The DEV Carbon Standard 2025

DEV STANDARDS FOUNDATION

DEV DECENTRALIZED ENVIRONMENTAL VERIFICATION CARBON STANDARD

The DEV Carbon Standard 2025.

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LIST OF ACRONYMS

AI – Artificial Intelligence.
CDM – Clean Development Mechanism.
DEV - Decentralized Environmental Verification.
ESG - Environmental, Social and Governance.
ETS - Emissions Trading System.
FPIC - Free, Prior and Informed Consent.
FY - Fiscal Year.
GDP - Gross Domestic Product.
GHG - Greenhouse Gases.
IEEE - Institute of Electrical and Electronics Engineers.
INCOSE - International Council on Systems Engineering.
IPCC - Intergovernmental Panel on Climate Change.
ISO - International Organization for Standardization.
KPI - Key Performance Indicator.
MBSE - Model-based Systems Engineering.
ML - Machine Learning.
MRV - Measurement, Reporting and Verification.
NASA - National Aeronautics and Space Administration.
NBS - Nature-based Solutions.
NIST - National Institute of Standards and Technology.
NRTD - Near Real Time Data.
OT - Offset Type (DEV Classification).
RTD - Real Time Data.
SA - Systems Assurance.
SDG / SDGs - Sustainable Development Goal(s).
SE - Systems Engineering.
SECM - Systems Engineering Competency Model.
SI - Systems Integration.
TEK - Traditional Ecological Knowledge.
TRL - Technology Readiness Level.
UN - United Nations.
UNESCO - United Nations Educational, Scientific and Cultural Organization.
UNFCCC - United Nations Framework Conference on Climate Change.
VCM - Voluntary Carbon Market.

PREFACE - NOTE TO THE READER

Climate change is reshaping every facet of the global economy. Governments, corporations and civil-society actors are racing to align with the Paris-Agreement temperature goal and with evolving national "net-zero" legislation and policy frameworks. A practical pathway to that end combines two complementary levers:

- On-site (internal) mitigation – direct actions that an organization takes within its own operations or supply chain to avoid or cut emissions at the source: switching to renewable electricity, electrifying vehicle fleets, increasing energy efficiency, redesigning products, or substituting low-carbon materials.
- Off-site (external) mitigation – financing climate-positive projects elsewhere that measurably remove or prevent greenhouse-gas (GHG) emissions outside the buyer's footprint. This second level is what gives rise to the instrument known as the carbon credit (often used interchangeably with carbon offset).

A carbon credit represents one metric ton of carbon-dioxide equivalent (tCO_2e) that has been either removed from the atmosphere—through ecosystem restoration, soil-carbon enhancement, direct-air capture, etc.—or prevented from entering it—through renewable-energy deployment, methane destruction, industrial efficiency, and similar activities. Once the credit is retired in a recognized registry, the purchaser can claim that ton to counterbalance ("offset") an equal quantity of its own residual emissions for the same reporting year.

Two broad architectures govern today's use of carbon credits:

- Compliance markets, established by legislation or international agreements (e.g., the European Union Emissions Trading System or the Korean ETS), in which regulated entities must surrender a specific quantity of allowances or verified credits to meet legally binding caps.
- Voluntary carbon markets (VCMs), where organizations purchase carbon offsets to meet self-declared climate targets, satisfy investor or customer expectations, or prepare for future regulations. Although voluntary, VCM transactions continue to expand geographically and sectorally.

Despite their promise, carbon markets face three persistent challenges:

- Transparency – Most standards publish only summary project information, leaving the underlying data—sensor feeds, modelling assumptions, sampling plots—inaccessible to peers, communities, or independent researchers.
- Integrity of impact claims – Key concepts such as additionality, permanence and leakage are frequently interpreted through

heterogeneous methodologies that rely on infrequent manual audits and counter-factual baselines, generating controversy over the real-world climate benefit of many credits.

- Fair benefit-sharing – Communities that live in or near project areas often have limited bargaining power, minimal visibility of contractual terms, and unequal access to the data that determine revenue distribution.

The DEV Carbon Standard 2025 responds to these gaps by combining three pillars:

- Open Data – Every Key Performance Indicator (KPI), supporting dataset, and data source must be published on an online, freely accessible platform, enabling decentralized verification by any stakeholder with an internet connection.
- Systems-Engineering Audits – Independent Engineering Auditors evaluate each project's data architecture against established standards (INCOSE, IEEE, ISO, etc.), then monitor data quality over the life of the project.
- Climate Justice & Biocultural Principles – Negotiations with landowners, communities and Indigenous communities occur after a scientific feasibility study, ensuring equal knowledge of the ecosystem's carbon potential, while contractual terms are limited to ten-year renewable periods to respect social-cultural cycles.

By embedding engineering rigor, open-source transparency, and equitable governance into every stage of the project cycle, the DEV Carbon Standard offers market participants a credible pathway to generate, trade, and retire carbon credits that stand up to scientific scrutiny and open data verification.

Whether you represent a project developer, a credit purchaser, a regulator, or a member of the public, this document is designed to be a practical reference. It explains not only the audit requirements and data protocols that underpin the certification process, but also the broader conceptual framework—why metrics such as weekly tCO_2e absorption, dynamic buffer pools, and additionality with proof-of-value matter for a reliable, high-integrity carbon market.

The chapters that follow assume familiarity with the fundamentals of carbon accounting. If you are new to the field, begin with the forthcoming Key Concepts Glossary, which summarizes the essential terminology used throughout the text. Readers seeking only a high-level overview may find that the Preface and Glossary, together with Section 1 About the DEV Carbon Standard, provide sufficient orientation. Those involved in project integration, audit planning, or data-platform development are encouraged to engage with the full standard, accompanying protocols, and the guides and technical handbooks published by DEV-licensed Certifiers and Auditors.

KEY CONCEPTS GLOSSARY

Carbon credit / Carbon offset (tCO_2e)
A transferable certificate that represents one metric ton of carbon-dioxide equivalent (tCO_2e) either permanently removed from the atmosphere or demonstrably prevented from entering it. Once a credit is “retired” in a registry, no other entity can claim the same certificate.

On-site (internal) mitigation vs. Off-site (external) mitigation
On-site mitigation refers to direct emission-reduction activities within an organization’s own operations or supply chain (e.g., switching to renewable power, electrifying fleets). Off-site mitigation involves financing qualified projects outside that boundary—typically through the purchase and retirement of carbon credits—to counterbalance residual emissions.

Compliance carbon market
A legally mandated trading system (e.g., EU ETS, California Cap-and-Trade) in which regulated entities must surrender allowances or approved credits to satisfy emission caps set by statute or treaty.

Voluntary carbon market (VCM)
A marketplace where organizations purchase and retire offsets without a legal obligation, typically to meet self-declared climate targets, satisfy investor expectations, or prepare for future regulation.

Carbon registry & retirement
Registries issue serial numbers, track ownership and record the final “retirement” of each credit. Retirement marks the credit as used, ensuring a single entity claims the associated certificate just once.

Carbon accounting / Net-zero target
Carbon accounting is the systematic measurement and reporting of an organization’s GHG emissions. A net-zero target commits the organization to reduce emissions as much as technically and economically feasible and to neutralize any residual emissions with high-integrity removals.

Carbon removal vs. Emission avoidance
Carbon removal physically extracts CO_2 from the atmosphere and stores it (e.g., reforestation, direct-air capture). Emission avoidance prevents new CO_2 from being emitted in the first place (e.g., renewable-energy projects, methane destruction). Both can generate credits but differ in permanence dynamics and co-benefits.

Baseline
A quantified snapshot—historical or projected—of greenhouse-gas emissions or removals that would occur without the proposed project. All additional climate impact is measured against this reference line.

Additionality
The requirement that the credited emission reduction or removal would not have happened absent the incentive created by the carbon market. Projects must prove that they are beyond "business as usual."

Permanence
The degree to which a credited ton of CO_2e stays out of the atmosphere for the agreed time horizon. Nature-based projects guard against reversals (fire, disease, illegal logging) with buffers and monitoring; engineered removals often aim for multi-century storage.

Leakage (local & global)
An unintended increase in emissions outside the project boundary caused by the project itself. Local leakage shifts impact to adjacent areas (e.g., protecting one forest accelerates logging next door); global leakage displaces emissions to an entirely different region or sector.

Open data / Open validation / Open verification
Open data is the public release of raw and processed project information (sensor streams, models, audit findings). Open validation allows anyone to inspect whether project design meets methodological rules; open verification lets independent parties confirm that reported performance matches the released data.

Key Performance Indicator (KPI)
A metric—quantitative, time-bound and auditable—that tracks critical aspects of a project (e.g., weekly tCO_2e absorbed, soil-carbon content, buffer-pool balance). KPIs are the backbone of monitoring, reporting and verification (MRV).

Buffer pool
A risk-management reserve of carbon credits withheld—typically a fixed percentage of each project's verified tCO_2e—to safeguard market integrity against future under-performance or reversals (fire, pest outbreak, data error). Credits placed in the buffer are non-saleable: when monitoring shows a loss of sequestered carbon in a project, an equivalent amount is canceled from the pool to keep the overall accounting whole.

1. ABOUT THE DEV CARBON STANDARD

In recent years, carbon offset initiatives have become an essential component of global strategies to address climate change. However, several areas of opportunity have been identified across the carbon markets that, if addressed, could significantly enhance their effectiveness, transparency, and credibility. Among these are the limited transparency in data reporting, the reliance on infrequent and manually generated verification reports, and the absence of continuous, real-world, real-time data audits. Current practices often lack robust mechanisms to guarantee data quality and integrity, data assurance, data access, and a common-sense approach to additionality, permanence, and the prevention of carbon leakage.

Moreover, existing standards operate on closed data systems and methodologies that do not make it mandatory for projects to disclose their full technical data to public scrutiny. This limits the ability of stakeholders—including local communities and indigenous communities—to engage in equitable, informed decision-making processes. The absence of standardized, rigorous engineering and data science frameworks further exacerbates the lack of confidence in carbon offset claims. Additionally, the use of artificial intelligence (AI) within carbon markets is still in early stages, with minimal alignment to ethical guidelines that ensure fairness, sustainability, inclusion, and respect for human rights.

The Decentralized Environmental Verification (DEV) Carbon Standard was designed to address these areas of opportunity by introducing an open data, systems engineering-based framework for the certification, validation, and verification of carbon offsets. It leverages continuous, real-time data feeds and integrates artificial intelligence systems in full alignment with UNESCO's Recommendation on the Ethics of AI, ensuring transparency, accountability, and fairness throughout the lifecycle of each carbon solution. The Standard promotes inclusive partnerships through the Biocultural Approach, respects human rights as established by the United Nations Universal Declaration of Human Rights, and guarantees the secure and responsible management of data across all stakeholders. By addressing the key challenges in today's carbon markets, the DEV Carbon Standard offers a credible, innovative, and trustworthy pathway to restore confidence and drive impactful climate action.

DEV is a new environmental transparency model designed to provide accountability to sustainability projects and sustainability-related markets. The DEV standards have two levels of detail: standards and protocols, all of which are open to the public. Sustainability Certifiers licensed to operate under the different DEV standards can then proceed to create their own guides for projects to comply with the protocols: these guides become then the third level of detail.

Furthermore, auditors licensed under any DEV standard can develop their own technical handbooks and technical notes to fulfill the guidelines presented in the certifiers' guides. That becomes the fourth level of detail.

The DEV Carbon Standard is the world's first open data standard for carbon offset certification. It ensures the highest level of transparency by using Systems Engineering standards for the validation, verification, and certification of all the key actors for the carbon credit creation. The DEV Carbon Standard makes it possible for any person with internet access to directly verify the Key Performance Indicators (KPI), the support data and the data sources behind the carbon offsets. It provides the framework for a truly decentralized verification of carbon solutions, whilst ensuring that the data being showcased is relevant, accurate, and reliable.

In summary:

The DEV Carbon Standard is the first carbon standard where all carbon solutions are audited against strict engineering and data science standards. By using the DEV Carbon Standard to increase the transparency of the data systems, trust in carbon markets can be rebuilt.

Also, the DEV Carbon Standard promotes the ethical use of emerging technologies for the modelling, monitoring, auditing, and continual evaluation of carbon solutions. For instance, this standard is the first to adopt UNESCO´s recommendations on Ethical Artificial Intelligence.

Also, this standard takes into account perspectives that strengthen carbon solutions at the local level, such as the Biocultural Approach (as proposed by NaturaTech LAC), the notion of Climate Justice, and best practices to build fair and balanced partnerships with indigenous communities (including the integration of their ancestral and traditional knowledge into nature-based solutions, instead of imposing models that disrupt their traditions).

SEAGRASS

2. THE KEY STAKEHOLDERS

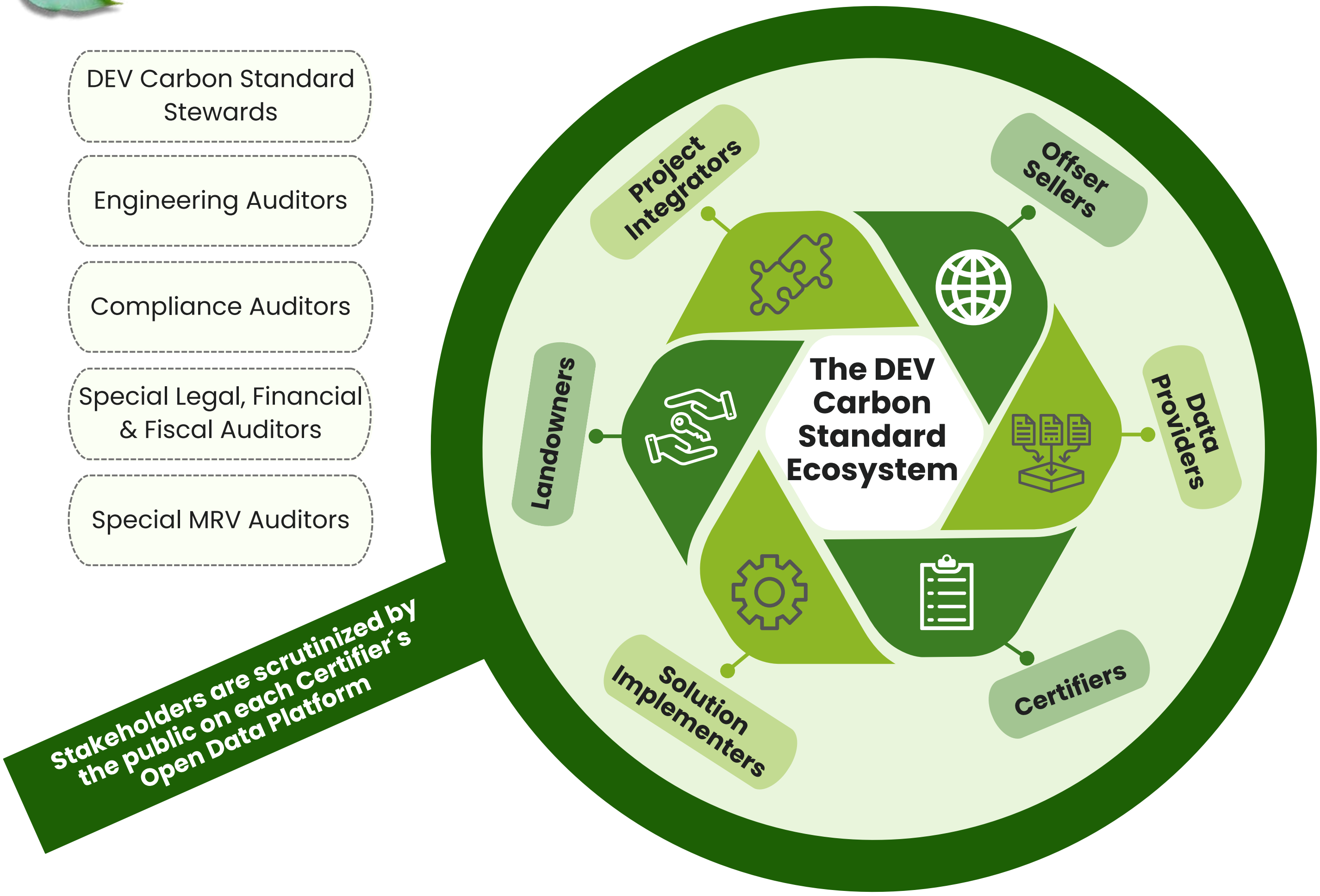


DIAGRAM 1. STAKEHOLDERS

The Stewards of the Standard. Foundations and technical partners that: **(1)** guard the text of the DEV Carbon Standard so if other entities try to modify it, there is always a way to know which is the current valid version, and **(2)** approve and oversee the Certifiers and Engineering Auditors.

The Engineering Auditors. These third-party Auditors are approved by the Stewards of the Standard. They audit the carbon solutions created by the Project Integrators under state-of-the-art systems engineering and other engineering standards (ISO, INCOSE & IEEE, etc.). The data audit starts with the feasibility study, and once the carbon solution created by a Project Integrator enters a Certifier's registry, the data quality audit becomes a permanent, year-round audit. Project Integrators have to apply to enter the DEV Carbon Ecosystem (sending a letter of intent to an Engineering Auditor). Engineering Auditors have the prerogative to approve or deny approval of the new PIs (after due diligence), and inform successful applicants of the data quality protocols required to develop projects under the DEV Carbon Standard.

Project Integrators. These are organizations that design and develop carbon solutions. They bring together the relevant actors for each new project: Landowners, Solution Implementers, and the Offset Sellers (in case the Project Integrator needs external sellers). Project Integrators need to apply to enter the DEV Carbon Ecosystem (submitting their application to an Engineering Auditor). PIs are required to conduct a thorough KYC (know your costumer) of landowners before onboarding them, and develop a fair and balanced relation with landowners and communities.

Landowners. Landowners receive payments for the sale of carbon credits / offsets from projects implemented on their properties. In clean energy projects this role is taken by the power plant owners / clean energy project owners; in the blue carbon projects it is usually taken by coastal communities with approval of the authorities with jurisdiction over the area. In the case of private property, the landowners pay for the feasibility study, and in the case of community or indigenous land it is usually project sponsors (companies) who pay for the feasibility study. The DEV Carbon Standard has multiple protocols to ensure landowners & communities are always treated fairly and are part of decision-making processes throughout the lifecycle of the carbon solution. Landowners are onboarded by Project Integrators.

Solution Implementers. These are providers of a specific solution for a carbon project (for example, reforestation, organic plant nutrients, soil restoration, regenerative agriculture, a clean energy technology, or clean tech in general). They are approved by the Certifiers.

Certifiers. Certifiers are approved by the Stewards of the Standard. They are licensed to represent the DEV Carbon Standard and Protocols, and to create and publish detailed guidelines for the rest of the actors of the DEV Carbon Ecosystem. They certify the carbon credits or offsets in alignment with the DEV Carbon Standard 2025. They create and update a DEV Carbon Registry where KPIs, support data, and data sources (evidence), are made publicly available. Also, the final purchase of the credit or offset certificates is always executed on a Certifier's dedicated marketplace. Certifiers are the only actors in the DEV Carbon Ecosystem that maintain direct communication with the Stewards of the Standard, and represent the Stewards and the DEV Carbon Standard and Protocols in most instances. Certifiers are overseen by the Stewards.

Data Providers. Satellite, sensor, or data companies hired by the carbon solutions. They have to be approved by the Certifiers. Because the Certifiers must publish certification data of every approved project, the data from the Data Providers must be reliable, relevant, accurate, valid, and verifiable.

Sellers. They are appointed by the Project Integrators to help them promote their project portfolios. Sellers must have a commercial agreement with a licensed Project Integrator.

Open Data Platforms (linked to the DEV registries). These are the digital platforms which showcase the KPIs, support data, and data sources behind every sealed offset. They allow data sharing to social media platforms to make decentralized verification easy and appealing. These platforms must be launched and maintained by each Certifier. Upon a project's approval, the Engineering Auditor suggests to the Certifier the adequate frequency of the data input to support each KPI, which could be Real Time Data (RTD), Near Real Time Data (NRTD), or another frequency for the data feed.

Compliance Auditors. Third-party auditors that have to be approved by the Certifiers to audit the Project Integrators and their carbon solutions on two levels: **(1)** the application and observance of the DEV Carbon Standard and protocols; and **(2)** the compliance with applicable local carbon offset and environmental regulations. Their compliance audit occurs at any time between the beginning of the Feasibility Study and the first six months of project implementation.

Financial, Legal & Fiscal Auditors. These are third-party auditors that have to be approved by the Certifiers to audit the administrative, financial, legal, and fiscal aspects of a carbon project. Their audits are assigned at entirely random times with a maximum frequency of one audit per carbon project every 12 months once a project is fully operational. Resulting scores and recommendations by these auditors will be shared by the auditor to both the audited Project Integrator and the Certifier, giving the opportunity to the Project Integrator to immediately correct whatever was identified as unclear or non-compliant. Failure to correct any important aspect identified in the audit without justification, would cause the Certifier to put offset certification on hold until the pending correction is complete.

MRV Auditors. Third-party auditors that have to be approved by the Certifiers to audit the Monitoring Reporting and Verification aspects of any Project Integrator and its Carbon Solutions at any time. These MRV audits are assigned at entirely random times with a maximum frequency of one audit per carbon project every 12 months once the project is fully operational. Resulting scores and recommendations by these auditors will be shared by the special auditor to both the audited Project Integrator and the Certifier, giving the opportunity to the Project Integrator to immediately correct whatever was identified as unclear or non-compliant. Failure to correct any important aspect identified in the audit without justification, would cause the Certifier to put offset certification on hold until the pending correction is complete.

DESERTS

3. TERMS & CONDITIONS

3.1 GENERAL

3.1.1 ON THE PRINCIPLE OF OPEN DATA

Open data in the context of the DEV Carbon Standard means that the data supporting the claims of the carbon offsets must be fully disclosed: data must be shared publicly on a dedicated open data platform. This includes the KPIs, the support data evidencing the stated KPI results, and the data sources of such support data (e.g. details of the specific sensors or satellites used). In other words, the Certifier does not reserve the information used to evaluate and certify a project (unless it is personal, sensible, or IP-related information), but instead opens it to public scrutiny on an Open Data Platform.

3.1.2 ON THE PRINCIPLE OF A SYSTEMS ENGINEERING APPROACH TO DATA TREATMENT

Open data requires an integral data strategy which includes coherent guidelines to maximize transparency at every point of the certification process. This means that a strategy for efficient and trustworthy data acquisition, data analysis, data visualization, data validation, data verification, and data certification must be in place. This approach is underpinned by the International Council on Systems Engineering (INCOSE) principles. The Certifiers will ensure that INCOSEs standards and best practices are applied to the continuous data cycle for all projects certified under the DEV Carbon Standard.

3.1.3 ON THE PRINCIPLE OF A CONTINUOUS DATA CYCLE

The DEV Carbon Standard framework enables a continuous data cycle which continuously produces real time data (RTD), near- real time data (NRTD), high-frequency data feeds and robust data sets throughout the life of the project. The data is made publicly available on the Open Data Platforms created by the Certifiers.

3.1.4 PRIORITIES OF THE STANDARD

There is a governance system protecting the DEV Carbon Standard which ensures it remains rigorous on the monitoring and evaluation of every carbon solution. **The 3 priorities of the DEV Carbon Standard are: (1) data reliability, (2) data transparency, and (3) fairness to the stakeholders, particularly landowners, communities, and indigenous communities.**

Fairness to the landowners and communities is achieved, among other actions, by having a cards-open negotiation process between the Project Integrator and the Landowner / Community after the feasibility study has been completed and both parties know the real carbon capture or avoidance potential of the local ecosystem and the proposed Carbon Solution. This means that they can negotiate on equitable terms (on equal knowledge) their percentages (the future credit / offset sale income distribution).

No secret sauces, no magic formulas, no obscure complex methodologies that end up treating landowners unfairly by having them sign contracts first and learn the project's potential later. The key is equal knowledge for open and fair negotiations that will originate transparent and reliable carbon credits / offsets.

3.1.5 ON THE ENGINEERING AUDITORS

The Stewards of the Standard approve and oversee independent Engineering Auditors.

The Engineering Auditors are the entities that can approve Project Integrators. An Engineering Auditor audits the data systems of a carbon solution under the INCOSE (Systems Engineering) and IEEE (Electric & Electronic Engineering) standards and best practices. Should any data system fail for any reason, and data flow to a Certifier's Open Data Platform stops, the Engineering Auditor will evaluate the failing data system and issue a warning to the system's owner and the relevant Certifier: this protocol guarantees that the offset Client never receives unsubstantiated offsets or inflated sequestration figures.

Further, if a data system underpinning the proof of carbon capture or avoidance fails to provide the data feed (in terms of accuracy, precision, timeliness, quantity or quality) for any reason, the offset certification becomes invalid until the data system is validated to be fully functional. No credit / offset is sealed without the necessary support data to evidence its claims. All credits / offsets are based on acquired, analyzed, validated, verified, and certified data, rather than on statistical inferences, formulas or mathematical calculations.

3.1.7 FISCAL YEAR ACCOUNTING

CO_2e tons emitted and accounted for during any given fiscal year by Buyers are compensated with CO_2e tons sequestered or avoided (offsets) within the same fiscal year (FY 1 Apr - 31 Mar).

3.2 RULES REGARDING PROJECT INTEGRATORS

3.2.1 ON THE PROJECT DESIGN

Project Integrators are responsible for designing Carbon Solutions, gathering the key stakeholders for offset creation, signing the contracts with all those key stakeholders, and ensuring an optimized information and resource flow throughout the project's lifecycle. The design of the project must stipulate the condition of open data (excluding personal or IP-related data and non-relevant or non-verifiable data superfluous to measurements). Project design shall focus on clear, measurable statements and objectives, accurate descriptions of the technologies to be used along the stages of the project, and realistic, optimized KPIs free of ambiguous impact statements.

PIs could have, if its capabilities make it viable, several roles within the offset creation, but never that of a Steward of the Standard, Certifier nor any of the 4 types of Auditors. For instance, PIs may be the Seller of the offsets, or may be a Solution Implementer (i.e. directly intervening an ecosystem): in any case, the Integrator will be audited separately for each of its roles within a project, so covering several roles does require robust technical capabilities and efficiency.

PIs must conduct a thorough KYC of landowners before onboarding them. PIs are responsible for the landowners they onboard. Fairness to landowners, communities, and indigenous communities is essential. Human Rights protection, robust social safeguards, and the Biocultural perspective are crucial, and the PIs will be audited on these aspects multiple times throughout the project's lifecycle. Also, PIs must align and explain how they align (including the KPIs they will track) their projects with applicable national and international policy and / or cooperation frameworks such as SDGs, the Escazu Agreement, Open Data principles, and Ethical AI principles.

3.2.2 ON THE FEASIBILITY STUDY

The feasibility study is the second step of the Credit / Offset certification process, and comes right after the project's initial design. The study has a thorough due diligence with both methodological and Engineering tasks that help the Engineering Auditor define four main things: **(1)** the project's viability, **(2)** the project's historical carbon capture or avoidance through a baseline (of between 3 and 5 years), **(3)** the project's carbon capture or avoidance through the launching period, and **(4)** a suggestion of the percentage of carbon credits that could be destined to the buffer pool, which could be revised by the certifier. The deliverable of the feasibility study is a certificate stating if the project is feasible or not, and a report explaining the results. If the feasibility study has a positive evaluation, the Project Integrator can submit the project to a Certifier. No Certifier can consider a project for credit / offset certification before having the results of the feasibility study. The results of the feasibility study are an input for the Certifier's data analysis that is conducted in order to define the final credits / offsets that will be issued.

3.2.3 ON THE COMPLIANCE AUDIT

On top of the due diligence already covered by the Engineering Auditor during the feasibility study, a separate Compliance Auditor must make sure that the carbon project complies with any applicable local regulations, and with the DEV Carbon Standard and protocols. This audit happens during the first 6 months of the implementation of the project (once the project is fully operational).

3.2.4 ON THE TWO TYPES OF SPECIAL AUDITS

There are two additional audits that can be assigned by the Certifier at any time (but no more than once every 12 months) to review a project in detail: **(1)** the Special Financial, Legal, and Fiscal Audit, and **(2)** the Special Monitoring, Reporting, and Verification Audit.

3.2.5 ON OFFSET TYPES RECOGNIZED BY THE DEV CARBON STANDARD

Project Integrators must choose one of the DEV recognized offset types for each project. If a project does give place to two different offset types simultaneously the Integrator must consult with the Certifier and the Engineering Auditor for the correct KPI definition in order to be able to measure each offset output accurately and avoid double-counting of CO_2e tonnage.

The DEV Carbon Standard currently recognizes seven types of offsets. One which only takes into account CO_2, while the other six have measurable positive impacts on other social and environmental areas in addition to CO_2e offset. The supplementary impact areas include: food security, biodiversity, waste reduction, freshwater conservation, and sustainable supply & logistic chains.

Any supplementary impact must be measurable, auditable and proven separately (under the open data principle). Any supplementary impact stated has its own KPIs, support data, and data sources, all of which are audited in the same way as for carbon impact. A project claiming positive social and environmental effects in addition to carbon capture (sequestration) or avoidance, must provide evidence. Certification will be revoked from any project not reporting accurate data for carbon sequestration / avoidance or stated social impacts. The DEV Carbon Standard has a zero tolerance policy on misrepresentation of data and tampering with KPIs.

3.2.6 LIST OF RECOGNIZED OFFSET TYPES

3.2.6.1 OFFSET TYPE ID: OT-01

Land ecosystems Carbon Offsets with a supplementary positive impact on food security and biodiversity. Source: restoration, regeneration, and protection of land ecosystems. Includes measuring and enhancing the nutrients generated by the ecosystem in benefit of the surrounding area and communities. May include integral regenerative agroforestry solutions. Particularly regarding Offset Types 1 and 2, Project Integrators will follow the best practices recommended by NaturaTech LAC on the Biocultural Approach (building fair and balanced relations with local and indigenous communities, while including traditional knowledge into carbon solutions when applicable).

For further details on this type of offset, specific protocols can be consulted and are listed in the diagram at the end of this document.

3.2.6.2 OFFSET TYPE ID: OT-02

Regenerative Agriculture Carbon offsets with a supplementary positive impact on food security. Source: regenerative agriculture projects.

For further details on this type of offset, specific protocols can be consulted and are listed in the diagram at the end of this document.

3.2.6.3 OFFSET TYPE ID: OT-03

Carbon offsets from proven avoidance. There are two possible subtypes:

OT-03.1. Avoidance offsets from clean energy projects which have compensated their own carbon footprint. An important note is that up to now many clean energy projects around the world sell offsets without fully compensating their own footprint first. The DEV Carbon Standard requires an audit of the project's carbon accounting and a full open data carbon inset (internal compensation of the carbon footprint, in the form of CO_2e tons subtracted from the project's yearly carbon offset output) before the project can sell offsets. This means that no clean energy power plant can sell offsets unless its footprint CO_2e tons have been subtracted from the project's yearly CO_2e tons avoided. With the provision of full carbon accounting & inset, plus the open data policy, these avoidance offsets become reliable and verifiable.

For further details on this type of offset, specific protocols can be consulted and are listed in the diagram at the end of this document.

OT-03.2. Avoidance offsets from energy efficiency technologies. Innovations that prove emission avoidance through energy efficiency.

As with clean energy projects, the technology carbon footprint must be measured and inset before certifying offsets.

For further details on this type of offset, specific protocols can be consulted and are listed in the diagram at the end of this document.

3.2.6.4 OFFSET TYPE ID: OT-04

Offsets from direct Carbon capture technologies. As for offset ID OT-03 (clean energy projects), the internal footprint must be covered via inset before selling carbon offsets.

For further details on this type of offset, specific protocols can be consulted and are listed in the diagram at the end of this document.

3.2.6.5 OFFSET TYPE ID: OT-05

Carbon offsets from industrial or agro-industrial innovations and technologies which have a supplementary impact on five areas: food security, biodiversity, waste reduction, freshwater conservation, and sustainable supply & logistic chains. This offset type requires a vast amount of real time data (RTD) and near real time data (NRTD) to prove the positive impact on several areas simultaneously. This offset type is hard to achieve and prove but has the potential to inspire bold industrial innovations and new clean technologies.

For further details on this type of offset, specific protocols can be consulted and are listed in the diagram at the end of this document.

3.2.6.6 OFFSET TYPE ID: OT-06

Blue Carbon. Source: water bodies, coastal, marine, and ocean protection and restoration projects. In the case of Blue Carbon offsets, usually the role of the Landowner as beneficiary of offset payment is substituted by the coastal communities or specific scientific missions with the approval of the authorities with jurisdiction over the area where the project is developed.

For further details on this type of offset, specific protocols can be consulted and are listed in the diagram at the end of this document.

3.2.6.7 OFFSET TYPE ID: OT-07

Soil regeneration & carbon capture offsets. Source: soil regeneration practices including regenerative farming and ranching solutions. Projects must account for the carbon footprint of the entire project, including the animals, and inset that footprint before selling offsets.

For further details on this type of offset, specific protocols can be consulted and are listed in the diagram at the end of this document.

3.2.7 ON THE DEFINITION OF PROJECT STAGES

The development of carbon solutions may take longer in some countries than in others. Some projects pose technology and strategy adaptation challenges, for example in the face of changing social, environmental or economic conditions in the area where the solution is implemented. It is important for Project Integrators to structure a timeframe for each project, divided into clear stages that allow for optimal deployment.

Division into three stages is appropriate for most projects, each with a growing deployment of solutions or technologies implemented to boost carbon capture or avoidance, and growing data sources to match the increasing activity:

1) inaugural stage (which may include an inset period to compensate for the internal carbon footprint, or a time to test different approaches or technologies on the ground under the specific project conditions);
2) project maturing stage (typically producing already a number of yearly offsets, but not yet the maximum target amount); and
3) full carbon solution and data system deployment.

3.2.8 BUFFER POOL AND ADDITIONALITY GUARANTEE APPROACH

3.2.8.1 ON THE PRINCIPLE OF ADDITIONALITY WITH PROOF-OF-VALUE

Open data offsets certified under the DEV Carbon Standard must comply with the principle of additionality but must also include a proof-of-value dimension. The huge gap between protection of an ecosystem on paper and the actual protection leaves out (from Carbon Markets) many of the world's most relevant ecosystems in terms of biodiversity and contribution to climate stability.

The Global South is home to thousands of ecosystems protected on paper, which are in reality endangered and degrading since they are used for a myriad of illegal activities. Every single day illegal logging, illegal mining, drug production, human trafficking, illegal hunting, and illegal fishing occur in national and local natural reserves which enjoy formal protection status. In many cases, local authorities lack the resources for adequate monitoring of large areas. In other cases, these illegal activities take place in private or communal land, including indigenous land, where the local populations also lack the appropriate resources to protect their ecosystems from constant external pressure (even if their land is part of nature conservation programs on paper).

Such ecosystems and their crucial neighboring areas and buffer zones are affected and degraded every day. The communities in and around those ecosystems, and in many cases the local environmental authorities, need more resources to better enforce conservation measures, restore degraded areas, and implement sustainable management practices that protect biodiversity while supporting local livelihoods.

Therefore, as a Project Integrator proves that a Project truly helps an ecosystem recover its health (as it was protected on paper but not in reality), the case will be analyzed by the Certifier. If the metrics and data quality are deemed adequate and valid by the Certifier, then credits / offsets may be created.

These cases also require the approval & support from the relevant local or national authorities (and the legal owners of the land under formal protection status). The local or national authority will benefit from the increase in monitoring and restoration of the affected area. The Project Integrator will work in close collaboration with the authorities. The Certifier will monitor project information flows regarding additionality and local reality, and will terminate the project should there be any manipulation or deliberate misrepresentation of data by the Project Integrator -according to the DEV Carbon Standard zero tolerance policy. In such cases, the Project Integrator will be banned from participating in future DEV Carbon Standard projects.

3.2.8.2 PROBLEMS AND MISCONCEPTIONS OF NATURE-BASED SOLUTIONS (NBS)

Nature-Based Solutions (NBS) have gained significant attention as strategies for addressing climate change, enhancing biodiversity, and promoting sustainable development. However, several challenges and misconceptions hinder their effectiveness.

A major issue is the oversimplified understanding of ecosystems. Many interventions assume that increasing green cover or restoring degraded areas will automatically enhance carbon sequestration and biodiversity. Yet, ecosystems function through intricate interactions among species, soil, water cycles, and climate. Without thorough ecological assessments, interventions can have unintended consequences, such as disrupting nutrient cycles or local biodiversity, which may undermine long-term carbon sequestration.

Despite aiming to work with nature, NBS often involve interventions in ecosystems that have not been adequately studied. For instance, afforestation in unsuitable areas can degrade soil, cause water scarcity, or even increase carbon emissions if non-native species are introduced, or if native species are planted inappropriately. Poorly planned interventions can weaken an ecosystem's ability to provide essential services like carbon capture, water filtration, and habitat provision.

Another common misconception is that NBS should offer immediate, large-scale solutions. However, ecological restoration takes time—newly planted forests sequester carbon at lower rates than established ones, and wetland recovery can take decades. Yet, looking for quick returns, may impose an irresponsible tunnel-vision push for "additionalities" that can do far more harm than good.

The concept of additionality has become a dogma in carbon markets, rarely questioned despite its real-world implications. Protecting existing ecosystems does more for climate stability than planting new trees or creating artificial habitats. Many restoration efforts fail or create hidden long-term issues because they lack a deep understanding of ecosystem dynamics.

Another challenge is the assumption that NBS can be universally replicated without adapting to local ecological and social contexts. What succeeds in one ecosystem may fail in another due to subtle but crucial differences. Ignoring local conditions and community knowledge leads to ineffective or even harmful interventions. The obsession with additionalities often dismisses traditional ecological knowledge as anecdotal, undermining meaningful learning and systemic understanding. This is how carbon market dogmas fail both ecosystems and the communities that have protected those ecosystems for generations. This is also why the Biocultural approach is necessary.

Reliable data and shared learning—achieved through the Biocultural approach and fair stakeholder engagement—must be given at least equal weight to pre-established formulas in carbon solutions. Yet, many NBS projects are evaluated solely on carbon sequestration potential, sidelining critical ecosystem functions. This narrow focus results in poorly designed interventions, such as large-scale tree planting in grasslands or peatlands, which can actually reduce biodiversity and disturb natural carbon sinks. A holistic approach must consider biodiversity, water regulation, soil health, and community benefits.

With growing interest in NBS, there is a risk of corporations and governments using them to appear environmentally responsible while avoiding real systemic changes. Some companies invest in tree-planting projects while continuing unsustainable practices elsewhere, using NBS as a cover for inaction. Transparency, accountability, and science-based implementation are essential to prevent greenwashing.

Successful NBS require local community involvement, yet many projects fail to integrate indigenous knowledge and traditional ecological practices. Without considering social equity and traditional knowledge, interventions risk causing land conflicts, displacement, or restricted access to natural resources and traditional / ceremonial areas. A truly sustainable NBS approach must be inclusive and participatory, recognizing the deep interconnections between ecological and social and cultural systems.

While NBS hold immense potential for climate adaptation and environmental restoration, their success depends on ecological understanding, careful planning, and long-term commitment. The growing emphasis on additionality, if left unchecked, risks undermining ecosystems instead of restoring them. A systemic view, full transparency, and rigorous, data-driven implementation are crucial—not just to avoid greenwashing, but to prevent large-scale interventions from causing lasting harm in the quest for additionalities.

3.2.8.3 CHALLENGES OF THE CURRENT ADDITIONALITY APPROACH IN CARBON MARKETS

The additionality principle is a cornerstone of Carbon Markets, requiring that emission reductions or carbon sequestration projects demonstrate that they would not have occurred without the financial incentive of Carbon Credits / Offsets. While this approach aims to ensure that Carbon certificates represent real and additional climate benefits, it still presents significant challenges that undermine its sustainability and may pose risks to ecological integrity.

1. **The Inherent Uncertainty and Unsustainability of Additionality-Based Models**

A fundamental issue with the additionality approach is its reliance on counterfactual scenarios—hypothetical baselines that estimate what would have happened in the absence of the project. These projections introduce a high degree of uncertainty, as they are based on assumptions about future land use, carbon sequestration rates, and policy environments. This uncertainty leads to over-crediting or under-crediting carbon sequestration, distorting the integrity of Carbon Markets. Moreover, projects often prioritize activities that are easiest to quantify and attribute to additionality, rather than those that are most ecologically effective in the long term.

From a sustainability perspective, additionality incentivizes short-term interventions over long-term conservation. Forest conservation, which is one of the most effective climate mitigation strategies, is often not recognized as additional because it does not result in a measurable increase in sequestration beyond a hypothetical baseline. As a result, protecting mature ecosystems is undervalued, despite its critical role in maintaining biodiversity, preventing carbon release from deforestation, and stabilizing global climate patterns.

Le Clercq *et. al.* (2023) mention that In Latin America, environmental protection remains a major challenge. Despite the climate crisis the planet is facing, according to the **Environmental Impunity Index**, governments allocate an average of only 0.18% of their GDP to this cause. Moreover, 63% of countries do not explicitly recognize the right to a healthy environment in their Constitution, making it even more difficult to demand bold actions. All statistical information presented in the next six paragraphs is drawn from the Environmental Impunity Index for Latin America of 2023 (Le Clercq, Cedillo, & Cháidez, 2023), which serves as the primary reference for the analysis and data discussed herein.

The lack of commitment is also reflected in the low ratification of the Escazú Agreement, signed by only 42% of countries. This treaty is key to ensuring access to information, public participation, and environmental justice, but without widespread adherence, its benefits are limited.

At the institutional level, the situation is concerning, as 91% of countries lack national environmental prosecutors or attorneys, and only 9% have specialized environmental courts. Without strong defence mechanisms, environmental conflicts are prolonged and often end in impunity. This creates high vulnerability for ecosystems, especially in regions like Latin America, where illegal activities such as poaching and illegal logging continue to threaten biodiversity every day.

Also, human development in the region is conditioned by planetary pressures. Although the Human Development Index is 0.754, it drops to 0.695 when adjusted for material footprint and CO_2 emissions, highlighting that the current development model is unsustainable and is costing humans our quality of life.

The human cost is extremely high. Mexico, Brazil, and Colombia account for 49% of the region's environmental conflicts, with Mexico leading at 19.8%. Furthermore, these three countries report 71.5% of environmental defenders' murders in Latin America, with Mexico representing 34% of the total.

For these reasons, speeches and good intentions are not enough. In a context where commitments often remain on paper, the DEV Carbon Standard bets on data transparency and measurable results to ensure that every effort truly contributes to environmental protection. In a world where inaction has irreversible consequences, there is no room for speculation. Carbon capture projects must demonstrate that change is possible and make it tangible.

The model proposed in this section is an effective, scalable, and sustainable solution in the long run for protecting ecosystems from an innovative perspective for Carbon Markets worldwide. At least in science and engineering, dogmas have to be revised to match reality: this is why the additionality concept should be updated to become **additionality with proof of value**.

2. The Flawed Additionality Logic in Nature-Based Solutions

In the context of nature-based solutions (NBS), additionality often prioritizes tree planting projects over ecosystem protection and thoughtful, patient restoration. This approach fails to acknowledge that conserving existing ecosystems is more effective than creating new ones. While reforestation and afforestation are frequently promoted under Carbon Offset models, they can disrupt local ecosystems if implemented without a systemic ecological understanding. In some cases, additionality-based incentives encourage monoculture plantations rather than diverse, native ecosystems, ultimately reducing ecological resilience and long-term sequestration potential.

Furthermore, additionality-based Carbon crediting often overlooks the complex and self-regulating nature of ecosystems. The carbon absorption capacity of a given landscape is influenced by soil health, hydrological cycles, species diversity, and climate conditions, yet additionality-driven projects often focus on isolated interventions rather than holistic ecosystem management. By failing to integrate systemic conservation strategies, these projects risk degrading ecological networks and reducing the long-term stability of carbon sequestration.

3. The Need for a Conservation-Centered Approach

To ensure truly sustainable Carbon Markets, data-based nature conservation must be recognized as the foundation of climate mitigation strategies, rather than being excluded due to the additionality requirement. A more robust framework should **PAIR** humans with existing natural ecosystems by:

- **P**rioritizing the protection of intact ecosystems, acknowledging that their preservation prevents Carbon emissions from land degradation and deforestation.
- **A**dopting a systemic view of ecosystems, measuring Carbon sequestration within the context of broader ecological functions rather than relying on small-scale sampling and isolated interventions.
- **I**ntegrating adaptive mechanisms, such as dynamic buffer pools, to align Credit issuance with actual measured Carbon sequestration rather than hypothetical additionality projections.
- **R**edefining additionality to primarily include conservation as a fundamental climate action, ensuring that existing natural ecosystems receive financial and policy support.

By shifting from a projection-based additionality model to a conservation-first framework, Carbon Markets can become more ecologically sound, scientifically rigorous, and resilient against uncertainties. Rather than prioritizing human-engineered interventions, ensuring the longevity of natural ecosystems should be the primary focus of Carbon Market mechanisms.

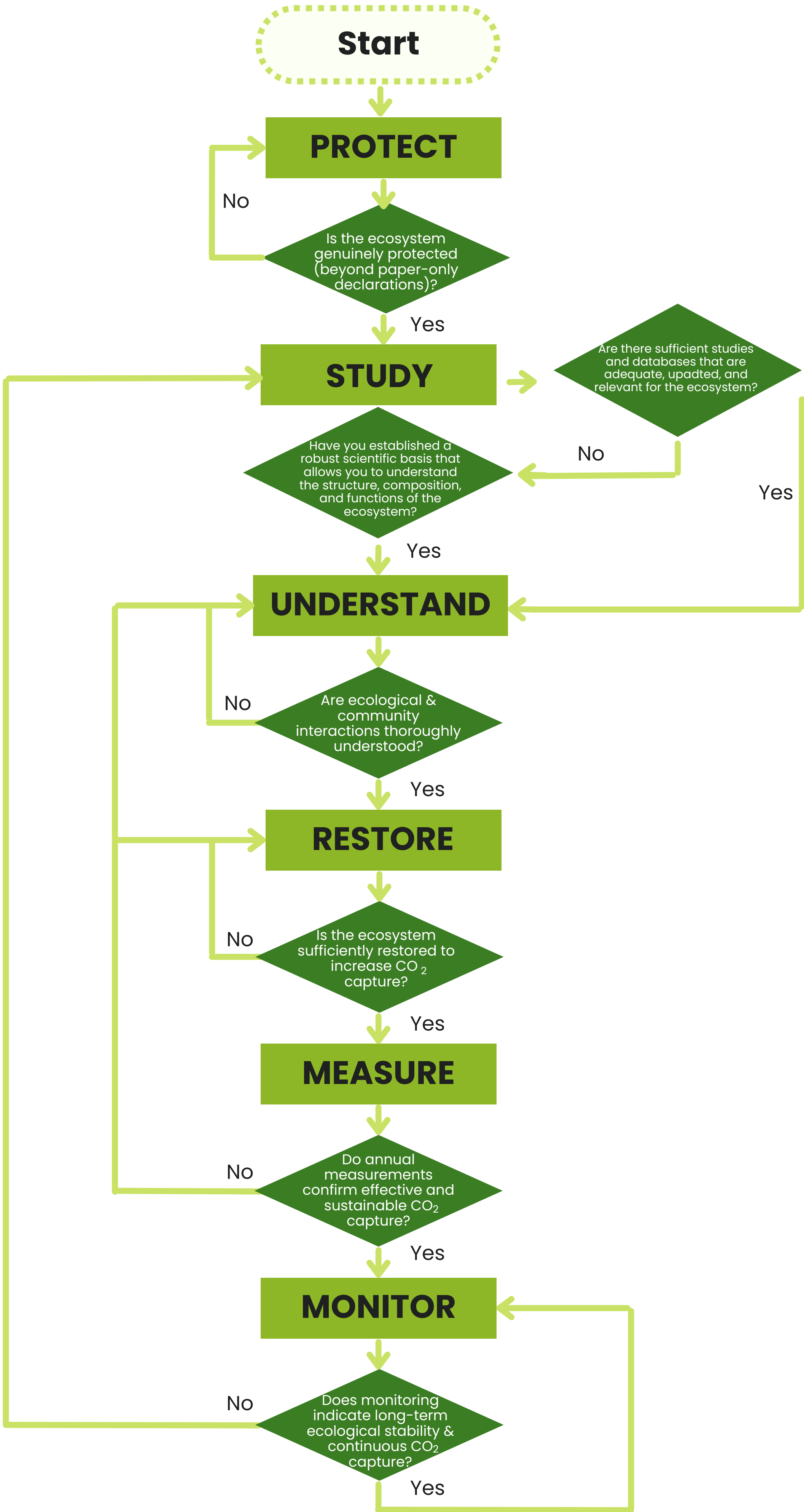
3.2.8.4 A SYSTEMIC APPROACH TO CARBON CREDIT CERTIFICATION: BEYOND STATISTICAL PROJECTIONS

Carbon credit certification faces a fundamental challenge in estimating future CO_2 absorption, as methodologies relying on statistical projections introduce significant uncertainty. Traditional predictive models attempt to estimate carbon sequestration based on limited sampling areas, which often fail to represent the complexity of entire ecosystems. This leads to inaccuracies, as small-scale sampling cannot capture the systemic interactions that regulate carbon absorption at a larger scale.

Furthermore, many current methodologies encourage an “additionality rush” without fully understanding ecological interconnections. This narrow focus can inadvertently disrupt ecosystems, reducing their long-term carbon sequestration capacity. A systemic perspective is essential to accurately measure ecosystem health and carbon absorption, moving beyond fragmented, point-based assessments.

To address these shortcomings, a more holistic approach to Carbon Credit certification is needed. **The DEV Carbon Standard establishes six levels of Carbon additionalities** based on the adequate consecutive steps for nature conservation and restoration:

Visualize the flowchart on the next page.



FLOWCHART 1. SIX LEVELS OF CARBON ADDITIONALITIES.

STEP 1) PROTECT: Ensuring Ecosystem Conservation and Integrity

Instead of prioritizing artificial interventions, the first step should be to effectively protect the ecosystem, ensuring that any subsequent measures enhance rather than compromise their stability. The foundation of any NBS should be the protection of ecosystems. Effective protection requires a comprehensive reality check, identifying all potential risks to the ecosystem, including hidden threats, illegal activities, and systemic vulnerabilities. A rigorous assessment of these factors is essential to guarantee the legitimacy and sustainability of conservation actions. Also, a fair and transparent negotiation process must be upheld, ensuring equitable treatment of all stakeholders and maintaining open communication to build trust.

The principle of additionality has to change to an additionality with proof of value principle: for instance, if a jungle is protected on paper but not in reality (it is poorly monitored and it is continually invaded for all sorts of illegal or unauthorized activities), and a Carbon Solution can prove that it is reducing that gap between documents and reality, then it is a case worth considering for certification. Carbon projects in areas protected on paper, that can demonstrate their value (and how they are additional) with abundant open data, should have a chance in Carbon Markets. In other words: **data and reality should not be denied because of dogmas.**

Projects must ensure that ecosystem protection considers social factors, including land tenure, community access to natural resources, and local governance. Social safeguards must be established to protect the rights of local communities and indigenous peoples, ensuring their informed consent and active participation in the planning and execution of conservation initiatives.

STEP 2) STUDY: Conducting Comprehensive Ecosystem Assessments

To establish a robust scientific basis for conservation efforts, thorough ecosystem studies must be conducted, leveraging Ethical Artificial Intelligence (AI), remote sensing technologies, and ecological indices. These studies should focus on understanding the structure, composition, and functions of ecosystems, identifying key species, interactions, and environmental thresholds. The use of satellite imagery and advanced ecological modelling enables accurate tracking of ecosystem health and changes over time. Ethical AI applications must prioritize transparency, avoid biases, and be aligned with principles of environmental justice.

Additionality with proof of value enables Climate Justice, since there are thousands of "natural protected areas" in emerging economies that are not fully protected due to a lack of resources to monitor them. These protected areas face pressure and multiple risks, and invaluable ecosystems are lost every year, while conservation and restoration projects in these areas cannot be considered additional in Carbon Markets. **This is not a call for the relativization of Carbon Market principles so that every project can have its own view of additionality, but rather a much-needed reality check**: **the additionality rush is hurting many ecosystems with poorly planned large-scale interventions, while leaving many key ecosystems in Latin America, Africa, Asia, and Oceania outside Carbon Markets. The current additionality rush goes against Climate Justice, and this must change.**

Ecological studies must incorporate the analysis of socioeconomic, demographic, and cultural data to assess the relationship between communities and ecosystems. The collection of biocultural data should include the documentation of traditional environmental management practices, Indigenous knowledge systems, land use and the historical relationship between communities and ecosystems and the presence of Indigenous or sacred territories. To ensure social safeguards, Project Integrators must assess social impacts, ensuring that conservation efforts do not lead to displacement or negative effects on communities.

STEP 3) UNDERSTAND: Interpreting Ecological Interactions for Sustainable Action

Beyond merely studying ecosystems, it is crucial to analyze and interpret ecological interactions to guide effective and sustainable interventions. This step integrates biocultural knowledge, recognizing the interconnectedness of ecosystems and human communities. Traditional ecological knowledge (TEK) and local expertise should be incorporated alongside scientific research to enhance understanding and promote knowledge-sharing frameworks. This interdisciplinary approach ensures that conservation and Carbon absorption initiatives respect and benefit local communities while maintaining ecological balance.

The analysis of ecological interactions must integrate local knowledge and traditional wisdom in ecosystem management and restoration, recognizing communities as key actors in conservation. It is crucial to develop mechanisms for co-creating knowledge with Indigenous and local communities, ensuring that their perspectives are valued and respected.

STEP 4) RESTORE: Prioritizing Ecosystem Recovery Before Carbon Optimization

Before implementing strategies aimed at enhancing CO_2 absorption, it is essential to restore degraded ecosystems, ensuring that interventions do not merely compensate for past destruction but actively contribute to long-term ecological resilience. Restoration and conservation initiatives must prioritize allowing ecosystems to develop their own resilience over time, recognizing that in many cases, reducing external threats—such as deforestation, pollution, or invasive species—may be more effective than rushed large-scale interventions. Restoration projects should be data-driven, relying on open-access ecological data and historical records to design effective rehabilitation strategies. Open data initiatives facilitate transparency and allow for cross-sector collaboration, ensuring that restoration efforts are scientifically sound, scalable, and tailored to local conditions.

Restoration processes must be culturally sensitive and integrate traditional landscape management practices, such as agroforestry and sustainable biodiversity use. The collection of biocultural data should include historical records of community-led restoration and local strategies for assisted natural regeneration. As a social safeguard, projects must commit to ensuring equitable benefits for communities, including sustainable economic opportunities and access to decision-making processes. To prevent negative impacts, social safeguards must ensure that restoration projects respect community rights and avoid land appropriation or the imposition of models that do not align with local realities and necessities.

STEP 5) MEASURE: Measuring and Adjusting CO_2 Absorption with Abundant Real-World Data

The intervention phase involves continuous, real-world measurements of CO_2 absorption rather than relying on projections, ensuring accuracy and adaptability in Carbon certification. This process must be built upon the foundational principles established in steps 1 to 4, ensuring reasonable and data-based efforts towards permanence with proof of value and non-leakage with proof of value (both concepts defined in the DEV Carbon Standard in line with a much-needed revision and evolution of previously dogmatic concepts throughout Carbon Markets). The dynamic certification system adjusts based on verified carbon sequestration data, reinforcing accountability and maintaining ecological integrity. Each certification must provide proof of value, demonstrating that the Carbon absorption claimed is verifiable and sustainable over time.

CO_2 measurements, provided by the Engeneering Auditor, must be complemented with meassured social impacts, reported by the Project Integrator, such as equity in benefit distribution and improvements in local livelihoods. Biocultural data should be included in the assessment of results, recognizing how traditional practices contribute to carbon absorption. As a social safeguard, measurement transparency must ensure that communities have access to the project data and KPIs.

STEP 6) MONITOR: Implementing Long-Term Monitoring and Evaluation

Sustainable conservation and Carbon sequestration require continuous monitoring and evaluation to track progress, identify emerging risks, and refine strategies accordingly.

Monitoring systems should integrate remote sensing, and open-data analytics to ensure precision and reliability. By maintaining long-term observation and adaptive management, conservation initiatives can remain resilient to environmental changes while securing their impact and credibility.

The Certifier must create its own forms in order to classify the additionality category (step) corresponding to each carbon project. The Certifier must have an additionality classification before the project proceeds to the production period, where additionalities are generated. The buffer pool is adjusted by the Certifier based, among other things, on the type of additionalities that the project produces and the risk profile of the project and area.

Monitoring must include indicators of social and cultural impact, evaluating community participation and respect for territorial rights. Biocultural data should be continuously updated, documenting changes in traditional practices and ecosystem governance. Social safeguards must ensure that any project adjustments consider community voices, implementing consultation and accountability mechanisms to address potential negative impacts.

Cross-section – Community involvement

Success chances increase when the community co-designs the strategy. Strong involvement, engagement, and commitment from the community living within or around the project area is crucial for success. In other words, if a project successfully moves through these six stages, it means it has achieved equitable and inclusive collaboration with local communities. As a result, additionalities will meet community ownership and engagement.

Furthermore, the Carbon Credits generated under this approach will have a genuine social dimension embedded in the additionalities, as they inherently include a risk management process that safeguards both the natural ecosystem and the communities involved.

This approach ensures that projects do not only meet environmental objectives but also contribute to social well-being by integrating traditional knowledge, securing land rights, and fostering sustainable livelihoods. By prioritizing biocultural data and social safeguards, these initiatives reinforce climate justice and long-term resilience, making Carbon Markets more equitable and impactful.

The DEV Carbon Standard specifies that negotiations occur between the Project Integrator and Landowners only after they know the engineering audit (feasibility study) results, understanding that those results will be adjusted by the Certifier and their data analysis processes. This means that Landowners can only commit to a carbon absorption project once data is available and they can negotiate on an equal-knowledge base with project integrators—not before.

This guarantees a data-driven and fair process, ensuring that communities enter agreements based on verified information rather than assumptions, reinforcing transparency and equitable benefit-sharing in Carbon Markets. Also, the duration of an initial contract between the community and the Project Integrator cannot exceed 10 years, and it is recommended that agreements be for shorter periods to respect the social cycles of each community. If everything goes well, the Project Integrator can renew the contract with the community after the specified period, ensuring flexibility and adaptation to changing social and environmental conditions.

Why signing 10-year renewable commitments instead of 50 to 90-year commitments, as has been common in Carbon projects so far? **Multi-decade agreements with landowners have proven to be very problematic, sometimes leading to the collapse of the Carbon projects they were supposed to make "permanent".** This happens, first, because usually such agreements are signed before and not after the technical tests, which leads to landowners learning the exact terms of the income stream they would get even one year and a half after they signed the contract. Second, some intermediaries have often convinced landowners to sign contracts that make them liable under many scenarios that are definitely not under the landowner's control, and when an event that affects monitored areas happens, the biggest blow is always taken by the landowner. Third, some projects are cancelled once the next generation on the landowner's side takes over, particularly if the terms are considered unfair or disconnected from the current local reality. It is more sensible to reassess the will and intent of the landowner every few years, than trying to convince landowners to commit to contracts for nearly a century. This is yet another area where the "dogma of permanence" for carbon projects frequently fails the test of reality.

This framework ensures that Carbon certification is not only based on additionality but also aligned with ecological realities, eliminating double counting risks through rigorous verification, transparency, and adaptive management. By integrating open data and systems engineering, this methodology guarantees scientifically sound, scalable, and ethically responsible conservation efforts.

Ecosystem corridors and interconnected landscapes, rather than isolated trees, are what will ultimately stabilize the climate. This framework embraces a systemic, data-driven approach to Carbon Credit certification, fostering long-term ecological resilience while strengthening market confidence.

3.2.8.5 BUFFER SYSTEM AND ADDITIONALITIES IN THE TIMELINE OF A CO_2 ABSORPTION PROJECT

The proposed framework describes the methodology used to calculate CO_2 absorption in an ecosystem before and after the implementation of a conservation or restoration project. This approach allows for the determination of Carbon absorption additionality and establishes a buffer system that ensures the environmental and economic integrity of the project.

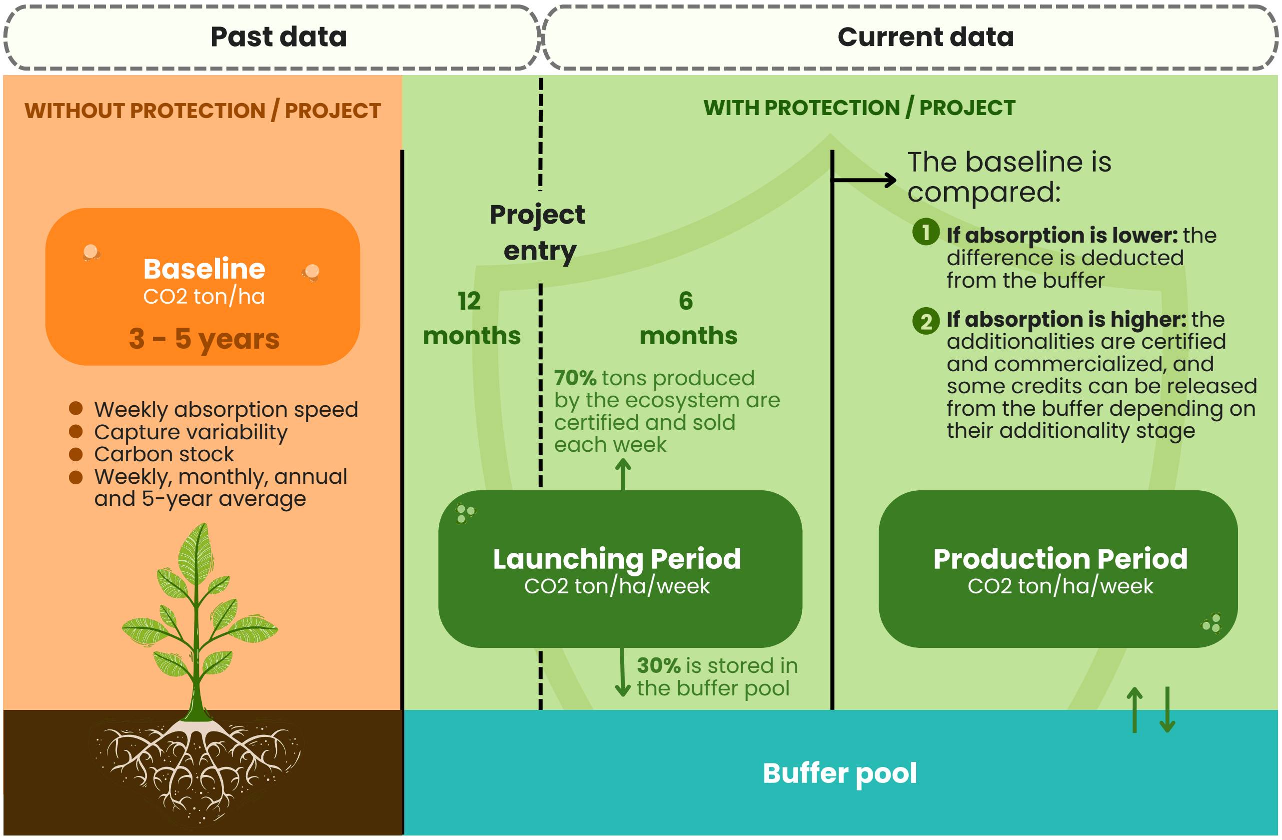


DIAGRAM 2. BUFFER SYSTEM AND ADDITIONALITIES

A) Baseline Calculation

Before the project is implemented, a retrospective analysis of CO_2 absorption in the ecosystem is conducted. This reference period, known as the baseline, covers a total of five years and ends twelve months before the project's entry. The purpose of the baseline is to establish reference parameters that include:

- Weekly CO_2 absorption rates.
- Absorption variability, considering environmental and climatic factors.
- Seasonality, meaning fluctuations in carbon capture throughout the year.
- Average absorption rates at different time scales, including weekly, monthly, annual, and five-year values.
- Total Carbon stock stored in the ecosystem until the end of the baseline calculation.

This data helps characterize the natural dynamics of the ecosystem and serves as a comparative basis for evaluating the impact of the conservation or restoration project. The baseline is static and serves as the reference for comparing the ecosystem's CO_2 absorption in the future. The baseline is calculated by the Engineering Auditor during the feasibility study.

B) Project Launching Period

Twelve months before the project's entry marks the beginning of the launch period, which lasts approximately 18 months, depending on the type of project and ecosystem. The Certifier must determine the exact duration of this period for each Carbon Solution.

During the 12 months leading up to the project's entry, the Engineering Auditor calculates the ecosystem's weekly CO_2 absorption to determine the total tons of CO_2 that the Certifier could later declare available for sale. In the following six months, weekly absorption measurements continue, and the CO_2 captured by the ecosystem each week is also available for sale.

The type of Carbon Credits generated during the launch period provide economic incentives for ecosystem protection and help prevent disruptions in CO_2 capture. They also ensure the continuous replenishment of ecological reserve funds, supporting the long-term environmental stability of the project.
This approach secures funding while the project consolidates, discourages deliberate ecosystem degradation, and provides tangible resources to reduce destructive (and, in some cases, illegal) activities. Additionally, it alleviates environmental pressures, allowing nature to restore itself.

During the launching period, the ecosystem generates marketable Carbon Credits, to finance the interventions needed to achieve additionalities through its present capacity to absorb CO_2.

During this period, the amount of CO_2 absorbed per hectare is quantified on a weekly basis. Of this absorption:

- ≈70% can be certified and commercialized.
- The remaining ≈30% is stored in a *dynamic buffer* that ensures system stability against potential risks.

The Engineering Auditor suggests a percentage of tons to be certified and those allocated to the buffer, based on the ecosystem variability calculated during the feasibility study. The Certifier must have internal guidelines to calculate the amount of long-term stored Carbon in each ecosystem based on the information provided by the Engineering Auditor.

Until now, an uncertain future has funded the present (projected additionalities finance present operations). But the DEV Carbon Standard

shifts this paradigm, ensuring that the ecosystem's current CO_2 absorption capacity finances future interventions while guaranteeing true additionality.

c) Production period

Once the launching period concludes, a new quantification of CO_2 absorption over the past months is conducted. This analysis follows the same methodology used for the baseline to determine whether the amount of captured Carbon has increased due to project interventions.

Depending on the outcome of this assessment, adjustments are applied to the buffer system:

1. If CO_2 absorption is lower than estimated, the difference is deducted from the buffer to compensate for the reduction in Carbon capture.
2. If CO_2 absorption exceeds initial estimates, the additional CO_2 tons are directly certified and commercialized. Depending on the level of additionality produced and the project's stage of development, Credits produced during the launching period can also be released from the buffer, making them available for commercialization.

In the comparison with the baseline, the total Carbon stock of the ecosystem is also measured to assess whether there was a gain or loss. If there were gains in the total Carbon stock, this translates into Carbon Credits. If there were no gains but no Carbon stock was lost either, Credits produced during the launching period can be released to the market.

The buffer pool is flexible. The Certifier has the prerogative to determine the percentage of absorbed tons allocated to the buffer pool during both the launching period and the production period, based on the ecosystem risks identified. This dynamic adjustment system ensures that the issued Carbon Credits are truly additional and accurately reflect the project's positive impact on CO_2 capture.

This methodology guarantees the additionality of Carbon absorption by relying on empirical data rather than future statistical projections. The approach is based on a rigorous comparison between real, observed absorption rates and the historical baseline, **ensuring that any credited Carbon sequestration is genuinely attributable to the conservation or restoration interventions.**

The buffer acts as a safeguard against potential over-crediting by storing a percentage of captured CO_2 and adjusting issuance based on observed absorption trends. A re-evaluation of the ecosystem’s absorption capacity after 18 months ensures that the additionality of Carbon Credits is verified based on actual performance rather than projections.

The project does not rely on hypothetical future estimates; instead, it establishes a detailed five-year historical baseline, providing an objective and data-driven reference for comparison. Weekly quantifications of CO_2 absorption (by the Engineering Auditor in the context of the year-round audit of the projects) allow for constant tracking of ecosystem performance, preventing overestimation of Carbon Credits. By integrating these elements, the methodology eliminates uncertainties associated with predictive statistical models and ensures that issued Carbon Credits reflect real, verifiable, and sustainable CO_2 absorption.

3.2.8.6 ENSURING ADDITIONALITY IN CARBON CREDIT GENERATION

A key advantage of this methodology is that it guarantees true additionality, a fundamental principle in Carbon Credit certification. Also, it ensures that Carbon Credits represent genuine and additional CO_2 removals beyond what would have naturally occurred in a business-as-usual scenario. This approach strengthens additionality through multiple mechanisms:

Credits are issued exclusively based on actual, observed CO_2 absorption rather than speculative future projections. This guarantees that each Credit sold corresponds to real, verified atmospheric Carbon removal. The methodology establishes a five-year historical baseline using empirical data, ensuring that only absorption exceeding natural sequestration is credited. This prevents inflating Carbon Credit issuance.

A percentage of weekly absorbed CO_2 is allocated to the buffer, which is later adjusted based on observed absorption levels. If actual absorption is lower than expected, Credits are deducted from the buffer; if absorption exceeds estimates, additional Credits are released for sale. This mechanism ensures that only real, additional CO_2 removals are credited, preventing market distortions.

After the 18-month launching period, absorption is compared using the same methodology as the baseline. This process verifies that the ecosystem's sequestration capacity has genuinely increased due to conservation or restoration efforts, reinforcing the integrity of issued Credits.

Since Credits are backed by real, measured data (they are all ex-post Credits), buyers can be confident that each purchased Credit represents a tangible environmental benefit, strengthening trust and stability in the Carbon Markets.

3.2.8.7 BENEFITS OF THIS APPROACH

Only verified absorbed metric tons are certified, reducing the risk of credit over-allocation and ensuring environmental credibility. By relying on empirical data instead of hypothetical projections, our methodology eliminates uncertainties associated with statistical forecasting or regression models.

The use of real, observed data to issue Credits improves the credibility of Carbon programs, encouraging greater investor trust and participation. The dynamic buffer system allows for adjustments based on actual sequestration data, protecting against unexpected environmental fluctuations or project underperformance.

Projects with higher-than-expected absorption rates can reclaim Credits from the buffer, creating a financial incentive for improved ecosystem management and Carbon sequestration efforts. This data-driven approach ensures that Carbon Credits reflect real, additional, and verifiable CO_2 absorption, setting a higher standard for environmental integrity in Carbon Markets.

3.2.9 ON THE PRINCIPLE OF PERMANENCE WITH PROOF OF VALUE

A prevalent misconception arises regarding the term "permanent" in the context of Carbon Credits / Offsets: GHG emitted to the atmosphere can stay there for thousands of years, while a prevailing convention suggests that CO2e must only be sequestered for as little as 30 years in certain instances (100 in more ambitious ones), to qualify as "permanent". And yet, guaranteeing that a forest will not burn or be damaged under any natural disaster or social unrest event in the next decades can be quite complex in the Global South, where many more integral sustainability solutions are desperately needed. From a scientific standpoint, anything less than an absolute assurance against reversals indefinitely into the future does not align with the true meaning of "permanent", and yet a vague written declaration by a landowner currently passes most due diligence processes. **This becomes a matter of Climate Justice.**

The DEV Carbon Standard is all about measuring reality and sharing the resulting data in total honesty: the Project Integrators are required to commit to objectives and strategies that contribute to the permanence of their Carbon Solutions, within the limits of reality and common sense, and with open data to acknowledge any risk factors that threaten or may threaten those commitments in the future.

3.2.10 ON THE PRINCIPLE OF CARBON LEAKAGE AVOIDANCE WITH PROOF OF VALUE

Closing a coal mine or relocating a factory does not inherently lead to a reduction in CO2 emissions if the displaced production simply shifts to other coal mines or factories elsewhere. This phenomenon, known as leakage, occurs when actions taken in one location trigger counteractive responses elsewhere, reversing the intended carbon reduction benefits. Similar to additionality, and permanence, leakage poses challenges in empirical measurement when assessing Carbon Credits / Offsets and often requires settling for a mere mention of the existence of a plan to avoid it, instead of demanding projects to disclose more data to make the tracking of these difficult variables easier every year.

Leakage can manifest at both local and global scales. Local leakage occurs when, for example, protecting 100 hectares of forest from deforestation merely leads to deforestation occurring in the adjacent 100 hectares. On a global scale, solutions may inadvertently displace carbon emissions elsewhere. As the Cambridge Centre for Carbon Credits highlights on its website and reports on the matter: "at the moment we don't have a fully defined solution to estimate global leakage".

The absence of comprehensive open data complicates efforts to effectively address and study leakage cases. Increasing the availability of open data can facilitate the identification of leakage patterns and discourage its occurrence. In the absence of robust data, written declarations are currently accepted as sufficient proof that a Carbon project avoids leakage, which is exactly as it happens with promising offset permanence for 100 years in a forest on a letter. Again, a dogma that should be revised.

The DEV Carbon Standard approach to leakage is: measure more and better than you are required to, and open all the data for public scrutiny. In the case of local leakage, context satellite data obtained during the feasibility study helps the Engineering Auditor understand the area surrounding each project from the very beginning, and then constant monitoring during the rest of the project helps track the occurrence and evolution of any local leakage processes. In the case of global leakage, the more data that is shared, the clearer the leakage patterns will become, and new solutions will arise.

3.2.11 ON MRV

Within the DEV Carbon Standard, Measurement, Reporting, and Verification (MRV), are complemented by four additional key aspects: **(1)** open validation, **(2)** open verification, **(3)** open data, and **(4)** the existence of four different types of third-party auditors.

3.2.12 ON HOW DOUBLE COUNTING IS NOT POSSIBLE UNDER THE DEV CARBON STANDARD

Besides additionality, permanence and non-leakage, there is another aspect of credit / offset certification that the lack of data transparency has made hard to track, let alone solve: double counting. The current consensus is that two entities should not be able to claim the sequestration of the same CO2e metric ton. Yet, double counting happens all the time because of the lack of open data. If all carbon credits were open data ex-post credits, double counting would quickly become an impossibility.

The retirement of a credit / offset in a carbon registry (the change in its status, from "active" to "retired") is currently done manually. Without universally recognizable and traceable digital "fingerprints", offset retirement is useless in terms of guaranteeing the avoidance of double counting. Why is it so? Because retiring an offset from a carbon registry without knowing exactly what sensor data is linked to that offset in the first place is like selling a house via a deed that is not linked it to the house, or that may be linked to a house in that neighborhood, but no-one knows exactly to which one.

The DEV approach to solving this issue is: taking human bias and error out of the offset certification equation by replacing statistical inferences and manual yearly report-writing with engineering, automation solutions, and also by making open data mandatory. **The technical explanation is: DEV enabled a self-updating, geo-referenced, time-stamping, multi-layered cryptographic certification system that seals offset certificates and permanently binds them to data points and data sets streaming on several independent tracks of automated, permanently audited data feeds.**

Does this mean using Blockchain for offset sealing? Yes, but that is just one of over 30 dimensions of the DEV Systems Engineering solution. Just using digital cryptography such as Blockchain to help users track changes in offset ownership (who owns the offset when) and the eventual retirement of an offset from a registry is extremely easy (it is equivalent to barcodes in a supermarket): the real challenge is proving that the offset itself is built on valid data in the first place.

Certifiers are required to develop detailed internal guidance for each ecosystem it certifies. This document must explain the calculation methods and the scientific and engineering-based approach used to ensure the accuracy and integrity of carbon credit issuance. It serves as a key safeguard to prevent overestimation and guarantees that all certifications are based on transparent, open, and ecosystem-specific data in line with the principles of the DEV Carbon Standard 2025.

3.2.13 ON THE PROJECT INTEGRATOR'S RELATION WITH THE LANDOWNERS

The Project Integrator is the point of contact for Landowners (or owners of clean energy projects, or the authorities and communities for Blue Carbon projects). The Project Integrator informs the private Landowners of the Feasibility Study fees as quoted by the Engineering Auditor. Before onboarding any Landowner, the Project Integrator must make sure to conduct a thorough KYC / due diligence. The PI is responsible for the Landowners it onboards, and will be audited accordingly.

For communal or indigenous land cases, the Integrator will usually have a project sponsor (a company) pay for the feasibility study fees. The feasibility study will advise on: project viability and compliance, the baseline, and estimated annual carbon capture/ sequestration/ avoidance capacity from the project. Based on this information, parties will negotiate their percentages of future Credit / Offset sale revenue. This negotiation phase guarantees fairness (the Landowner receiving the best possible payment within the project's feasibility limits) and rationality in the resource allocation (according to the cost structure) so that the project can be successful and its positive impact can be lasting, measurable, and certifiable. Post negotiation agreements, contracts are signed and the Certifier may start to measure and seal credits / offsets on an annual basis. Then the Seller finds an appropriate Buyer for the resulting offsets. The Integrator must also tell the Landowner that there will be other audits along the lifecycle of the project.

Right after receiving the Feasibility Study report and the Carbon Solution Certificate from the Engineering Auditor, Project Integrators must fill Form A and submit it to the Certifier to report the risks it has identified in and around the area of the project. Form A also allows the Project Integrator to report the additionality stage of the project (according to the DEV model) and more information on the social safeguards applicable to the project.

3.2.14 ON THE PROJECT INTEGRATOR'S RELATION WITH THE SOLUTION IMPLEMENTERS

Project Integrators rely on Solution Implementers to conduct field work to achieve the project's objectives. Solution Implementers deploy the interventions, technologies, and activities which deliver and increase Carbon capture over time. Hiring terms for each Solution Implementer will depend on project budget and scope. Collaboration between the Project Integrator and the Solution Implementers starts early at the project design stage, and is confirmed after the feasibility study has provided the parties with financial specifics.

3.2.15 ON THE PROJECT INTEGRATOR'S RELATION WITH THE SELLERS

The Project Integrator may promote and advertise the Carbon Solutions directly or via associate Sellers (and must have a clear contract with them). The Project Integrator must exercise caution when choosing and training the Sellers, as it should mitigate risks of misrepresentation of the DEV Carbon Standard 2025. The Project Integrator is responsible for the Sellers it onboards.

3.3 RULES REGARDING CERTIFIERS AND THE DATA PROVIDERS

3.3.1 DATA SOURCE REQUIREMENTS

Devices (e.g. ground sensors) and networks used to collect and distribute the data are approved by the Certifier. The Certifier will evaluate according to the relevant IEEE, ISO, and INCOSE guidelines. Data Providers must ensure use of approved devices only, other devices will require additional audit processes, including of databases and networks - at the expense of the Data Provider. Should inconsistencies and sensor tampering attempts be uncovered during additional audits, all the Data Provider's contracts will be terminated, and they will be banned from participation in any Project under the DEV Carbon Standard.

3.3.2 DATA FEED

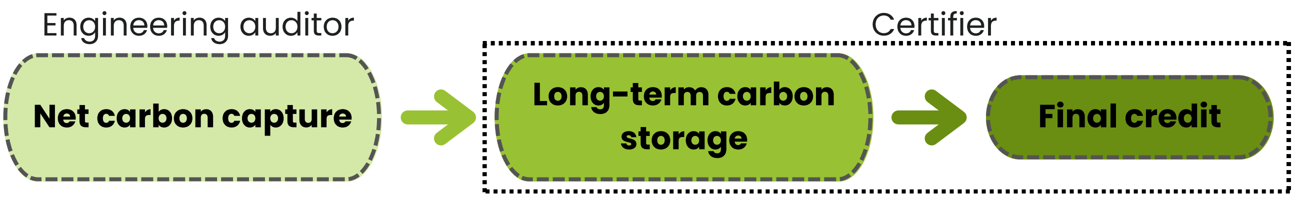
When relevant to the Project's KPIs, real time data (RTD) or near real time data (NRTD) is preferred. Where RTD or NRTD is not deemed necessary by the Certifier, high-frequency data feeds are preferred over lower frequency data feeds. The Engineering Auditor will suggest the data feed frequency and data system requirements for each Carbon Solution, and the Certifier will decide and evaluate accordingly. Based on the feasibility study, the certifier carries out calculations to determine the long-term stored carbon in the projects. The resulting tons from these calculations are the ones that will be certified.

3.3.3 OPEN DATA PLATFORM

The support data must be disclosed by each Certifier on a dedicated Open Data Platform. Data collected from the carbon solutions must be "open" both in technical and non-technical formats to increase accessibility. Anyone with an internet connection may inspect and interact with the data and share it via social media for maximum exposure and transparency.

3.3.4 QUALITY OF THE CREDIT / OFFSET CERTIFICATES

Each Certifier must guarantee that the certificates are reliable and un-alterable, and must always be linked to the original data source. The Feasibility Study produced by the Engineering Auditor reports the net amount of carbon absorbed by the project. Based on this, the Certifier must apply a second filter to the data to assess the risk of carbon being released back into the atmosphere as CO_2, and to determine the amount of long-term stored carbon. These methodologies must be documented in certifiers' guidelines that are transparent and verifiable. This ensures that the certified carbon credit is of the highest quality. Also, Certifiers are required to define the specific rules and procedures for credit retirement and data validation (either in published guides or in their platforms).



3.4 ADDITIONAL GUIDELINES FOR SPECIFIC STAKEHOLDERS

The following guidelines apply to specific stakeholders working under the DEV Carbon Standard. These guidelines focus on ensuring the integrity, transparency, and ethical governance of Carbon Solutions. Certifiers and Compliance Auditors shall supervise and evaluate the consistent application of these guidelines across all projects, in line with the DEV Carbon Standard's commitment to fairness, accountability, and open data.

3.4.1 BIOCULTURAL APPROACH

Project Integrators must apply the Biocultural Approach, as defined by NaturaTech LAC, when designing and implementing Carbon Solutions involving indigenous or local communities. This approach prioritizes Climate Justice by fostering fair, transparent, and balanced partnerships that respect and integrate the ancestral and traditional knowledge of these communities. Project Integrators must ensure that nature-based solutions are co-designed with the active participation of local stakeholders, avoiding the imposition of external models that could disrupt cultural traditions or social structures. The Biocultural Approach requires culturally sensitive consultation processes, equitable benefit-sharing agreements, and the inclusion of traditional land management practices, when applicable, to enhance ecosystem restoration and carbon capture. Furthermore, Project Integrators are responsible for ensuring that these partnerships empower communities and support their long-term social, environmental, and economic resilience. All actions and achievements under this guideline must be documented and made available through the Open Data Platform for public transparency and verification.

3.4.2 RECOMMENDATIONS ON THE ETHICS OF ARTIFICIAL INTELLIGENCE

Certifiers and Compliance Auditors must ensure that all AI systems, tools and algorithms utilized across the DEV Carbon Ecosystem adhere to the ethical principles outlined in UNESCO's Recommendation on the Ethics of Artificial Intelligence. These principles include:

- Respect for Human Rights, Fundamental Freedoms, and Human Dignity: AI systems must be designed and implemented in ways that uphold and promote these essential values.
- Environmental Sustainability: AI applications should contribute positively to environmental conservation and ecosystem health.
- Diversity and Inclusion: AI must be developed and used in manners that respect cultural diversity and promote inclusive participation.
- Living in Peaceful, Just, and Interconnected Societies: AI should foster social cohesion and uphold principles of justice and interconnectedness.

In their evaluations of the Carbon Solutions, Certifiers and Compliance Auditors are responsible for verifying that AI systems used for any Carbon Solution comply with these ethical standards throughout their lifecycle. This includes assessing the AI's impact on human rights, environmental sustainability, cultural diversity, and social justice.

3.4.3 HUMAN RIGHTS

Project Integrators must ensure that the design, development, and implementation of all Carbon Solutions under the DEV Carbon Standard are fully aligned with the principles enshrined in the Universal Declaration of Human Rights (United Nations General Assembly, 1948). Project Integrators are required to respect, protect, and promote human rights in all interactions with project stakeholders, including landowners, indigenous communities, and local populations. Special attention must be given to the rights to free, prior, and informed consent (FPIC), equality, non-discrimination, cultural integrity, and participation in decision-making processes. Project Integrators must actively prevent any actions that could result in human rights violations, exploitation, or displacement of communities. Furthermore, they must establish clear grievance mechanisms that are accessible, transparent, and responsive. Compliance with this guideline must be documented and verified by the Compliance Auditors.

3.4.4 CYBERSECURITY

Project Integrators, Data Providers, Auditors, Solution Implementers, and Sellers must comply with the cybersecurity guidelines established by the Certifiers. These cybersecurity guidelines are designed to ensure the integrity, confidentiality, and availability of all data streams, databases, and digital platforms involved in the certification and verification processes. Stakeholders must implement robust measures to protect systems from unauthorized access, data breaches, tampering, and cyber threats. Compliance includes, but is not limited to, securing data transmission channels, maintaining updated security certificates, conducting regular security audits, and following incident response protocols as defined by the Certifiers.

3.4.5 DATA MANAGEMENT

Project Integrators, Data Providers, Auditors, Solution Implementers, and Sellers must adhere to the data management guidelines established by the Certifiers. These guidelines ensure the responsible handling of all data, including personal, private, and sensitive information collected throughout the lifecycle of carbon solutions. Certifiers are the sole entities responsible for defining these data management directives. Data handling procedures must be transparent, auditable, and aligned with the DEV Carbon Standard. Certifiers will supervise and enforce compliance, and stakeholders must maintain comprehensive documentation to demonstrate adherence to these requirements.

GRASSLANDS

4. THE AUDIT SYSTEM

There are 6 types of audits under the DEV Carbon Standard:

1. A feasibility study by the Engineering Auditors. It marks the beginning of any project.
2. A permanent data quality audit by the Engineering Auditors. This happens during the entire lifetime of the carbon solution.
3. A methodology and local regulation compliance audit, by the Compliance Auditors. This happens any time between the beginning of the feasibility study and up to six months into the offset certification.
4. An administrative, financial, legal and fiscal audit, by the Special Financial Auditors. This happens at random times, no more than once every year.
5. A Monitoring, Reporting and Verification audit, by the Special MRV Auditors. This happens at random times, no more than once every year.
6. The public scrutiny audit: as all offset data must be published in an Open Data Platform, any person with internet access can choose to conduct an independent assessment of the relevance, validity, veracity, accuracy, and sufficiency of the data backing the projects.

The system of checks and balances, besides the public eye via the Open Data Platform, works as follows:

1. The Stewards of the Standard approve the Engineering Auditors and the Certifiers.
2. The Engineering Auditors approve the Project Integrators.
3. The Project Integrators approve their Offset Sellers, and also onboard the Landowners for each Carbon Solution after due diligence (KYC).
4. The Compliance Auditors make sure Credit / Offset creation and sale complies not only with the DEV Carbon Standard but also with applicable national and local regulations.
5. Certifiers have to approve the Compliance Auditors, the Financial, Legal & Fiscal Auditors, and the MRV Auditors, which in turn audit all Carbon Solutions.
6. The Certifiers approve the Data Providers and the Solution Implementers, which are audited as well.

4.1 REQUIREMENTS PER AUDIT TYPE: 1.- FEASIBILITY STUDY

4.1.1 FOR OFFSET TYPES 01, 02, AND 07

List of documents / information required from the Project Integrator:

1. General corporate information, proof of incorporation according to the local regulation, and legal representative´s ID and contact information.
2. Formal request for the Feasibility Study quote.
3. A statement of the relevant results / highlights of the KYC that the Project Integrator conducted on the landowner it is onboarding.

NOTE: After receiving the Feasibility Study Report, the Project Integrator will have to present Form A to the Certifier. It is advisable that the Project Integrator starts working on Form A as soon as the feasibility study begins. Form A includes sections for risk identification, social safeguards and the additionality profile of the Carbon Solution.

List of documents / information required from the Landowner / Asset Owner:

1. Primary document for proof of ownership of the land, area, and limits (deed).
2. Support document 1 (a will if recently inherited, or a previous deed when applicable).
3. Support document 2 (proof of most recent payment of local land taxes).
4. Verification of legal document (at the local land registration office).
5. Scan of the ID of the owner.
6. Contact information of the owner (full name, telephone number, alternative telephone number, full address, e-mail, alternative e-mail).
7. Contact information of a secondary point of contact (full name, telephone number, alternative telephone number, full address, e-mail, alternative e-mail).
8. Contact information of a third point of contact (full name, telephone number, alternative telephone number, full address, e-mail, alternative e-mail).
9. Full address of the property and directions to arrive to the place.
10. KMZ.
11. General environmental studies / information (when available).
12. Biodiversity study / information (when available).
13. Food production study / information (when available).
14. Soil health study / information (when available).
15. Water availability studies / information (when available).
16. Water quality studies / information (when available).

What will be measured:

1. Initial compliance (this includes the validation of the documents).
2. Geographical context information.
3. Climatological information.
4. Type of ecosystem.

5. Type of vegetation.
6. Topographic profile.
7. Soil & soil nutrient profile.
8. Erosion profile.
9. Carbon baseline.
10. Estimate of yearly carbon capture potential.
11. Water availability profile.

4.1.2 FOR OFFSET TYPE 03.1

List of documents / information required from the Project Integrator:

1. General corporate information, proof of incorporation according to the local regulation, and legal representative´s ID and contact information.
2. Formal request for the Feasibility Study quote.
3. A statement of the relevant results / highlights of the KYC that the Project Integrator conducted on the Asset Owner it is onboarding.

NOTE: After receiving the Feasibility Study Report, the Project Integrator will have to present Form A to the Certifier. It is advisable that the Project Integrator starts working on Form A as soon as the feasibility study begins. Form A includes sections for risk identification, social safeguards and the additionality profile of the Carbon Solution.

List of documents / information required from the Asset Owner:

1. Primary document for proof of ownership of the company and the clean energy project (certificates of incorporation, deeds).
2. Other support documents: proof of most recent payment of local taxes, energy-generation permits, grid permits, any other relevant active licenses.
3. ID of the owner and / or of the legal representative of the company.
4. Contact information of the owner or legal representative (full name, telephone number, alternative telephone number, full address, e-mail, alternative e-mail).
5. Contact information of a secondary point of contact (full name, telephone number, alternative telephone number, full address, e-mail, alternative e-mail).
6. Contact information of a third point of contact (full name, telephone number, alternative telephone number, full address, e-mail, alternative e-mail).

7. Full address of the energy project.
8. Company presentation.
9. KMZ.
10. Technical documents about the technology used in the power plant.
11. Technical documents about the energy output.
12. Technical documents about the sensors, including certificates.
13. Technical documents about risk assessment and risk-mitigation strategies.
14. Plant plan.
15. Other company ESG / SDG policy documents.
16. Carbon footprint calculation.
17. Waste or by-products technical documentation and reports.
18. General environmental studies / information, including the ones presented to local authorities and approved by them.

What will be measured:

1. Initial compliance (this includes the validation of the documents).
2. Geographical context information.
3. Key social information (social risk-factor identification).
4. Technology mix and profile.
5. Energy output validation.
6. Assessing the technical readiness to extract data (RTD / NRTD).
7. Layout, structure.
8. Optimal SDG approach.
9. Carbon footprint.
10. Local environmental compliance validation.
11. In situ audit: organized depending on the identified critical verification variables.

4.1.3 FOR OFFSET TYPE 03.2

List of documents / information required from the Project Integrator.

1. General corporate information, proof of incorporation according to the local regulation, and legal representative´s ID and contact information.
2. Formal request for the Feasibility Study quote.
3. A statement of the relevant results / highlights of the KYC that the Project Integrator conducted on the Asset Owner it is onboarding.

NOTE: After receiving the Feasibility Study Report, the Project Integrator will have to present Form A to the Certifier. It is advisable that the Project Integrator starts working on Form A as soon as the feasibility study begins. Form A includes sections for risk identification, social safeguards and the additionality profile of the Carbon Solution.

List of documents / information required from the Asset Owner

1. Primary document for proof of ownership of the company and the energy efficiency technology (certificates of incorporation, patents, pending patents, industrial certificates, etc.).
2. Support documents: proof of most recent payment of local taxes, energy-generation permits, grid permits, any other relevant active licenses.
3. ID of the owner and / or of the legal representative of the company.
4. Contact information of the owner or legal representative (full name, telephone number, alternative telephone number, full address, e-mail, alternative e-mail).
5. Contact information of a secondary point of contact (full name, telephone number, alternative telephone number, full address, e-mail, alternative e-mail).
6. Contact information of a third point of contact (full name, telephone number, alternative telephone number, full address, e-mail, alternative e-mail).
7. TRL (Technology Readiness Level).
8. Company and technology presentations, including technical definitions, key facts & figures.
9. Technical documents about the results obtained by the use of the technology.
10. Technical documents about the sensors, including certificates.
11. Technical documents about risk assessment and risk-mitigation strategies.
12. Cases and historic data.
13. Carbon footprint calculation of the technology.
14. Other relevant waste or by-products technical documentation and reports.
15. Environmental impact studies / information, including the ones presented to local authorities and approved by them.

What will be measured:

1. Initial compliance (this includes the validation of the documents).
2. Technology profile.
3. Assessing the technical readiness to extract data (RTD / NRTD).
4. Risk profile and policies towards them.
5. Validation of results.
6. TRL.
7. Carbon footprint.
8. Applicable local environmental compliance.

4.1.4 FOR OFFSET TYPE 04

List of documents / information required from the Project Integrator:

1. General corporate information, proof of incorporation according to the local regulation, and legal representative´s ID and contact information.
2. Formal request for the Feasibility Study quote.
3. A statement of the relevant results / highlights of the KYC that the Project Integrator conducted on the Asset Owner it is onboarding.

NOTE: After receiving the Feasibility Study Report, the Project Integrator will have to present Form A to the Certifier. It is advisable that the Project Integrator starts working on Form A as soon as the feasibility study begins. Form A includes sections for risk identification, social safeguards and the additionality profile of the Carbon Solution.

List of documents / information required from the Asset Owner:

1. Primary document for proof of ownership of the company and the direct carbon capture technology (certificates of incorporation, patents, pending patents, industrial certificates, etc.).
2. Support documents: proof of most recent payment of local taxes, local authority permits, any other relevant active licenses.
3. ID of the owner and / or of the legal representative of the company.
4. Contact information of the owner or legal representative (full name, telephone number, alternative telephone number, full address, e-mail, alternative e-mail).
5. Contact information of a secondary point of contact (full name, telephone number, alternative telephone number, full address, e-mail, alternative e-mail).
6. Contact information of a third point of contact (full name, telephone number, alternative telephone number, full address, e-mail, alternative e-mail).
7. TRL.
8. Company and technology presentations, including technical definitions, key facts & figures.
9. Technical documents about the results obtained by the use of the technology.
10. Technical documents about the sensors, including certificates.
11. Technical documents about risk assessment and risk-mitigation strategies.
12. Cases and historic data.
13. Carbon footprint calculation of the technology.
14. Waste or by-products technical documentation and reports.
15. Environmental impact studies / information, including the ones presented to local authorities and approved by them.

What will be measured:

1. Initial compliance (this includes the validation of the documents).
2. Technology profile & TRL.
3. Assessing the technical readiness to extract data (RTD / NRTD).
4. Risk profile and policies towards them.
5. Carbon footprint.
6. Applicable local environmental compliance & optimal SDG approach.

4.1.5 FOR OFFSET TYPE 05

List of documents / information required from the Project Integrator:

1. General corporate information, proof of incorporation according to the local regulation, and legal representative´s ID and contact information.
2. Formal request for the Feasibility Study quote.
3. A statement of the relevant results / highlights of the KYC that the Project Integrator conducted on the Asset Owner it is onboarding.

NOTE: After receiving the Feasibility Study Report, the Project Integrator will have to present Form A to the Certifier. It is advisable that the Project Integrator starts working on Form A as soon as the feasibility study begins. Form A includes sections for risk identification, social safeguards and the additionality profile of the Carbon Solution.

List of documents / information required from the Asset Owner:

1. Primary document for proof of ownership of the company and its technology (certificates of incorporation, patents, pending patents, industrial certificates, etc.).
2. Support documents: proof of most recent payment of local taxes, local authority permits, any other relevant active licenses.
3. ID of the owner and / or of the legal representative of the company.
4. Contact information of the owner or legal representative (full name, telephone number, alternative telephone number, full address, e-mail, alternative e-mail).
5. Contact information of a secondary point of contact (full name, telephone number, alternative telephone number, full address, e-mail, alternative e-mail).
6. Contact information of a third point of contact (full name, telephone number, alternative telephone number, full address, e-mail, alternative e-mail).
7. Company and technology presentations, including technical definitions, key facts & figures.
8. Technical documents about the results obtained by the use of the technology.
9. Technical documents about the sensors, including certificates.
10. Technical documents about risk assessment and risk-mitigation strategies.

11. TRL + cases and historic data.
12. Carbon footprint calculation of the technology.
13. Other relevant waste or by-products technical documentation and reports.
14. Environmental impact studies / information, including the ones presented to local authorities and approved by them.
15. Biodiversity impact study (when available).
16. Food security impact study (when available).
17. Waste impact study (when available).
18. Water impact studies / information (when available).
19. Supply chain sustainability study (when available).

What will be measured:

1. Methodology compliance.
2. Legal compliance (this includes the validation of the documents).
3. Technology profile & TRL.
4. Assessing the technical readiness to extract data (RTD / NRTD).
5. Risk profile and policies towards them.
6. Validation of results.
7. Carbon footprint.
8. Applicable local environmental compliance.
9. Assessment of 5 supplementary positive impact categories.

4.1.6 FOR OFFSET TYPE 06

List of documents / information required from the Project Integrator:

1. General corporate information, proof of incorporation according to the local regulation, and legal representative´s ID and contact information.
2. Formal request for the Feasibility Study quote.
3. A statement of the relevant results / highlights of the KYC that the Project Integrator conducted on the landowner it is onboarding.

NOTE: After receiving the Feasibility Study Report, the Project Integrator will have to present Form A to the Certifier. It is advisable that the Project Integrator starts working on Form A as soon as the feasibility study begins. Form A includes sections for risk identification, social safeguards and the additionality profile of the Carbon Solution.

List of documents / information required from the Asset Owner / local project lead:

1. LOI from the government or relevant authority.
2. LOI from a research institution with ocean sciences experience and capabilities.

3. LOI from one to three community leaders in the coastal area of the project (if applicable).
4. Scientific methodology to be applied.
5. List and detailed description of technologies and interventions to be applied throughout the project lifecycle.
6. Contact information of all the relevant stakeholder representatives.
7. Risk assessment as reported by the local stakeholders (signed by at least one of them).
8. Location, total area of the intervention + KMZ.
9. Biodiversity study.
10. Food security study.
11. Water quality studies, including coastal and marine pollution report (with specific pollution- related environmental risks for the ecosystems and communities).

What will be measured:

1. Geographical & climatological information.
2. Technical viability, TRL, and technology mix.
3. Key social information on the coastlines included (social risk-factor identification).
4. Types of ecosystems & risks by ecosystem.
5. Carbon baseline & estimate of yearly carbon capture potential.
6. Biodiversity index / profile.
7. Water quality profile.

4.2 REQUIREMENTS PER AUDIT TYPE: 2.- COMPLIANCE AUDIT

The second type of third-party audit is the Compliance Audit, which reviews carbon solutions on two levels:

1) The application and observance of The DEV Carbon Standard and protocols.

2) The compliance with applicable local carbon offset or other relevant environmental regulations.

The Compliance Auditor will determine what documents it needs to access in each case, according to the case's characteristics.

4.3 REQUIREMENTS PER AUDIT TYPE: 3.- FINANCIAL, LEGAL & FISCAL AUDIT

This third-party audit makes it easier for Project Integrators to have their project's financial data organized and structured under international standards, which opens the possibility to be compliant with the requirements of financial institutions around the world (for example, to access green finance opportunities in the future). There is no set time for this type of audit: it can be scheduled at random times by the Certifier.

The typical documents required by the auditors are:

1. The project's budget.
2. The project´s financial projections.
3. Proof of the most recent tax payment / proof of local tax compliance.
4. Incorporation documents, updated commercial licenses, necessary local permits, or any other local requirement established by authorities for companies to be able to sell carbon offsets.
5. Contracts with the stakeholders and proof of payments to the stakeholders according to the contracts.
6. Additionally, there might be an interview and a site visit when deemed necessary.

4.4 REQUIREMENTS PER AUDIT TYPE: 4.- MEASUREMENT, REPORTING AND VERIFICATION AUDIT

This third-party audit adds another layer of certainty, as it can be scheduled at random times, and as it targets specific MRV KPIs that under the DEV Carbon Standard are impossible to alter or tamper with in any coherent way.

For example, the auditor may require from a Data Provider a table with last Thursday's key sensor readings at 3 p.m., or ask for the last calibration and certification date of a particular sensor and the name of the laboratory or engineer that signed it. Whatever answers are provided to the auditor, the auditor will compare them with the data previously streamed and validated, and with the MRV and data feed guidelines established during the feasibility study. Furthermore, this audit may involve interviews and site visits.

MANGROVES

5. THE CARBON SOLUTION CERTIFICATION PROCESS

The Carbon Solution certification process

1. The integrator designs the Carbon Solution and brings together the Landowner (after a KYC) and the Solution Implementers.

2. The feasibility study is executed by an Engineering Auditor.

   The study establishes **(1)** the project's viability, **(2)** the project's historical carbon capture or avoidance through a baseline (of between 3 and 5 years), **(3)** the project's carbon capture or avoidance through the launching period, and **(4)** a suggestion of the percentage of carbon credits that could be destined to the buffer pool, which could be revised by the certifier.

3. Once the Auditor declared a project feasible, and provided the results of the feasibility study, the Integrator will fine-tune the project budget, and negotiate percentages for income distribution with stakeholders. The contracts are signed, ensuring a balanced and fair distribution.

4. The Certifier carries out calculations to determine the long-term stored carbon in the projects. The resulting tons from these calculations are the ones that will be certified. The project is uploaded to the Open Data Platform. The Certifier chooses when to send other auditors to verify the project's claims: **(1)** the Financial, Legal and Fiscal Auditor, and **(2)** the MRV Auditor.

5. The Project Integrator (or an associate Seller) finds buyers.

6. The client receives the offset certificates. The client may use the open data for marketing material and reports.

DIAGRAM 3. CERTIFICATION PROCESS

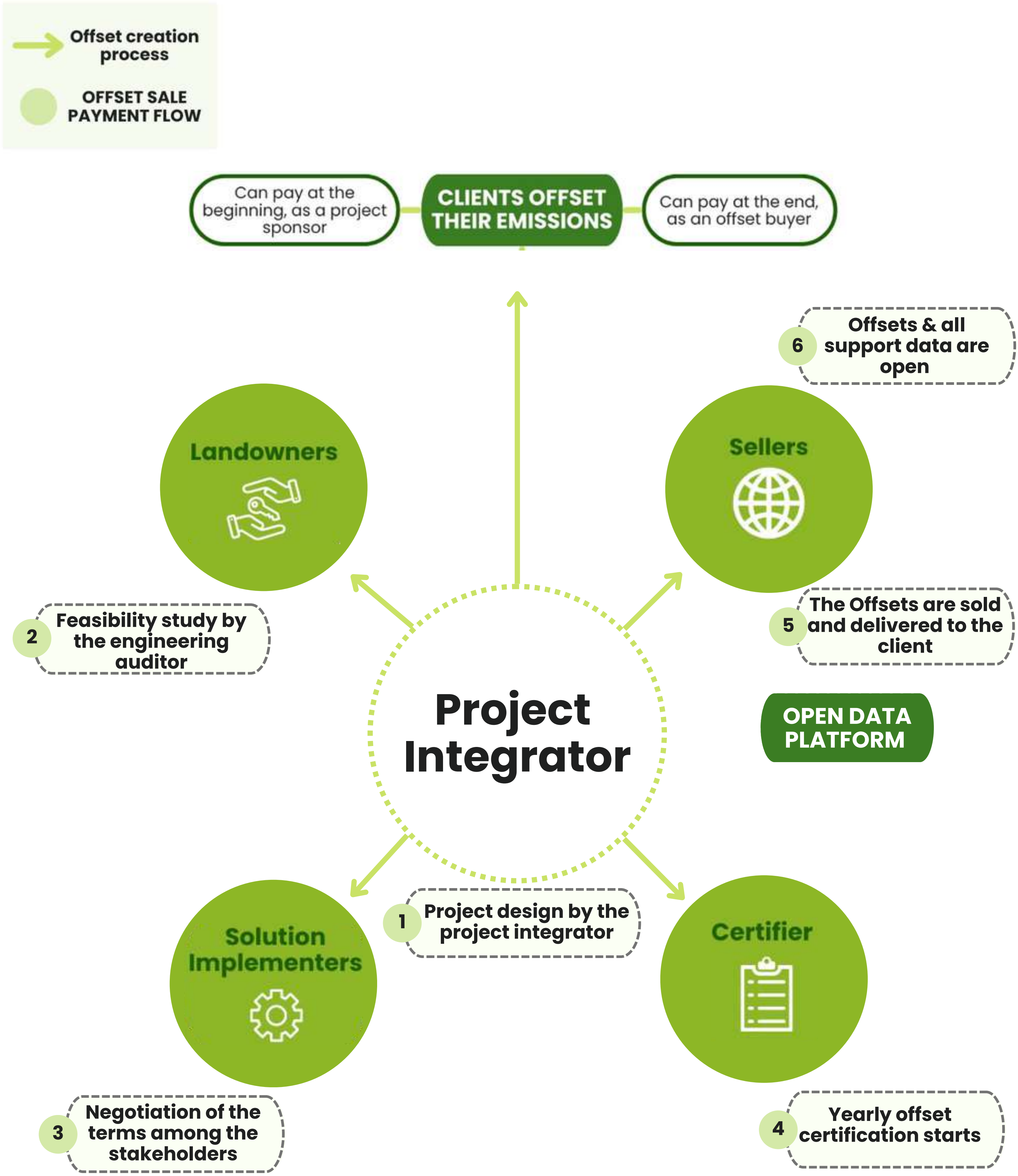


DIAGRAM 3.1 THE PROCESS VIEWED FROM ANOTHER PERSPECTIVE

OPEN SEA

6. THE CONTINUOUS DATA CYCLE

Normal Measurement, Reporting and Verification (MRV) practices across carbon markets have an extremely low-frequency data feed: they produce yearly impact reports that are text documents with static data that humans have to create and update manually every time (which means that a person has to read, organize, interpret, analyze, write, and edit information, which equals the possibility of reporting bias, error or worse).

Under the DEV Carbon Standard there are four accepted categories of data feed frequency:

1. Real Time Data. The preferred type when there are KPIs that can be tracked with more robust sensor systems.
2. Near Real Time Data. The second-best option when RTD is not applicable or not viable.
3. High-frequency data feed. The third option, including KPIs that can be tracked with more basic sensor systems.
4. Monthly to yearly reporting. Used only for KPIs that don't require a higher-frequency data update. For example, satellite and drone images would usually be in this category.

This means that in addition to normal MRV and project audit requirements, the DEV Carbon Standard uses a continuous data cycle that is audited under Systems Engineering standards, and of course, open to public scrutiny on the Open Data Platform.

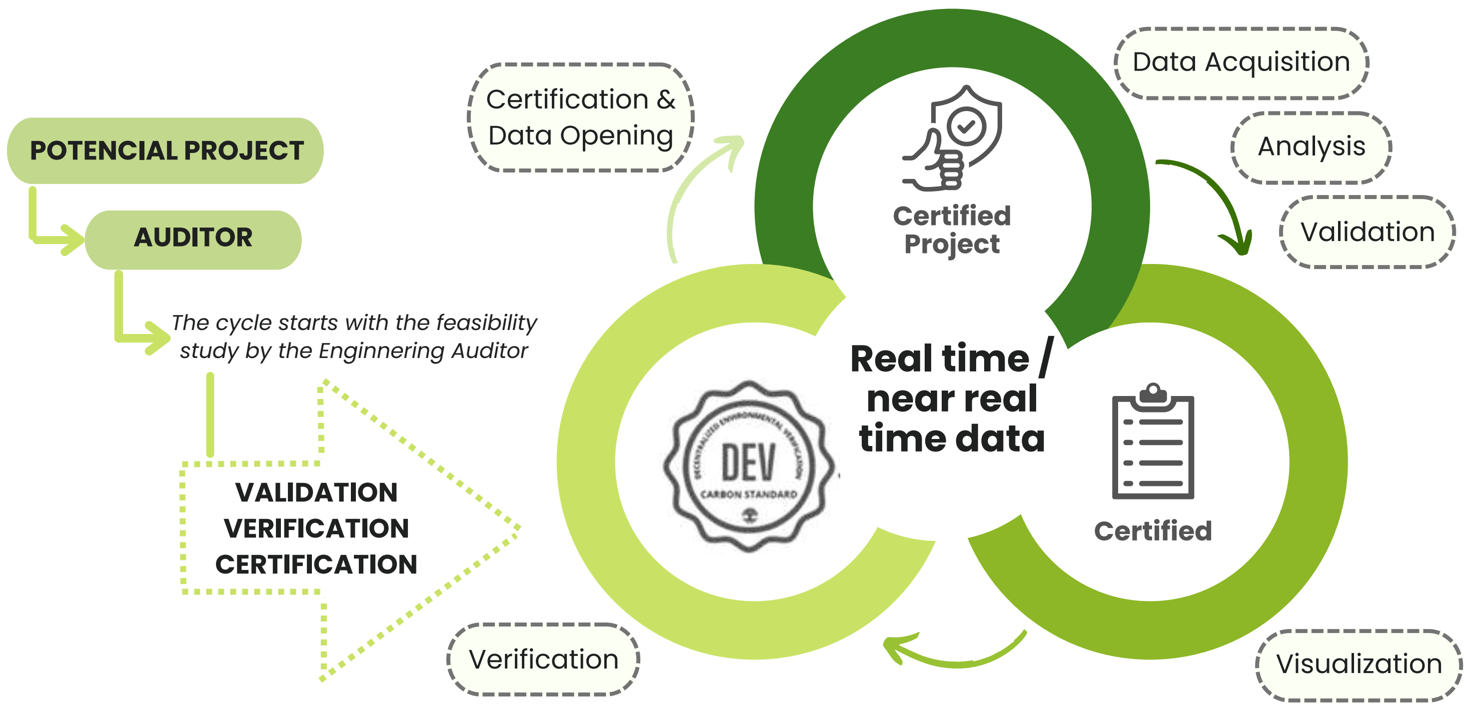


DIAGRAM 4. DATA CYCLE


MESOPHYLL FORESTS

7. CARBON SCIENTIFIC, TECHNICAL, AND ENGINEERING METHODOLOGIES FRAMEWORK

This section introduces the framework for the DEV open data Carbon Credits / Offsets. Open data Carbon Credits / Offsets are anchored by two main pillars: Systems Engineering and open data policies. In the urgent global endeavor to mitigate climate change, the need for rigorous methodologies and transparent data governance has reached an urgency level.

This framework is a direct response to this pressing need, furnishing the theoretical, methodological, technical, scientific, and engineering set of building blocks for the DEV Carbon Standard and its protocols. This framework achieves the integration of systems thinking, Systems Engineering, data transparency principles, and carbon accounting methodologies.

Systems Engineering, characterized by its interdisciplinary approach and lifecycle perspective, furnishes a robust foundation for designing, analyzing, and managing the intricate systems inherent in carbon offset projects. By considering the interactions between various components and the broader environmental context, Systems Engineering ensures that Carbon initiatives are conceptualized, executed, and monitored with efficacy, integrity, and accuracy. This approach is well beyond offset methodologies based on sets of rules and premises that inadvertently enable tautological and circular scientific reference models because of the lack of open, verifiable data behind their claims. **This is the point where Carbon Markets transition from statistical inferences to engineering.**

There is an urgent need for open data policies in Carbon Markets. Through the transparent dissemination of data pertaining to Carbon Solutions, stakeholders will gain access to crucial information, enabling them to evaluate the veracity of claims and hold entities accountable for their true environmental impact, and not only what they report and one single audit states.

Open data policies will serve as a cornerstone for fostering trust and confidence in Carbon Markets, facilitating informed decision-making and propelling substantive progress towards global climate goals

The integration of Systems Engineering and open data policies collectively presents a formidable opportunity for augmenting the accuracy, reliability, and credibility of carbon offsets and carbon markets as a whole.

In this section you will find a brief introductory note about Systems Engineering, a brief introductory note about open data, and the list of documents that constitute the knowledge framework for the DEV Carbon Standard.

7.1 METHODOLOGY STRUCTURE

The DEV Carbon Standard 2025 uses engineering models and open data principles to fast-track transparency in Carbon Markets.

Project Integrators are the backbone of Carbon Solutions. The DEV Carbon Standard 2025 helps Project Integrators comply with state-of-the-art engineering and data transparency frameworks by just following a clear, simplified set of rules and processes.

Few industries on the planet currently operate with as little data as the Carbon Markets. We rely on yearly reports when what we truly need is real-world, real-time data about Carbon Solutions. We depend on closed-door audits when what we actually require are data validation and verification processes that are open to public scrutiny. We rely on written paragraphs for information, but what we actually need are more sensors streaming data directly. The DEV Carbon Standard is here to help Carbon Markets transit from statistical inferences to engineering, and from words to real time data.

In order to simplify complex engineering frameworks in a few clear principles, guidelines and processes, the methodology has been structured in two components:

1. The two-track approach (Systems Engineering & open data).
2. Tools for project integrators (additional recommendations and materials).

7.2 THE TWO-TRACK APPROACH

The DEV Carbon Standard follow two tracks simultaneously: Systems Engineering and open data. These two elements are crucial to understand and to comply with the principles and guidelines of the Standard.

Throughout their lifecycle, Carbon Solutions are chiefly evaluated by their performance on data transparency, which is achieved by the integration of both tracks.

This two-track approach is best explained through the continuous data cycle designed for DEV-compliant offsets. This data cycle approach integrates reliable a data input system and transparency mechanisms embedded in the system itself.

7.2.1 SYSTEMS ENGINEERING

Systems engineering is an interdisciplinary approach to designing, analyzing, and managing complex systems over their entire life cycles. It encompasses a holistic perspective that considers the interactions between various components and subsystems within a system, as well as the relationships between the system and its environment.

Systems engineering originated in the mid-20th century, primarily in response to the increasing complexity of engineering projects, such as those in aerospace, defense, and large-scale infrastructure. As technological advancements led to the development of more sophisticated systems with interconnected components, traditional engineering approaches proved inadequate for addressing the challenges posed by these complex systems.

Key aspects of systems engineering include integration, interdisciplinary collaboration, requirements management, design and optimization, risk management, lifecycle approach, and systems thinking.

Integration involves combining different elements, such as hardware, software, personnel, processes, and facilities, to create a functioning system that meets defined requirements and objectives. Interdisciplinary collaboration is essential, as systems engineering requires input from various disciplines, including engineering (mechanical, electrical, software), mathematics, physics, and social sciences.

Requirements management is a critical aspect of systems engineering, involving the elicitation, analysis, and management of requirements throughout the system's life cycle. This ensures that the final system meets stakeholder needs and technical specifications. Design and optimization focus on designing the architecture, structure, and behavior of complex systems to achieve desired performance, reliability, and efficiency. Risk management involves identifying and managing risks associated with system development, implementation, and operation.

The lifecycle approach considers the entire lifecycle of a system, from concept development and design to manufacturing, deployment, operation, maintenance, and disposal. This ensures that the system is designed for sustainability, reliability, and ease of maintenance.

Finally, systems thinking emphasizes a holistic perspective that considers the interactions and interdependencies between different parts of a system and its broader context. This approach helps identify emergent properties, unintended consequences, and system- level behaviors that may not be apparent when focusing on individual components.

7.2.1.1 SYSTEMS ENGINEERING COMPETENCY MODEL (SECM)

The NASA Systems Engineering Competency Model (SECM) serves as a comprehensive framework developed by NASA to delineate the requisite knowledge, skills, abilities, and behaviors necessary for proficient performance within the realm of systems engineering at the agency. It offers a detailed guide for recruiting, training, nurturing, and appraising systems engineers across the diverse array of projects and programs within NASA.

One fundamental aspect of the NASA SECM is its division of systems engineering competencies into distinct domains or categories, which encapsulate various facets of systems engineering practice. These domains typically encompass Technical proficiency, Project Management acumen, Leadership qualities, Communication skills, Collaboration capabilities, and Professionalism standards.

Within each domain, the SECM delineates specific competency elements that further elaborate on the knowledge, skills, abilities, and behaviors essential for effective systems engineering. These elements span a broad spectrum, including but not limited to Requirements Management, System Architecture, Risk Management, Integration and Testing, Decision Making, Stakeholder Engagement, Team Leadership, Conflict Resolution, Written and Oral Communication, Ethics, and Continuous Learning.

Moreover, the SECM establishes proficiency levels for each competency element, ranging from rudimentary to advanced levels of proficiency. These proficiency levels serve as a structured framework for evaluating and enhancing systems engineering competencies across different stages of an engineer's career trajectory.

To facilitate competency assessment and development endeavors within NASA, the SECM incorporates behavioral indicators for each competency element and proficiency level. These indicators delineate observable actions or behaviors that correlate with successful performance, thereby providing clarity on expectations and offering guidance for both individuals and managers in assessing competency levels and pinpointing areas for improvement.

In essence, the NASA SECM plays a pivotal role in supporting competency assessment and development initiatives at NASA by furnishing a standardized framework for gauging systems engineering capabilities. It informs various aspects of talent management, including recruitment processes, performance evaluations, training and development initiatives, career planning endeavors, and succession management strategies.

7.2.1.2 MODEL-BASED SYSTEMS ENGINEERING

Systems Engineering emerged in response to the growing complexity of engineering projects, particularly in sectors like aerospace, defense, and large-scale infrastructure. As technology progressed, systems became more intricate with interconnected parts, requiring a departure from traditional engineering methods to adequately address the associated challenges.

Central to systems engineering are several key aspects:

1. Integration entails merging different elements, such as hardware, software, personnel, processes, and facilities, to create a functioning system that meets predetermined requirements and goals. Interdisciplinary collaboration is crucial, as it involves input from various fields, including mechanical, electrical, and software engineering, as well as mathematics, physics, and social sciences.
2. Requirements management is pivotal, involving the identification, analysis, and control of requirements throughout the system's life cycle to ensure alignment with stakeholder needs and technical specifications.
3. Design and optimization focus on crafting the architecture, structure, and behavior of complex systems to achieve desired levels of performance, reliability, and efficiency.
4. Risk management encompasses identifying and mitigating risks associated with system development, implementation, and operation to safeguard against potential failures or setbacks.
5. The lifecycle approach considers all stages of a system's existence, from conception and design through manufacturing, deployment, operation, maintenance, and eventual disposal. This holistic perspective ensures that systems are built for longevity, reliability, and ease of upkeep.
6. Lastly, systems thinking emphasizes understanding the holistic interactions and interdependencies among different system components and their broader context. This approach helps uncover emergent properties, unintended consequences, and system- level behaviors that may not be evident when focusing solely on individual parts.

The realm of Systems Engineering has been enriched by a wealth of frameworks, guidelines, principles, models, and standards contributed by prominent institutions over the past three decades. Foremost among these institutions are the International Council on Systems Engineering (INCOSE), the

National Aeronautics and Space Administration (NASA), the Institute of Electrical and Electronics Engineers (IEEE), and the National Institute of Standards and Technology (NIST).

INCOSE, a global organization dedicated to advancing Systems Engineering practice, has been instrumental in developing and promoting various frameworks and methodologies.

One of the significant contributions from INCOSE is the concept of Model-Based Systems Engineering (MBSE), which emphasizes the use of models as primary artifacts to define, analyze, and communicate system requirements and designs. Additionally, INCOSE has formulated comprehensive definitions and a visionary outlook for Systems Engineering in the coming decades, providing a roadmap for practitioners to navigate evolving challenges and opportunities in the field.

NASA, renowned for its expertise in complex system development for aerospace missions and beyond, has produced a series of authoritative handbooks and guides on Systems Engineering. These publications, such as the "NASA Systems Engineering Handbook" and the "NASA Systems Engineering Processes and Requirements," offer invaluable insights, best practices, and practical methodologies derived from decades of experience in managing intricate engineering endeavors.

The IEEE and NIST have also made significant contributions to Systems Engineering through the development of standards and guidelines aimed at promoting consistency, interoperability, and quality in engineering processes and products. IEEE standards, such as IEEE 1220 for Systems Engineering processes and IEEE 15288 for Systems and Software Engineering, provide frameworks for managing the lifecycle of complex systems. Similarly, NIST standards, including the NIST Systems Engineering Handbook and various publications under the Systems Security Engineering initiative, offer guidance on integrating security considerations into Systems Engineering practices.

The efforts of these institutions have shaped the landscape of Systems Engineering, providing practitioners with a rich array of resources to tackle complex challenges and drive innovation across diverse domains. As Systems Engineering continues to evolve in response to technological advancements and emerging complexities, these foundational frameworks and standards serve as invaluable reference points for ensuring the efficacy, reliability, and resilience of engineered systems.

Model-Based Systems Engineering (MBSE) is an approach to Systems Engineering that emphasizes the use of models as primary artifacts throughout the entire system development lifecycle. Unlike traditional document-centric approaches, where requirements, designs, and specifications are primarily captured in textual documents, MBSE relies on graphical and computational models to represent system elements, relationships, and behaviors.

Key components of MBSE include:

1. **Models as Central Artifacts:** In MBSE, models serve as central artifacts for defining, analyzing, and communicating system requirements, designs, and architectures. These models can encompass various viewpoints, including functional, behavioral, structural, and operational perspectives, allowing stakeholders to gain a comprehensive understanding of the system under development.
2. **Interdisciplinary Integration:** MBSE promotes interdisciplinary collaboration by providing a common platform for engineers and stakeholders from diverse domains to contribute to the development of system models. This integration fosters communication, alignment, and consensus-building among team members, leading to more robust and coherent system designs.
3. **Semantic Consistency:** MBSE facilitates semantic consistency by establishing a formal and structured representation of system elements and their relationships. Through standardized modeling languages and notations, such as SysML (Systems Modeling Language) or UML (Unified Modeling Language), MBSE ensures clarity, precision, and consistency in the interpretation of system models across different stakeholders and phases of the system lifecycle.
4. **Traceability and Impact Analysis:** MBSE enables traceability and impact analysis by establishing explicit relationships between different elements of the system model. This traceability allows for the systematic tracking of requirements, design decisions, and changes throughout the system lifecycle, facilitating informed decision-making and risk management.
5. **Simulation and Validation:** MBSE supports simulation and validation activities by providing executable models that can be used to analyze system behavior, performance, and functionality. Through simulation-based assessments, engineers can evaluate design alternatives, verify system requirements, and identify potential issues or risks early in the development process.
6. **Iterative Development:** MBSE promotes an iterative and incremental approach to system development, where models evolve and mature over time in response to changing requirements, feedback, and insights gained from analysis and simulation. This iterative nature allows for flexibility and adaptability in addressing evolving needs and uncertainties throughout the system lifecycle.

On the other hand, open data refers to data that is freely available for anyone to access, use, and share without restrictions. It is typically made available in digital formats and is often released under open licenses or in the public domain, allowing for widespread dissemination and reuse.

7.2.2 OPEN DATA

The concept of open data emphasizes transparency, accessibility, and interoperability, aiming to democratize access to information and promote collaboration, innovation, and accountability.

Open data is essential for effective nature protection as it provides transparency and accountability in environmental management. By making environmental data openly accessible to stakeholders, including policymakers, researchers, conservation organizations, and the public, open data ensures that decisions and actions related to nature conservation are based on reliable information and evidence. Transparency in data sharing allows for scrutiny of conservation efforts, enabling stakeholders to assess the impact of policies and interventions on ecosystems, biodiversity, and natural resources. This transparency fosters accountability among governments, industries, and other actors involved in environmental management, encouraging responsible stewardship of natural assets and adherence to conservation goals and targets.

Open data plays a crucial role in sustainability efforts, particularly in addressing climate change, for several reasons:

1. **Enhanced Transparency and Accountability:** Open data enables greater transparency and accountability in climate change mitigation and adaptation efforts. By making data related to greenhouse gas emissions, climate impacts, and environmental policies freely available to the public, governments, businesses, and civil society organizations can be held accountable for their actions and progress towards climate goals.
2. **Informed Decision-Making:** Open data provides decision-makers with access to a wealth of information and evidence-based insights that can inform climate action strategies, policies, and investments. Decision-makers can use open data to identify trends, assess risks, evaluate the effectiveness of interventions, and prioritize resources where they are most needed to achieve sustainability goals.
3. **Facilitated Collaboration and Innovation:** Open data fosters collaboration and innovation by enabling diverse stakeholders, including researchers, policymakers, businesses, and communities, to access and share data, knowledge, and expertise. This collaboration can lead to the development of innovative solutions, technologies, and approaches to address climate change challenges more effectively.

4. **Empowered Communities and Citizen Engagement:** Open data empowers communities and individuals to participate in climate change efforts by providing them with access to information and tools to understand and address local climate impacts. Citizen scientists can contribute valuable data and insights to climate monitoring and research efforts, while community-based organizations can use open data to advocate for climate-resilient infrastructure and policies.
5. **Improved Planning and Resource Allocation:** Open data supports better planning and resource allocation for climate change adaptation and mitigation initiatives. Governments and organizations can use open data to identify vulnerable regions, assess climate risks, and allocate resources for infrastructure development, disaster preparedness, and ecosystem restoration in areas most susceptible to climate impacts.
6. **Monitoring and Evaluation of Progress:** Open data enables the monitoring and evaluation of progress towards climate goals by providing transparent and standardized metrics for tracking emissions reductions, renewable energy deployment, forest conservation, and other sustainability indicators. This data-driven approach allows stakeholders to assess the effectiveness of climate policies and interventions and adjust strategies as needed to achieve desired outcomes.

7.2.2.1 OPEN DATA POLICIES & DATA TRANSPARENCY

Enhancing Stakeholder Confidence is currently of utmost importance, particularly in light of numerous instances of greenwashing that have tarnished the reputation of carbon solutions overall. Implementing transparent carbon principles will instill trust among stakeholders, including governments, businesses (buyers of carbon offsets/credits), investors, and the public. Through the establishment of clear rules, procedures, and oversight mechanisms, transparency promotes credibility and reduces uncertainty, thereby encouraging increased participation and investment in carbon markets as effective tools for climate mitigation.

Establishing transparent principles and guidelines for carbon markets is essential for bolstering accountability, ensuring environmental integrity, and fostering trust in climate change mitigation efforts. Transparency must permeate all facets of carbon markets, encompassing project development, emissions accounting, carbon trading, and the utilization of carbon credits or offsets.

Transparent guidelines are imperative to verify that Carbon projects financed through market mechanisms deliver genuine and additional emissions reductions or removals. Without transparent regulations governing project development, monitoring, and reporting, there exists a risk that carbon credits or offsets may be issued for activities that fail to yield authentic emissions reductions, thereby compromising the environmental integrity of Carbon Markets.

Furthermore, comprehensive transparent principles will aid in combatting greenwashing by verifying that carbon credits or offsets indeed represent legitimate emissions reductions or removals surpassing business-as-usual scenarios. Well-defined guidelines for assessing additionality and quantifying emission reductions help differentiate genuine climate action from misleading or deceptive claims, thus nurturing trust and credibility in carbon markets.

Open data and data transparency policies in the context of international cooperation for sustainability and data governance refer to the principles and practices aimed at making data openly accessible, understandable, and usable by all stakeholders. These policies prioritize the sharing of data related to sustainability, environmental protection, and global development to facilitate informed decision-making, foster collaboration, and drive positive societal and environmental outcomes.

A complete definition of open data and data transparency policies in this context would encompass the following elements:

1. **Accessibility:** Open data policies ensure that data related to sustainability and environmental issues are readily available to the public, policymakers, researchers, businesses, and other stakeholders. This accessibility is typically facilitated through online platforms, data portals, and repositories that provide easy and free access to datasets.
2. **Interoperability:** Data transparency policies promote interoperability by standardizing data formats, metadata, and protocols to facilitate the exchange and integration of data across different systems, organizations, and geographic regions. This interoperability enhances the usability and utility of data for analysis, modeling, and decision-making.
3. **Quality and Reliability:** Open data policies emphasize the importance of data quality and reliability to ensure that information used for sustainability purposes is accurate, up-to-date, and trustworthy. This may involve establishing data quality standards, conducting quality assurance checks, and providing metadata to help users assess the reliability of the data.

4. **Transparency and Accountability:** Data transparency policies promote transparency and accountability by disclosing information about the sources, methods, and limitations of the data. This transparency enables stakeholders to understand how data is collected, processed, and used, and to hold data providers accountable for the integrity and accuracy of the information.
5. **Privacy and Security:** Open data policies address privacy and security concerns by safeguarding sensitive information and personal data through appropriate anonymization, encryption, and access controls. These policies ensure that data sharing respects individual privacy rights and complies with relevant data protection regulations.
6. **Collaboration and Engagement:** Open data initiatives encourage collaboration and engagement among diverse stakeholders, including governments, NGOs, academia, businesses, and local communities. By fostering an open and inclusive data ecosystem, these policies enable collective problem-solving, knowledge sharing, and innovation for sustainable development.
7. **Capacity Building and Empowerment:** Open data policies support capacity building and empowerment efforts to enhance data literacy, analytical skills, and technical capabilities among stakeholders. This may involve providing training, education, and technical assistance to enable users to effectively access, analyze, and utilize data for decision-making and action.
8. **Continuous Improvement:** Open data and data transparency policies promote continuous improvement through feedback mechanisms, data-driven evaluation, and stakeholder engagement. By soliciting input from users and incorporating lessons learned, these policies ensure that data initiatives evolve to meet the changing needs and priorities of the sustainability community.

Open data plays a crucial role in sustainability efforts, particularly in addressing climate change, for several reasons:

1. **Enhanced Transparency and Accountability:** Open data enables greater transparency and accountability in climate change mitigation and adaptation efforts. By making data related to greenhouse gas emissions, climate impacts, and environmental policies freely available to the public, governments, businesses, and civil society organizations can be held accountable for their actions and progress towards climate goals.
2. **Informed Decision-Making:** Open data provides decision-makers with access to a wealth of information and evidence-based insights that can inform climate action strategies, policies, and investments. Decision-makers can use open data to identify trends, assess risks,

evaluate the effectiveness of interventions, and prioritize resources where they are most needed to achieve sustainability goals.

3. **Facilitated Collaboration and Innovation:** Open data fosters collaboration and innovation by enabling diverse stakeholders, including researchers, policymakers, businesses, and communities, to access and share data, knowledge, and expertise. This can lead to the development of innovative solutions, technologies, and approaches to address climate change challenges more effectively.
4. **Empowered Communities and Citizen Engagement:** Open data empowers communities and individuals to participate in climate change efforts by providing them with access to information and tools to understand and address local climate impacts. Citizen scientists can contribute valuable data and insights to climate monitoring and research efforts, while community-based organizations can use open data to advocate for climate-resilient infrastructure and policies.
5. **Improved Planning and Resource Allocation:** Open data supports better planning and resource allocation for climate change adaptation and mitigation initiatives. Governments and organizations can use open data to identify vulnerable regions, assess climate risks, and allocate resources for infrastructure development, disaster preparedness, and ecosystem restoration in areas most susceptible to climate impacts.
6. **Monitoring and Evaluation of Progress:** Open data enables the monitoring and evaluation of progress towards climate goals by providing transparent and standardized metrics for tracking emissions reductions, renewable energy deployment, forest conservation, and other sustainability indicators. This data-driven approach allows stakeholders to assess the effectiveness of climate policies and interventions and adjust strategies as needed. This also includes tracking and proving progress in SDGs and other relevant national and international policy and cooperation frameworks.

7.3 TOOLS FOR PROJECT INTEGRATORS

At a project design level the key premise is: make reasonable KPIs and set project targets with common sense.

At a compliance level the key premise is: keep things simple and clear. There are many audits in the DEV Carbon Ecosystem (on top of it being an open data system), so as long as Project Integrators don't add red tape and layers of complexity in their management of the projects, audits shall run smoothly every time. As a Project Integrator, just follow the Standard and the auditors' and certifiers' recommendations, and your projects will move in an agile manner: the whole system has already simplified and condensed complex engineering into just six steps for offset certification success.

Most of the tech and data elements any project may require have already been considered and embedded within the DEV system so that Project Integrators can focus on creating value-adding carbon projects within a framework of data transparency, instead of worrying also about developing data solutions or additional technology to track and report progress.

Systems Engineering is after all a framework to understand and simplify complex systems of systems: just follow the 6 steps for offset certification using the templates and reference documents you received along with your Project Integrator license, and don't be afraid to ask questions to the auditors and the certifiers.

The DEV Systems Engineering framework includes science and engineering tools and methodologies like:

1. Systems Engineering.
2. Model-Based Systems Engineering.
3. Systems Integration.
4. Systems of systems.
5. System Assurance.
6. Digital-physical system integration through IoT.
7. Sensor-powered data systems:
    a. Calibration.
    b. Validation.
    c. Verification.
    d. Certification.
8. Big data structure & treatment.
9. Reliable data cycles:
    a. Data acquisition.
    b. Data validation.
    c. Data analysis.
    d. Data visualization.
    e. Data verification.
    f. Data certification.
10. Earth Sciences frameworks & approaches.
11. Open data principles, guidelines and policies.
12. Open data ideal formats.
13. Open data strategies.

14. Requirement definition for Systems Engineering-based models for carbon offset data reliability, traceability and visibility.
15. Decentralized Environmental Verification.
16. Systems Engineering models useful for open verification in the context of carbon markets.
17. Viable data engineering alternatives to avoid double-counting in carbon markets.
18. Ethical use of Artificial Intelligence-powered environmental data tools.
19. Frameworks and principles for the ethical use of planetary data.
20. Frameworks and principles for the ethical use of indigenous communities data.
21. Frameworks and principles for the ethical use of soil data.
22. Frameworks and principles for the ethical use of coastal, marine, and ocean data.
23. Transparency principles and guidelines for avoidance carbon offsets.
24. Transparency principles and guidelines for direct carbon capture technologies.
25. Guidelines for open data MRV models.
26. Engineering standards relevant to improve the data accuracy, transparency, traceability and accessibility in the context of forest protection and restoration solutions.
27. Technical guidelines for soil restoration interventions and methodologies.
28. Technical guidelines for regenerative agriculture and agro-forestry solutions.
29. Technical guidelines for mangrove restoration.
30. Technical guidelines for blue carbon interventions.
31. Frameworks for ESG & SDG KPI definition and tracking.

7.4 THE LIST OF DOCUMENTS THAT CONSTITUTE THE FRAMEWORK FOR THE DEV CARBON STANDARD

1. INCOSE's Systems Engineering Vision 2035, Engineering Solutions for a Better World.
2. INCOSE's Systems Engineering & System Definitions.
3. INCOSE's Systems Engineering Competency Framework.
4. Survey of Model-Based Systems Engineering (MBSE) Methodologies (INCOSE MBSE Initiative).
5. The NASA Systems Engineering Handbook.
6. The Expanded Guidance for NASA Systems Engineering.
7. The Future Model-Based Systems Engineering Vision and Strategy Bridge for NASA.
8. The Model-Based Mission Assurance in a Model-Based Systems Engineering (MBSE) Framework (NASA).
9. NASA´s Systems Engineering Processes and Requirements.
10. The NASA Earth Science Reference Handbook.

11. The Sandia National Laboratories report on MBSE, "Systematic Literature Review: How is Model-Based Systems Engineering Justified?".
12. NIST's Framework for Cyber-Physical Systems.
13. NIST's "Developing Cyber-Resilient Systems: A Systems Security Engineering Approach".
14. NIST's "Engineering Trustworthy Secure Systems".
15. NIST's Big Data Interoperability Framework.
16. NIST´s "Environmental Scan 2023: Societal and Technology Landscape to Inform Science and Technology Research".
17. The Open Data Charter.
18. The world's first standard on AI ethics: UNESCO's Recommendation on the Ethics of Artificial Intelligence.
19. UNESCO's Ethical Impact Assessment: A Tool of the Recommendation on the Ethics of Artificial Intelligence.
20. The Core Carbon Principles (CCPs), proposed by The Integrity Council for the Voluntary Carbon Market.
21. ÆRTH's Planetary Data Integrity Principles.
22. The Systems Engineering and Systems Integration Methodology for the Validation and Verification of Carbon Capture & Avoidance Data (by The Association of Engineers for Carbon Facts).
23. The Methodology to Avoid Double Counting in Carbon Markets (also referred to as the "NO double counting Principles") of the Data Transparency Research Group organized by The Global Nature Data Engineering Network.
24. The Carbon Offset & Carbon Credit Transparency Principles proposed by The Council for Fair Green Finance.
25. The Carbon Data Transparency, Traceability & Visibility Standard (by The Scientific Alliance for Carbon Offset Transparency).
26. The Technical Industrial Standard for Open Data Carbon Offsets (Estándar Técnico Industrial para Offsets de Carbono de Datos Abiertos). NORMEX.
27. The 2023 OECD Open, Useful and Re-usable Data INDEX.
28. The UN A/RES/70/1 - Transforming our world: the 2030 Agenda for Sustainable Development.
29. The UN Global Compact Management Model: Framework for Implementation.
30. The UN Global Compact Guide to Corporate Sustainability.
31. CDM - **(1)** Accreditation Standard. **(2)** Project standard for project activities. **(3)** Determining coverage of data and validity of standardized baselines. **(4)** Large-scale Consolidated Methodology. Afforestation and reforestation of lands except wetlands. **(5)** CDM - Large-scale Methodology. Afforestation and reforestation of degraded mangrove habitats.
32. The IUCN Global Ecosystem Typology
33. The IUCN Red Listed Ecosystems platform.
34. The Oxford Principles for Net Zero Aligned Carbon Offsetting.

CORAL REEFS

8. SPECIFIC PROTOCOLS BY OFFSET TYPE IN 2025

1

DEV Carbon Standard 2025 (English)

Carbon Capture Blocks: A Modular Scientific Framework (English)

Protocols (English)

2

DEV Carbon Standard 2025 for Mexico (Spanish)

Carbon Capture Blocks: A Modular Scientific Framework for Mexico (Spanish)

Protocols for Mexico (Spanish)

The **Modular Scientific Framework** contains:

1. Guiding principles

2. General terms and definitions of the CO_2 capture cycle in ecosystems (GPP, NPP, NEE, carbon cycle in sea, land, and atmosphere)

3. Methodological development for quantifying carbon absorption and carbon stock for each ecosystem process, organized into modular carbon capture blocks.

The **protocols** are:

OT-01 Terrestrial ecosystems	OT-06 Marine ecosystems
Deserts	Mangroves
Tropical forests	Seagrass beds
Mesophyll forests	Coral reefs
Grasslands	Open sea

DIAGRAM 5. PROTOCOLS

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