturing it and transferring it to enhanced geological carbon reservoirs. This poses a residual risk that stored CO2 may be released from storage back to the atmosphere, impacting surrounding ecosystems, communities, the climate system and the environmental integrity of policies under which reduction or removals are counted and/or traded (carbon reversal).

Under the Kyoto Protocol, the absence of emission limitation or reduction targets for developing countries meant CDM host countries faced no direct climate liability if carbon removal or CCS activities leaked CO2 back to the atmosphere. Such concerns led Kyoto Protocol signatory Parties to establish, in 2003, the use of temporary or long-term certified emission reductions (tCER/lCER) units for removals by afforestation and reforestation (A/R) CDM activities. Both tCERs or lCERs expired after fixed periods of time, with the acquiring Party thereafter responsible for their replacement. However, the temporary credit approach to A/R proved unpopular in carbon markets.

To avoid the applying the same, unpopular, tCER/lCER approach to CCS, Parties to the Kyoto Protocol, in 2011, instead agreed to establish various safeguards for undertaking CCS as CDM project activities. The safeguards sought to establish robust, high quality, permanent GCS by setting requirements for national laws and regulations to guide and oversee storage site selection, operation, closure and post injection, and for liability arrangements to be agreed between buyer and seller country Party upfront for the remediation of any carbon reversal. A buffer pool was also included.

The regulatory safeguards established for GCS sites under the CDM mirrored requirements established in OECD countries over proceeding years (e.g. in dedicated CCS legislation in Australia, the European Union, U.S. and Canada). Such regulatory alignment helped build confidence and trust in the quality of credits originating from GCS activities located in any jurisdiction, thereby supporting market fungibility and avoid the use of temporary credits.

QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC): STORAGE SITE REGULATION AND PERMITTING

The handling of non-permanence and the allocation liability in the event of a carbon reversal,[10] especially over the longer-term beyond the end of crediting and post CO2 injection, is among the most challenging aspects of GCS methodological design.

Standard setters need assurances that the environmental integrity of the credits or certifications that they issue for GCS activities today do not become compromised by the reversal of the emission reduction or removal effect due to future leakage of stored CO2. In all cases, there is a need to decouple that residual risk from the issued credits to ensure equivalence and fungibility with other units in carbon markets.

Drawing from historical precedents and lessons-learned (see box: Carbon removals, geostorage and reversal risks below), most standard setters apply some combination of upfront quality assurance and quality control (QA/QC) requirements on GCS operations. Commonly this is implemented through a requirement for dedicated GCS legal and regulatory frameworks to be present in the host country. Such regimes, which primarily exist only in OECD countries today, can provide assurances that systems are in place to oversee GCS site selection, design, responsible operation, effective closure, and also establish long-term monitoring and liability arrangements in the event of future CO2 leaks (carbon reversal) from the GCS site. Usually such requirements are covered by local permitting processes implemented by the government or its mandated agency/authority.

ENSURING THE LONG-TERM INTEGRITY OF GCS CREDITS HINGES ON ROBUST QA/QC FRAMEWORKS, LEGAL REGIMES, AND SAFEGUARDS AGAINST CARBON REVERSAL RISKS.

ROBUST SAFEGUARDS ARE ESSENTIAL TO ENSURE HIGH-QUALITY, PERMANENT, AND ACCOUNTABLE GCS CREDITING. VARIOUS METHODS ARE CONSIDERED BY STANDARD SETTERS INCLUDING QUALITY ASSURANCE ON PROJECT DEVELOPMENT AND INSURANCE APPROACHES SUCH AS BUFFERS

At the methodological level, the most practical means to implement QA/QC requirements for GCS sites in methodologies and protocols is by restricting their geographical applicability to jurisdictions with dedicated GCS regulations. Some standard setters therefore explicitly limit jurisdictional coverage: AEPA protocols apply only in Alberta; British Columbia protocols apply only to BC; ECCC applies only to Canadian provinces; EU applies only to European Union member states; ACR (v1.1) is only applicable in the U.S and Canada.

Other methodologies and protocols imply de facto restrictions by only allowing projects permitted under, for example, EU or US laws,[11] yet, often also including terms such as "or equivalent/similar requirements, procedures etc.", implying some flexibility. This type of de facto geographical restriction with flexibility is applied by Verra/VCS, Puro.earth and Isometric. Each of these ICPs specifies technical and/or legal guidance/expectations regarding the prevailing local regulatory and permitting conditions, implying a requirement for specific GCS site permits (e.g. the Verra/VCS GCS Requirements;[12] Isometric Saline Aquifer module;[13] Puro.earth Geological Storage Methodology[14]).

Gold Standard and GCC also provide substantial technical guidance on matters such as site selection, well design, operation, post-injection and closure, but appear less prescriptive as to the type of permit. The technical guidance is rather oriented towards filling gaps in local (host country) legal regimes so that some form of general permit(s) could be issued to GCS projects in circumstances where dedicated GCS laws and regulations are locally absent.

BUFFERS AND NON-PERMANENCE RISK TOOLS: ADDRESSING SHORT- TO MEDIUM-TERM REVERSAL LIABILITY

To insure against the impact of short-term carbon reversals during the operational phase and into post-injection/post crediting phases of GCS projects, most standard setters employ a buffer pool,[15] including ACR, Verra/VCS, Gold Standard, GCC, Isometric, ECCC and British Columbia. The EU and BSI indirectly apply a buffer pool through related national GCS regulations.

The size of individual project contributions to the buffer pool range from, potentially, around 2.5% (Gold Standard) up to 16.4% (British Columbia). In the case of Verra/VCS, Gold Standard and British Columbia, the exact level of buffer contribution is determined from a risk rating established though a non-permanence risk assessment. For others, the buffer is fixed (e.g. ACR applies a 10% 'ERT Reserve' contribution unless insurance coverage is provided;[16] GCC and CDM both apply a 5% withholding; Isometric is de facto fixed at 2% for GCS sites). Access to the buffer pool can depend on whether a specific reversal event is considered intentional/unintentional or unavoidable/avoidable. For Isometric and ACR, the buffer reserve is project specific.

Neither Puro.Earth nor Alberta applies a buffer pool. The former requires replacement of any units determined to have leaked to the atmosphere, while the latter applies a fixed contribution of the credits generated by activities to be "retired to the atmosphere" (ranging 0.5-1%).

SAFEGUARDS AND ACCOUNTING

Most standard setters are implementing measures to manage carbon reversals from the GCS at the level of project proponents. However, unlike the Kyoto Protocol, where CO2 reversals from CDM activities would not affect any host country targets (box: Carbon removals, geostorage and reversal risks above and Box 6), all Parties to the Paris Agreement must pledge ambitious climate action in their nationally determined contributions (NDCs), which usually includes some form of emission limitation or reduction target.

As such, countries hosting GCS sites will be accountable in respect of their NDC for any CO2 emissions resulting from storage leaks (carbon reversal). In addition, there remains a need to ensure that crediting is limited to only high quality, permanent, GCS activities, that the surrounding environment and communities are effectively protected, and that carbon reversals are adequately addressed.

The situation calls for strong safeguards to ensure high quality, high environmental integrity, crediting of CCS and eCDR activities under Article 6 of the Paris Agreement.

SAFEGUARDS FOR CREDITING UNDER ARTICLE 6

Drawing upon principles, precedents and practice from the CDM, safeguarding requirements underpinning the hosting of creditable GCS activities can include:

a. Political support for the technology.
b. Legal and regulatory safeguards to robustly govern GCS sites, including site leaks, which are implementable over the long-term.
c. Environmental and social safeguards that require comprehensive and thorough risk and safety assessment, including potential impacts on human health and ecosystems.

Mechanisms under Article 6.2 and Article 6.4 of the Paris Agreement are assessed in respect of these safeguards.

Article 6.2 (cooperative approaches): the following applies in respect of (a) above:

a. Activities must contribute towards implementation of a host country's NDC, implying GCS technologies must be included within Parties' NDCs and/or long-term low emission development strategy (LT-LEDS) to be eligible for crediting. Inclusion in these national policy documents, alongside the requirement for authorisations of resulting credits, will be indicative of political support for GCS approaches.

In respect of (b) and (c) above, Parties participating in cooperative approaches must submit an Initial Report and Regular Information that, among others, describes how the Party will:

a. Minimise the risk of non-permanence and how, when carbon reversals occur, ensure that these are addressed in full.
b. Minimise and, where possible, avoid negative environmental and social impacts and ensure consistency with its sustainable development objectives.

Article 6.4 (the Paris Agreement Crediting Mechanism; PACM): the following applies in respect of (a), (b) and (c) above:

a. Parties must indicate publicly the types of activity that the Party would consider approving/authorising, and approve and authorise project activities noting how they contribute to the achievement of its NDC, etc.
b. Methodologies and projects must follow the Standard: Requirements for activities involving removals under the Article 6.4 mechanism (PACM Removals Standard),[17] covering monitoring and reporting, post-crediting period monitoring and reporting, addressing reversals, reversal risk assessment, a reversal risk buffer pool account, and remediation of reversals. Additional tools will also apply.
c. Project activities must be assessed using the A6.4 Sustainable Development Tool, which will include specific annexes for CDR activities.

In the case of both Article 6.2 and Article 6.4, the respective units of internationally transferred mitigation outcomes (ITMOs) or Article 6, paragraph 4 emission reductions (A6.4ERs) must be:[18]

"...measured in CO2-equivalent calculated in accordance with the methodologies and metrics assessed by the IPCC and adopted by the CMA..."

Article 6.2 or PACM activities involving GCS should therefore follow the methodological guidance for CO2 transport and storage set out in Volume 2, Chapter 5 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC Guidelines). The 2006 IPCC Guidelines suggests a range of good practice regulatory safeguards relating to site selection, risk assessment etc. (see Box 5 and Annex A) that can also support the fulfilment of item (b) above.

A variety of standards are anticipated to be eligible to issue Article 6.2 compliant credits to GCS activities, posing open questions as to how Initial Reports will recognise and integrate the variety of approaches taken to manage long-term permanence. Consideration of liability for remediating carbon reversals in conjunction with relevant standards is also likely to be feature for bilateral agreements governing cooperative approaches that encompass GCS.
Equally, some uncertainty persists over whether national approvals will form part of the Article 6.4 rulebook in the PACM removals standards, tools or methodologies. The exclusion of host country roles in the PACM Draft Standard: Addressing non-permanence/reversals suggests that they will not be engaged in matters such as the approaches to long-term monitoring, addressing liability for remediating carbon reversals, or accessing the PACM buffer account.

The Technical Advisory Body of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) has so far excluded methodologies or protocols involving GCS or enhanced removals from inclusion as CORSIA Eligible Emission Units (CEEUs).

ACCOUNTING IN RESPECT OF NDCs

The approaches to include and count GCS activities under NDCs is reviewed, and measures to avoid double counting of the mitigation outcomes are discussed.

The Handbook highlights important linkages between methodologies, safeguards and accounting for GCS operations and the origination and trading of credits and other units in the Paris Agreement era.

UNDER ARTICLES 6.2 AND 6.4, GCS ACTIVITIES MUST ALIGN WITH HOST COUNTRY NDCs, DEMONSTRATE SAFEGUARDS AGAINST REVERSALS, AND APPLY IPCC METHODOLOGIES AND METRICS

STANDARD SETTER			SOURCE COVERAGE, SCOPE AND STRUCTURE						STORAGE COVERAGE					
Name	Type	Purpose	CCS	DACCS	BECCS	WtECCS	Jurisdiction	Modular	Saline Aquifer	Depleted O&G fields	EOR	In situ mineraliz'n	Sub-seabed	Geostorage Regulation
ACR	ICP	C	✓	✓	—		US, CA		—	—	✓			LP (US Class II/VI or CA equiv)
Verra/VCS	ICP	C	—	✓	✓	✓	Global	✓	✓	✓				LP + TG (GCS Requirements)
GCC	ICP	C	✓	✓	✓	✓	Global		✓	✓	✗			LP(g) + TG (GCC CO2 Geo Guidance)
Gold Standard	ICP	C			✓		Global		✓	✓	✗	—	✗	LP(g) + TG (GS4GG Tool 03)
Puro.Earth	ICP	C		✓	✓	✓	Global		✓	✓	✗	✓		LP + LG (Table 1)
Isometric	ICP	C		✓	✓	—	Global	✓	✓		✗	✓		LP + TG (CO2 Storage Modules)
Env & Clim Change Canada (ECCC)	Govt. (Dom.)	C		✓			CA		✓	✓	✗	✓		LP (Provincial permit)
Alberta	Govt. (Dom.)	C	✓	✓	✓		AB		✓	✓	✓			LP (AB D065)
British Columbia	Govt. (Dom.)	C	✓	✓			B.C.		✓	✓	✓			LP (B.C. OGAA, PNGA, ERAA)
European Union (EU)	Govt. (Dom.)	Q		✓	✓	✓	EU-27		✓	✓	✗	—		LP (MS Storage Permit)
British Stds Inst (BSI)	Govt. (Dom.)	Q		✓	✓	✗	UK (primary)		✓	✓		—		LP (UK Storage Permit)
Clean Dev Mech (CDM)	Govt. (Intl.)	C (old)	✓				Non-Annex I (Developing) Country		✓	✓	✓			LP + LG (Participation Requiremnts)
IPCC	Govt. (Intl.)	Q (NGHGI)	✓	○	✓	✓	Global	○	✓	✓	✓			LP + TG (QA/QC checks)

Acronyms and abbreviations - Pg 49

✓ Covered ○ Partially Covered — Under Consideration; Unclear ✗ Explicitly Excluded

METHODOLOGICAL APPROACHES						PROJECT EMISSIONS COVERAGE ACROSS THE LIFECYCLE & SUPPLY CHAIN						LEAKAGE ESTIMATION/ MITIGATION COVERAGE		
Name	Lifecycle emissions	Additionality	Baseline	Reversals	Long-term monitoring	Construct. emissions	Land use change	Decomm. emissions	Materials consumed	Waste disposal	Monitoring emissions	Biomass sourcing	Energy sourcing	Materials sourcing
ACR	✗	RS, PS	P / S	B*, R (≤10%)	LTM-HC	○			–			–		
Verra/VCS	✓	RS, FA, CP	P, LUC (R/NB)	B(r) (d) (≤7%)	LTM-HC (o/i)(r)	✓		✓	✓	✓		✓	✓	✓
GCC	○	RS, FA, CP (TOOL 01)	P / S (R/NB)	B (5%)	LTM-HC				✓			○		
Gold Standard	○	RS, FA, CP (TOOL 01/02)	P / S, LUC	B(r) (2.5-8.5%)	LTM-HC (o/i)	✓	✓	✗	✓			○		
Puro.Earth	✓	RS, FA	P, LUC (R/NB)	CC, R	LTM-HC	✓	✓	✓	✓	✓	✓	✓	✓	✗
Isometric	✓	RS, FA, CP, PS	P, CS (R/NB)	B(r) (d) (2%)	LTM-HC	✓	✓	✓	✓	✓	✓	✓	✓	✓
Env & Clim Change Canada (ECCC)	✓	RS	P	"B (3%)"	LTM-HC	○		✗	✓		✓		✓	
Alberta	○	RS (TIER/Flex)"	P	CC (d) (0.5-1%)	LTM-HC	○		✗	✓	✓				
British Columbia		RS, FA, PA	P (zero)	B(r) (≤16.44%)	LTM-HC									
European Union (EU)	✓		P (zero)	B*	LTM-HC	✓		✓	✓	✓		✓	✓	
British Stds Inst (BSI)	✓		P	B*	LTM-HC	✓	✓	✓	✓	✓		✓	✓	–
Clean Dev Mech (CDM)		RS, FA, CP (TOOL 01/02)	P / S	B (5%)	LTM-HC (o)									
IPCC					LTM-HC									

Acronyms and abbreviations - Pg 49

✓ Covered ○ Partially Covered – Under Consideration; Unclear ✗ Explicitly Excluded

01 INTRODUCTION

1.1 BACKGROUND

In 2021, IETA and partners[19] launched a process to establish common principles, safeguard criteria and accounting standards for the treatment of geological storage of carbon dioxide (CO2; hereafter, "GCS") within carbon markets, covering CO2 captured from any of fossil ("CCS"), biogenic ("BECCS") or direct air ("DACCS") sources.[20]

Using IETA's global reach and market convening power, the initiative brought together key actors into a discussion around the levels of assurance needed for GCS methods to offer effective climate mitigation. That work programme concluded with the launch, in December 2022, of IETA's High Level Criteria for Crediting Carbon Geostorage.[21]

The foundational analysis informing IETA's High Level Criteria for GCS subsequently provided the base for IETA's Handbook for Geostorage and Carbon Crediting (version 1.0), launched in April 2024.[22]

1.2 ABOUT THIS UPDATE

Since publication of IETA's Handbook for Geostorage and Crediting 1.0, new methodologies, revisions to existing methodologies, and new methodological topics have emerged in discourses around CCS and eCDR. In particular, key areas in the BECCS and DACCS supply chains have been subject to closer methodological scrutiny.

These developments prompted IETA and its members to embark on a round of updates to the Handbook version 1.0. This new edition (version 2.0) includes the following:

Section 2 presents background information on methodological principles and accounting protocol design for GCS activities.

Section 3 provides a synthesis of current methodologies and protocols that are applicable to various CCS and eCDR activities involving GCS.

Section 4 considers the safeguards and accounting for CCS and eCDR and the interface between project-level crediting and the reporting of emissions and removals by countries in pursuit of NDCs and the Paris Agreement goals.

Annex A includes a summary of the treatment of CCS, BECCS and GCS within the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC Guidelines), a key document underpinning MRV, governance and accounting of GCS related mitigation activities under the Paris Agreement.

IETA'S HANDBOOK FOR GEOSTORAGE AND CARBON CREDITING 2.0 BUILDS ON GLOBAL CRITERIA AND EVOLVING METHODOLOGIES TO STRENGTHEN SAFEGUARDS, ACCOUNTING, AND CLIMATE INTEGRITY FOR CCS AND ECDR.

02 CARBON CREDITING AND GEOLOGICAL CARBON STORAGE (GCS)

2.1 GEOSTORAGE AND CREDITING

Capture and geological storage of CO_2 presents some unique methodological features compared to other types of project-based activities and methodologies: principally, most types of climate mitigation technologies avoid the formation of CO_2 by replacing emissive activities with lower emitting substitutes performing a similar function. Conversely, activities involving GCS either reduce/avoid atmospheric CO_2 emissions from point sources (CCS) or remove CO_2 that is already in atmospheric stocks (eCDR) through the engineered capture and injection of CO_2 into geological formations.

Implementation of CCS and the eCDR methods considered in this handbook enhance geological carbon reservoirs by directly returning carbon from where it came (fossil CCS), removing it from atmospheric stock (DACCS) or transferring it from biogenic stock in the Earth's fast carbon cycle into the slow (geological) carbon cycle (BECCS). Undertaking these activities may increase the formation of CO_2 due to the energy and materials requirements for the capture, transport and storage of CO_2. It therefore remains vital that:

1. Monitoring and accounting boundaries are appropriately drawn so as to consider the full range of GHG effects arising from a specific GCS activity (i.e. to avoid leakage effects that can arise when emissions attributable to the activity occur outside the activity boundary and are not appropriately recorded), and
2. The captured CO_2 injected into an enhanced geological reservoir remains in place for a significant (permanent) period of time in order not to reverse the ongoing effectiveness of the initial climate change mitigation effect (i.e. the risk of non-permanence and carbon reversal; see Section 4).

In respect of (1) above, there is an increasing focus on the full GHG effects—including the risk of leakage effects occurring outside the direct control of the project operator—with enhanced interest in precisely determining, crediting and/or certifying only the net removal or net negativity achieved by eCDR activities (Box 1).

In respect of (2) above, standard setters, in establishing methodologies, must seek reasonable assurance (hereafter referred to as Quality Assurance and Quality Control or "QA/QC") that the environmental integrity of any credits that they issue to GCS project operators today will not become compromised by the future reversal of the emission reduction or removal effect after crediting has ended. Furthermore, the residual risk of future carbon reversal in an underlying project activity should be decoupled from issued credits to allow for equivalence and fungibility with other units in carbon markets derived from other types of activities.

The handbook considers the unique methodological components for CCS and eCDR—including boundaries, leakage, non-permanence and liability for remediating carbon reversal—alongside the more conventional aspects of project-based methodologies (e.g. applicability, baselines, additionality etc) and summarises how they are implemented within existing methodologies and protocols.

BUYERS AND STANDARD SETTERS ARE INCREASINGLY CALLING FOR FULL ACCOUNTING OF LIFECYCLE EMISSIONS TO ENSURE THAT THE FULL ECDR SUPPLY CHAIN GHG EFFECTS ARE ACCOUNTED FOR WITHIN ISSUED CREDITS CLIMATE BENEFITS ARE NOT REVERSED.

BOX 1 - GROWING DEMANDS FOR NET NEGATIVITY FROM eCDR

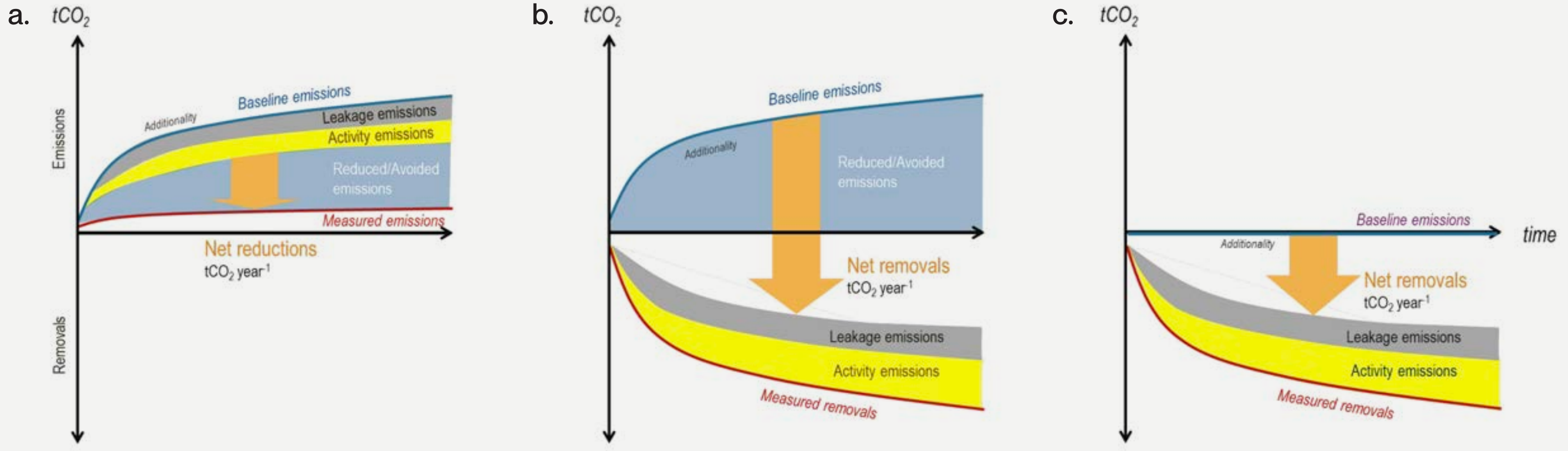
Buyer and suppliers of eCDR credits are increasingly mindful of the potential adverse side effects of emissions intensive supply chains and are calling for full value chain accounting to ensure projects and credits are of high quality and integrity.

Buyers such as Carbon Direct and Microsoft (2024), for example, require that projects seeking funding under the Microsoft CDR Program deliver net negativity by, inter alia, accounting for and reporting "…all GHG emissions associated with a CDR project using repeatable and verifiable GHG quantification methods"…[involving]…"the use of cradle-to-grave life cycle assessments (LCAs) and/or models that accurately estimate CDR, calibrated by periodic direct measurement." (Carbon Direct and Microsoft, 2024. p. 11). Other buyer groups engaged in CDR credit purchases echo similar sentiments (e.g. Frontier includes a purchase criterion of 'net negativity').

On the supplier side, standard setters are implementing wide accounting boundaries and sometimes requiring LCA-style GHG assessment in support of CDR activity certification. The European Union carbon removal and carbon farming certification regulation (CRCF), for example, requires that quantification of carbon removal takes account of, inter alia, the associated GHGs covering "… the increase in direct and indirect GHG emissions over the entire lifecycle of the activity which are attributable to its implementation, including indirect land use change" (Article 4). Puro.earth and Isometric require cradle-to-grave GHG assessments prior to registration, and ongoing ex post monitoring of the identified lifecycle components.

Notes and sources: Carbon Direct and Microsoft 2024. Criteria for High-Quality Carbon Dioxide Removal: 2024 edition (https://www.carbon-direct.com/research-and-reports/criteria-for-high-quality-carbon-dioxide-removal); Frontier (https://frontierclimate.com/apply); Regulation (EU) 2024/3012 of the European Parliament and of the Council of 27 November 2024 establishing a Union certification framework for permanent carbon removals, carbon farming and carbon storage in products; Isometric protocols typically refer to a "cradle-to-grave GHG Statement…encompassing the GHG emissions relating to the activities outlined within the system boundary", which is similar to a LCA.

FIGURE 1 - PROJECT-BASED ACCOUNTING (SCHEMATIC)



Source: adapted from IEAGHG 2024. Measurement, Reporting and Verification (MRV) for Carbon Dioxide Removals (CDR) in the context of both project-based approaches and national greenhouse gas inventories. IEA Greenhouse Gas R&D Programme, TR 2024-09, October 2024, https://doi.org/10.62849/2024-09.

Notes: (a) shows emission reductions by CCS; (b) shows net removals including a quotient of emission reductions/avoidance (the blue wedge), which can occur where emissions exist in the baseline scenario but not in the project scenario (e.g. waste-to-energy with CCS, which co-captures biogenic and fossil CO2 originating from mixed waste streams); (c) shows the situation for most eCDR activities where they are undertaken solely for climate mitigation purposes (i.e. zero emission or removals in the baseline).

EQUATION 1

NRp = BEp – (ME/Rp + PEp + LEp)

Where;

NR = Net reductions / Net removals[23] (tCO2 or tC)

BE = Baseline emissions/flux (tCO2 or tC)

ME/R = Measured emissions or measured (gross) removals (tCO2 or tC)

PE = Project (or Activity) emissions (tCO2 or tC)

LE = Leakage emissions (tCO2 or tC)

p = relevant measurement period (e.g. 1 year)

2.2 PROJECT-BASED ACCOUNTING PRINCIPLES

Emission reductions or net removals by project GCS activities can be calculated as:
Standards, methodologies, protocols and related modules and tools for carbon crediting prescribe approaches for data collection and processing for use as inputs within this general accounting framework.

The carbon accounting under three different GCS project activity circumstances is visualised schematically below (Figure 1).

2.3 METHODOLOGICAL COMPONENTS

Key terms and definitions. The unique nature of GCS activities means some specific terms and definitions need to be clearly and carefully formulated to ensure their use is consistent with international standards and other best practice. **Applicability/eligibility conditions.** The specific circumstances, attributes and other conditions that apply to activities wishing to use a given methodology. For GCS related activities, these can include the eligible sources of CO2 being captured (e.g. which types of CO2 and from which sectors, both of which have implications for baseline selection; see below), the modes of transport, the allowable geological storage media (e.g. deep saline formations; depleted hydrocarbon fields; eligibility for enhanced oil recovery) and restrictions on the utilisation/ beneficial use of CO2 for purposes other than geological storage (e.g. CO2 for manufacture of chemicals). Specific restrictions on the geographical setting can also be applied.

THE HANDBOOK OUTLINES HOW CCS AND eCDR MUST ADDRESS LEAKAGE, NON-PERMANENCE, AND LIABILITY—WHILE APPLYING CLEAR PROJECT-BASED ACCOUNTING PRINCIPLES TO ENSURE FUNGIBILITY IN CARBON MARKETS.

Project boundary. Describes all the emission sources to be included across the project chain (capture, transport, storage) deemed to be under the control of the project participant(s) and that are significant and reasonably attributable to the project activity. Can include temporal as well as physical boundaries.

Storage site characterisation and selection. Outlines the steps required to characterise and select the proposed GCS site in order to demonstrate, among others, that there is sufficient capacity to store the intended mass/volume of CO2 over the lifetime of the operation, injectivity to accept CO2 at the required rate, and containment to ensure that the CO2 will not leak from the storage reservoir(s).

Baseline. The procedures and options to establish the baseline scenario, and the methodology for calculating baseline emissions against which reductions and/or removals arising from the activity are quantified.

Additionality. A project is deemed additional only if it delivers emission reductions or removals over and above what would have occurred in the absence of the incentive offered by crediting the GCS activity. Methodologies and protocols make use of different approaches and tests to demonstrate the additionality of projects. Unlike some other mitigation technologies, GCS projects generally only impose financial costs to operators and are undertaken for the sole purpose of climate mitigation; however, the presence of relevant CCS or carbon removal regulation, economic incentives and/or potential revenue generation from use of captured CO2 may warrant that candidate project activities be subject to an assessment of their additionality.

Project emissions. Describes the methods for measuring and quantifying the emissions sources occurring inside the project boundary that shall be compared to the baseline. For GCS activities, project emissions include combustion emissions sources inside the project boundary, emissions relating to any bought in heat and/or electricity, CO2 leaks across the chain of activities, including any potential release or see page 4 from the GCS site. Some methodologies may define release or emission as the movement of CO2 outside of the pre-defined boundary of a GCS which could lead to releases to the atmosphere.

Leakage. Describes the methods for measuring the net change in GHG that occur outside of the project boundary and that are measurable and attributable to the project activity. Leakage associated with GCS activities can include emissions from incremental fossil fuel production that is needed to cover the energy requirements for CO2 capture, transport and injection, any land use change effects resulting from the demand for biomass as a source of energy (for BECCS) or the diversion of low carbon intensity energy away from existing users for use in DAC facility.

Monitoring. Sets out the requirements for project monitoring. For GCS activities this includes both the operational and post-injection phases, and various surface and sub-surface aspects including the provision of QA/QC over the security of storage, early warning of irregularities and the risk of leaks, and the quantification of leaks if they are detected. Unlike conventional emission reduction or removal activities, a more complex stepwise technical guidance can be expected to be required involving the design of a sub-surface monitoring plan with appropriate QA/QC aspects and a range of details specific to the proposed storage site (e.g. technology types, locations, frequency of application).

Non-permanence and liability for CO2 reversal. GCS projects could in some cases experience a reversal of storage (a leak or seepage) of stored CO2 back to the atmosphere at some point in time either during or after the end of project operation. If leaks occur during the crediting period, liability generally falls to the project operator to remediate the damage caused (e.g. by drawing down on a buffer account or buying recognised credits from elsewhere). If a leak occurs after the crediting period, then liability for the emissions and their remediation needs to be effectively allocated to maintain the environmental integrity of the issued credits.

Environmental and social impacts and sustainability. Describes any requirements for undertaking environmental and socio-economic impact assessments across the project chain and relevant environmental media (e.g. air emissions, solid waste generation, water use) and including plans in the event of any foreseen negative environmental or community impacts. Requirements to assess the sustainability of project activities is often also included (e.g. based on contributions to the UN Sustainable Development Goals (SDGs) or other specified sustainability goals/criteria (e.g. in relation to biomass fuels).

FROM SITE SELECTION TO MONITORING AND LIABILITY, GCS METHODOLOGIES MUST ADDRESS BOUNDARIES, LEAKAGE, AND NON-PERMANENCE TO SAFEGUARD THE INTEGRITY OF ISSUED CREDITS.

03 METHODOLOGIES AND PROTOCOLS FOR GCS: A SYNTHESIS

3.1 REVIEWED STANDARDS

Reviewed standards are listed in Table 1 (independent crediting programmes) and Table 2 (domestic crediting/quantification standards), covering 13 standard setters.[25]

Those listed have been reviewed and synthesized with the aim of highlighting commonalities, illustrating differences and drawing out good practice from across the current GCS standards ecosystem. Other related documents are also covered. Most of the reviewed standards apply for the purpose of carbon credit origination, except for the EU and BSI, which are for the purpose of quantification/certification.

TABLE 1 - PROJECT-BASED METHODOLOGICAL STANDARDS FROM INDEPENDENT CREDITING PROGRAMMES (AT 08/2025)

STANDARDS BODY	METHODOLOGY/PROTOCOL/MODULE	VERSION	SOURCE
American Carbon Registry (ACR)	Methodology for the Quantification, Monitoring, Reporting and Verification of Greenhouse Gas Emissions Reductions and Removals from Carbon Capture and Storage Projects	v.1.1 (09/2021) v2.0 (pending)	Link
Verra-Verified Carbon Standard (VCS)	VM0049 Methodology for Carbon Capture and Storage	v.1.0 (06/2024)	Link
	VMD0056 CO2 Capture from Air (Direct Air Capture) (module)	v.1.0 (10/2024)	
	VMD0057 CO2 Transport for CCS Projects (module)	v.1.0 (10/2024)	
	VMD0058 Module for CO2 Storage in Saline Aquifers and Depleted Hydrocarbon Reservoirs (module)	v.1.0 (10/2024)	
	VMD0059 CO2 Capture from Bioenergy (module)	v.1.0 (04/2025)	
	Geologic Carbon Storage Non-Permanence Risk Tool (tool)	v.4.1 (04/2025)	Link
	Geologic Carbon Storage (GCS) Requirements (requirement)	v.4.1 (04/2025)	Link
Global Carbon Council (GCC)	GCCMT001 - Methodology for Project Activities Involving the Capture, Transport and Geological Storage of Carbon Dioxide	v.1.1 (04/2024)	Link
	GCC Guidance for Geological Storage	v.1.1	
Gold Standard	Methodology for Biomass Fermentation with Carbon Capture and Geologic Storage	v.2.0 (05/2025)	Link
	Methodology Tool 03 - Project Emissions Calculations and Monitoring Requirements for Geological Storage Complexes	draft (07/2024)	Link
	Methodology Tool 04 - Reversal risk assessment for geological storage	draft (09/2024)	Link
Puro.earth	Geologically Stored Carbon Methodology	v.2 (ed.2024)	Link
Isometric	Direct Air Capture	v.1.1.5 (08/2025)	Link
	Biogenic Carbon Capture and Storage	v.1.1.8 (08/2025)	
	CO2 Storage in Saline Aquifers (mod)	v1.1.0 (05/2025)	
	CO2 Storage via In-situ Mineralization in Mafic and Ultramafic Formations (mod)	v1.1.0 (08/2025)	
	(various related modules)		

TABLE 2 - METHODOLOGICAL STANDARDS FROM GOVERNMENTAL BODIES (AT 08/2025)

STANDARDS BODY	METHODOLOGY/PROTOCOL/MODULE	VERSION	SOURCE
UNFCCC	Modalities and procedures for carbon dioxide capture and storage in geological formations as clean development mechanism project activities (CDM CCS M&Ps) Decision 10/CMP.7	2011	Link
IPCC	2006 IPCC Guidelines (Volume 2, Chapter 5)	2006	Link
Environment and Climate Change Canada (ECCC)	Direct air carbon dioxide capture and geological storage	v.1.0 (01/2025)	Link
Alberta Emission Offset System	Enhanced Oil Recovery	v.2.0 (01/2022)	Link
	Quantification protocol for CO2 capture and permanent storage in deep saline aquifers (version 2.0)	(01/2025)	Link
British Columbia Offset Programme	Carbon Capture and Sequestration (CCS) Protocol (version 1.0)	(08/2025)	Link
European Commission (EU) (DG CLIMA)	Commission Delegated Regulation establishing the certification methodologies for permanent carbon removals activities (BECCS and DACCS)	Draft (07/2025)	Link
British Standards Institute (BSI) (Dept. of Energy Security and Net Zero, UK; DESNZ)	Direct air carbon capture and storage (DACCS). Quantification of greenhouse gas (GHG) emissions and removals (BSI Flex 2007)	v1.0 (07/2025)	Link
	Bioenergy with carbon capture and storage (BECCS). Quantification of greenhouse gas emissions (GHG) and removals (BSI Flex 2006)	v1.0 (07/2025)	Link

3.2 SYNTHESIS OF CURRENT METHODOLOGIES

3.2.1 Applicability conditions

The reviewed methodologies and protocols vary considerably in terms of applicability conditions and eligible activities.

CCS/mixed. Alberta, ACR and GCC methodologies all include fossil CCS and therefore adopt broad scopes of application covering industrial CO2 sources (e.g. hydrogen production, gas sweetening, cement production) non-industrial CO2 sources (e.g. electric generating facilities, including biomass), and DAC. Verra/VCS is expected to be expanded to fossil CCS in future via the CCS+ Initiative (Box 2). The British Columbia protocol is not specific on the source of CO2, suggesting widespread applicability to most sources of CO2.

eCDR only. Puro.earth, Gold Standard and Isometric methodologies and protocols apply only to carbon removals. Puro.earth and Isometric include biogenic CO2, DAC and potentially also waste-to-energy emissions.[26] Gold Standard is limited to the capture and storage of CO2 in fermentation off-gas from biomass refining.

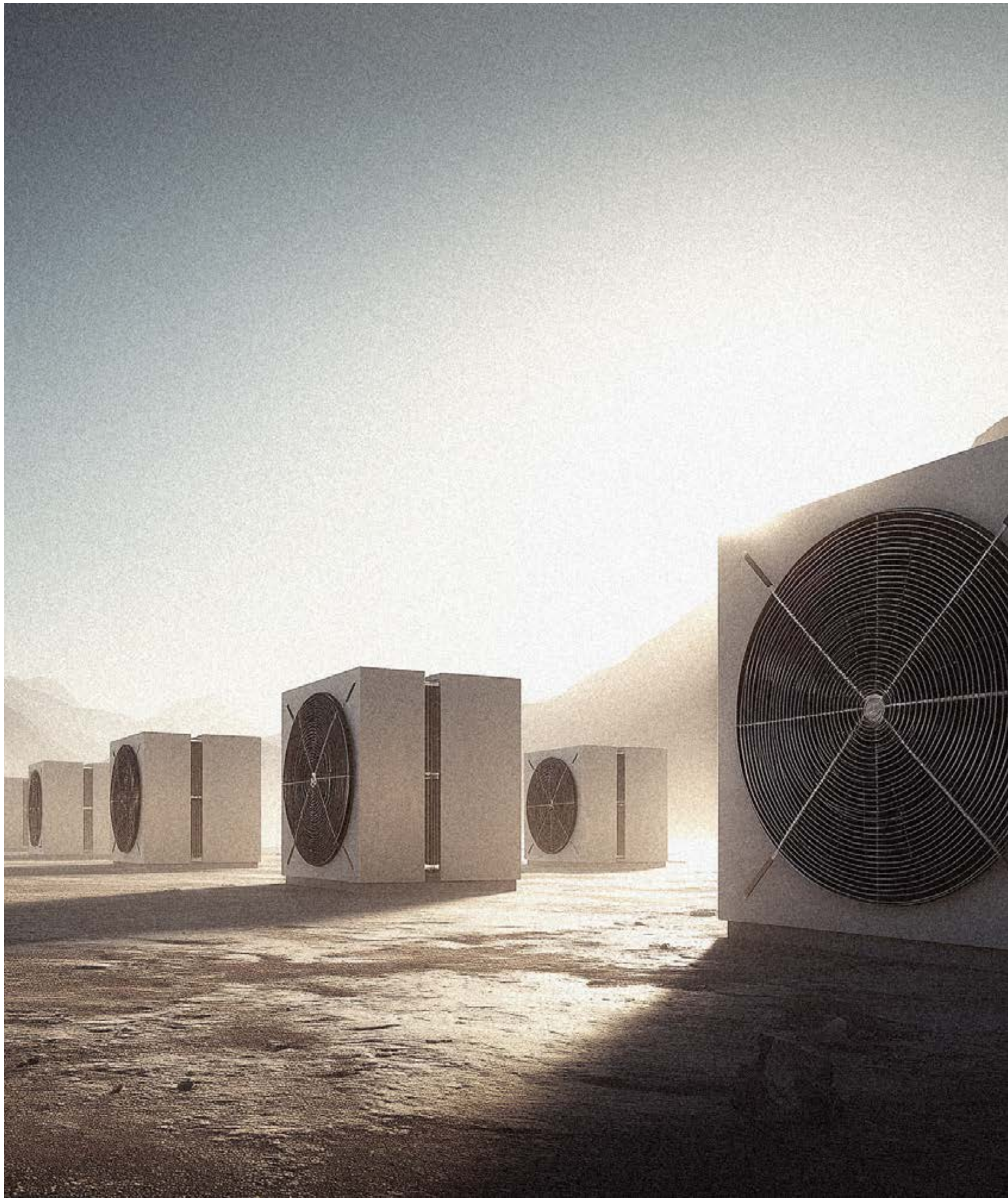
Modular flexibility. Verra/VCS and Isometric use modular approaches potentially covering a wide array of configurations: various capture sources, transport modes, and storage types. So far, Verra/VCS, under the generic VM0049 Carbon Capture and Storage methodology, has approved modules for DAC and bioenergy CO2 capture (BEC), and saline aquifer and depleted hydrocarbon field storage (Box 2). Isometric has protocols for DAC and BEC, and modules for saline aquifers and CO2 storage via mineralisation.

BOX 2 - THE CCS+ INITIATIVE APPROACH TO METHODOLOGY DEVELOPMENT

Formed in 2021, the CCS+ initiative—consisting of nearly 50 member companies and a secretariat—has the core goal of developing a comprehensive, modular, quantification and accounting methodology applicable to a variety of CCS and CDR configurations and circumstances.

To date, a central methodology and four supporting modules covering DACCS and BECCS have been approved by CCS+ Initiative members (see Table 1). These have all been adopted by VERRA under its voluntary carbon standard (VCS). Two tools have also been developed to account and allocate project and leakage emissions in circumstances where infrastructure is shared, and for differentiating between reductions and removals from the capture of mixed CO2 sources.

In addition to developing new modules, the CCS+ initiative is also seeking to operationalise the system under an "open source" arrangement, aiming to provide a harmonized, efficient, approach to MRV implementation.



Storage types. The suite of GCS methodologies and protocols impose various constraints on the allowable geological storage media. ACR (v1.1) is unique in being only applicable to operational EOR activities.[27] Alberta applies separate methodologies for activities involving EOR and saline aquifers. While most allow for storage in depleted hydrocarbon fields, Puro.Earth, Isometric, Gold Standard and Environment and Climate Change Canada (ECCC) all explicitly exclude EOR, as does the EU's Carbon Removal and Carbon Farming certification regulation (CRCF). Gold Standard also does not allow for storage in any sub-seabed reservoirs. The treatment of CO2 injected dissolved in water as being applied to shallow basalts formations is somewhat ambiguous across the suite of methodologies and protocols:[28] only Puro.earth and Isometric are explicit in covering this storage approach, while Verra/VCS is considering a draft module at time of writing.

Jurisdictions. The ECCC, Alberta, British Columbia, ACR, EU and BSI methodologies are geographically limited to Canada, Alberta, British Columbia, the U.S. and Canada, the 27 European Union member states, and the United Kingdom (UK) respectively (although the BSI standard hints at global applicability).

Permits. All methodologies establish requirements for permitting of the GCS site, which can also impose geographical restrictions. Verra/VCS, GCC, Gold Standard, Puro.earth and Isometric all suggest global applicability but include expectations regarding the technical and legal elements governing site permitting and the prevailing legal regime for geological storage. Such conditions suggest partial or de facto geographical restrictions because of the low number of countries worldwide that have established dedicated GCS regulatory programs (see 3.2.6).

ALL STANDARDS SETTERS APPLY RESTRICTIONS TO THE APPLICABILITY OF THEIR GCS METHODOLOGIES, AND JURISDICTIONAL ASPECTS VARY IN TURN.

The various applicability or eligibility conditions have implications for the following aspects of methodology design:

- Baselines. Any limitations on the scope of eligible CO2 capture sources under a methodology will determine the extent to which baseline choices must be elaborated. For some eCDR methodologies, the baseline is straightforward as it is assumed no activity would happen, so each tonne of CO2 stored is assumed to be removed from the atmosphere (e.g. EU or British Columbia). Methodologies applicable to point source CO2 capture tend to be more complex, with factors such as new build or retrofit featuring in the baseline emissions determination (e.g. ACR and GCC). Puro.earth and Isometric require various other factors to be considered in the baseline scenario (e.g. prior land use; a counterfactual storage scenario).
- Non-permanence and longer-term liability in case of carbon reversals. Applying geographical limitations significantly simplifies methodological requirements for the management of non-permanence and long-term liability for carbon reversal. This is because laws, regulations and permitting requirements in the jurisdictions to which the limitation applies allows aspects such as site selection and regulatory monitoring to be excluded from the direct scope of the methodological framework. Global application, by contrast, requires such aspects to either be addressed in the methodology itself or else through reference to specific jurisdictions (as in the case of Isometric, which cites EU and U.S. laws), but also creates ambiguity over the exact expectations.

The CDM CCS M&Ps also contains several limitations on activity type (e.g. exclusion of projects from international waters) and provides technical guidance for the minimum requirements for national laws and regulations.

All standards setters apply restrictions to the applicability of their GCS methodologies. These cover technical aspects (CO2 source; storage type etc.) and jurisdictional aspects (the countries in which the methodology or protocol may be applied). In the case of the former, several are developing modular approaches that can accommodate future expansions to other sources and sink types. In the case of the latter, the restriction often relates to the jurisdictional safeguards in place to regulate GCS site selection, operation, closure and post-closure.

More recently, ICPs have been providing increasingly detailed technical and/or legal guidance on the expectations for regulatory approvals of GCS activities (e.g. Verra/VCS, Gold Standard, GCC, Puro.earth and Isometric), although some ambiguity and variations exist (see below).

3.2.2 Project/activity boundary

The project or activity boundary and covered emission sources are generally straightforward to define for CCS projects, albeit with the growing calls for net removal credits driving a trend towards increasingly wide lifecycle GHG accounting boundaries (Box 1). As such, there is growing diversity in the way emissions sources are included or excluded by standard setters:

- Puro.earth, Isometric, ECCC, EU and BSI all adopt lifecycle GHG accounting encompassing estimated emissions from site construction (including land use change), materials supply chains, biomass supply-chains, site decommissioning etc. Isometric specifies many detailed lifecycle GHG effects to be measured using the suite of modules offered under the standard.[29] ACR (v2.0) is also tending towards inclusion of relevant up- and downstream project emissions.
- Some standards include only selected lifecycle emissions such as those embodied in bought-in materials consumed during capture (GCC, Alberta, ECCC), emissions from well drilling during construction (ACR, ECCC), while explicitly excluding other sources such as construction and decommissioning (Alberta, ECCC).
- All methodologies take account of energy and fuel emissions associated with capturing, transporting and injecting CO2 into the subsurface. Variations do exist in the treatment of emissions associated with supplying energy (including biomass energy) to project sites (see Project Emissions and Leakage below).
- Verra/VCS and Gold Standard take a narrow perspective of the boundary, encompassing the project site where CO2 is captured, transported and stored. Any emissions attributable to the project outside of this boundary (e.g. upstream, relating to emissions embodied in bought in energy and materials) are treated as leakage emissions.
- In all cases, the subsurface GCS site is located within the project boundary and is therefore subject to monitoring of the subsurface CO2 plume and quantification of any emissions.

ACR and Isometric also refer to a temporal boundary, and ACR places obligations for post injection monitoring therein. However, most methodologies rely on the regulatory arrangements for the GCS site to address the longer-term residual liability for emissions and carbon reversal.

3.2.3 Baseline scenario and baseline emissions

Baselines for eCDR tend to be straightforward based on the view that without the project activity there is a low likelihood of any carbon removal occurring. The EC, for example, assumes a standardised baseline of zero removals. However, Isometric and, to some extent, Puro.earth, require a counterfactual storage scenario to be considered (i.e. whether carbon would remain or otherwise become stored if the project did not happen).

Baselines for fossil CCS can be more complex to determine because of the presence of an underlying activity that produces goods or services that could be derived by other methods (e.g. electricity). The ACR and GCC methodologies are unique in allowing for baseline emissions to be calculated using either projection-based or standards-based approaches. The choice of approach depends on various factors (e.g. the source of CO2 and the age of facility in respect of whether it is a new build or retrofit etc).

Projection-based approaches use historical or actual data to determine the baseline emissions based on the assumption that the amount of CO2 injected would otherwise be emitted to or remain in the atmosphere. Both the Alberta and the British Columbia protocols establish the baseline according to the mass of CO2 injected into the reservoir (irrespective of CO2 source). In the case of Puro.earth, Verra/VCS (VMD0056, DAC), Gold Standard, Isometric, ECCC and EC, which apply to removals only, the amount of CO2 injected is also applied as the baseline emissions with the assumption that this is equal to the amount of CO2 that would otherwise remain in the atmosphere absent of the project activity. In the case of Isometric and Puro.earth, this assumption is modified by any identified and quantified counterfactual storage (including land use change effects). Verra/VCS (VMD0059, BEC), GCC, Puro.earth and Isometric explicitly or implicitly include variations on the baseline scenario for BECCS projects depending on whether the activity applies to an existing (retrofit) or new-build plant. This affects the treatment of upstream emissions from biomass supply in the project emissions calculation (e.g. excluded for a retrofit to existing facilities on the assumption that the emissions occur in the baseline).

Standards-based approaches use a benchmark to determine the baseline emissions. The benchmark is based upon an activity providing an equivalent service or function as the source of CO2 in the underlying activity (e.g. a standard emission factor for a cement facility as opposed to the actual mass of CO2 captured from the facility in the project activity). These methods can be used to address concerns over the possibility of incentivising inefficient and/or carbon intensive activities instead or promoting alternative forms of production. A standards-based approach can be considered more conservative: it can avoid over-crediting an inefficient facility because the baseline is set according to a benchmark for CO2 generation in the underlying (CO2 source) activity, rather than the actual amount of CO2 generated. Baseline emissions determined through benchmarks can also better accommodate situations where the energy penalty of retrofitting CO2 capture to an existing facility has impacts upon the efficiency of the underlying activity (e.g. fuel boilers in electric power facilities).

Using only a projection-based approach, or limiting applicability to removals only, significantly simplifies methodological aspects of GCS standards. In contrast, including a standards-based approach can support wider applicability across multiple activities and sectors, but increases the complexity and poses some issues. For example, the ACR (v1.1) protocol draws upon U.S. state and federal proposals for emissions performance standards to guide the standards-based (benchmark) for CCS in electric generating facilities. Under the CDM, the combined margin approach was used to determine the baseline for CO2 capture when applied to electric generating facilities, an approach also adopted in the GCC methodology for CCS applied to grid-connected fossil fuel power plants.

A baseline established using a standards-based benchmark, in being conservative, may significantly reduce the level of credits compared to projection-based methods, which could impact upon project financing and financial additionality assessment. Notably, ACR (v1.1) recommends that the most conservative of either a projection- or standards-based approaches should be adopted.

There are important interactions between baseline approaches and applicability conditions.

When the methodology applies a wide range of CO2 sources, greater complexity arises in identification and selection of the baseline scenario and in the baseline emissions methodology. This is because of the potentially different ways of delivering the goods or services produced by the underlying activity generating CO2 (e.g. electricity or cement).

Protocols focused on removals only (e.g. Verra/VCS, Puro.earth, Isometric, EC, BSI) generally avoid the need for baseline considerations and associated challenges. In some cases, a counterfactual storage or land use change effects are to be considered (new build sites) and, in the case of BECCS, the retrofit of CO2 capture to an existing site can modify baseline emission approaches.

BASELINES FOR GCS VARY FROM SIMPLE ZERO-REMOVAL ASSUMPTIONS FOR eCDR TO COMPLEX PROJECTION- OR STANDARDS-BASED APPROACHES FOR FOSSIL CCS, BALANCING SIMPLICITY WITH CREDIBILITY AND FINANCIAL IMPACT.

3.2.4 Additionality

Current methodologies and standards show some minor variations in approaches to demonstrate additionality, although almost all rely on some or all of the following tests:

1. Does the activity exceed regulatory requirements? The regulatory surplus test.
2. Is the activity the most economically attractive course of action, taking barriers into account? The financial additionality test.
3. Is the activity common practice in the local and regional context? The common practice test.

Most standards directly or indirectly draw such assessments from principles established under the CDM (e.g. TOOL01[30] and TOOL02[31]), to which both GCC and Gold Standard refer directly. Some also include a performance standard based on determining 'climate' or 'environmental' additionality relative to typical practice. ACR, for example, employs both the typical 'regulatory surplus' test, as well as a type of 'best in class' or 'front runner' type test (e.g. environmental additionality based on common practice analysis).[32] Isometric, along with the three aforementioned usual tests, also includes an 'environmental performance' additionality test, which requires proponents to demonstrate that the activity is net negative after taking account of the counterfactual storage.

Different approaches are adopted within existing methodologies and protocols to determine additionality, ranging from an implicit assumption of additionality to more bespoke, project-specific, additionality assessments. Most standard setters require at least regulatory surplus testing.

Quantification / certification protocols from EU and BSI so far exclude specific mention of additionality.

3.2.5 Project and leakage emissions

Project emissions and leakage emissions are the sources that are measured during project implementation and counted against the baseline (or the measured removals) to estimate the net GHG effectiveness of a GCS activity (Figure 1). The covered sources are determined by the project or activity boundary. In many cases, leakage emissions may be mitigated rather than quantified.

Most of the methodologies cover the same project emissions sources, including fossil emissions relating to heat and/or electricity used to capture, transport and inject CO2. However, other variations exist across the suite of methodologies. For example, the CDM and ACR (v1.1; on the basis of de minimis streams) exclude upstream GHG effects (e.g. embodied emissions) associated with the supply of materials for a project and generally do not require the upstream emissions associated with the extraction and supply of fuel or energy imported to a project site to be included. Conversely, almost all other methodologies include some consideration of lifecycle GHG effects such as upstream emissions and emissions embodied in bought-in goods (e.g. capture chemicals). Both Puro.earth and Isometric also include emissions arising from energy used during geological storage site monitoring, and Isometric includes staff travel. Methodologies and protocols from at least Verra/VCS, BSI and EU include a materiality threshold below which qualifying leakage emissions sources may be excluded (e.g. typically 2%). Some ICPs include a discount factor which is applied to account for monitoring uncertainty (Verra/VCS, if greater than 10%; Isometric). ACR (v2.0) is tending towards inclusion of relevant up- and downstream project emissions.

The GCC methodology takes a different approach to storage site monitoring than the other methodologies. It specifies three components of storage site monitoring that could lead to project emissions, namely: conditions of use; CO2 migration analysis; storage site architecture.

Biomass and leakage

Most methodologies covering BECCS consider leakage effects such as land use change potentially driven by biomass use, and implement measures to control these, usually through a proxy such as biomass sustainability (Box 3).

BOX 3 - SOURCING SUSTAINABLE BIOMASS FOR BECCS

Using biomass for eCDR (e.g. BECCS) only produces a net removal effect if appropriate management is applied to maintain the source biological carbon stocks in equilibrium (i.e. growth and harvesting remaining broadly in balance). Information on biological carbon stocks is recorded in the land use, land use change and forestry (LULUCF) section of a country's national GHG inventories (NGHGIs), with the assumption that carbon in harvested biomass is mostly instantly emitted to the atmosphere. As such, emissions from biomass combustion for energy do not need to be recorded in the Energy section of the NGHGI to avoid double counting (i.e. its recorded as a memo item but zero-rated or recorded as a negative emission (removal) when captured and durably stored). Yet, the patchy reporting by countries of the LULUCF sector emissions and removals makes it challenging to discern whether biological stocks are being effectively managed at source, and/or whether possible leakage effects are occurring (e.g. direct or indirect land use changes resulting from activity-shifting by previous users of the source biomass).

To fill this gap, eCDR methodologies using biomass are setting requirements for biomass 'sustainability' as a proxy indicator of leakage risk mitigation. Approaches to assess sustainability generally consist of, firstly, a biomass classification system (e.g. waste; forest products; agricultural products; other), and second, sustainability and traceability criteria/conditions for each type. For example, requirements from Verra/VCS (VMD0059) include (in sum):

- Traceability. Provide relevant data on e.g. biomass type and category, volumes, origin, modes of transportation employed, certification, chain of custody information etc.
- Sustainability. Subject to demonstrated traceability, the following applies:
- Waste. Considered to be 'sustainable' by default = no leakage (subject to demonstrating that it is waste).
- Forest and agricultural products.
- Compliance with regulatory/certification programmes:
  - A recognised regulatory programme (e.g. EU Renewable Energy Directive) or an alternative regulatory programme meeting listed requirements (below)
  - An eligible certification programme (e.g. Forest Stewardship Council; Sustainable Biomass Program; International Sustainability and Carbon Certification etc) or an alternative certification programme meeting listed requirements (below), or,
  - Compliance with listed requirements:
  - Biodiversity; sustainable forest management; soil heath; water; food security; social sustainability; LULUCF (country of origin must have a current nationally determined contribution (NDC) covering LULUCF); cascading use.
- Other. Not sustainable.

If biomass used in activities cannot be demonstrated to be sustainable, usually no carbon removal credits are awarded.

Source: adapted from Zakkour, P.D., J. Lujan, G. Cook and A. Frey (forthcoming). Carbon Crediting Standards for Technology-Based Carbon Dioxide Removal in Developing Countries. A report by Carbon Counts and Energy Changes, sponsored by the World Bank.

The following approaches are currently applied in BECCS methodologies and protocols:

- Verra/VCS (VMD0059) states that BECCS qualifies as CDR if it is derived from sustainable biomass, and that in circumstances where excess non-traceable biomass feedstock is consumed at the source plant, project proponents must use various parts of CDM TOOL16 Project and Leakage Emissions from Biomass to determine market leakage. Verra/VCS is also exceptional in allowing sustainable but non-traceable biomass to be counted as an emission reduction, subject to certain rules and conditions (see VT0013 Differentiating Reductions and Removals in CCS Projects).
- Puro.earth follows a similar approach as described in Box 3, with mitigation of biomass leakage risks through conditions set in the Puro Biomass Sourcing Criteria, and the assessment and quantification of unmitigated leakage emissions (circumstances where the criteria are not met during operations).
- Isometric, in its Biomass Feedstock Accounting module, also follows a similar approach as Box 3, with an assessment of direct and indirect market leakage effects of biomass sourcing using multi-criteria and allowing 'zero leakage' emissions to be applied to materials meeting the criteria. This can include third party certification programmes for forestry biomass.
- The GCC methodology requires project participants to use CDM TOOL 16 to estimate biomass leakage emissions.
- The EU CRCF requires that certification methodologies, among others:
  - Promote the sustainability of biomass in accordance with the sustainability and GHG emissions saving criteria for biofuels, bioliquids and biomass fuels in the Renewable Energy Directive (EU 2018/2001).
  - Ensure the consistency of the application of the principle of the cascading use of biomass.
  - Ensure the avoidance of unsustainable demand for biomass raw material.
- BSI, as well as requiring a sustainability assessment, also calls for a full assessment of leakage risks and quantification of leakage emissions.

Carbon intensity of energy for DACCS

Energy requirements for DAC are in the order of 7.2-8.8 GJ (2,000-2,400 kWh) per tCO_2 captured (heat and electricity), meaning the source of energy significantly impacts upon the net negativity of the process. Methodologies for DAC are therefore applying increasing scrutiny to the approaches taken to estimate emissions from the supply of energy to the process, drawing upon accounting methods applied to certify "green" hydrogen. In most cases a combination of mitigation and quantification is applied (Box 4).

BOX 4 - SOURCING LOW CARBON INTENSITY ENERGY FOR DIRECT AIR CAPTURE

DACCS only produces a net removal effect if it is powered by low- or zero-carbon energy sources. Assurance and MRV of low carbon intensity (CI) or renewable energy use in DACCS, including the mitigation of potential leakage effects of energy acquisition (e.g. market leakage due to previous low CI or renewable energy users switching to other, more emissive, energy sources), has emerged as a core theme in DACCS certification standards over recent years.

Power procurement methods are widely prescribed in DAC methodologies and protocols. Several nuances notwithstanding, assurance over the use of low CI/renewable energy generally cover requirements to:

1. Use low CI/renewable energy self-generated onsite ("behind-the-meter").
2. Use low CI/renewable energy generated offsite from sources owned or otherwise purpose-built for the DAC facility operator and acquired via a wheeling agreement (e.g. Verra/VCS VT0010), and/or
3. Procure low CI/renewable energy through 'green' power purchase agreements (PPA)
   - Wheeled power or PPAs subject to:
     - Spatial correlation: the DAC facility and low CI power plant(s) being on the same electricity transmission system, eGRID subregions (U.S./Canada), bidding zone (EU) or equivalent).
     - Double claiming: environmental attribute certificates (such as renewable energy certificates) issued to the power plant(s) being acquired and retired by the DAC facility operator.
     - Matching of expected demand and contracted supply.
4. Procure or otherwise acquire waste heat, subject to among others:
   - Evidence that the waste heat was previously non-recoverable by the third party.
   - The underlying process is not expanded because of the heat demand of the DAC facility.

Where these conditions are met, the energy used at the DAC facility may apply a low CI or zero emissions factor. To date, DACCS methodologies have not allowed the use of 'virtual' green PPAs or the basic acquisition of low CI energy or environmental attribute certificate (EAC) absent of a direct linkage to the power supply source.

Temporal correlation. The time matching of dispatched power and its use by the DAC facility is also an active methodological topic. Some stakeholders contend that the granularity of temporal correlation needs to be very high because of diurnal and seasonal imbalances in renewable energy supply (i.e. intermittency) and DAC energy demand, meaning that DAC facilities could use electricity supplied from high emission sources at some points across a daily and yearly cycle. Others assert that temporal correlation with a frequency higher than annual matching is not technically feasible and is likely to be financially prohibitive. They also highlight that the analytical evidence calling for higher frequency temporal correlation is contestable in respect of the effect on emissions outcomes.

Plant vintage. To mitigate market leakage risks, the vintage of the low CI/renewable power plants is also considered. Limiting procurement of low CI/renewable electricity to recently built plants provides indications that the risk of diverting it from other users is minimised, a topic referred to as the "additionality" of power. Several eCDR methodologies set a maximum period of 36 months between the start of operation of the power plants under procurement and the eCDR project (Isometric; Puro.earth; EC; BSI). Fully repowered renewable generation of wind or solar projects can also qualify (e.g. under Verra/VCS VT0010).

Source: adapted from Zakkour, P.D., J. Lujan, G. Cook and A. Frey (forthcoming). Carbon Crediting Standards for Technology-Based Carbon Dioxide Removal in Developing Countries. A report by Carbon Counts and Energy Changes, sponsored by the World Bank. Note: 1 Verra/VCS VT0010 Emissions From Electricity Consumption And Generation. Version 1.1 (11 March 2025); 2The counting of low CI/renewable energy solely on the basis of the purchase and retirement of EACs without any contractual linkage (PPA or wheeling agreement) or geographical linkage (supply and offtake in different electricity transmission systems). 3 Commission Delegated Regulation (EU) 2023/1184 of 10 February 2023 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a Union methodology setting out detailed rules for the production of renewable liquid and gaseous transport fuels of non-biological origin.

Power procurement requirements are currently implemented in methodologies and protocols from Verra/VCS, Puro.earth, Isometric, ECCC, EU and BSI following approaches broadly aligned as outlined above (Box 4).

Variations currently exist in expectations around temporal matching, including:

- EC and BSI: annual matching, with review of potential hourly matching by 2028.
- Isometric (Energy Accounting module): hourly matching (>200 GWh/yr) or annual matching under certain conditions.
- Puro.earth (Geologically Stored Carbon Methodology): annual matching, with the expectation of a transition to hourly matching in future.
- Verra/VCS (VT0010): annual matching, with a view to increasing the reconciliation frequency.

Puro.earth (Geologically Stored Carbon methodology) and previous versions of the Isometric Energy Accounting module (v1.1) allow for energy leakage risks to be mitigated by relying on existing regional and local policies and measures, such as sourcing electricity from facilities covered by emissions trading and power sector decarbonisation plans, where present.

There is an emerging trend towards increasingly stringent environmental accounting drawing from lifecycle analysis-type frameworks. Accurately estimating the full lifecycle GHG emissions of activities can be challenging. In some circumstances certain lifecycle GHG emissions and removals could be excluded where system inputs are being counted or regulated under other legislation, carbon pricing or market-based frameworks.

For BECCS, all standard setters apply some type of leakage mitigation. The most stringent approach is to implement sustainability and traceability requirements on biomass to ensure leakage is mitigated.

For DACCS, methodological approaches are being developed to account for the use of low carbon intensity of renewable energy procurement to run the DAC facility. The 'additionality' of procured power is also a feature to mitigate leakage (market leakage).

3.2.6 Non-permanence and liability for carbon reversals

Policymakers, regulators, crediting programmes and stakeholders at large need assurances that the environmental integrity of certifications and credits issued to GCS project operators today do not become compromised by future leaks of stored CO2 that reverse the original emission reduction or removal effect.
The current suite of methodologies illustrate that standard setters are using various approaches to manage reversal risks, broadly consisting of three main methodological components:

1. Upfront QA/QC requirements governing the appropriate selection, operation, closure and post-closure of GCS sites.
2. Monitoring of the GCS site performance during the operational phase and in a post-closure phase, and reporting of any irregularities, migration, leaks and emissions, and
3. Mechanisms for the ongoing management of long-term liability to, among other things, for remediate climate impacts in the event of carbon reversal.

General QA/QC requirements for storage sites
Variations exist in the way methodologies are implementing these QA/QC requirements.

The methodologies from ACR, Alberta and British Columbia do not offer significant guidance on QA/QC for GCS site selection and operation but instead rely on Canadian and U.S. federal and provincial/state regulations to backstop such requirements. Similarly, the EU and BSI certification standards rely on EU and UK law, respectively, that govern CO2 storage activities. As such, QA/QC aspects largely fall outside of the direct scope of the methodology. These standards therefore also apply geographical limitations, as noted above (Section 2.3.1 Applicability conditions).

Under the CDM CCS M&Ps, Parties to the Kyoto Protocol agreed that non-Annex I parties wishing to host GCS activities under the CDM may only do so if they had established laws or regulations that, inter alia:

- Set procedures for appropriate selection, characterisation and development of GCS sites
- Define means by which to confer rights to store CO2 in, and gain access to, subsurface pore space,
- Provide for timely and effective redress for affected entities and remedial measures in the event of leaks, and
- Establish means for addressing liability arrangements for GCS sites.

Technical guidance is provided in Appendix B of the CDM CCS M&Ps.

Regarding the VCM, the more recent methodologies from Verra/VCS, Gold Standard, GCC, Puro.earth and Isometric, in contrast to earlier VCM standards, offer a something of a hybrid approach that is more reflective of the CDM. Their methodologies provide substantial technical QA/QC guidance in respect of matters such as site selection, well design, operation, post-injection and closure. Rather than a specific QA/QC benchmark with direct requirements for project developers applying the methodology, the benchmark is framed as an expectation of the laws, regulations and regulatory oversight that is implemented by countries wishing to host project activities applying the methodology.

There is also considerable nuance across the current suite of methodologies: some are open to interpretation as to whether a specific geological storage permit and dedicated regulator is needed or whether a generic permit — issued and overseen following the provided technical or legal guidance — would suffice.

MANAGING NON-PERMANENCE IN GCS REQUIRES ROBUST QA/QC, CONTINUOUS MONITORING, AND CLEAR LIABILITY MECHANISMS TO SAFEGUARD THE INTEGRITY OF ISSUED CREDITS.

The following local permitting and oversight requirements are specified by ICPs:

- Verra/VCS (GCS Requirements v4.1): the GCS site shall be located "in a jurisdiction where regulatory oversight: 1) is provided by the government or a government agency (i.e., a statutory regulator); 2) meets the minimum criteria [specified in the GCS Requirements v4.1 document]". Expectations for the local legal framework are also included with the reversal risk assessment.
- Puro.earth (Geological Storage Carbon Methodology): "the injection of a CO2 Stream into a geological storage reservoir shall only take place in jurisdictions with a robust legal framework for the environmentally safe geological storage of CO2". The methodology includes a list of a priori accepted jurisdictions while also allowing for, subject to approval, projects in jurisdictions where the local regulatory framework meets all requirements for a robust legal framework.
- Isometric (CO2 Storage in Saline Aquifer module v1.1): permit "application and approval" is needed under "the national/international regulations" and "If there is a lack of distinct relevant local regulations to meet the minimum requirements in this module...Project Proponents are required to follow either the U.S. EPA Underground Injection Control (UIC) or EU directives".
- Global Carbon Council (GCCMT001): the GCS site shall be "...surveyed, identified and permitted in compliance with relevant national laws, regulations and standards applicable to the exploration, survey, development of, and utilisation of, subsurface resources and/or protection of subsurface resources in the host country" and "In jurisdictions where any of the above requirements for the storage complex are not specified in local regulations" a permit issued in accordance with the GCC Guidance for Geological CO2 Storage must be obtained.
- Gold Standard (Methodology Tool 03): "The project shall obtain the necessary regulatory permits, licenses, certifications, or other authorizations for the storage site from the appropriate national or subnational entities and/or certification bodies". The scope of the "regulatory approval and/or independent certification process" is to be aligned with technical guidance provided in Tool 3.

In each of these cases, some interpretation can be applied over the precise expectations for the permit type and regulator. The GCC and Gold Standard suggest greater latitude in the use or acceptance of a more general type of permit than the other ICPs.

Project proponents applying any of the current GCS methodologies and protocols will require, inter alia, evidence of government/governmental agency issued permit to store CO2 including access and tenure rights to the pore space in the GCS site, and the need for regulatory oversight of GCS operations. Some uncertainty exists over which entity is responsible for judging the robustness of national laws and regulations relative to the benchmark guidance specified in the standard. Puro.earth is explicit in reserving the right to "determine the eligibility of a legal framework".

The variation in QA/QC requirements across methodologies suggests that wider deployment and accelerated scale-up of GCS technologies will require continued efforts to find a good balance between ensuring sufficiently high environmental quality standards while maintaining widespread applicability to a range of potential host country circumstances.

Short-term liability for reversals (operational phase)

If CO2 leaks from a GCS site during a crediting period (i.e. in the site's operational phase), all methodologies require those leaks to be measured and reported as project emissions.

BOX 5 - CO2 CAPTURE, TRANSPORT AND GEOLOGICAL STORAGE IN 2006 IPCC GUIDELINES

The 2006 IPCC Guidelines can help to build the case with local stakeholders to establish robust regulatory standards to address non-permanence risks posed by GCS (see Section 4).

Under current IPCC 2006 Guidelines, countries may count captured CO2 as not emitted in their NGHGI—or as a negative emission in the case of BECCS—if it can be shown that the CO2 is stored in "properly monitored geological storage sites" as set out in Volume 2, Chapter 5: Carbon Dioxide Transport, Injection and Geological Storage.

The guidance in Volume 2, Chapter 5, states that the absence of empirical data on GCS emissions mean that Tier 3 measurements (i.e. project/activity specific data) shall be used in the NGHGI to help "build confidence that there will be minimum leakage". The methodological approach for Tier 3 data compilation entails, among others, characterisation, modelling and monitoring the GCS site. It also suggests conditions under which monitoring may cease. Various QA/QC guidance also implies regulatory oversight of GCS operations (see Annex B).

Robust monitoring under IPCC Guidelines is key to trusted, permanent carbon storage.

In terms of regulatory requirements, good practice for NGHGI compilers included in Volume 2, Chapter 5, includes determining whether:

- an adequate geological site characterization report has been produced for each storage site,
- the operator has assessed the potential for leakage at the storage site, and
- each site has a suitable monitoring plan (see Annex A).

As such, crediting methodologies should seek to dovetail QA/QC requirements with NGHGI reporting approaches to allow for GCS related activities to be accounted for appropriately in NGHGIs (see Section 4.3.1 below). In particular, alignment of methods will be critical in supporting robust international transfers of mitigation outcomes (see Section 4.2.2 below).

Presently DACCS is not covered by the 2006 IPCC Guidelines. However, the Paris Agreement rulebook suggest that there is latitude for Parties to report carbon removal by DACCS activities so long as the CO2 transport and storage components are monitored and reported in accordance with Volume 2, Chapter 5. Notably, Norway reported emissions reductions achieved by its Sleipner CCS project in its NGHGIs from 1999 onwards despite IPCC guidance on CCS only being available from 2006. Further clarity should be forthcoming in an IPCC Methodologies Report on CDR, due be finalised by 2027.

ICPs have been providing increasingly detailed technical and/or legal guidance on the expectations for regulatory approvals of GCS activities (e.g. Verra/VCS, Gold Standard, GCC, Puro.earth and Isometric), although some ambiguity and variations exist.

These approaches have yet to be fully tested, and some questions remain as to whether the approaches can be effectively implemented across a range of jurisdictions, or whether sufficient guidance is provided assure operators and validation and verification bodies (VVBs) regarding the types of permits and oversight to be applied.

In circumstances where the scale of a leak exceeds the level of reduction or removals occurring within a monitoring period, a reversal, a carbon reversal, or a net reversal of storage can be considered to have occurred (i.e. emissions were higher than reductions or removals for that same period, leading to net negative climate change impacts). Aside from requirements to suspend any ongoing injection operations until the leak is repaired or corrected, methodologies typically require a carbon reversal to be remediated by acquiring and retiring reduction or removal credits.
To support these remediation requirements, some standards apply a buffer pool; namely ACR, Verra/VCS, Gold Standard, GCC, ECCC, British Columbia and Isometric. The buffer pool is a withheld credit reserve taken from all GCS projects registered with a particular registry that can be used for this purpose, ranging from 3% up to 16.4%. The size of individual project contributions to the buffer pool are either fixed (e.g. ACR at 10% (v1.1); GCC and CDM at 5% of credits generated) or from a risk rating determined through by a risk assessment procedure/tool (e.g. ACR (v2.0), Verra/VCS, Gold Standard, British Columbia). Isometric, while including reversal risk assessment procedures, pre-determines that saline aquifer storage is at 'Very Low Risk' of reversal and fixes the buffer contribution at 2%. Buffer pools are typically applied at the registry level for all similar project types. ACR and Isometric, in contrast, apply a project-level buffer. The GCC proposes to apply a buffer but has yet to define how it will function. EU and UK include a buffer through their links with national legislation that includes provisions for 'financial mechanisms'. Use of the buffer pool for remediation can depend in whether a specific reversal event is considered intentional or unintentional (or unavoidable or avoidable).

Neither Alberta nor Puro.Earth employ a buffer pool for GCS activities. Alberta instead applies fixed credit discount that is "retired to the atmosphere". Puro.earth requires any operator ('CO2 Supplier') reporting reversals to surrender equivalents units (i.e. Puro CORCs)[33] equal to Reversal quantity.

Buffers offer a means for standard setters to implement a layer of insurance against the risk of non-permanence and carbon reversal. In doing so, buffers reduce the number of credits issued to project developers. Variations exist across the existing suite of methodologies in terms of the (i) the level and means for calculating the contribution (ii) the level at which it is pooled (registry or project) and (iii) the conditions under which it can be called upon (e.g. avoidable or unavoidable).

The buffer contribution is additional to the uncertainty discount applied by some ICPs (e.g. Verra/VCS, Isometric; see Section 3.2.5).

APPROACHES TO LONGTERM LIABILITY FOR GCS VARY, BUT ALLOCATING RESPONSIBILITY AND ASSIGNING REVERSAL LIABILITY(TO HOST COUNTRIES OR OTHER ENTITIES) IS KEY.

GCS methodologies have historically relied on applicability conditions to limit use to jurisdictions with local laws and regulations that backstop the responsibility for GCS site post injection monitoring and the handling of liability for remediating carbon reversals.

More recently, ICPs have been setting out more detailed technical, legal and regulatory expectations, although some ambiguity and uncertainty exists about whether, when and how long-term responsibilities and liabilities for GCS sites will be allocated and implemented.

Greater consideration of the 2006 IPCC Guidelines in respect of how GCS sites should be monitored, and the conditions under which monitoring could cease, could help to clarify and harmonise approaches to managing longer term monitoring and liabilities for remediating any reversals.

Long-term liability for reversals (post-injection phase)

Long-term stewardship of GCS sites involves allocating responsibility for any ongoing monitoring and assigning liability for any impacts of CO_2 leaks including carbon reversals in the post-injection phase. The matter is handled somewhat unevenly across the current suite of GCS methodologies.

Verra/VCS, Gold Standard and Isometric require a site closure plan to be established but refrain from prescribing precise conditions for continuing and/or terminating monitoring activities in the post-injection phase. The expectation seems to be that these conditions will be defined by the local permitting regime and through the approaches prescribed in the site closure plan. GCC similarly requires the preparation of a site closure plan, with a preliminary plan included of the documentation prepared for project registration. Puro.earth requires that post-closure monitoring be undertaken until the transfer of responsibility to a national entity. Isometric notes the conditions for long-term liability under U.S. and EU laws and regulations, but refrain from outlining conditions for any liability transfer.

Both ACR and GCC propose a minimum of 5 years post injection monitoring by the project owner (with attendant liability for any carbon reversal), and, in addition, variously require either/or:

- An extension of 5 years' post-closure monitoring until plume stability is demonstrated indicative of a low risk of leakage (GCC and ACR v2.0).
- Extensions by 2 years of post-closure monitoring on a rotational basis until "no leakage" assurance is achieved (GCC and ACR).

GCC, Puro.earth and ECCC methodologies are explicit in stating that the host jurisdiction/country is expected to take on long-term liability for the project GCS site, including for carbon reversal, while this is implicit for the EU and the UK in referring to national GCS laws. The latter two also explicitly mention that the requirement for remediation in the event of any carbon reversals will fall upon the host jurisdiction/country government. Further aspects mentioned by standards include:

- ACR (v1.1) requires a legal Risk Mitigation Covenant, filed in the jurisdiction, to allow for access to monitoring and to prohibit or compensate for any post injection intentional reversal of stored CO_2 or an equivalent mechanism as approved by ACR. In ACR (v2.0), long-term liability can also be assured in instances where this is transferred to a jurisdictional authority.
- Alberta offers various flexible mechanisms by which to manage and address long-term liability, including the ability to limit reversal liability for GCS credits for Alberta's provincial compliance carbon market ("TIER") by increasing a project's discount factor.
- GCC proposes that, once monitoring indicates that the risk of seepage is sufficiently low and that permanent storage is highly likely to be achieved, site closure can occur, and monitoring can be discontinued. Thereafter, in line with 2006 IPCC Guidelines, the host country shall be liable for undertaking any future monitoring (as per paragraph 4(v) of Volume 2, Chapter, 5, Section 5.7.1 in line with Paris Agreement requirements).[34]

Following a transfer of liability, the accounting of any GCS site leaks as emissions in NGHGI ensuring that a de facto trigger for remediation exists and environmental integrity is thereby maintained (see Section 4).

3.2.7 Environmental and social impacts, and sustainability

All ICP standards include general requirements for environmental and social safeguards as well as sustainable development requirements, although there is some variation across the methodologies. Usually these are contained in the general ICP standard.

Often requirements are connected to national laws and regulations in which the project is located. For example:

- ACR (v1.1) refers to federal and/or state level requirements for EIA and obliges project participants to share these documents with ACR. ACR also requires project proponents to

document a mitigation plan for any foreseen negative community or environmental impacts and to disclose any negative environmental or community impacts made during the reporting period.

- Verra/VCS (VCS Standard v.4.7) requires project proponents to demonstrate how the project activities or additional activities, contribute to sustainable development in accordance with the UN Sustainable Development Goals (SDGs), and includes safeguard requirements to do 'no net harm'[35] and make an assessment of stakeholder risks and human rights and equity etc. The Verra/VCS GCS Requirements (v4.1) also require non-permanence risk to be assessed including a "discussion of concerns and vulnerabilities" and an "urgent response and remedial plans in the event of a leak".
- Isometric (Isometric Standard v.1.7.6) refers to similar topics and notes the Integrity Council for the Voluntary Carbon Market's (ICVCM) Core Carbon Principles requirements.[36] The Isometric Standard also suggests that a full Environmental and/or Social Impact Assessment (EIA and/or SIA) be conducted by a third party for all projects, which becomes mandatory if impacts are considered significant and/or if required by the host jurisdiction.

Some of the governmental standards, such as the EU and BSI, include basic information on measures to address environmental and social impacts. However, projects developed under these protocols are subject to the relevant assessment requirements/regulations in place in the respective jurisdictions.

The CDM CCS M&Ps specifically require that a comprehensive and thorough risk and safety assessment be carried out in order to assess the integrity of the GCS site and potential impacts on local communities and ecosystems in proximity to the proposed project activity. They outline the environmental media and specific risks to be included, alongside a requirement to employ best available techniques.

All methodologies involving BECCS include checks on the sustainability of biomass (see Box 3), and the DACCS methodologies include measures to prevent displacement of renewable energy through "additionality" provisions (e.g. ECCC; see Box 3).

3.2.8 Transboundary projects

Existing methodologies and protocols do not address possible issues posed by the transboundary movement of CO2 in a GCS project activity (which may occur either intentionally or unintentionally). Some work was undertaken within the CDM to address the issue,[37] although the matter was never fully concluded by Parties[38] (see also Annex A, Section A-3).

Issues relating to, inter alia, permitting of cross-border storage sites, unintentional cross-border migration of CO2 in the subsurface, leaks from storage sites occurring across borders, and possibilities for double counting represent difficult subjects that are primarily legal in nature rather than methodological. The 2006 IPCC Guidelines provide guidance for how such movements of CO2 should be recorded by NGHGI compilers (see Annex A-3).

GCS STANDARDS EMBED ENVIRONMENTAL AND SOCIAL SAFEGUARDS—RANGING FROM EIAs AND COMMUNITY IMPACT PLANS TO SDG ALIGNMENT AND HUMAN RIGHTS PROTECTIONS—TO ENSURE PROJECTS DELIVER SUSTAINABILITY BENEFITS.

04 SAFEGUARDING AND ACCOUNTING FOR GCS UNDER THE PARIS AGREEMENT

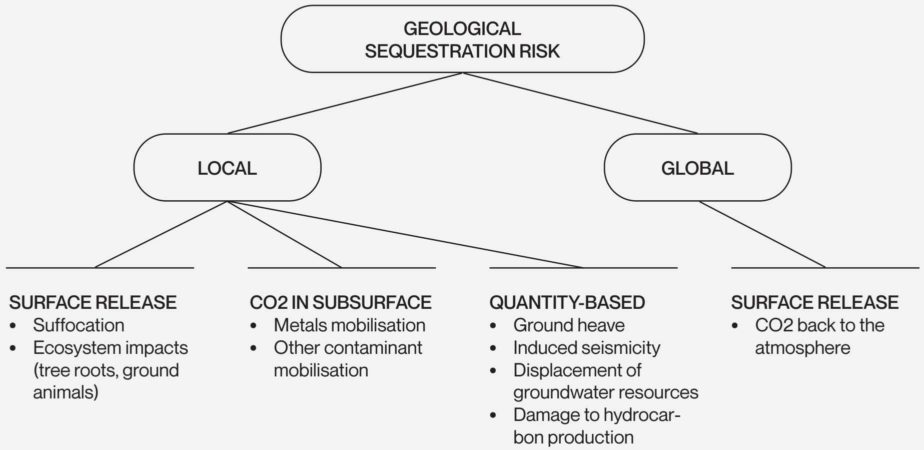
GIVEN UNIQUE RISKS AND OPPORTUNITIES, GCS PROJECTS REQUIRE SPECIFIC SAFEGUARDS TO PROTECT LOCAL COMMUNITIES AND ECOSYSTEMS WHILE ENSURING PERMANENTLY STORED CO2.

4.1 GEOSTORAGE AND RISK

Activities involving GCS either reduce or avoid atmospheric CO2 emissions from point sources or remove CO2 that is already in the atmosphere by capturing and transferring already formed CO2 to the lithosphere, (Section 2.1).

Climate mitigation approaches involving enhanced geological carbon reservoirs therefore present unique risks, impacting upon how they are counted towards climate goals and credited for use in carbon markets. More specifically, risks of GCS include potential impacts on the local environment and human health, and, given the possibility for stored CO2 to leak from a GCS site back to the atmosphere in the future, its effectiveness in delivering long-term (permanent) climate change mitigation. The nature of these parallel 'local' and 'global' risks is summarised graphically below (Figure 2).

FIGURE 2 - TAXONOMY OF POSSIBLE RISKS OF GEOLOGICAL STORAGE



Source: Wilson, E. J and Keith, D.W., 2002. 'Geological Carbon Storage: Understanding the Rules of the Underground.' In: Proc. of the 6th Intl. Conf. on GHG Control Tech.; Volume 1. J. Gale and Y. Kaya (eds). Kyoto, Japan, October 2002. Elsevier.

To address these risks, mitigation activities involving GCS call for specific and additional safeguards in methodological design relative to other types of climate mitigation activities. Local populations and ecosystems must be protected from potential adverse environmental effects, while the environmental integrity of climate mitigation accounting and claims must be insulated from the risk of carbon reversal (see also Section 3.2.6).

4.2 SAFEGUARDING

The framework outlined above (Section 4.1; Figure 2) has formed the basis for the design of safeguards to manage and mitigate GCS risks over the last 20 years or so. Approaches are primarily built upon a three-part legal and regulatory model as follows (see also Section 3.2.6):

1. Development: upfront QA/QC requirements relating to GCS site permitting or licensing conditions to ensure appropriate site characterisation, selection and operation, including appropriate monitoring that can track subsurface CO2 plume behaviour and provide assurances over CO2 storage integrity.
2. Operation, closure and post-injection: rules and regulatory oversight of GCS site operations, closure and post-injection actions to ensure effective management is applied that reduces the risk of future CO2 leaks occurring.
3. Liability: allocation of short- and long-term responsibility for the stored CO2 to ensure appropriate redress is implemented if leaks/carbon reversal occurs.

The EU, the U.S., Canada, Australia and the UK among others have established laws, regulations, technical standards and governance procedures to manage these aspects. Crediting and/or certification of GCS activities in these jurisdictions can rely on the local regulatory frameworks to mitigate the risk of non-permanence and to allocate liability in the event of carbon reversals. Conversely, in jurisdictions where GCS laws and regulations are locally absent—and/or cannot be entirely filled by parallel laws and regulations—alternative means for implementing safeguards are needed if GCS activities are to proceed with high environmental integrity.

4.2.1 Safeguards under the CDM

Project-based mechanisms for fossil CCS emerged from the CDM after more than six years of negotiations on the specific treatment of GCS. Discussions culminated at CMP.[39] in 2011 with agreement of the Modalities and procedures for carbon dioxide capture and storage in geological formations as clean development mechanism project activities (Decision 10/CMP.; Box 6).

BOX 6 - CARBON REVERSALS IN THE CDM

Modalities and procedures for CDM projects were agreed in 2001. However, under the Kyoto Protocol, the absence of emission limitation or reduction targets for developing countries meant CDM host countries faced no direct climate liability if stored carbon resulting from CDR or CCS projects leaked CO2 back to the atmosphere. The arrangement posed environmental integrity risks to the Kyoto Protocol goals.

Concerns over the risks of carbon reversal from afforestation and reforestation (A/R) CDM project activities led Kyoto Protocol Parties to establish, in 2003, dedicated M&Ps for A/R2 that specified the issuance of only temporary or long-term certified emission reductions units (tCER/lCER). Both tCERs or lCERS expired after fixed periods of time, with the acquiring Party thereafter responsible for their replacement. The temporary credit approach to A/R proved unpopular in carbon markets, however.

In 2005, two CDM methodologies for CCS were submitted by project developers for consideration by the CDM Executive Board (EB). Following an initial review, the CDM EB requested guidance from Parties to the Kyoto Protocol (the CMP) as to whether CCS projects could be considered as CDM project activities taking into account issues relating to project boundary, leakage and permanence.

Thereafter, in 2006 the CMP agreed to request views from Parties and observers on the following concerns relating to CCS activities:

(a) Long-term physical leakage (seepage) levels of risks and uncertainty;
(b) Project boundary issues (such as reservoirs in international waters or several projects using one reservoir) and projects involving more than one country (projects that cross national boundaries);
(c) Long-term responsibility for monitoring the reservoir and any remediation measures that may be necessary after the end of the crediting period;
(d) Long-term liability for storage sites;
(e) Accounting options for any long-term leakage (seepage) from reservoirs;
(f) Criteria and steps for the selection of suitable storage sites with respect to the potential for release of greenhouse gases (GHGs);
(g) Potential leakage paths and site characteristics and monitoring methodologies for physical leakage (seepage) from the storage site and related infrastructure, for example, transportation;
(h) Operation of reservoirs (for example, well-sealing and abandonment procedures), dynamics of carbon dioxide (CO2) distribution within the reservoir and remediation issues;
(i) Any other relevant matters, including environmental impacts.

The unpopularity of the tCERs/lCERs approach to managing reversal risks led Parties to consider alternative approaches for CCS. Negotiations on the above topics ensued over the period 2007-2011 with multiple submissions by Parties and observers and the development of three synthesis reports on possible approaches to resolve concerns. Eventually, in 2011, Parties agreed to establish, by way of new, dedicated, modalities and procedures, specific new safeguards for undertaking CCS as CDM project activities in developing countries (Decision 10/CMP.7) that allowed the generation of permanent certified emission reductions (CERs).

Notes: 1 Modalities and procedures for a clean development mechanism, as defined in Article 12 of the Kyoto Protocol (Decision 17/CP.7); 2Modalities and procedures for afforestation and reforestation project activities under the clean development mechanism in the first commitment period of the Kyoto Protocol (Decision 19/CP.9); 322nd Meeting of the CDM Executive Board, November 2005; 4Decision 1/CMP.2; 5FCCC/SBSTA/2008/INF.1, FCCC/SBSTA/2008/INF.3, FCCC/SBSTA/2011/INF.7

By way of Decision 10/CMP.7, Kyoto Protocol Parties established the following assurance and safeguard mechanisms for countries wishing to host GCS activities (see also Handbook v1.0):

a. **Political support:** requirement to submit an expression of agreement to the UNFCCC secretariat to allow the implementation of CCS project activities in its territory.[40]
b. **Legal and regulatory safeguards:** other Participation Requirements specifying de minimis legal and regulatory standards for GCS sites (e.g. site selection, redress for affected communities, remedial measures against leaks/reversals, liability arrangements) mirroring the three-part legal and regulatory model outlined above.
c. **Environmental and social safeguards:** requirement to undertake comprehensive and thorough risk and safety assessments to assess the integrity of the GCS and potential impacts on human health and ecosystems in proximity to the proposed GCS site.

In doing so, the rules established safeguards for GCS activities in developing countries similar to those implemented in OECD countries. Such regulatory alignment is essential for credit fungibility and the mitigation of regulatory arbitrage.

The potential to establish similar safeguards as set out in (a), (b) and (c) above under the Article 6 of the Paris Agreement is considered below.[41]

4.2.2 Safeguards under Article 6

Article 6.4 (PACM)

The Paris Agreement Crediting Mechanism (PACM) is an UN-operated project-based crediting mechanism similar to the CDM. Activities registered under the PACM may be issued Article 6, Paragraph 4, emission reductions (A6.4ERs), which can be used as ITMOs towards NDCs, towards other international mitigation purposes (OIMP or IMP), or for other purposes (e.g. mitigation contributions).

The PACM is governed by the rules, modalities and procedures (RMPs) agreed by Paris Agreement Parties in 2021,[42] and is implemented by the Article 6.4 Supervisory Body (SBM), which is responsible for developing the requirements and processes necessary to operate the mechanism.

The RMPs requested the SBM to review various methodological and procedural aspects of the CDM and other mechanisms to help inform its design, including to elaborate and further develop guidance on activities involving removals (monitoring, reporting, accounting for removals and crediting periods, addressing reversals, avoidance of leakage, and avoidance of other negative environmental and social impacts).

a. **Policy support for GCS activities**

The RMPs set out requirements for Parties wishing to host PACM activities. These include the following notifications to the SBM:

- **Indicate publicly** the types of activity that the Party would consider approving/authorising, and how such types of activity and any associated emission reductions would contribute to the achievement of its NDC and, if applicable, to its long-term low GHG emissions development strategy (LT-LEDS), and also to the long term goals of the Paris Agreement.[43]
- **Approval** of PACM activities prior to their registration, including an explanation of how the activity contributes to sustainable development and relates and contributes to the host country's NDC.[44]
- **Authorisation** covering, among others, the entities wishing to participate in the PACM activity (public or private) and how A6.4ERs issued to the PACM activity shall be used (e.g. towards NDCs, IMP or other purposes).[45] Where A6.4ERs are authorised for use towards NDCs or OIMP they shall be subject to corresponding adjustments.[46]

Public indication of the types of activities that Parties consider relevant to the PACM provides an opportunity for countries to state their political support for GCS activities. Backing such indications with similar clarifications in NDCs and other documents (e.g. LT-LEDS) provides an additional assurance check that candidate host countries have established some form of national policy support for GCS technology, and, at least in principle, acknowledge the MRV responsibilities associated with hosting such activities.

Notably, only around 50 Parties mention CCS within their First or Second NDCs (Zakkour and Heidug, 2019)[47] and even fewer envisage a role for eCDR.[48] So far, only a handful of countries have submitted their NDC 3.0, but the new round of submissions could see greater support for GCS related mitigation approaches.

Political support for GCS activities could be further reinforced at the time of approval and authorization of individual PACM activities.

b. **Legal and regulatory requirements**

The RMPs specify that an A6.4ER is:

> *"…measured in CO2-equivalent calculated in accordance with the methodologies and metrics assessed by the IPCC and adopted by the CMA,[49] or in other metrics adopted by the CMA pursuant to the RMPs".*

As such, PACM activities involving GCS should follow the MRV requirements for CO2 transport and storage set out in Volume 2, Chapter 5 of the 2006 IPCC Guidelines. As noted in Box 5, the 2006 IPCC Guidelines include several legal and regulatory considerations (see also Annex A).

Furthermore, the 2006 IPCC Guidelines oblige host countries to monitor and report any emissions from CO2 transport and GCS sites, including those resulting from PACM activities, and report any emissions in NGHGIs included within biennial transparency reports (BTRs). As such, host countries assume a de facto backstopping role in the event of any carbon reversal, with remediation obligations arising through the counting of reported emissions against the host country's progress made in achieving its NDC (i.e. in its BTRs; see Section 4.3.1). As such, the SBM and other bodies may need to consider how this responsibility might be managed between the UNFCCC secretariat, A6.4ER seller and buyer countries (or airline, in the case of CORISA use under IMP).

UNDER ARTICLE 6.4, GCS PROJECTS REQUIRE CLEAR POLITICAL SUPPORT, ROBUST MRV, AND CLEAR RULES THAT ENSURE PERMANENCE AND SAFEGUARD NDC INTEGRITY.

THE DRAFT PACM REMOVALS STANDARD INTRODUCES DETAILED RULES ON REVERSALS AND SAFEGUARDS BUT LEAVES HOST COUNTRY LAWS WITH A LIMITED ROLE IN ENSURING PERMANENCE.

In response to a request in the RMPs, in October 2024, the SBM presented the draft Standard: Requirements for activities involving removals under the Article 6.4 mechanism (PACM Removals Standard).[50] This standard, which was taken note of by Parties at CMA.6 in November 2024,[51] applies de facto to GCS activities under the PACM covering various aspects (Box 7).

At the time of writing, further work is ongoing by the SBM and its Methodological Expert Panel (MEP) covering:[52]

- Standard: Addressing non-permanence/ reversals (including post-crediting period monitoring, reporting, and remediation of reversals, post-reversal action; late, incomplete or missing monitoring reports; reversal risk assessment; avoidable and unavoidable reversals, reversal compensation).
- Tool: Reversal Risk Assessment (including upper limits on risk rating; risk rating constituting a negligible risk; remediation measures in the risk assessment tool).
- Other means to implement remedial actions following a reversal (including insurance policies, or comparable guarantee products, or third-party guarantees; a monetary permanence reserve enabling remediation of reversals through the central purchase and cancellation of A6.4ERs with negligible or no reversal risk).

The SBM, at its 17th meeting (August 2025), removed the role of host countries from the scope of the Standard: Addressing non-permanence/ reversals.

Therefore, unlike the CCS CDM Modalities and Procedures, the PACM Removals Standard does not envision a strong role for national laws, regulations or regulators in establishing assurances over the permanence of GCS activities and for remediating any carbon reversals (beyond the approval and authorisation indicated in (a) above).

BOX 7 - TOPICS COVERED IN THE PACM REMOVALS STANDARD

Monitoring and reporting, specifying the scope and frequency of monitoring to be applied, and the items to be reported Post-crediting period monitoring and reporting, requiring monitoring to continue after the end of the last crediting period so as to:

- assess whether any reversals have occurred,
- quantify the amount of reversals, and
- confirm the continued storage of GHGs

Addressing reversals, requiring project participants to prevent and minimise reversals, to remediate any reversals in full, and to implement the following:

- Reversal risk assessment, considering risks such as financial, regulatory, political/governance, natural disturbance, climate impacts, and to establish a risk mitigation plan. The methodology is to be set out in a Reversal Risk Assessment Tool (forthcoming).
- A Reversal Risk Buffer Pool Account, with contributions based on quantitative results of the reversal risk assessment. Also includes the option to tag A6.4ERs as being at negligible risk of reversal.

Remediation of reversals, specifying the conditions under which the Reversal Risk Buffer Pool Account may be accessed to remediate reversals.

The PACM Removals Standard requires project participants to self-assess the risk of reversal, albeit subject to validation, verification and SBM oversight.

c. **Environmental and social safeguards**

The PACM Removals Standard requires participants to apply robust social and environmental safeguards to minimise and, where possible, avoid negative environmental and social impacts of the activity. All projects developed under the PACM must be assessed using the A6.4 Sustainable Development Tool (A6.4 SD Tool).

The SBM, at its 10th meeting (February 2024), requested the UNFCCC secretariat to develop new specific annex(es) to the A6.4 SD Tool to include “safeguards criteria and guiding questions specific to respective CDR activities at an appropriate stage in its development of regulations for activities involving removals”.[53]

The SBM, at its 17th meeting (August 2025), further clarified the request for additional criteria and guiding questions for safeguards for various CDR methods, “including DACCS and BECCS”. Work on the A6.4 SD Tool remains ongoing at time of writing and new specific annexes have yet to be published. As such, expectations around the sustainable development contributions or other environmental and social safeguards to be met by eCDR methods under the PACM are pending.

Article 6.2 (cooperative approaches)

Article 6.2 cooperative approaches differ from Article 6.4 in having decentralised governance, albeit subject to common guidance around the types of units, participation, accounting and re-

Countries wishing to host GCS-based activities under PACM and generate credits as A6.4ERs will need to, among others: (i) indicate public support and include such activities within their NDCs; and (ii) comply with PACM standards and tools to manage non-permanence risk and carbon reversal.

In accordance with the Paris Agreement, any CO2 leaks (carbon reversal) from GCS sites will need to be monitored and reported as emissions by the host country in accordance with the 2006 IPCC Guidelines, thereby directly impacting upon its capacity to meet its NDC. The requirement applies irrespective of whether the activity was an authorised PACM activity or not (see Section 4.3.1 below).

Therefore, although the PACM seeks to establish measures for remediating carbon reversals only at the level of activity participants, ultimate liability for any GCS site leaks (carbon reversals) will fall upon the host country regardless of the PACM buffer account or other project level mechanisms.

porting by participating Parties.[54] The decentralised arrangements can bring various bilateral and multilateral crediting systems into the ambit of market mechanisms under the Paris Agreement, including ICP and/or domestic standards. Third party mechanisms compliant with Article 6.2 guidance have latitude to set their own methodological and governance requirements.

a. Policy support for GCS activities

In a similar way as required under the RMPs, Article 6.2 guidance mandates each participating Party in a cooperative approach to ensure that:

> *"4….(f) Its participation contributes to the implementation of its NDC and long-term low-emission development strategy, if it has submitted one…"* [55]

The implication is that any Party wishing to host and credit GCS-based activities under Article 6.2 must include variants of the technology within its NDC or LT-LEDS. In the same way as under PACM, inclusion within NDCs offers an assurance check for host country policy support for the technology, as well as acknowledgment of the associated MRV responsibilities. As noted above for PACM, such inclusion is limited at present.

Countries hosting a cooperative approach are also required to authorise and report and account (track) for transactions of the resulting units (ITMOs).

b. Legal and regulatory requirements

As with the RMPs for Article 6.4, guidance on Article 6.2 cooperative approaches notes that ITMOs resulting from a cooperative approach must be:[56]

> *'1…(c) Measured in metric tonnes of carbon dioxide equivalent (t CO2 eq) in accordance with the methodologies and metrics assessed by the Intergovernmental Panel on Climate Change…'*

Countries generating ITMOs from GCS-based cooperative approaches will therefore need to fulfil the requirements of the 2006 IPCC Guidelines, including legal and regulatory considerations therein (Box 5; Annex A).

Most methodologies and protocols require GCS sites to be permitted under national laws and regulations in order to be credited or certified under the standard. Two approaches are emerging in these respects:

1. Limiting jurisdictions. Several standard setters limit applicability of their GCS methodology/protocol to jurisdictions with dedicated laws and regulations that include appropriate legal and regulatory safeguards for GCS sites (e.g. ACR and domestic crediting systems; Section 3.2)
2. Prescribing expectations. More recently, standard setters—including Verra/VCS, Gold Standard, GCC, Puro.earth and Isometric—have set out legal criteria and/or technical guidance for the regulatory oversight to be applied in candidate host jurisdictions. Some refer to specific legal and regulatory systems, but also apply some subtlety on the exact expectations for permitting, while others may offer greater latitude for interpretation in terms of scope and applicability (see Section 3.2.6).

ARTICLE 6.2 COOPERATIVE APPROACHES GIVE COUNTRIES FLEXIBILITY TO CREDIT GCS ACTIVITIES, BUT REQUIRE NDC INCLUSION, IPCC-ALIGNED MRV, AND ROBUST NATIONAL LAWS OR EQUIVALENT SAFEGUARDS.

UNDER ARTICLE 6.2, COUNTRIES HOSTING GCS MUST SHOW IN INITIAL REPORTS HOW THEY WILL MANAGE NON-PERMANENCE, ALLOCATE REVERSAL LIABILITY, AND SAFEGUARD SUSTAINABLE DEVELOPMENT.

Parties intending to participate in Article 6.2 are required to submit prior to first authorization an Initial Report, as well as subsequent Regular Information thereafter. These reports shall contain comprehensive information on various matters including: (i) that the Party fulfils the Participation Requirements (as in (a) above); and, (ii) a description of how each cooperative approach ensures environmental integrity in terms of, among others: [57]

> *"18. (h)(iii)…minimizing the risk of non-permanence of mitigation across several NDC periods and how, when reversals of emission reductions or removals occur, the cooperative approach will ensure that these are addressed in full."*

Consequently, any country that includes GCS activities within the scope of its NDC and/or LT-LEDS and anticipates implementing these through Article 6.2 should state in its Initial Report how it intends to manage non-permanence risks. Equally, buyer countries in a cooperative approach will need to have considered the matter. In either case, Parties will need to have a strong understanding of the approach taken to legal and regulatory safeguards in the methodologies and protocols that could be used to credit GCS activities under Article 6.2.

As noted for the PACM, the 2006 IPCC Guidelines oblige host countries to monitor and report any emissions from CO2 transport and GCS sites (Box 5), including those resulting for cooperative approaches, and report any emissions in NGHGIs. Therefore, in same way as for the PACM, host countries assume a de facto backstopping role in the event of any carbon reversal, with remediation obligations arising through the counting of reported emissions against the host country's progress made in achieving its NDC (i.e. in BTRs; see Section 4.3.1).

Countries participating in cooperative approaches should therefore consider how responsibility for remediation in the event of a reversal might be allocated and/or shared with standard setters, projects participants and between buyer and seller Parties (or with airlines, in the case of CORISA use under IMP). Examples of measures could include providing host country access to buffer accounts and/or agreeing liability arrangements for remediating carbon reversals in bilateral agreements governing Article 6.2 cooperative approaches.

So far, Switzerland has been most active in establishing bilateral agreements for Article 6.2 cooperative approaches, with 14 in place at the time of writing.[58] Given the active presence of Swiss-based DAC firms in Kenya,[59] the bilateral agreement with Kenya is the most likely of the 14 to encompass GCS. However, while the topic of permanence and carbon reversals is acknowledged therein, the agreement lacks specificity in terms of how principles and criteria for environmental integrity might be practically implemented (Box 8). Further details can be expected in any Initial Reports and Regular Information from Switzerland that pertain to specific projects involving GCS.

In the case of Japan, which operates its own international crediting mechanism (the Joint Crediting Mechanism; JCM), structuring such arrangements could be more straightforward (Box 9).

BOX 8 - PERMANENCE AND CARBON REVERSAL IN THE SWITZERLAND-KENYA BILATERAL AGREEMENT

ARTICLE 3
Environmental integrity
Minimal principles and criteria relevant for ensuring environmental integrity of Mitigation Outcomes, for which transfer and use are authorised, are hereby established:

Mitigation Outcomes shall be new, real, verified, additional to any that would otherwise occur and permanent or achieved under a system that ensures permanence, including by appropriate compensation of any material reversals;

Source: Switzerland-Kenya Implementing Agreement to the Paris Agreement, May 2025

c. Environmental and social safeguards

Within its Article 6.2 Initial Report, as well as in Regular Information provided thereafter, Parties must, among others, describe how each cooperative approach will (or is):

> *"Minimize and, where possible, avoid negative environmental and social impacts and be consistent with its sustainable development objectives."*
>
> [and]
>
> *"Be consistent with the sustainable development objectives of the Party, noting national prerogatives."*

BOX 9 - POTENTIAL GCS SAFEGUARDS UNDER THE JAPANESE JOINT CREDITING MECHANISM (JCM)

Under the JCM, each partner country signs a bilateral agreement with the Government of Japan (see: https://www.jcm.go.jp/about). Various relevant safeguards are included in the project evaluation criteria. For example, Annex I of the FY2022 Guidelines for Submitting Proposals include the following eligibility requirements:

2) Is the model project expected to reduce emissions of GHG including energy-related CO2 through JCM?

- The model project should be consistent with the climate change policies in the country where the project is implemented (hereinafter referred to as 'partner and other countries').

6) Are the decarbonizing technologies internationally in practical use and can be introduced in the partner and other countries? This means:

- The technologies should be realized in other project(s) (a track record of commercial operation or demonstration project etc. will be reviewed), or the facilities/equipment using the technology should be commercially manufactured (Catalogues, specification etc. will be reviewed).
- Are equipment maintenance technologies and local support available in the partner and other countries?

11) Does the model project adhere to the environmental and social legal system requirement?

- The installation and operation of the facilities/equipment shall comply with the environmental laws and regulations of the partner country and refer to international practices and guidelines regarding the environmental protection (air pollution, water contamination, waste treatment, noise/vibration, ecosystem etc.).

Further, the Japan Oil, Gas and Metals National Corporation (JOGMEC) has established guidelines for CCS projects, which draws heavily on ISO and U.S. best practice standards. The JOGMEC work could be integrated with JCM bilateral agreements to ensure best practice is followed for CCS projects under the JCM.

Sources: GEC (2022) Call for Proposals for JCM Model Projects in FY2022, Guidelines for Submitting Proposals. 6 April 2022. Global Environment Centre Foundation (GEC). JOGMEC (2022). Recommended guideline for the implementation of Carbon dioxide Capture and Storage projects (JOGMEC CCS guideline). Executive Summary. Version 1. May 2022. Japan Oil, Gas and Metals National Corporation (JOGMEC).

As outlined above (Section 3.2.7), third party standards generally require environmental, sustainability and social impacts to be assessed for all project types.

GCS methodologies and protocols also increasingly require project proponents to undertake specific risk and safety assessments for each activity, the results of which could be used to inform environmental and socio-economic impacts and risks (see Section 3.2.7 for examples).

Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

Credits originated under either the PACM or Article 6.2 cooperative approaches maybe used towards the CORSIA in respect of OIMP/IMP.

Credits originated by ICPs or other standards can be treated as CORSIA Eligible Emission Units (CEEUs) when they are: (i) originated from ICPs and methodologies thereunder approved by the CORSIA Technical Advisory Body; (ii) authorised for use towards IMP by the host country Party; and, (iii) meet the test for applying a CORSIA label as set out in the applicable ICP's rules.

CEEUs can be used by airlines participating in CORSIA to offset their reported emissions, and will be correspondingly adjusted by the country of origination (see Section 4.3).

Most of the ICPs reviewed in this Handbook are approved to supply CEEUs by the CORSIA Technical Advisory Body. However, the Technical Advisory Body has through various ways so far excluded methodologies involving GCS or enhanced removals.[60]

THE CORSIA TECHNICAL ADVISORY BODY HAS SO FAR EXCLUDED METHODOLOGIES INVOLVING GCS OR ENHANCED REMOVALS.

FOR GCS TO COUNT UNDER THE PARIS AGREEMENT, PROJECTS MUST BE INCLUDED IN NDCS AND RECORDED IN NATIONAL INVENTORIES TO ENABLE PROPER TRACKING AND ADJUSTMENTS.

Countries wishing to host GCS-based activities as Article 6.2 cooperative approaches and generate credits as ITMOs will need to, among others: (i) include such activities within their NDCs; and (ii) state in their Initial Report how they intend to manage non-permanence risk and carbon reversal.

Any CO2 leaks (carbon reversal) from GCS sites will need to be monitored and reported as emissions by the host country in accordance with the 2006 IPCC Guidelines, thereby directly impacting upon its capacity to meet its NDC. The requirement applies irrespective of whether the activity was an authorised Article 6.2 cooperative approach or not (see Section 4.3.1 below). As such, Initial Reports and Regular Information should address how liability for remediating carbon reversals will be managed between ITMO buyers and sellers.

The bilateral agreements between Parties participating on Article 6.2 cooperative approaches incorporating GCS activities will likely need to carefully consider the approach to address the risk of non-permanence and the allocation of responsibility to remediate carbon reversals (see Japan's Joint Crediting Mechanism; JCM, or the Swiss Article 6 procurement programme).

CORSIA has yet to approve any CCS or eCDR methodologies as eligible to generate CEEUs.

4.3 ACCOUNTING

For GCS activities to be effectively counted within the Paris Agreement framework, the resulting reductions and/or removals must be recognised and counted not only in approaches under Article 6 (as described above), but also in the tracking of progress made in implementing and achieving Parties' NDCs.

Both components are related: activities that Parties consider eligible for crediting under Article 6 should be included in NDCs, while the application of corresponding adjustments to A6.4ERs and/or ITMOs under Article 6 mean that the reductions and/or removals must be effectively recorded in the host country NGHGI in order to make the necessary adjustments during NDC progress tracking.[61]

4.3.1 Counting GCS activities towards NDCs

As noted above (Section 4.2.2), Article 13 of the Paris Agreement requires signatory Parties to regularly provide:

- a NGHGI of anthropogenic emissions by sources and removals by sinks of GHGs using good practice methodologies accepted by the IPCC and agreed upon by the CMA.
- information necessary to track progress made in implementing and achieving its NDC.

In respect of these requirements, two further UNFCCC decisions govern NDC design and implementation:

1. Information to enhance clarity and understanding (ICTU; Decision 4/CMA.1), which provides guidance on the information that Parties should disclose in preparing their NDCs.
2. The enhanced transparency framework and its modalities procedures and guidelines (ETF/MPGs; Decision 18/CMA 1.), which set out the reporting that Parties must provide in tracking progress towards achieving their NDC.

Including GCS in NDCs

For NDC design, ICTU requires that an NDC's scope include:[62]

> *"…sectors, gases, categories and pools […] consistent with Intergovernmental Panel on Climate Change (IPCC) guidelines".*

> And that, in accounting for NDCs:

> *"Parties whose NDC cannot be accounted for using methodologies covered by IPCC guidelines provide information on their own methodology used…"*

> [and also that]

> *"…once a source, sink or activity is included, continue to include it".*

Tracking GCS towards NDCs

For NDC tracking, the ETF requires Parties to submit BTRs that must include, among others, a NGHGI as well as measures of progress made in achieving the NDC.

The guidance provided in ICTU means that Parties wishing to use CCS or eCDR in pursuit of NDCs should acknowledge the detailed good practice methodological guidance for hosting GCS sites set out in the 2006 IPCC Guidelines (Box 5; Annex A).

The absence of specific guidance on DACCS also means that a Party looking to deploy such activities will need to provide information in their NDC on the accounting measures that they will take to recognise and count the activity in their NGHGIs.

Continued reporting by Parties of the amounts of CO2 captured and geologically stored is contingent on proper monitoring of the GCS. The obligation in ICTU to continue including GCS sites and the ETF requirement to monitor them in accordance with 2006 IPCC Guidelines means that Parties are the de facto underwriter of reversal risk, even where projects were implemented by private entities and/or subject to trading under Article 6.

The conditions for ceasing monitoring set out in Volume 2, Chapter 5, signpost potential conditions under which ongoing liability for reversal residual risks may be curtailed.

The MPGs for the ETF state that in preparing NGHGIs in BTRs:[63]

> *"Each Party shall use the 2006 IPCC Guidelines, and…any subsequent version"*
>
> [and that]
>
> *"Each Party may use nationally appropriate methodologies if they better reflect its national circumstances and are consistent with the IPCC guidelines"*
>
> [and that]
>
> *"Each Party shall report methods used, including the rationale for the choice of methods, in accordance with good practice elaborated in the IPCC guidelines"*

The decisions of the UNFCCC regarding both NDC design and tracking show clear direction towards the use of the 2006 IPCC Guidelines (Box 5).

4.3.2 Double counting

Double counting or claiming is not an issue unique to CCS or eCDR, but rather a wider topic to be addressed in interactions and accounting between VCM and government-to-government carbon trading. For the environmental integrity of the Paris Agreement, the matter is addressed through the authorizations and corresponding adjustments provisions in the Article 6 rules.

Yet, some stakeholders have called for corporate climate-related compensation or neutralisation claims using carbon credits to be backed by corresponding adjustments or otherwise be limited to that of a 'mitigation contribution' type claim. Proponents of this approach assert that without the corresponding adjustment, a double claim by a country and a company casts doubt upon any offset claim by the company, and that the limitation to a contribution claim helps to reinforce the idea that offsetting should not replace measures by companies to reduce their own emissions.

On the other hand, such credits and claims could occur within a single country, which if corresponding adjustments are applied, means the corporate entity may lay claim to a reduction or removal that may not be counted by its own host country government.[64] Yet, host country governments would rather tend to rely upon such 'double counting' to occur in order to promote domestic climate action by private actors.[65] For this reason, in circumstances where credits from a GCS activity are acquired by an entity to substantiate corporate climate-related claims, and the same associated reductions or removals are also recorded in the NGHGI of the host country, the arrangement should be considered as one on 'nesting' rather than double counting or claiming: the emissions of the corporation and the reductions or removals achieved by the GCS activity are nested and therefore counted in the same NGHGI of the country in which they occur.[66] As a corollary, eliminating the concept of nested GHG inventories in essence places corporate and country GHG accounts on an equal footing in respect of the Paris Agreement.

Similarly, if a corporate credit acquisition and cancellation involves cross-border trade without authorizations (or an authorization for other purposes), the measured reduction or removal will be reflected in the NGHGI of the host country and no corresponding adjustment needs to be applied in respect of achieving its NDC: the benefit of the action will remain with the host country. Without a corresponding adjustment, the corporate's country of residence will have no claim to the credit towards achieving its NDC. Thus, although the action may be claimed by both the corporate and the host country in which the activity took place, the corporate claim and related accounting remains entirely within the purview of the VCM and has no impact upon the environmental integrity of the Paris Agreement.

If, on the other hand, the credit acquired and cancelled by the corporate is authorised by the host country for use towards NDC or IMP, but not by the buyer country (i.e. partial corresponding adjustment by the supplier), accounting differences could arise that impact upon environmental integrity—the reductions or removals achieved by activity will be added back to the host country's emissions in respect of NDC achievement, but will not be deducted from any buyer account. As such, a single claim by the corporate does not pose any risk of double counting.

Most ICPs include provisions relating to double counting or double claiming, as well as specific measures for corresponding adjustments especially in relation to IMP (principally CORSIA).

Double counting is not a GCS-specific issue. The risk of double-counting is unlikely to pose issues unless transboundary projects are allowed (i.e. capture in one country and storage in another), although such projects face more significant challenges in terms of authorizations and approvals.

The accounting risks are addressed through the Paris Agreement's requirement to apply corresponding adjustments for transfers of ITMOs or A6.4ERs towards NDCs and for CEEUs under CORSIA.

ANNEX
IPCC 2006 GUIDELINES AND GCS

A.1 COVERAGE OF CCS AND BECCS IN 2006 IPCC GUIDELINES

The following sections of the 2006 GLs apply to CCS and BECCS activities:

- **Volume 1, Chapter 1 (Introduction).** The general concepts for reporting indicates that (i) CO2 emissions from biomass combustion for energy are reported in AFOLU Sector as part of net changes in carbon stocks; (ii) captured CO2 should be allocated (i.e. reported as emitted) in the sector generating the CO2 unless it can be shown that the CO2 is "stored in properly monitored geological storage sites as set out in Chapter 5 of Volume 2". Therefore, countries wishing to count mitigation activities utilizing GCS towards their NDCs must fulfil the MRV requirements for CO2 transport and storage described below.

- **Volume 2, Chapter 2 (Stationary Combustion).** Subsection 2.3.4 describes how emissions reductions achieved by CO2 capture at combustion sources may be deducted from the relevant sector emissions total in the NGHGI. This includes capture of CO2 from fossil thermal, biomass or waste-to-energy fuelled power plants. The guidance confirms capture of biogenic CO2 can be treated as negative emissions in NGHGIs. In all cases, Tier 3 methods must be applied to CO2 capture sources.[67]

- **Volume 2, Chapter 4 (Fugitive Emissions).** This section describes how both fugitive emissions from GCS projects and the transport and disposal of acid gas from oil and gas facilities must be treated. Subsection 4.2.1 describes methods for natural gas processing and hydrogen production. Guidance on accounting and reporting of emissions from EOR systems is also included.

- **Volume 3, various chapters (Industrial Processes and Product Use).** Chapter 1 describes the general methods for the capture of process CO2 emissions from industrial activities, while the specific chapters for each subsector provide further details on capture from each emissions source type (cement (2.2), methanol (3.9), ammonia (3.2), iron and steel (4.2)).

- **Volume 2, Chapter 5 (Carbon Dioxide Transport, Injection and Geological Storage).** This chapter sets down specific requirements for the MRV of CO2 after the capture stage, covering emissions from the transport of CO2 in pipelines, surface injection facilities and underground geological CO2 storage sites.

In combination, the guidance in Volumes 2 and 3 provide the basis for monitoring and reporting captured and geologically stored fossil and biogenic CO2 as 'not emitted' in NGHGIs (i.e. recognising GCS activities as mitigation measures/activities). This provides the basis for the MRV of GCS activities as measure within NGHGIs and BTRs (Section 4.3.1).

Importantly, CO2 captured in the relevant source sectors may only be deducted from the sector totals in a country's NGHGI if it is stored in "properly monitored storage sites" following the guidance in Volume 2, Chapter 5.[68] Therein, Volume 2, Chapter 5, sets down detailed requirements for inventory compilers to follow in respect of the oversight to GCS in order to build confidence in the durability of storage.

Presently DAC is not covered by IPCC GHG inventory compilation guidance, although the elements applicable to geological CO2 storage sites should be seen as common, regardless of CO2 source (see also Box 5).

These requirements are described in detail below.

A.2 REQUIREMENTS FOR CO2 STORAGE SITES UNDER IPCC 2006 (VOL. 2, CH. 5)

A.2.1 Monitoring

NGHGI compilers must apply Tier 3 monitoring to estimate emissions from the capture, transport, and storage of CO2. All data collected by operators at the site level must therefore be reported to the host country NGHGI compiler and directly used to compile the NGHGI report.

Estimates of emissions from these activities based on Tier 1 or Tier 2 emissions factors may not be used for NGHGI compilation: actual activity level data must be used.

A.2.2 Methodology: Site characterisation and selection

Volume 2, Chapter 5, sets down specific Tier 3 requirements for geological CO2 storage sites to 'help build confidence that there will be minimum leakage' (p. 5.14). In these respects, the 2006 IPCC Guidelines state that:

- "In order to understand the fate of CO2 injected into geological reservoirs over long timescales, assess its potential to be emitted back to the atmosphere or seabed via the leakage pathways identified in Table 5.3, and measure any fugitive emissions, it is necessary to:

  (a) Properly and thoroughly characterise the geology of the storage site and surrounding strata;
  (b) Model the injection of CO2 into the storage reservoir and the future behaviour of the storage system;
  (c) Monitor the storage system;
  (d) Use the results of the monitoring to validate and/or update the models of the storage system."
  (pp. 5.13-5.14)

In order to meet Tier 3 reporting requirements these same requirements must be devolved to GCS site operators. Thus, any GCS standard, methodology or protocol (as covered in the main sections of the Handbook) must look to fulfil these requirements so that emission reductions or removals achieved by GCS project activities can be effectively recorded in national inventory reports. Accounting and policy problems will arise if this this not fulfilled.

A.2.3 Methodology: Regulatory aspects

In respect of regulatory interactions, the method in Volume 2, Chapter 5, suggests that:

"...if one or more appropriate governing bodies that regulate carbon dioxide capture and storage exist, then the inventory compiler may obtain emissions information from those bodies... [and that]... If no such agency exists, then it would be good practice for the inventory compiler to follow the methodology presented below."

The step-wise methodology presented below this chapeau covers, among others, the following:

1. Identify and document all geological storage operations in the jurisdiction...
2. Determine whether an adequate geological site characterization report has been produced for each storage site....
3. Determine whether the operator has assessed the potential for leakage at the storage site...
4. Determine whether each site has a suitable monitoring plan...
5. Collect and verify annual emissions from each site...

Significant effort by the NGHGI compiler is therefore required if there GCS regulations are locally absent.

A.2.4 Quality Assurance, Quality Control

Fulfilling the QA/QC requirements in the 2006 IPCC Guidelines implies several de facto regulatory approval and verification elements to be implemented by the NGHGI compiler or other national regulatory agencies. Specifically:

"On-site QA/QC will be achieved by regular inspection of monitoring equipment and site infrastructure by the operator. Monitoring equipment and programmes will be subject to independent scrutiny by the inventory compiler and/or regulatory agency. (pp. 5.19)

All data including the site characterization reports, geological models, simulations of CO2 injection, predictive modelling of the site, risk assessments, injection plans, licence applications, monitoring strategies and results and verification should be retained by the operator and forwarded to the inventory compiler for QA/QC.

Where applicable, the relevant regulatory body can provide verification of emissions estimates and/or the monitoring plan described above. If no such body exists, the site operator should at the outset provide the inventory compiler with the results of peer review by a competent third party confirming that the geological and numerical models are representative, the reservoir simulator is suitable, the modelling realistic and the monitoring plan suitable.

As they become available, the site operator should compare the results of the monitoring programme with the predictive models and adjust models, monitoring programme and/or injection strategy appropriately. The site operator should inform the inventory compiler of changes made." (5.20)

Furthermore, Section 5.10 specifies the Reporting and Documentation to be obtained by the national inventory compiler prior to the start of geological storage operations:

5.10 REPORTING AND DOCUMENTATION

Guidelines for reporting emissions from geological storage:
Prior to the start of the geological storage operation, the national inventory compiler where storage takes place should obtain and archive the following:

- Report on the methods and results of the site characterization
- Report on the methods and results of modelling
- A description of the proposed monitoring programme including appropriate background measurements
- The year in which CO2 storage began or will begin
- The proposed sources of the CO2 and the infrastructure involved in the whole CCGS chain between source and storage reservoir.

The same national inventory compiler should receive annually from each site:

- The mass of CO2 injected during the reporting year
- The mass of CO2 stored during the reporting year
- The cumulative mass of CO2 stored at the site
- The source (s) of the CO2 and the infrastructure involved in the whole CCGS chain between source and storage reservoir
- A report detailing the rationale, methodology, monitoring frequency and results of the monitoring programme - to include the mass of any fugitive emissions of CO2 and any other greenhouse gases to the atmosphere or seabed from the storage site during the reporting year.
- A report on any adjustment of the modelling and forward modelling of the site that was necessary in the light of the monitoring results.
- The mass of any fugitive emissions of CO2 and any other greenhouse gases to the atmosphere or seabed from the storage site during the reporting year.
- Descriptions of the monitoring programmes and monitoring methods used, the monitoring frequency and their results.
- Results of third-party verification of the monitoring programme and methods.

There may be additional reporting requirements at the project level where the site is part of an emissions trading scheme." (p. 5.20)

Consequently, any GCS standing, methodology or protocol must be cognizant of these reporting obligations and include them accordingly in order to align project and national GHG accounts. Problematically, the inventory compiler in most jurisdictions is unlikely to be sufficiently competent or suitably prepared for the collection and review of these sorts of technical reports, information and data.

A.2.5 Linkages to permanence, liability, and carbon reversals

In terms of the liability for remediating carbon reversals, countries reporting CO2 as not emitted consistent with 2006 IPCC Guidelines will have to act as the backstop holder of liability for any emissions of stored CO2. Any emissions from GCS sites will need to be included in NGHGIs inside BTRs, and therefore counted against NDC progress.

A project-based methodology can devolve liability to the project operator during the crediting period, and potentially beyond the crediting period and into the post-injection phase through ongoing monitoring and remediation obligations. Section 3.2.6 considers the current approaches across methodologies and protocols. The extent to which ongoing monitoring can be enforced through a voluntary standard is open to debate, however, as discussed in the main body of the handbook (Section 4.2.2).

For long-term monitoring, the 2006 IPCC Guidelines support reduction and cessation of monitoring on a performance basis. Specifically, host countries are required to ensure that:

"The [monitoring] plan should provide for monitoring of the site after the injection phase. The post-injection phase of monitoring should take account of the results of the forward modelling of CO2 distribution to ensure that monitoring equipment is deployed at appropriate places and appropriate times. Once the CO2 approaches its predicted long-term distribution within the reservoir and there is agreement between the models of CO2 distribution and measurements made in accordance with the monitoring plan, it may be appropriate to decrease the frequency of (or discontinue) monitoring. Monitoring may need to be resumed if the storage site is affected by unexpected events, for example seismic events." (pp. 5.15-5.16).

The provisions for continued monitoring of the site post-injection, and the termination of monitoring, can help inform methodological choices regarding the period of time during which project operators must undertake storage monitoring.

A.3 TRANSBOUNDARY ACCOUNTING

The 2006 IPCC Guidelines include provisions for the MRV and accounting of cross-border transfers of CO2 across a chain of operations. Specifically, in respect of the Reporting and Documentation requirements, inventory compilers are obliged to meet the following requirements:

"Reporting of cross-border CCS operations

CO2 may be captured in one country, Country A, and exported for storage in a different country, Country B. Under this scenario, Country A should report the amount of CO2 captured, any emissions from transport and/or temporary storage that takes place in Country A, and the amount of CO2 exported to Country B. Country B should report the amount of CO2 imported, any emissions from transport and/or temporary storage (that takes place in Country B), and any emissions from injection and geological storage sites.

If CO2 is injected in one country, Country A, and travels from the storage site and leaks in a different country, Country B, Country A is responsible for reporting the emissions from the geological storage site. If such leakage is anticipated based on site characterization and modelling, Country A should make an arrangement with Country B to ensure that appropriate standards for long-term storage and monitoring and/or estimation of emissions are applied (relevant regulatory bodies may have existing arrangements to address cross-border issues with regard to groundwater protection and/or oil and gas recovery).

If more than one country utilizes a common storage site, the country where the geological storage takes place is responsible for reporting emissions from that site. If the emissions occur outside of that country, they are still responsible for reporting those emissions as described above. In the case where a storage site occurs in more than one country, the countries concerned should make an arrangement whereby each reports an agreed fraction of the total emissions." (pp. 5.20-5.21)

These requirements imply that a project activity that potentially risks cross-border movement of CO2 – either deliberately, accidently, or because of shared infrastructure – will need to ensure agreement is reached between the relevant countries regarding how monitoring and reporting will be undertaken, and how liability will be allocated in the event of carbon reversals.

These types of requirements typically far exceed the types of obligations that can be placed on a project developer within voluntary carbon crediting methodologies.

BOX 10 - CROSS-BORDER CCS PROJECTS UNDER THE CDM

The cover decision to the CDM CCS M&Ps agreed that the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol (CMP) would consider "The eligibility of carbon dioxide capture and storage project activities which involve the transport of carbon dioxide from one country to another or which involve geological storage sites that are located in more than one country".

A UNFCCC Technical Report on transboundary projects was prepared in 2012 (UNFCCC 2012) to support decisions in these regards. The paper covered a range of technical scenarios and some of the potential legal aspects and implications. However, since then, no further decisions were taken by the CMP to determine eligibility of cross-border CCS projects and so guidance is lacking in these respects.

Notes: 1Decision 10/CMP.7; 2UNFCCC, 2012. Transboundary carbon capture and storage project activities. Technical paper. FCCC/TP/2012/9.

1. IETA Geostorage and Carbon Crediting: A Comprehensive Handbook for Methodological Design and Safeguarding.
2. Not all current GCS-related quantification or crediting methodologies are covered (e.g. Australian Carbon Credit Unit (ACCU) Scheme is presently excluded). The review also excludes CCS within the scope of emissions trading (e.g. the EU emissions trading scheme; EU ETS) and where CCS or eCDR falls into the purview of low carbon fuel standards (e.g. the California CCS Protocol under the LCFS; CCS treatment in the EU Renewable Energy Directive).
3. IETA Geostorage and Carbon Crediting: A Comprehensive Handbook for Methodological Design and Safeguarding.
4. ACR is in the process of further expanding the scope in a forthcoming methodology update (v2.0), which includes CO2 capture from bioenergy as well as storage in depleted hydrocarbon reservoirs and saline aquifers
5. Injection of CO2 dissolved in water into basalts for the purposes of geological storage by rapid shallow mineralization.
6. The CO2 generated from biomass combustion or decomposition can only be treated as zero-rated—and therefore counted as negative emissions when captured and geologically stored—if the biomass is sourced from managed land where growth and harvesting are in long-term equilibrium (sustainable).
7. The DAC facility and the power plants are to be located on the same electricity transmission system/grid.
8. The time of power plants dispatch and the time of energy use at the DAC facility. Most methodologies currently accept annual matching (i.e. energy supplied and used in the same calendar year) although there are calls increase the granularity to daily or hourly matching.
9. To mitigate against market leakage (e.g. the diversion of low/zero emissions power from other, previous, users), most methodologies limit the vintage of low/zero emissions power plants from which electricity is procured to a maximum of 36 months prior to project start.
10. The loss of CO2 containment and its re-release from the GCS stie to the atmosphere, which reverses the original climate change mitigation effect.
11. The European Union Directive 2009/31/EC on geological CO2 storage ('the CCS Directive'); U.S. EPA Safe Drinking Water Act, Underground Injection Control, Class VI Well Rule ('the UIC Class VI Well Rule')
12. "Located in a jurisdiction where regulatory oversight is: 1) is provided by the government or a government agency (i.e., a statutory regulator); 2) meets the minimum criteria [specified in the GCS Requirements v4.1 document]". The latter includes requirements for drilling permits, access and tenure rights, assignment of responsibility for closure and funding for post-injection site care etc.
13. In addition to requiring a well permit issued by a "relevant authority", it states that "The site should be well characterized in accordance with the permit application and approval requirements under the national/international regulations. If there is a lack of distinct relevant local regulations to meet the minimum requirements of this Module, Project Proponents are required to follow either the U.S. EPA Underground Injection Control (UIC) or EU directives."
14. Table 1 therein sets out minimum legal "robustness" requirements.
15. A withheld credit reserve that can be called upon to remediate/compensate for any reversals in circumstances where releases of stored CO2 exceed the level of measured reductions or removals within a given timeframe (i.e. a monitoring period).
16. ACR (v2.0) will apply a risk analysis that can allow for the Reserve contribution to be reduced.
17. A6.4-SBM014-A06 / A6.4-STAN-METH-002. Also covers emission reduction activities with reversal risks (e.g. fossil CCS)
18. Decision 2/CMA.3; Annex I.
19. With leadership from Mitsui & Co.
20. BECCS and DACCS form a core part of a suite of technologies referred to as engineered carbon dioxide removal.
21. https://www.ieta.org/initiatives/high-level-criteria-for-carbon-geostorage-activities/
22. https://www.ieta.org/ieta-publishes-comprehensive-global-handbook-on-geostorage-and-carbon-crediting
23. Measured removals should be recorded as negative emissions for calculation purposes.
24. The term seepage refers to fugitive emissions (leaks) from the CCS system to avoid confusion with emissions leakage outside of project boundaries.
25. Not all current GCS-related quantification or crediting methodologies are covered (e.g. Australian Carbon Credit Unit (ACCU) Scheme is presently excluded). The review also excludes CCS within the scope of emissions trading (e.g. the EU emissions trading scheme; EU ETS) and where CCS or eCDR falls into the purview of low carbon fuel standards (e.g. the California CCS Protocol under the LCFS; CCS treatment in the EU Renewable Energy Directive).
26. The capture of co-mingled fossil CO2, as might be found in waste incinerator emissions, is allowed but not credited.
27. ACR forthcoming update (v2.0) will include storage in depleted hydrocarbon reservoirs and saline aquifers.
28. The Orca and Mammoth projects in Iceland have been permitted in alignment with the EU CCS Directive, suggesting that approach could be relevant to the EU and UK methodologies.
29. Isometric modules include GHG Accounting, Energy Use Accounting, Transportation Emissions Accounting, Embodied Emissions Accounting, Biomass Feedstock Accounting etc. These refer to the inclusion of emissions arising from monitoring activities and also from staff travel.
30. Tool for the demonstration and assessment of additionality
31. Combined tool to identify the baseline scenario and demonstrate additionality
32. Environmental additionality equates to an assessment of whether an activity leads to emission reductions or removals that exceeds a pre-agreed crediting baseline, such as a standardised performance benchmark.
33. Where CORCS are unavailable, the CO2 Supplier may surrender other 'unretired certified carbon removal credits of comparable physical storage permanence and comparable low risk of reversal' subject to Puro.earth approval.
34. See Annex, B-2.4.
35. Based on assessing the environmental and socio-economic impacts of an activity
36. Section 4: Assessment Framework - Core Carbon Principles 2023, The Integrity Council for the Voluntary Carbon Market
37. FCCC/TP/2012/9: Technical paper on transboundary carbon capture and storage project activities
38. FCCC/SBSTA/2012/L.21: Draft conclusions proposed by the Chair
39. Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol
40. Decision 10/CMP.7 Annex, Section F (Participation Requirements), paragraph 8.
41. Non-market cooperative approaches under Article 6.8 are not considered here, although similar safeguarding questions would apply were GCS activities to be included thereunder.
42. Decision 3/CMA.3.
43. Decision 3/CMA.3. Annex, para 26(e).
44. Decision 3/CMA.3. Annex, para 40.
45. Decision 3/CMA.3. Annex, paras 41-45.
46. The requirement for internationally transferred mitigation outcomes to be added back to a Party's NDC tracking account when counted against another Party's NDC or used for other international mitigation purposes or other purposes.
47. Zakkour, P.D. and W. Heidug, 2019. A Mechanism for CCS in the Post-Paris Era: Piloting Results-Based Finance and Supply Side Policy Under Article 6. King Abdullah Petroleum Studies and Research Center discussion paper. April 2019. https://doi.org/10.30573/KS--2019-DP52.
48. Zakkour, P.D., J. Lujan, G. Cook and A. Frey (forthcoming). Carbon Crediting Standards for Technology-Based Carbon Dioxide Removal in Developing Countries. A report by Carbon Counts and Energy Changes, sponsored by the World Bank
49. Conference of the Parties serving as the Meeting of the Parties to the Paris Agreement
50. A6.4-SBM014-A06 / A6.4-STAN-METH-002. Also covers emission reduction activities with reversal risks (e.g. fossil CCS)
51. Decision 5/CMA.6
52. Workplan of the MEP, 2025
53. A6.4-SB010-Meeting report
54. Decision 2/CMA.3
55. Decision 2/CMA.3. Annex II, paragraph 4(f)
56. Decision 2/CMA.3; Annex I.
57. Decision 2/CMA.3; Annex IV.A and B.
58. https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/klimapolitik/climate--international-affairs/staatsvertraege-umsetzung-klimauebereinkommen-von-paris-artikel6.html
59. https://climeworks.com/press-release/climeworks-and-great-carbon-valley-chart-path-to-large-scale-dac
60. ICAO (International Civil Aviation Organisation) 2024. CORSIA Emissions Unit Eligibility Criteria. Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). October 2024.
61. In other words, a carbon removal must be first be recorded in the NGHGI, and, where it is treated as an ITMO under Article 6, then correspondingly added back to the national emissions totals in the NGHGI for the purposes of NDC progress tracking.
62. Decision 4/CMA.1, Annex I.3(b), Annex II.1(b), Annex II.3(b))
63. Decision 18/CMA.1, Annex C.1. para 20, para 22. Annex E.1, para 39.
64. Because the host country government has applied a corresponding adjustment against the credit origination but not against the emissions of the corporate.
65. In other words, when a government creates policy to incentivise private actors to mitigate emissions, these actions should result in measurable reductions or removals in its NGHGI and therefore count towards achieving its NDC.
66. See IEAGHG 2024. Measurement, Reporting and Verification (MRV) for Carbon Dioxide Removals (CDR) in the context of both project-based approaches and national greenhouse gas inventories. IEA Greenhouse Gas R&D Programme, TR 2024-09, October 2024, https://doi.org/10.62849/2024-09
67. The IPCC Guidelines allow for different tiers to be used to estimate emission and removals by sinks. Tiers 1 and 2 involve the use of international or regional emission factors, respectively. Tier 3 methods usually involve the use of data and information specific to a particular project or activity, thereby resulting in a better quality of NGHGI.
68. 2006 IPCC, Volume 1, section 1.1

TABLES ON Pg 12-13

ICP	Independent crediting programme
C	Crediting (estimating net removal for purposes of issuing carbon credits)
Q	Quantification (estimating net carbon removal, which could form the basis for issuance of carbon credits)
LP	Local permit (requires a dedicated CO2 geostorage permit [e.g. US EPA Class VI, EU CCS Directive, Canadian Provincial laws etc or equivalent]). MS = Member State of the EU, aligned with EU CCS Directive requirements
LP + TG	Local permit + Technical guidance (requires a dedicated CO2 geostorage permit meeting technical guidance provided in the standard). (g) genotes that a general permit is allowed if issuance is based on the use of information aligned with the provided technical guidance.
LP + LG	Local permit + Legal guidance (requires a dedicated CO2 geostorage permit, issued according to the legal guidance/checklist provided in the standard)
RS	Regulatory surplus test.
FA	Financial additionality test.
CP	Common practice analysis.
PS	Performance standard test (environmental or technical)
P	Projection-based (i.e. assumed that captured and injected CO2 would otherwise be emitted or remain in atmosphere - often correlated with historical emissions/removals)
S	Standards-based (i.e. emissions absent of the project activity estimated using a benchmark providing similar product or service)
R/NB	Retrofit or new-build modifies baseline scenario and emission requirements (e.g. retrofit means supply chain emissions exist in the baseline)
LUC	Land use change effect to be considered in the baseline accounting for the carbon storage in an undisturbed site (for NB sites). Similar to counterfactual storage (CS). LUC emissions to be counted in construction emissions.
CS	Counterfactual storage (quantification of the CO2 removal and storage that would have taken place withou the project's activity, assuming the baseline scenario)
B	Buffer reserve (withholding of credits in a dedicated account [e.g. ECCC Environmental Integrity Account; ERT Reserve] to be called upon and units cancelled in the event of a carbon reversal) (r) denotes that the buffer contribution based on a risk rating/risk assessment. (d) denotes that a discount factor is applied to address uncertainty or reversals (e.g. Verra/VCS 'Identification and Assessment of Uncertainties'; Isometric 'Conservative estimate of Removals'; AB portion 'retired to atmosphere'). Discount factor applies in addition to buffer contributions, where relevant. Figures in parenthesis are indicative estimates of the percentage buffer contributions from issued credits. Discount factors would be additional to the buffer contributions. * National geostorage regulations implementing financial mechanisms may incorporate a separate buffer reserve or allow for other forms of insurance against reversal risk.
R	Replacement obligation (of equivalent units; e.g. Section 6.7.5.3 of Puro Standard, v4.2)
CC	Credit cancellation (where reversals occur after injection has ceased but no liability transfer has been enacted). Absence of buffer means that the credits must be acquired (e.g. from market, insurer)
LTM-HC	Liability transfer and long-term monitoring by the state/host country, implying liability for reversals through monitoring of emissions from storage. (o/i) denotes that the ex ante acceptance of, or the transfer of, liability for CO2 storage site monitoring and remediation to the host country may be optional or is implied rather than prescribed. (r) denotes that the absence of a liability transfer process negatively impacts upon assessed risk.

ACRONYMS AND ABBREVIATIONS

A6.4ER	Article 6.4 emission reduction (tradable unit)
AEPA	Alberta Environment and Protected Areas
BECCS	Bioenergy with carbon capture and storage
BTR	Biennial Transparency Report
CCGS	CO2 capture and geological storage (from 2006 IPCC Guidelines)
CCS	Carbon dioxide (CO2) capture and storage
CEEU	CORSIA Eligible Emissions Unit
CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
CMP	Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
COP	Conference of Parties to the UNFCCC
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CRCF	Carbon Removal and Carbon Farming certification regulation (EU)
DAC	Direct air capture
DACCS	Direct air carbon capture and storage
eCDR	Engineered carbon dioxide removal
EOR	Enhanced oil recovery
ETF	Enhanced transparency framework (Paris Agreement)
GCC	Global Carbon Council
GCS	Geological CO2 storage
GHG	Greenhouse gas
IMP	International mitigation purposes (Article 6)
IPCC	Intergovernmental Panel on Climate Change
ITMO	Internationally transferred mitigation outcome (tradable unit)
LT-LEDS	Long-term low emissions development strategies
M&P	Modalities and procedures
MPGs	Modalities, procedures and guidelines for the ETF
MRV	Measurement, reporting and verification
NDC	Nationally determined contribution
NGHGI	National GHG inventory or anthropogenic emissions by sources or removals by sinks
OIMP	Other international mitigation purposes (Article 6)
RMPs	Rules, modalities and procedures (Article 6.4)
SBM	Article 6.4 (PACM) Supervisory Body
UNFCCC	United Nations Framework Convention on Climate Change
VCM	Voluntary carbon market
VCS	Verified carbon standard
VVB	Validation and verification body

IETA

Headquarters
Grand-Rue 11
CH-1204 Genève
Switzerland
+41 22 737 05 00

Brussels
Rue du Commerce
Handelsstraat 123
1000 Brussels
Belgium
+32 289 55 747

Washington
1001 Pennsylvania Ave. NW
Suite 7117
Washington, DC 20004
+1 470 222 IETA (4382)

Toronto
180 John Street
Toronto, ON
M5T 1X5

Singapore
63 Robinson Rd,
Level 8 Afro-Asia,
Singapore 068894

IETA also has representation in: Argentina, Brazil, China, Colombia, India, Italy, Japan, South Africa, UK and US.

ieta.org