

White Paper – Validation Logic

Planedo’s Validation Logic – Scientific Foundations, Methodology & System Architecture for Credible CO₂ Impact

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1. Introduction & Objectives

Why Planedo requires a proprietary validation system – and what it delivers

1.1 Background and Motivation

In a world increasingly driven by climate commitments, the credibility of carbon reduction claims is under growing scrutiny. Traditional carbon offset systems have often failed to ensure scientific rigor, traceability, or additionality. Voluntary carbon markets in particular have been criticized for opaque methodologies, unverifiable impacts, and cases of double counting.

Planedo was developed to address these challenges directly. At its core, Planedo is not a trading platform or compensation scheme. It is a **scientific validation system** that quantifies, verifies, and documents real CO₂ reductions – using the combined power of **Artificial Intelligence (AI)**, **human review**, and **Distributed Ledger Technology (DLT)**.

1.2 The Role of Validation

Validation is the central pillar of Planedo. Every Planedo NFT represents **10 kg of scientifically validated CO₂ impact**. These units are not symbolic or market-driven; they are the output of a structured, auditable, and methodologically sound validation process. This validation ensures:

- The **measurability** of the CO₂ reduction
- The **additionality** beyond legal requirements or business-as-usual scenarios
- The **exclusion of duplicate or already-credited reductions**
- The **scientific plausibility** of the claimed impact
- The **public traceability** of every issued unit

In this way, Planedo serves as a **reliable verification framework** that transforms diverse climate actions into quantifiable, non-speculative units of impact.

1.3 Why Planedo Developed Its Own System

Rather than relying on third-party certification frameworks (e.g., Verra, Gold Standard), Planedo has built its own **independent and transparent validation system**, because:

- **Existing standards lack transparency:** Their methodologies are often proprietary, and verification documents are rarely public.
- **Scientific accuracy is inconsistent:** Many certifications rely on outdated or oversimplified emission factors and assumptions.
- **Double counting remains unresolved:** Especially when credits are sold across jurisdictions or claimed multiple times.

By building its own system, Planedo can ensure that each validated impact:

- **Follows the highest scientific standards**
- Is **fully documented** and traceable in a public ledger
- Remains **non-transferable** unless explicitly earned or minted through validated reduction

1.4 What This White Paper Provides

This white paper outlines the **validation logic** behind Planedo in a transparent and structured way. It explains:

- The **scientific foundations** for measuring CO₂ impact
- The **multi-layered validation process**
- The treatment of **soft vs. hard minting**
- **Rules for exclusion and additionality**
- **Safeguards** against duplication and manipulation
- The system's **regulatory and methodological alignment**

Ultimately, this paper aims to make Planedo's validation logic **understandable, inspectable, and trustworthy** – for scientists, regulators, project owners, and the general public alike.

2. Scientific Foundations of CO₂ Impact

From avoidance to sequestration – definitions, mechanisms, and measurability

2.1 Understanding CO₂ Impact: A Scientific Perspective

In climate science, **not all CO₂ reductions are created equal**. A reliable validation system must distinguish between different **types, mechanisms, and timelines** of impact. Planedo's validation logic is built upon widely recognized scientific principles, while applying a stricter, more structured approach to their quantification and attribution.

The two primary categories of climate-relevant action are:

- **CO₂ avoidance** (also called prevention): Actions that prevent emissions from occurring in the first place (e.g., switching to renewable energy, improving energy efficiency).
- **CO₂ sequestration**: Actions that actively remove CO₂ from the atmosphere and store it (e.g., reforestation, soil carbon storage, direct air capture).

Planedo supports both, as long as they are **quantifiable, additional, and scientifically verifiable**.

2.2 Key Definitions in Planedo's Validation Framework

To ensure methodological clarity, Planedo uses the following **scientific definitions**:

- **Baseline Scenario:** The projected CO₂ emissions or removals that would occur without the proposed intervention. Establishing a credible baseline is crucial for determining **net impact**.
 - **Gross Reduction:** The total amount of CO₂ saved or sequestered compared to the baseline.
 - **Net Reduction:** The gross reduction adjusted for **uncertainties, leakage, and systemic side-effects**.
 - **Additionality:** A reduction is only valid if it would not have occurred without the specific project activity – this is a core eligibility condition in Planedo’s logic.
 - **Permanence:** Refers to the duration that the CO₂ remains out of the atmosphere. Planedo applies **conservatively modeled decay rates** and safety factors for biological sequestration.
 - **Leakage:** Emissions that may increase elsewhere as an unintended consequence of the project (e.g., forest protection in one area leading to deforestation in another).
 - **Quantifiability:** A CO₂ effect must be measurable using accepted scientific methods, models, or standards.
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2.3 Accepted Sources and Methodologies

Planedo’s validation logic is based on methodologies from **recognized scientific and regulatory bodies**, including:

- **IPCC Guidelines** (Intergovernmental Panel on Climate Change)
- **ISO 14064 / 14067 Standards** (GHG quantification and carbon footprinting)
- **National greenhouse gas inventories**
- **Scientific peer-reviewed literature**
- **Sector-specific databases**, such as:
 - Ecoinvent
 - UBA (German Environment Agency)
 - EEA (European Environment Agency)

These references form the backbone of Planedo’s **emissions factors, life-cycle assessments, and project evaluation models**.

2.4 Types of Recognized CO₂ Effects

Planedo distinguishes between different types of climate impact and applies **tailored methodologies** for each:

Type of Impact	Example	Measurement Approach
Direct Emissions Avoidance	Solar panels replacing fossil energy	Energy balance × grid emissions factor
Process Innovation	Low-clinker cement replacing standard cement	Material substitution × emission intensity
Biological Sequestration	Humus-building agriculture, agroforestry	Soil carbon tests, modeled over time
Technological Capture	Direct air capture (DAC)	Device throughput × capture efficiency
Efficiency Measures	Insulation, heat pumps	Modeled consumption before/after

Each impact type is mapped to a **dedicated validation path** within the Planedo system, ensuring that methodological differences are reflected in how reductions are calculated and verified.

2.5 CO₂ as a Measurable and Comparable Unit

Planedo treats CO₂ not as a symbolic or financial unit, but as a **scientifically grounded quantity** that must meet rigorous validation standards before being transformed into a Planedo. This includes:

- **10 kg per Planedo NFT:** Each unit corresponds to a scientifically validated reduction of exactly 10 kilograms of CO₂.
- **Uniform value per unit:** Regardless of source or project size, all Planedos are equivalent in climate impact.
- **Validation prior to issuance:** CO₂ effects are validated before they can be credited or represented as a Planedo.

This unit logic ensures **comparability**, **accountability**, and **systemic integrity** across all types of climate action within the Planedo ecosystem.

3. The Planedo Principle

Why CO₂ impact is not a classical offset – and why it isn’t a tradable certificate

3.1 One Reduction – One Purpose

The core of the Planedo validation logic is built around a **foundational rule**:

A CO₂ reduction can only be used once – and must serve a clearly defined purpose.

This principle may seem self-evident, but in many existing carbon markets, the **reuse, double counting, or resale** of emissions reductions is either **commonplace** or **difficult to trace**. This leads to inflated climate claims and undermines the integrity of environmental reporting.

Planedo was founded on the conviction that **only clearly validated, additional, and uniquely attributed reductions** should be recognized and documented. A Planedo represents this single use: once validated, it becomes a **non-transferable unit of climate impact** tied to either a **minting** or **earning** event.

3.2 Planedo is Not an Offset Certificate

While the function of a Planedo may resemble a carbon offset in terms of **documenting CO₂ impact**, it is fundamentally **not** a classical offset. Here’s how Planedo differs:

Feature	Traditional Offset	Planedo NFT
Tradable Asset	Yes, often sold on markets	No, not for trading or speculation
Financial Return	Can generate revenue for resellers	No resale or financial gain permitted
Use in Compensation Logic	Usually part of net-zero pledges	Only counted once, no double attribution
Transparency	Often limited to buyers	Publicly traceable via Planedo Explorer
Purpose	Offset/neutralize own emissions	Validate and document real climate impact

A Planedo is a **climate impact unit**, not a commodity. It is **proof**, not a credit.

3.3 Earning vs. Minting Planedos

Planedos can enter the system in two distinct and **mutually exclusive** ways:

1. **Earning Planedos:** Individuals, organizations, or project developers submit their **validated CO₂ reductions** and receive Planedos as a **reward for measurable impact**. These Planedos can be used to demonstrate sustainability commitments or to reduce their own CO₂ balance within the Planedo ecosystem.
2. **Minting Planedos:** Users can **finance validated projects** via a minting process, which results in the issuance of Planedos linked to **real, additional CO₂ reductions**. These are not speculative tokens, but a form of **impact documentation** tied to a fiat payment and validated outcome.

Importantly, a single reduction **cannot be both minted and earned**. This prevents **double attribution** and ensures that each CO₂ reduction is only ever represented once within the Planedo system.



3.4 No Market Value – But Real-World Integrity

Planedos are **not designed for speculation**. Their value lies in:

- **Credibility:** Each Planedo is backed by real, scientifically verified data.
- **Transparency:** All issuance is tracked on a public ledger (Planedo Explorer).
- **Trust:** The unit's impact is non-reversible, clearly sourced, and openly documented.

In this way, Planedo offers something **more robust than a marketable credit**: it offers **climate integrity**.

3.5 Framing Planedo Within ESG and Reporting

Rather than replacing existing ESG frameworks, Planedo **complements them** by adding a **validated layer of CO₂ transparency**. Organizations can use Planedos to:

- **Substantiate emissions reductions in sustainability reporting**
- **Demonstrate progress toward Scope 3 reduction goals**
- **Communicate verified impact to stakeholders and investors**
- **Support climate narratives with quantifiable evidence**

Because Planedos are **scientifically validated** and **immutably documented**, they carry more weight than generic carbon credits in ESG communications and **non-financial disclosures**.

4. The Planedo Validation Process

Three levels of verification: AI, human review, and scientific documentation

4.1 Overview: A Three-Tiered Validation Model

Planedo ensures the **credibility** of each CO₂ reduction through a rigorous **three-stage validation process**. This model combines the strengths of **automated technology**, **expert review**, and **transparent documentation**, ensuring that every Planedo represents a **real, measurable, and additional** climate impact.

The three stages are:

1. **Automated AI Validation**
2. **Human Review by Certified Validators**

3. Scientific Documentation & Public Disclosure

Each stage builds upon the previous one, creating a **robust and auditable chain of trust**.

4.2 Stage 1: Automated Validation by the Planedo AI

At the heart of the system is the **Planedo AI**, a machine learning framework trained on vast environmental datasets, emission factors, and sectoral benchmarks. Its main tasks include:

- **Pre-screening** project submissions for completeness and eligibility
- **Calculating CO₂ reductions** based on input parameters and validated methodologies
- **Checking for anomalies, inconsistencies, or potential duplication**
- **Flagging edge cases or low-confidence results** for further manual inspection

The AI uses standardized models across sectors – from energy and agriculture to construction and transport – and applies **adaptive learning** to improve over time.

Planedo's AI reduces human workload, ensures consistent application of rules, and makes the system scalable across thousands of submissions.

4.3 Stage 2: Expert Review by Human Validators

Even the most advanced AI must be supported by **expert oversight**, especially when:

- Project data is complex or context-sensitive
- Methodological exceptions are applied
- Regional or legal nuances must be considered
- Stakeholder inputs or documentation must be interpreted

Planedo engages trained **Validator-Cooperative Members** (validierende Genossen), who are:

- Independent from the project developers
- Trained in Planedo's validation framework
- Bound by strict guidelines and quality standards

They review AI outputs, verify source documents, and conduct plausibility checks. Any findings are logged in the project's validation dossier.

This **human layer ensures accountability** and provides flexibility where AI may fall short.

4.4 Stage 3: Scientific Documentation and Public Access

After a project has passed AI and human validation, it is subject to **final documentation**. This step includes:

- Compilation of a **Validation Dossier**, containing:
 - Methodology references
 - Input data and assumptions
 - Calculation models
 - Results and confidence levels
- Registration of the **Planedo NFT** (10 kg CO₂ impact) on Planedo’s DLT system
- Publication in the **Planedo Explorer**, including:
 - Project description
 - Validation summary
 - Timestamp and unique ID
 - Attribution (who earned or minted the Planedo)

This ensures that **every single Planedo** is:

- **Scientifically grounded**
- **Immutable**
- **Publicly traceable**

4.5 Modular Validation Paths per Project Type

Because climate action varies widely by context and sector, Planedo supports **modular validation paths** that match the specific type of CO₂ reduction:

Project Type	Validation Modules Involved
Solar Installation	Energy substitution module, grid factor validation
Soil Carbon Project	Sequestration modeling, satellite/field data input
Building Renovation	Pre/post energy use modeling, standard factors
Cement Innovation	Material LCA module, substitution ratio analysis
Agroforestry	Biomass modeling, permanence and decay adjustment

Each path invokes a **customized blend** of AI modules, emission factors, human checkpoints, and documentation logic.

4.6 Tiered Review Levels Based on Project Size

To balance precision with resource efficiency, Planedo applies a **tiered review approach**:

- **Small projects** (e.g. household retrofits):
→ AI validation + spot checks + simplified dossier
- **Medium projects** (e.g. farm-scale carbon storage):
→ AI + full human validation + standard documentation
- **Large/investor-backed projects** (e.g. corporate or municipal):
→ All three stages, including independent scientific advisory input and post-validation monitoring

This allows Planedo to maintain **high standards** without overburdening users or the validator network.

4.7 Conclusion: A Transparent and Auditable System

Planedo’s validation process is more than just a check-box exercise – it is a **layered, dynamic, and science-driven mechanism** that ensures every Planedo minted or earned is:

- **Scientifically verifiable**
- **Proven to be additional**
- **Checked by humans**
- **Documented for the public**

It is this multi-stage approach that sets Planedo apart from traditional carbon credit issuers – delivering not just numbers, but **trust**.

5. Hard vs. Soft Minting

Validating before or after the impact occurs – using dynamic carbon accounting logic

5.1 Two Pathways to CO₂ Validation

Planedo recognizes that **climate impact** can be realized in two fundamentally different ways:

1. **When the CO₂ reduction has already occurred**
2. **When the reduction is expected in the future, based on a validated mechanism**

These two paths are referred to in Planedo's system as:

- **Hard Minting:** Based on already achieved, measurable CO₂ reductions.
- **Soft Minting:** Based on projected CO₂ reductions that are conditional and verified over time.

Both approaches serve a role in accelerating climate action—but require **different rules, accounting logic, and transparency standards**.

5.2 Hard Minting: When Impact Has Already Happened

Hard Minting is the default and preferred route in the Planedo system. It applies when:

- The CO₂ reduction is already **fully achieved**
- The project is **completed or operational**
- There is sufficient **measurement or documentation** available

Examples include:

- A building retrofit that has demonstrably lowered heating demand
- A solar array that has produced renewable electricity
- A completed reforestation effort with current biomass data

In such cases, Planedo validates the impact **after the fact**, and a Planedo NFT is issued only once the **10 kg CO₂ reduction is scientifically confirmed**.

This method ensures the **highest certainty** and is considered the most **resilient against reputational risk or reversal**.

5.3 Soft Minting: Validating Impact That Is Still Emerging

Soft Minting is applied when CO₂ reductions are **projected**, but not yet fully realized. This applies especially to:

- Long-term infrastructure investments (e.g. DAC plants, green cement facilities)
- Nature-based solutions (e.g. soil carbon projects, tree planting)
- Innovation pilots with high potential, but delayed effect

Soft-minted Planedos are issued **in advance** or **in parallel** with the intervention, but:

- Are marked as **provisional** or **dynamically monitored**
- Must undergo **follow-up verification cycles**
- May be **adjusted or retracted** if the reduction does not occur as expected

To preserve integrity, Planedo uses:

- **Conservative baselines**
- **Safety margins and uncertainty buffers**
- **Dynamic modeling** (e.g. annual carbon stock updates)

- **Time-locking mechanisms** on DLT to prevent misuse

This ensures that **soft-minted Planedos remain valid only if the CO₂ impact materializes over time.**

5.4 Dynamic Carbon Accounting Logic

The Planedo system integrates a **time-aware logic layer** that connects:

- **The moment of validation**
- **The maturity and permanence of the CO₂ reduction**
- **The risk of reversal (especially for nature-based projects)**

This allows the system to:

- Track reductions year-over-year
- Update impact values as new data becomes available
- Freeze or deprecate Planedos if impact is later disproven

Each Planedo NFT contains **metadata** specifying:

- Minting method (hard or soft)
- Project maturity level
- Next review or revalidation date (if applicable)

This creates a **living validation system** that reflects the true state of global carbon reductions over time.

5.5 Transparency for Users and Observers

To ensure **trust and clarity**, soft-minted Planedos are clearly marked in the **Planedo Explorer**, with status indicators such as:

- Confirmed (hard minting, final)
- Pending Verification (soft minting, in validation cycle)
- Deprecated (impact could not be verified)

Users, auditors, and the public can **track the full lifecycle** of each NFT, reinforcing Planedo's commitment to **truthful and transparent CO₂ documentation.**

5.6 Strategic Role of Soft Minting

While hard minting ensures **certainty**, soft minting enables:

- **Early-stage financing** for transformative projects
- **Pre-validation of promising technologies**
- **Fiat-based support** through future-oriented CO₂ mechanisms

Used responsibly, soft minting can be a **catalyst for innovation and scale**, while maintaining scientific accountability through rigorous follow-up.

5.7 Conclusion: Two Paths, One Integrity Standard

Planedo accommodates both hard and soft minting—but applies a **single standard of truth**:

Only additional, measurable, and uniquely attributed CO₂ reductions may result in a Planedo.

Whether the impact occurred yesterday or is expected tomorrow, Planedo’s system ensures:

- **Transparent validation**
- **Clear attribution**
- **Scientific backing**
- **Lifecycle tracking**

6. Additionality & Exclusion Criteria

What qualifies as additional? Which projects are excluded from validation?

6.1 Why Additionality Is Non-Negotiable

At the core of Planedo’s validation logic lies one principle above all others:

Only additional climate actions can be validated.

This means that CO₂ reductions must go **beyond what is already legally required, economically inevitable, or otherwise planned**. Without additionality, a CO₂ reduction cannot credibly serve as the basis for a Planedo NFT.

Validating non-additional projects leads to:

- Artificial inflation of impact claims
- Undermining of real climate action
- Reputational risk for all involved stakeholders

Planedo applies a **strict additionality filter** to preserve integrity.

6.2 Dimensions of Additionality in Planedo

Planedo evaluates additionality along four dimensions:

Dimension	Guiding Question	Examples of Exclusion
Regulatory	Is this action already required by law?	National energy-efficiency mandates, building codes
Financial	Would this have happened anyway due to ROI?	Commercial solar farms with 2-year payback
Technological	Is the approach innovative or beyond industry baseline?	Switching from Euro 5 to Euro 6 trucks only
Temporal	Is the impact genuinely new and not already credited?	Old projects with past credits or subsidies

A project must demonstrate **at least one form of clear additionality** to be considered.

6.3 How Planedo Tests for Additionality

To enforce this standard, Planedo’s validation system includes:

- **Baseline analysis:** Establishing what would have happened without the project
- **Subsidy disclosure:** Projects must report whether they receive public funding or existing carbon credits
- **Policy cross-checking:** AI reviews local and national laws to identify potential overlaps with legal obligations
- **Financial modeling:** For high-volume projects, Planedo assesses whether the initiative is economically self-justified

Projects that fail these checks are **excluded from the validation process**.

6.4 Exclusion Criteria

Some projects are categorically excluded from Planedo validation, even if they produce measurable CO₂ reductions. These include:

6.4.1 Mandatory Measures

- Legal compliance (e.g. emissions limits, EU energy directives)
- Required renovations or industrial standards

6.4.2 Already Credited Projects

- Projects that have received Verra/Gold Standard credits

- Reductions sold on regulated carbon markets (e.g. EU ETS)

6.4.3 Double-Claimed Impacts

- Projects whose reductions are also counted in ESG or CSR reports of third parties (unless Planedo is the validating body)
- Nationally determined contributions (NDCs) not explicitly ringfenced

6.4.4 Non-Quantifiable Projects

- Actions without a clear CO₂ impact chain (e.g. general awareness campaigns)
 - Projects lacking sufficient data for modeling or benchmarking
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6.5 Grey Areas: Conditional Inclusion with Safeguards

Some projects may fall into **grey zones** where additionality is not easily determined. In such cases, Planedo:

- Applies **temporary exclusion** until clarified
- Requests additional documentation or expert opinions
- May assign a **“pending” status** to the project and withhold minting

The system is designed to **err on the side of caution**, preferring under-crediting to over-claiming.

6.6 Implications for Project Developers

To participate in Planedo, project developers must:

- Prove the **uniqueness** of their claimed CO₂ impact
- Confirm the project has **not been monetized or credited elsewhere**
- Provide full **data transparency**
- Acknowledge Planedo’s right to revoke Planedos if future audits reveal false additionality

This protects the **long-term credibility** of the Planedo ecosystem and ensures that every Planedo minted or earned holds real value.

6.7 Conclusion: No Additionality – No Validation

Additionality is not a “nice-to-have” in Planedo—it’s a **threshold condition**. The platform exists to **identify, support, and recognize CO₂ reductions that would not have happened without deliberate climate action**.

If it’s not additional, it’s not a Planedo.

7. Avoiding Double Counting

Linking to public data, ensuring unique attribution, and enforcing one-time usage

7.1 The Problem of Duplicate Claims

In both voluntary and regulated carbon markets, **double counting** is one of the most persistent risks to environmental integrity. When the same CO₂ reduction is claimed by multiple parties—intentionally or accidentally—it:

- Undermines climate goals
- Inflates environmental performance reports
- Damages public trust

Planedo was designed to make **double counting technically and procedurally impossible** through a **combination of system rules, metadata, and blockchain logic**.

7.2 What Double Counting Looks Like

Double counting can occur in several forms:

Type	Description
Double issuance	Two or more certificates are issued for the same CO ₂ reduction
Double use	A single certificate is used in multiple claims (e.g., two ESG reports)
Double claim	More than one party claims the same CO ₂ reduction in public disclosures
Country vs. company	A national climate target (e.g. NDC) and a company both claim the same impact

Planedo addresses all of these scenarios with a **multi-layered tracking and attribution system**.

7.3 The Planedo Protocol for Prevention

Planedo’s system enforces **one reduction = one use** through the following core mechanisms:

7.3.1 Unique Attribution per NFT

Each Planedo NFT is linked to:

- A specific CO₂ reduction (timestamp, location, technology)
- A single **issuer** (project owner or funder)
- A single **recipient** (minted or earned)

- A unique hash and ID on the DLT

This means the same reduction **cannot be split, reused, or reclaimed** by another party.

7.3.2 Registry Integration

Planedo cross-references multiple data sources and registries:

- National carbon registries (where accessible)
- Verra, Gold Standard, and other legacy systems
- European emissions databases (e.g. EU ETS transparency platform)
- ESG reporting frameworks and public climate disclosures

Projects already registered elsewhere are flagged and excluded from Planedo validation unless **clearly delinked**.

7.3.3 Smart Contracts with Lock Logic

The DLT-based smart contracts in Planedo:

- Automatically prevent the creation of **duplicate NFTs**
- Lock validated reductions to a **single minting event**
- Require confirmation that reductions are **not already credited elsewhere**

These rules are **enforced at the protocol level**, not left to user discretion.

7.4 Project Metadata and Traceability

Planedo NFTs include **detailed metadata** that allow anyone to verify:

- The project origin
- The type of CO₂ reduction
- Validation date and reference dossier
- Minting method (hard or soft)
- Public attribution (e.g., earned by organization X)

This metadata is stored **on-chain** and accessible via the **Planedo Explorer**, ensuring **full public auditability**.

7.5 Guarding Against Indirect Double Use

Even if two parties don't try to claim the **same NFT**, double counting can still occur if:

- A project developer and a funder both claim the same reduction
- A Planedo user claims reductions in **external reports** and via Planedo simultaneously

- A reduction is also listed under a government NDC

Planedo addresses this by:

- **Binding each reduction to a single beneficiary**
 - Including usage conditions in each NFT
 - Blocking Planedos from being used for compensation in **non-integrated systems** without third-party verification
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7.6 Audits and Retractions

Planedo's system allows for:

- **Retrospective audits** of previously validated projects
- **Community reporting** of suspected double claims
- **Revocation of Planedos** if misuse is confirmed

The DLT ledger retains all historical records, even in the case of invalidations—ensuring a **complete and honest chain of custody**.

7.7 Conclusion: One Reduction, One Entry, Forever

Avoiding double counting isn't just a feature—it's a **design principle** of Planedo.

Through **technical safeguards**, **public traceability**, and **strict issuance logic**, the system ensures that each Planedo:

- Represents exactly one CO₂ reduction
- Is claimed by exactly one actor
- Exists in exactly one form

No duplicates. No ambiguity. No greenwashing.

8. Safety Margins & Plausibility Checks

How Planedo handles uncertainty, applies conservative factors, and ensures realistic results

8.1 The Reality of Uncertainty in Climate Data

Every CO₂ reduction estimate involves some degree of **uncertainty**—whether due to fluctuating environmental conditions, technological limitations, or incomplete data. Unlike speculative systems that overstate climate impact, Planedo treats this uncertainty **as a scientific constant**.

To ensure the **credibility and reproducibility** of all validated impacts, Planedo applies:

- **Conservative emission factors**
- **Standardized safety margins**
- **Cross-referenced benchmarks**
- **Plausibility scoring for each project**

This guarantees that **no Planedo is issued based on overly optimistic assumptions**.

8.2 Applying Safety Margins (Conservatism)

Planedo systematically reduces reported CO₂ savings through **conservative safety deductions** to account for:

- Measurement inaccuracies
- Technological variability
- Behavioral changes (e.g. rebound effects)
- Temporal inconsistencies in sequestration or savings

Examples of default safety margins:

Project Type	Default Safety Margin
Soil carbon sequestration	10–30%
Reforestation	20%
Direct air capture (DAC)	5%
Industrial innovation	10%
Residential energy savings	10–15%

Planedo publishes a **transparent reference matrix** for these margins, and allows for adjustments based on **peer-reviewed data** and **real-world monitoring**.

8.3 Source Control: Emission Factors & Input Data

To ensure consistent calculations, Planedo relies only on **scientifically approved emission factors**, drawn from:

- **IPCC guidelines**
- **ISO 14064 databases**

- **National environment agencies (e.g. UBA, EPA)**
- **Ecoinvent and other LCA repositories**

All input data used for calculations must be either:

- **Primary data** from the project (e.g., energy bills, material receipts)
- **Validated secondary data** (e.g., recognized statistical averages)

AI-based analysis flags **implausible input combinations**, helping validators identify outliers or potential misreporting.

8.4 The Plausibility Engine: AI-Supported Reasonableness Checks

Planedo's AI includes a **plausibility engine** that performs:

- **Sectoral benchmarking:** Comparing project data against known averages
- **Outlier detection:** Identifying statistical anomalies
- **Context-aware filters:** Adjusting for local conditions (e.g., grid emissions intensity, climate zones)
- **Cross-verification:** Comparing user data with public records, satellite data, or IoT sensor streams (where available)

This system produces a **confidence score** that feeds into the validator dashboard, influencing:

- Required depth of manual review
 - Safety margin calibration
 - Re-validation timelines for soft-minted Planedos
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8.5 Handling Time-Dependent Projects

For projects where CO₂ reductions accrue over time (e.g., forest growth, building insulation), Planedo:

- Models impact across **project lifetime**
- Applies **yearly adjustments** based on updated input
- Tracks whether initial assumptions hold true
- Flags **diminishing returns or reversal risks**

If a project underperforms significantly, Planedo can:

- **Deactivate pending soft-minted Planedos**
- **Issue updated Planedos with lower impact values**

- **Log the adjustment on-chain** to maintain historical accuracy
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8.6 Auditor and Validator Discretion

While Planedo uses automated rules for safety factors and plausibility checks, **trained human validators** can:

- Override default margins with scientific justification
- Add qualitative reasoning to the validation dossier
- Request additional evidence before approval

This hybrid model ensures both **scientific rigor** and **practical flexibility**.

8.7 Conclusion: No Overstatement, Just Verified Impact

Planedo doesn't chase maximal impact numbers. It builds **climate credibility** by:

- **Erring on the side of caution**
- **Acknowledging uncertainty transparently**
- **Validating what can truly be proven**

Because when it comes to CO₂ reductions, **less hype and more science** is the only path to real trust.

9. Transparency & Traceability

How Planedo ensures public access, project-level validation data, and long-term auditability

9.1 Why Transparency Is a Core Design Principle

In carbon markets and sustainability reporting, lack of transparency has led to:

- **Greenwashing**
- **Double counting**
- **Misleading claims**
- **Erosion of trust in offsets and credits**

Planedo reverses this trend by treating **transparency not as a feature, but as a foundation**. Every validated CO₂ impact is traceable to its source, calculation, and validator—openly accessible to anyone.

This is achieved through a **DLT-based infrastructure**, **open data publication**, and a **dedicated public interface**: the **Planedo Explorer**.

9.2 The Planedo Explorer: Public Access for All

Every Planedo NFT is logged and searchable in the **Planedo Explorer**, which provides:

- A searchable registry of all validated Planedos
- Project overviews with:
 - Location (generalized where privacy applies)
 - Project description and context
 - Validation method and data inputs
 - Resulting CO₂ impact (in kg)
- NFT metadata, including:
 - Date of minting
 - Minting type (hard or soft)
 - Safety margins applied
 - Validation stage (AI, human, scientific documentation)
 - Expiration or review dates (for soft-minted units)

This ensures that **any stakeholder—whether a buyer, journalist, researcher, or regulator—can see exactly what each Planedo represents**.

9.3 Immutable Recordkeeping on DLT

Planedo uses a **private permissioned DLT system** (based on Hyperledger Fabric) to log:

- Minting transactions
- Validation results
- Methodological versions used
- Updates (e.g., revalidations, soft-mint confirmations)
- Revocations or status changes

All of this is **tamper-proof**, **timestamped**, and **digitally signed**—providing a **cryptographic audit trail** for every Planedo issued.

9.4 Validation Dossiers: From Black Box to Open Book

For each project that undergoes validation, Planedo generates a **validation dossier**, which includes:

- Project scope and context
- Applied methodology (with references)
- Input data and sources
- Calculation steps and emission factors
- Safety margins and uncertainties
- Validation outcome and classification (e.g., 10 kg = 1 Planedo)

These dossiers are:

- **Permanently linked** to the respective NFT
- **Published** (with sensitive data redacted where necessary)
- **Version-controlled**, in case of revalidation

This approach **demystifies CO₂ impact** and empowers third parties to **verify or replicate** the results.

9.5 Lifetime Tracking of CO₂ Reductions

Planedo maintains full **lifecycle traceability** of each CO₂ reduction, even beyond the initial validation:

- **Soft-minted Planedos** are re-evaluated periodically
- If CO₂ benefits reverse (e.g., due to forest loss), status changes are logged
- Stakeholders can **track the real-world permanence** of each action

The NFT does not disappear—it evolves, like the climate action it represents.

9.6 Integration with Third-Party Systems

To improve transparency across sectors, Planedo supports integration with:

- ESG reporting tools (e.g., CDP, GRI)
- Corporate sustainability dashboards
- National environmental reporting platforms
- API-based project management systems

Planedos can be **embedded** into external systems while preserving their **validation integrity** and **metadata fidelity**.

9.7 Open Access vs. Data Privacy

While Planedo champions openness, it also respects:

- **GDPR and global privacy laws**
- **Project confidentiality** (e.g., exact landowner identities)
- **Commercial sensitivity** (e.g., in innovation or pilot cases)

Thus, a tiered data model is used:

- **Public-level data** (project basics, CO₂ results, validation logic)
- **Restricted validator-level data** (detailed calculations, internal files)
- **Anonymized user-level info** (never publicly disclosed)

This balance ensures **radical transparency without compromising rights**.

9.8 Conclusion: Proof of Impact, Open by Default

Planedo builds trust through traceability. Every Planedo tells a story—and the public can read it.

No impact without proof. No proof without access.

With Planedo, **climate integrity becomes visible, verifiable, and permanent**—not a claim, but a documented reality.

10. Regulatory Compatibility

How Planedo aligns with EU law, ISO standards, and corporate carbon accounting frameworks

10.1 Why Regulatory Alignment Matters

For CO₂ validation systems to gain long-term acceptance, they must not only be scientifically sound but also **compatible with legal frameworks, reporting requirements, and industry standards**.

Planedo is designed to meet and exceed the expectations of:

- **European regulations** (e.g., MiCA, EU Taxonomy, CSRD, LkSG)
- **International standards** (e.g., ISO 14064, ISO 14067)
- **Corporate ESG and carbon accounting practices** (e.g., GHG Protocol)

The goal: ensure that every Planedo NFT can be used **confidently by institutions, enterprises, and public actors** without risking regulatory non-compliance.

10.2 MiCA (Markets in Crypto-Assets Regulation)

Planedo NFTs are **not financial instruments** and are intentionally structured to **avoid classification as asset-referenced tokens (ARTs)** under MiCA.

MiCA Criteria	Planedo NFT Treatment
Pegged to fiat or commodities?	No; linked to CO ₂ reduction, not currency or assets
Public trading allowed?	No; Planedos are not traded on secondary markets
Redeemable for value?	No; Planedos are proof of impact, not redeemable tokens
Speculative value?	No; no price appreciation or investor utility

Planedo is therefore **not subject to MiCA’s financial regulations**, while still adhering to its **transparency and auditability principles**.

10.3 EU Taxonomy for Sustainable Activities

The **EU Taxonomy** defines which economic activities qualify as environmentally sustainable. Planedo enables organizations to **demonstrate compliance** with taxonomy criteria by providing:

- **Verified documentation** of CO₂ reductions
- **Lifecycle emissions modeling**
- **Proof of additionality and traceability**

This allows Planedo-validated projects to be integrated into:

- **Green financing portfolios**
- **Sustainability-linked bonds**
- **Taxonomy-aligned investment disclosures**

Planedo’s validation dossiers include all necessary fields for **taxonomy compatibility**.

10.4 CSRD & ESG Reporting (Corporate Sustainability Reporting Directive)

Planedo supports companies in fulfilling CSRD obligations by:

- Providing **quantitative proof** of emissions reductions (Scope 1, 2, and selectively Scope 3)
- Enabling **project-level traceability**
- Offering **machine-readable data exports** for ESG platforms (e.g., CDP, EcoVadis)

Planedo also aligns with **GRI, SASB, and TCFD** frameworks, allowing organizations to **embed Planedos into sustainability dashboards** and **report on validated climate action**.

10.5 Supply Chain Act (LkSG) & Due Diligence

Planedo offers a pathway for companies to:

- **Quantify CO₂ impacts** in their **supply chain**
- Document **climate-related due diligence**
- Monitor emissions-intensive suppliers and their mitigation efforts

This is especially relevant for sectors such as **textiles, agriculture, manufacturing**, where **Scope 3 emissions** and **supplier risk exposure** play a critical role in compliance.

10.6 ISO Standards and Technical Consistency

Planedo's validation logic is grounded in internationally recognized standards:

ISO Standard	Application in Planedo
ISO 14064	CO ₂ quantification, project-level validation
ISO 14067	Carbon footprint analysis of products and services
ISO 14040 / 44	Lifecycle assessment (LCA) for complex reductions

All validation outputs are **cross-compatible** with these ISO standards, ensuring that organizations can use Planedo as a **recognized input** into global audits and certifications.

10.7 Compatibility with GHG Protocol & Corporate Accounting

Planedo complements the **Greenhouse Gas Protocol** and its widely used frameworks:

- **Corporate Standard**
- **Project Accounting Standard**
- **Scope 3 Standard**

Organizations can:

- Attribute Planedo-verified reductions to the appropriate scope
- Distinguish between **internally achieved** and **externally financed** impact
- Avoid double-counting through Planedo's **exclusive attribution logic**

This ensures **audit-ready carbon accounting**, aligned with what companies already report to regulators and investors.

10.8 Outlook: A Framework Built for Regulatory Evolution

Planedo is designed not only for today's regulatory environment, but for tomorrow's:



- **Dynamic updating of validation methods** as standards evolve
- **DLT-based compliance logs** for rapid audits
- **Modular APIs** for future integration into national registries or certification bodies

As climate regulation tightens, Planedo will remain **aligned, compliant, and ahead of the curve.**

10.9 Conclusion: Legally Sound, Scientifically Grounded

Planedo is more than a validation tool—it is a **regulatory companion** for institutions serious about transparent and effective climate action. By complying with MiCA, ISO, EU directives, and ESG frameworks, Planedo:

- Reduces regulatory risk
- Enhances audit security
- Increases investor and stakeholder trust

Validated impact, with built-in legal clarity.