1.0
version

Methodology for the Production and Verification of Carbon Capture and Sequestration Quantified Emissions Tokens® (QET-CCS) — $kgCO_2e$ Removed

This methodology defines a framework for QET-CCS, where each token represents 1 $kgCO_2e$ permanently removed and immutably tracked via the EarnDLT registry. It remains compatible with established carbon removal standards while anchored to ISO as the primary normative reference.

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QCCS

Methodology for the Production and Verification of Carbon Capture and Sequestration Quantified Emissions Tokens® (QET-CCS) — $kgCO_2e$ Removed v1.0

Executive Summary

This methodology establishes a comprehensive framework for producing, quantifying, and verifying Carbon Capture and Sequestration Quantified Emissions Tokens® (QET-CCS), ensuring all carbon removal activities are measured in $kgCO_2e$ removed from the atmosphere. Each QET-CCS represents 1 kilogram of verified carbon dioxide equivalent permanently removed and stored, designed to provide precise, audit-friendly carbon removal certificates aligned with ISO 14064-2 project-level quantification requirements and ISO 14064-3 verification standards. The QET-CCS tokens are issued, managed, and tracked on the EarnDLT blockchain-based registry platform (registry.greentruth.com), providing immutable record-keeping and transparent permanence monitoring documentation.

This methodology is designed to be compatible with and aligned to established carbon removal standards, including Puro Standard methodologies, American Carbon Registry (ACR) protocols, and Verra Verified Carbon Standard (VCS) frameworks, while maintaining independence and adherence to ISO standards as the primary normative references.

Key Features:

- ISO 14064-2 and ISO 14064-3 compliant measurement, reporting, and verification (MRV) framework
- Automatic buffer pool withholding (5-20% based on permanence risk) for reversal management
- Transparent public registry with full methodology disclosure and permanence monitoring
- ISO 14065-accredited verification body requirements
- Semi-annual pricing review mechanism with a 30-day notice guarantee

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This document is compliant with ISO 14064-2 and ISO 14064-3 standards for greenhouse gas project quantification and verification.

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1. Introduction and Scope

1.1 Purpose

This methodology provides a complete framework for creating QET-CCS tokens with verified carbon removal quantities, each representing 1 kilogram of carbon dioxide equivalent ($kgCO_2e$) permanently removed from the atmosphere through carbon capture and sequestration activities. This methodology enables project developers to demonstrate verifiable climate impact through tokenized carbon removal certificates that meet the highest standards of additionality, permanence, and transparency.

1.2 Application Scope

This methodology applies to all carbon capture and sequestration projects that meet the eligibility criteria defined in Section 5, including but not limited to:

Technological Carbon Removal:

- Direct Air Capture (DAC) with geological storage
- Bioenergy with Carbon Capture and Storage (BECCS)
- Industrial point-source carbon capture with geological storage
- Carbon mineralization and enhanced weathering
- Biochar production and application

Geological Storage:

- Deep saline aquifer storage
- Depleted oil and gas reservoir storage
- Enhanced oil recovery (EOR) with permanent storage accounting
- Basalt formation mineralization

Nature-Based Sequestration (with permanence monitoring):

- Afforestation and reforestation with long-term commitments
- Soil carbon sequestration with verification protocols
- Blue carbon (coastal and marine ecosystem restoration)

1.3 Exclusions

The following activities are explicitly excluded from this methodology:

- Avoided emissions projects (e.g., renewable energy, energy efficiency)

- Short-term carbon storage (<100 years durability)
- Projects lacking third-party verification
- Projects without robust permanence monitoring plans
- Emission reduction projects that do not result in net atmospheric removal

1.4 Functional Unit

The functional unit for QET-CCS methodology is **one kilogram of carbon dioxide equivalent (1 kgCO_2e) permanently removed from the atmosphere**, expressed as **kgCO_2e removed** at standard conditions.

Token Representation:

- 1 QET-CCS token = 1 kgCO_2e verified atmospheric carbon removal
- 1 metric ton (tonne) = 1,000 kg = 1,000 QET-CCS tokens
- Tokens are issued net of buffer pool withholding (see Section 7)

1.5 Reference to Core QET Methodology

This methodology directly references and incorporates the core "*Methodology for the Production and Verification of Quantified Emissions Tokens (QETs) in Accordance with ISO 14064-3*" for cross-cutting requirements, including data quality, uncertainty management, verification procedures, and registry integration.

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2. Normative References

This methodology references and incorporates elements from the following international standards, regulatory frameworks, and technical documents:

ISO Standards (Primary References):

- **ISO 14064-1:2018** — Greenhouse gases: Specification with guidance at the organization level for quantification and reporting
- **ISO 14064-2:2019** — Greenhouse gases: Specification with guidance at the project level for quantification, monitoring and reporting of GHG emission reductions or removal enhancements
- **ISO 14064-3:2019** — Greenhouse gases: Specification with guidance for the verification and validation of GHG assertions
- **ISO 14065:2020** — General principles and requirements for bodies validating and verifying environmental information

- **ISO 14067:2018** — Greenhouse gases: Carbon footprint of products
- **ISO 14080:2018** — Greenhouse gas management and related activities: Framework and principles for methodologies on climate action

Carbon Removal Standards (Reference Alignment):

- **Puro Standard** — CO_2 Removal Certificate (CORC) methodologies for biochar, geological storage, enhanced weathering
- **American Carbon Registry (ACR)** — Methodologies for carbon capture and storage projects
- **Verra Verified Carbon Standard (VCS)** — Carbon removal and sequestration methodologies
- **Gold Standard for the Global Goals** — Carbon sequestration requirements

Regulatory and Technical References:

- **IPCC Guidelines for National Greenhouse Gas Inventories (2006, 2019 Refinement)**
- **IPCC Special Report on Carbon Dioxide Capture and Storage (2005)**
- **US EPA Greenhouse Gas Reporting Program (40 CFR Part 98, Subpart RR)**
- **EU Emissions Trading System (EU ETS) CCS Monitoring and Reporting Guidelines**
- **California Air Resources Board (CARB) Carbon Capture and Sequestration Protocol**
- **GHG Protocol Corporate Accounting and Reporting Standard**
- **CDR.fyi Durable Carbon Removal Buyer's Guide**

EarnDLT QET Framework Documents:

- **QET Core Methodology** — Sections 4 (system boundaries), 5 (quantification), 6 (uncertainty), 7 (data structure), 8 (verification)
- **EarnDLT Platform Pricing Structure v3** — Carbon Removal-Based QET pricing and fee structure

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3. Terms and Definitions

3.1 QET-CCS (Carbon Capture and Sequestration QET)

Digital token representing 1 $kgCO_2e$ of verified carbon dioxide equivalent permanently removed from the atmosphere through capture and sequestration activities, issued net of buffer pool contributions.

3.2 Carbon Removal

The process of capturing carbon dioxide (CO_2) from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products, resulting in a net reduction of atmospheric CO_2 concentration.

3.3 Carbon Capture

The process of separating CO_2 from emission sources (point-source capture) or directly from ambient air (direct air capture), followed by compression, transport, and storage.

3.4 Geological Sequestration

The injection and permanent storage of CO_2 in deep underground geological formations including saline aquifers, depleted oil and gas reservoirs, or reactive basalt formations where mineralization occurs.

3.5 Permanence

The durability and longevity of carbon storage, typically evaluated over a 100-year time horizon for buffer pool calculations, with ongoing monitoring to detect and address any reversal events.

3.6 Reversal

An unintentional release of stored carbon back to the atmosphere due to natural disturbances, human activities, or storage failure, resulting in a reduction of the net climate benefit.

3.7 Buffer Pool

A risk management mechanism where a percentage of issued carbon removal credits are withheld in a pooled reserve to compensate for potential reversals, ensuring the overall climate integrity of the carbon removal program.

3.8 Additionality

The requirement that carbon removal activities would not have occurred in the absence of the QET-CCS program incentive, demonstrated through regulatory, financial, or common practice additionality tests.

3.9 Direct Air Capture (DAC)

Technology that captures CO_2 directly from ambient air using chemical processes, followed by compression, transport, and permanent storage.

3.10 Bioenergy with Carbon Capture and Storage (BECCS)

The process of generating energy from biomass and capturing the resulting CO_2 emissions for permanent geological storage, resulting in net negative emissions.

3.11 Biochar

A solid carbon-rich material produced by thermochemical conversion (pyrolysis) of biomass in the absence of oxygen, applied to soils or used in other applications for long-term carbon storage (100+ years).

3.12 Enhanced Rock Weathering

Accelerating natural weathering processes by spreading finely ground silicate rocks on agricultural or forest lands, resulting in CO_2 uptake through chemical reactions and storage in soil carbonates or runoff to the ocean.

3.13 Carbon Mineralization

The conversion of CO_2 into stable carbonate minerals through chemical reactions with metal oxides in mafic and ultramafic rocks (e.g., basalt, peridotite), providing permanent carbon storage.

3.14 Monitoring, Reporting, and Verification (MRV)

The comprehensive system for measuring carbon removal quantities, documenting project activities, and conducting independent third-party verification to ensure accuracy and credibility.

3.15 Permanence Monitoring Plan

A documented strategy for long-term surveillance of carbon storage sites to detect potential reversals, including monitoring frequency, parameters measured, reporting requirements, and remediation protocols.

3.16 EarnDLT Registry

Blockchain-based platform (registry.greentruth.com) for issuing, tracking, transferring, and retiring environmental attribute certificates with immutable record-keeping and public transparency.

3.17 ISO 14065-Accredited Verification Body

An independent third-party organization that has been accredited under ISO 14065:2020 to conduct validation and verification of greenhouse gas assertions, including carbon removal quantification claims.

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4. System Boundaries and Scope

4.1 Boundary Definition

Following **QET Core Methodology Section 4.4** with specific adaptations for carbon capture and sequestration projects, the system boundary encompasses all activities from carbon capture through permanent storage, including:

Upstream Boundary:

- Energy and material inputs for capture equipment manufacturing (amortized over equipment lifetime)
- Feedstock production for BECCS projects (biomass cultivation, harvesting, transport)
- Rock mining and grinding for enhanced weathering projects
- Biomass collection and transport for biochar projects

Core Process Boundary:

- Carbon capture operations (DAC, point-source capture, biomass combustion)
- CO_2 compression, purification, and conditioning
- CO_2 transport via pipeline, truck, or rail
- Injection into geological storage formations
- Biochar production via pyrolysis
- Enhanced weathering rock application
- Monitoring and verification activities

Downstream Boundary:

- Long-term storage monitoring and maintenance
- Site closure and post-closure monitoring
- Remediation activities in case of reversal events

4.2 Inclusions and Exclusions

Included in System Boundary:

- All direct energy consumption (electricity, thermal energy, fuel)
- All direct process emissions (combustion, fugitive leaks, processing losses)
- All lifecycle emissions from materials and consumables
- Transport emissions for all inputs and outputs
- Upstream emissions from grid electricity (location-based or market-based)
- Waste treatment and disposal emissions
- Monitoring equipment energy consumption

Excluded from System Boundary (per **QET Core Methodology Section 4.4.2**):

- Infrastructure construction emissions (unless required by applicable standard)
- Employee commuting and business travel
- Administrative office operations remote from project site
- Research and development activities
- Marketing and sales activities

4.3 Temporal and Organizational Boundaries

- **Reporting Period:** Monthly, quarterly, or annual reporting periods as determined by project type and verification frequency
- **Crediting Period:** Defined in project-specific permanence monitoring plan (typically 10-100 years)
- **Baseline Period:** Pre-project baseline established in accordance with ISO 14064-2 requirements
- **Organizational Boundary:** All facilities, operations, and entities under operational control or financial control of project developer, consistent with ISO 14064-1 organizational boundary principles

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5. Eligible Carbon Capture and Sequestration Methodologies

5.1 Pre-Approved Methodology Framework

All QET-CCS projects must utilize a pre-approved carbon removal methodology that meets the following eligibility criteria:

5.1.1 Alignment with ISO 14064-2 Requirements

All methodologies must demonstrate full compliance with ISO 14064-2:2019 project-level quantification requirements, including:

- Clear project description and justification
- Baseline scenario definition and additionality demonstration
- Quantification of GHG emission reductions and removal enhancements
- Monitoring plan with quality assurance procedures
- Documentation and record-keeping requirements

5.1.2 Consistency with Established Standards

Methodologies should demonstrate consistency and alignment with at least one of the following established carbon removal standards:

- **Puro Standard** CO_2 Removal Certificate (CORC) methodologies
- **American Carbon Registry (ACR)** approved CCS methodologies
- **Verra VCS** carbon removal and sequestration methodologies
- **Gold Standard** carbon sequestration protocols

5.2 Technology-Specific Approved Methodologies

5.2.1 Direct Air Capture (DAC) with Geological Storage

Methodology Requirements:

- Mass balance verification of CO_2 capture from ambient air
- Energy lifecycle analysis (electricity and thermal energy inputs)
- Transport emissions quantification
- Geological storage site characterization and monitoring
- Well injection monitoring and verification
- Minimum storage durability: 1,000 years
- **Buffer pool contribution: 5-10%** (based on geological risk assessment)

Applicable Reference Standards:

- ISO 14064-2 project-level quantification

- Puro Standard Geological Storage methodology
- US EPA Subpart RR reporting requirements

5.2.2 Bioenergy with Carbon Capture and Storage (BECCS)

Methodology Requirements:

- Sustainable biomass sourcing verification (no food competition, sustainable forestry)
- Biomass carbon accounting (biogenic vs. fossil carbon)
- Energy facility emissions quantification (combustion, auxiliary systems)
- CO_2 capture efficiency measurement (>90% capture rate)
- Transport and geological storage verification
- Lifecycle emissions from biomass production and transport
- Minimum storage durability: 1,000 years
- **Buffer pool contribution: 8-15%** (based on biomass sustainability and geological risk)

Applicable Reference Standards:

- ISO 14064-2 project-level quantification
- Puro Standard BECCS methodology
- ACR BECCS methodology

5.2.3 Biochar Production and Application

Methodology Requirements:

- Sustainable biomass sourcing verification
- Pyrolysis process characterization (temperature, residence time, yield)
- Biochar stability testing (H:Corg ratio <0.7 or other stability indicators)
- Application site monitoring and verification
- Energy inputs and co-product accounting (bio-oil, syngas)
- Minimum storage durability: 100 years
- **Buffer pool contribution: 10-15%** (based on application method and monitoring plan)

Applicable Reference Standards:

- ISO 14064-2 project-level quantification
- Puro Standard Biochar methodology
- European Biochar Certificate (EBC) standards

5.2.4 Enhanced Rock Weathering

Methodology Requirements:

- Rock sourcing and characterization (mineralogy, reactivity)

- Application rate and location documentation
- Soil or runoff monitoring for carbonate formation
- Lifecycle emissions from mining, grinding, and transport
- Quantification methodology for CO_2 uptake (lab testing + field monitoring)
- Minimum storage durability: 1,000 years (mineralized carbonates)
- **Buffer pool contribution: 15-20%** (higher uncertainty in quantification)

Applicable Reference Standards:

- ISO 14064-2 project-level quantification
- Puro Standard Enhanced Weathering methodology (in development)
- CDR.fyi Enhanced Weathering best practices

5.2.5 Industrial Point-Source Carbon Capture with Geological Storage

Methodology Requirements:

- Source emissions characterization (ethanol, ammonia, natural gas processing, cement, steel)
- CO_2 capture system efficiency measurement
- Distinction between fossil and biogenic carbon sources
- Transport and geological storage verification
- Energy penalty and auxiliary emissions quantification
- Minimum storage durability: 1,000 years
- **Buffer pool contribution: 5-10%** (based on geological risk assessment)

Applicable Reference Standards:

- ISO 14064-2 project-level quantification
- C2ES CCS Accounting Framework
- ACR Industrial CCS methodologies

5.2.6 Afforestation, Reforestation, and Soil Carbon Sequestration

Methodology Requirements:

- Baseline land use and carbon stock assessment
- Project area delineation and monitoring plot establishment
- Biomass growth modeling and periodic verification measurements
- Soil organic carbon monitoring (for soil carbon projects)
- Leakage assessment (activity shifting to other areas)
- Permanence monitoring plan with >100-year commitment
- **Buffer pool contribution: 15-25%** (high reversal risk from fire, disease, land use change)

Applicable Reference Standards:

- ISO 14064-2 project-level quantification
- Verra VCS afforestation/reforestation methodologies
- ACR forestry carbon protocols
- Gold Standard afforestation methodologies

5.3 Methodology Approval Process

5.3.1 Submission Requirements

Project developers utilizing methodologies not explicitly pre-approved in Section 5.2 must submit a methodology approval request, including:

- Complete methodology document with all quantification procedures
- Demonstration of ISO 14064-2 compliance
- Alignment analysis with at least one established standard (Puro, ACR, Verra, Gold Standard)
- Proposed buffer pool contribution based on permanence risk assessment
- Monitoring and verification plan
- Sample calculations and uncertainty analysis

5.3.2 Review Process

- Technical review by the EarnDLT methodology committee (ISO auditing experts and environmental legal counsel)
- 30-day public comment period on EarnDLT website
- Independent expert review for novel methodologies
- Approval decision within 60 days of complete submission

5.3.3 Methodology Updates

- All approved methodologies are subject to periodic review (minimum every 3 years)
- Updates for new scientific evidence, regulatory changes, or improved monitoring technologies
- 90-day notice provided to all active projects before methodology changes take effect
- Grandfathering provisions for projects in progress

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6. Quantification Methodology

6.1 General Calculation Framework

Following **QET Core Methodology Section 5** with adaptations for carbon removal projects per ISO 14064-2, the net carbon removal for QET-CCS issuance is calculated as:

Net Carbon Removal ($kgCO_2e$) = Gross Carbon Removal - Project Emissions - Baseline Emissions

Where:

- **Gross Carbon Removal:** Total CO_2 captured and permanently stored (measured directly)
- **Project Emissions:** All GHG emissions from project activities within system boundary
- **Baseline Emissions:** Emissions that would have occurred in absence of project (counterfactual scenario)

QET-CCS Issuable Quantity = Net Carbon Removal × (1 - Buffer Pool Contribution Rate)

6.2 Technology-Specific Quantification Methods

6.2.1 Direct Air Capture (DAC) Quantification

Gross Carbon Removal:

$$CO_2\ captured\ (KG) = Flow\ rate\ (kg/hr) \times Operating\ hours \times Purity\ factor \times Injection\ verification\ factor$$

Project Emissions:

$$E_{project} = E_{electricity} + E_{thermal} + E_{materials} + E_{transport}$$

Where:

- $E_{electricity} = kWh\ consumed \times Grid\ emission\ factor\ (kgCO_2e/kWh)$
- $E_{thermal} = MMBtu\ thermal \times Fuel\ emission\ factor\ (kgCO_2e/MMBtu)$
- $E_{materials} = Quantity \times Material\ emission\ factor$
- $E_{transport} = Distance \times Load \times Transport\ emission\ factor$

Net Carbon Removal:

$$Net\ CDR\ (kgCO_2e) = CO_2\ captured - E_{project} - E_{baseline}$$

Example Calculation:

- CO_2 captured and stored: 1,000,000 kg (1,000 tonnes)
- Electricity: 2,000 MWh × 0.45 $kgCO_2e$/kWh = 900,000 $kgCO_2e$
- Thermal energy: 500 MMBtu × 53 $kgCO_2e$/MMBtu = 26,500 $kgCO_2e$
- Materials/transport: 15,000 $kgCO_2e$
- Baseline emissions: 0 $kgCO_2e$
- Net carbon removal: 1,000,000 - 941,500 = 58,500 $kgCO_2e$
- Buffer pool (10%): 5,850 $kgCO_2e$
- **QET-CCS tokens issued: 52,650 tokens**

6.2.2 BECCS Quantification

Gross Carbon Removal (Biogenic CO_2 Only):

$$CO_2\ captured\ biogenic\ (kg) = Biomass\ carbon\ content \times Capture\ efficiency \times Fraction\ biogenic$$

Project Emissions:

$$E_{project} = E_{biomass\ production} + E_{biomass\ transport} + E_{facility\ operations} + E_{CO_2\ transport} + E_{fossil\ fuel\ use}$$

Baseline Emissions:

$$E_{baseline} = Emissions\ from\ displaced\ fossil\ energy + Biomass\ decay\ emissions\ avoided$$

Net Carbon Removal:

$$Net\ CDR = CO_2\ captured\ biogenic - E_{project} + E_{baseline}$$

6.2.3 Biochar Quantification

Gross Carbon Removal:

$$CO_2\ sequestered\ (kg) = Biochar\ mass\ (kg) \times Carbon\ content\ (\%) \times Stability\ factor \times (44/12)$$

Where:

- Carbon_content: Lab-measured carbon content (typically 60-80%)
- Stability_factor: Based on H:Corg ratio or Mean Residence Time (MRT) testing
    - H:Corg < 0.4: Stability_factor = 0.95 (>1,000 year durability)
    - H:Corg 0.4-0.7: Stability_factor = 0.85 (100-1,000 year durability)
- 44/12: Molecular weight conversion factor CO_2/C

Project Emissions:

$$E_{project} = E_{biomass\ collection} + E_{pyrolysis\ energy} + E_{biochar\ transport} + E_{application}$$

Net Carbon Removal:

$$Net\ CDR = CO_2\ sequestered - E_{project} + E_{baseline}$$

6.2.4 Enhanced Rock Weathering Quantification

Gross Carbon Removal:

$$CO_2\ uptake\ (kg) = Rock\ mass\ (kg) \times Reactive\ mineral\ content\ (\%) \times Weathering\ rate \times CO_2\ uptake\ stoichiometry \times Time\ period$$

Alternative Measurement Approaches:

- Soil carbonate analysis via periodic sampling
- Alkalinity measurements in soil water or agricultural runoff
- Modeling validated with field monitoring data

$$E_{project} = E_{mining} + E_{grinding} + E_{transport} + E_{application}$$

6.2.5 Geological Storage Verification

All methodologies utilizing geological storage must include verification of permanent sequestration:

Injection Verification:

- Continuous mass flow monitoring at injection wells
- Real-time pressure and temperature monitoring
- CO_2 purity testing (>95% purity required)
- Quarterly reporting of cumulative injected mass

Storage Site Monitoring:

- Annual or continuous seismic monitoring for plume migration
- Groundwater monitoring wells for leakage detection
- Surface monitoring (soil gas, atmospheric) in high-risk areas
- Minimum monitoring period: 10 years post-injection

Storage Permanence Certification:

- Site characterization demonstrating >1,000 year storage expectation
- Caprock integrity assessment
- Well integrity verification (mechanical integrity testing)
- Risk assessment per EPA Subpart RR or equivalent standards

6.3 Co-Product and Energy Recovery Allocation

When carbon removal projects generate co-products (e.g., bio-oil from pyrolysis, renewable power from BECCS), emissions must be allocated appropriately:

Energy Allocation Method (Default):

$$Allocation\ factor\ CDR = \frac{Energy\ value\ of\ carbon\ storage}{Energy\ value\ of\ carbon\ storage + Energy\ value\ of\ co{-}products}$$

Substitution Method (Preferred for displacing fossil fuels):

$$E_{project\ net} = E_{project} - (Co\text{-}product\ quantity \times Displaced\ product\ emission\ factor)$$

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7. Buffer Pool Administration and Reversal Risk Management

7.1 Buffer Pool Purpose and Mechanism

The QET-CCS buffer pool serves as a risk management mechanism to ensure the overall climate integrity of the carbon removal program by maintaining a reserve of tokens to compensate for unintentional reversals. Following industry best practices from Puro Standard, Verra VCS, and American Carbon Registry, EarnDLT implements a mandatory buffer pool contribution system.

Key Principles:

- All QET-CCS tokens issued are net of buffer pool withholding
- Buffer pool is funded through token withholding, not monetary fees
- Buffer pool tokens are retired to compensate for verified reversal events
- Annual buffer pool adequacy assessment and adjustment
- Public transparency of buffer pool balance and utilization

7.2 Buffer Pool Contribution Rates

Buffer pool contribution rates are determined based on carbon removal methodology, storage durability, and reversal risk assessment, aligned with ISO 14064-2 uncertainty and risk management principles.

Standard Buffer Pool Rates:

Carbon Removal Methodology	Storage Durability	Standard Buffer Rate	Risk Factors
DAC + Geological Storage	1,000+ years	5-8%	Geological risk, monitoring adequacy
Industrial CCS + Geological Storage	1,000+ years	5-10%	Geological risk, capture system reliability
BECCS + Geological Storage	1,000+ years	8-15%	Biomass sustainability, geological risk
Biochar (H:Corg <0.4)	1,000+ years	10-12%	Application method, soil disturbance risk
Biochar (H:Corg 0.4-0.7)	100-1,000 years	12-15%	Lower stability, application risk
Enhanced Rock Weathering	1,000+ years	15-20%	Quantification uncertainty, monitoring challenges
Afforestation/Reforestation	100+ years	18-25%	Fire, disease, land use change, and climate risk
Soil Carbon Sequestration	100+ years	15-20%	Management change, tillage, erosion

7.3 Risk-Based Buffer Pool Assessment

Project-specific buffer pool contributions are determined through a risk assessment process aligned with **QET Core Methodology Section 8.2**:

7.3.1 Geological Storage Risk Factors:

- Storage site characterization quality (seismic data, well logs)
- Caprock thickness and integrity
- Well construction and mechanical integrity
- Monitoring and verification plan adequacy
- Regulatory oversight and site closure plan
- Historical performance of similar sites

7.3.2 Biological/Nature-Based Storage Risk Factors:

- Climate change vulnerability assessment (fire, drought, pests)
- Land tenure security and legal protections
- Management commitment and financial stability
- Geographic diversification
- Historical disturbance frequency
- Carbon stock permanence monitoring plan

7.3.3 Technology Risk Factors:

- Operational track record and reliability
- Process control and quality assurance systems
- Financial viability of project developer
- Long-term maintenance and monitoring commitments
- Equipment failure and contingency planning

7.4 Buffer Pool Calculation Example

Project: Biochar production from agricultural residues

- Annual biochar production: 500 tonnes (500,000 kg)
- Carbon content: 70%
- H:Corg ratio: 0.35 (high stability)
- Net carbon removal: 500,000 kg × 0.70 × 0.95 × (44/12) = 1,221,667 $kgCO_2e$
- Standard buffer rate: 10%
- Project-specific risk assessment: +2% (new project, limited track record)
- Total buffer contribution: 12%
- Buffer pool withholding: 1,221,667 × 0.12 = 146,600 $kgCO_2e$
- **QET-CCS tokens issued: 1,075,067 tokens**
- Buffer pool tokens held: 146,600 tokens

7.5 Buffer Pool Administration

7.5.1 Funding Mechanism:

- Buffer pool funded automatically through token withholding at issuance
- No separate monetary fees for buffer pool participation
- Production fees (per **EarnDLT Pricing Structure**) are separate from buffer pool withholding

7.5.2 Buffer Pool Utilization:

- Buffer pool tokens are retired only for verified unintentional reversals
- Reversals verified by ISO 14065-accredited verification body
- Retirement quantity = Net carbon loss from reversal event
- Public disclosure of all buffer pool retirements on registry.greentruth.com

7.5.3 Buffer Pool Monitoring and Reporting:

- Quarterly buffer pool balance reporting
- Annual buffer pool adequacy assessment
- Buffer pool utilization history and trend analysis
- Adjustment of buffer rates based on empirical reversal data

7.5.4 Buffer Pool Replenishment:

- If the buffer pool is depleted below 50% of the target balance, new contribution rates increase by 2-5%
- Project developers of affected projects are notified 90 days in advance
- Replenishment surcharge applied until buffer pool adequacy is restored

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8. Data Requirements and Quality Assurance

8.1 Primary Data Requirements

Following **QET Core Methodology Section 5.1.1**, all QET-CCS projects must collect and maintain the following primary data:

8.1.1 Carbon Capture Data:

- CO_2 capture rate (kg/hr or tonnes/day) with continuous or batch measurement
- CO_2 purity analysis (minimum monthly testing)
- Capture system operating hours and downtime tracking
- Equipment calibration records (annual minimum)
- Process conditions (temperature, pressure, flow rate)

8.1.2 Energy Consumption Data:

- Electricity consumption (kWh) with sub-metering for project boundary
- Thermal energy consumption (MMBtu) by fuel type
- Grid emission factors (location-based or market-based per GHG Protocol)
- Renewable energy procurement documentation (if applicable)

8.1.3 Material and Feedstock Data:

- Biomass quantity, type, and carbon content (for BECCS, biochar)
- Rock quantity, mineralogy, and reactivity (for enhanced weathering)
- Chemical consumables and catalysts
- Lifecycle emission factors for all materials

8.1.4 Transport Data:

- CO_2 transport method (pipeline, truck, rail) and distance
- Biomass transport distance and load
- Transport emission factors (per **QET Core Methodology Section 5.6**)

8.1.5 Storage and Monitoring Data:

- Injection well flow rates and cumulative mass (for geological storage)
- Storage site pressure and temperature monitoring
- Biochar application location and soil monitoring data
- Forest/soil carbon stock measurements (for nature-based projects)

8.2 Data Quality Requirements

Following **QET Core Methodology Section 4.4**, all data must meet the following quality criteria:

8.2.1 Data Hierarchy (Highest to Lowest Preference):

1. Direct measurement with calibrated instruments (primary data)
2. Mass balance calculations based on measured inputs/outputs
3. Industry-specific emission factors from peer-reviewed sources

4. Default emission factors from IPCC, EPA, or equivalent authorities

8.2.2 Measurement Accuracy and Calibration:

- CO_2 capture measurement: ±5% accuracy, annual calibration
- Energy meters: ±2% accuracy, biennial calibration
- Flow meters: ±3% accuracy, annual calibration
- Laboratory analysis: ISO 17025-accredited laboratories for carbon content, stability testing

8.2.3 Data Management System Requirements:

- Centralized data management system with access controls
- Automated data logging for continuous monitoring
- Data backup and recovery procedures
- Audit trail for all data entry and modifications
- Version control for calculation spreadsheets and models

8.3 Supporting Documentation

Following **QET Core Methodology Section 8.1**, project developers must maintain:

- Equipment specifications and calibration certificates
- Laboratory analysis reports (carbon content, purity, stability testing)
- Energy utility bills and invoices
- Transport manifests and logistics records
- Monitoring reports (injection data, soil sampling, forest measurements)
- Third-party verification reports
- Producer attestation forms

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9. Uncertainty Reporting Requirements

9.1 Uncertainty Assessment Framework

Following **QET Core Methodology Section 6**, all QET-CCS projects must quantify and report uncertainty associated with carbon removal quantification, aligned with ISO 14064-2 uncertainty management requirements.

9.2 Sources of Uncertainty

9.2.1 Measurement Uncertainty:

- CO_2 capture measurement instruments (flow meters, analyzers)
- Energy consumption metering
- Biomass carbon content analysis
- Soil or biochar carbon stock measurements

9.2.2 Model Uncertainty:

- Biomass growth models for afforestation projects
- Enhanced weathering dissolution models
- Baseline scenario projections
- Leakage estimations

9.2.3 Parameter Uncertainty:

- Emission factors for electricity, fuels, and materials
- Carbon content of biomass feedstocks
- Biochar stability factors
- Storage permanence assumptions

9.2.4 Temporal Uncertainty:

- Sampling frequency and representativeness
- Seasonal variations in biomass growth or weathering rates
- Long-term storage monitoring intervals

9.3 Uncertainty Quantification Methods

9.3.1 Statistical Analysis (Preferred Method):

For parameters with multiple measurements, uncertainty should be quantified using statistical methods aligned with GHG Protocol and IPCC Good Practice Guidance:

Step 1: Calculate the Mean and Standard Deviation

$$\overline{x} = \frac{1}{n}\Sigma_{i=1}^{n} {}^{x_i}$$

$$s = \sqrt{\frac{1}{n-1}\Sigma_{i=1}^{n}\left(x_i - \overline{x}\right)^2}$$

Where:

- $\bar{x}$ = sample mean
- s = sample standard deviation
- n = number of measurements
- x_i = individual measurement values

Step 2: Calculate Uncertainty as a Percentage of the Mean

$$U_{parameter} = (\frac{s}{x}) \times 100\%$$

Alternative for Well-Sampled Parameters (n ≥ 30):

$$U_{parameter} = (\frac{s/\sqrt{n}}{\bar{x}}) \times 100\%$$

Where $s/\sqrt{n}$ is the standard error of the mean

Step 3: Calculate 95% Confidence Interval

For **normally distributed data** with sufficient sample size (n ≥ 30):

$$95\%\ Confidence\ Interval = \bar{x} \pm (1.96 \times s)$$

Or expressed as percentage:

$$95\%\ CI = \pm\ 1.96 \times U_{parameter}$$

For **smaller sample sizes** (n < 30), use Student's t-distribution:

$$95\%\ Confidence\ Interval = \bar{x} \pm (t_{0.025,n-1} \times \frac{s}{\sqrt{n}})$$

Where $t_{0.025,n-1}$ is the critical t-value for 95% confidence with (n-1) degrees of freedom.

Requirements for Statistical Analysis:

- Minimum sample size: n ≥ 10 for basic uncertainty estimation
- Recommended sample size: n ≥ 30 for robust confidence intervals
- Data must be checked for outliers and extreme values
- Normality assumption should be validated for datasets with n < 30
- Individual parameter uncertainties must be less than 60% for first-order error propagation method

Example Calculation:

Sample CO_2 capture measurements (n = 25 measurements over 1 month):

- Mean capture rate ($\bar{x}$): 1,000 kg/hr
- Standard deviation (s): 50 kg/hr
- Parameter uncertainty: (50/1,000) × 100% = **5%**
- 95% Confidence Interval (using t = 2.064 for df = 24): 1,000 ± (2.064 × 50/√25) = 1,000 ± 20.64 kg/hr
- Or expressed as a percentage: **±2.06%**

Note on Advanced Uncertainty Analysis:

The statistical methods described in Section 9.3.1 are appropriate for most QET-CCS projects where parameters are independent and reasonably well-characterized. However, **Monte Carlo simulation** (as described in Section 9.3.2) should be used instead of first-order error propagation when any of the following conditions apply:

- **Individual parameter uncertainties exceed 60%** — First-order error propagation becomes unreliable at high uncertainty levels, and Monte Carlo simulation provides more accurate uncertainty estimates

- **Parameters are correlated** — When input parameters (e.g., energy consumption and CO_2 capture rate) are interdependent, Monte Carlo methods can account for correlation effects that first-order methods ignore

- **Probability distributions are non-normal** — When parameters follow skewed, bimodal, or other non-Gaussian distributions, Monte Carlo simulation can properly represent these distributions

- **More sophisticated uncertainty analysis is required** — For high-value projects, novel methodologies, or projects with regulatory scrutiny, Monte Carlo simulation provides greater confidence in uncertainty estimates and better characterizes the full range of potential outcomes

Project developers should consult with their verification body to determine the appropriate level of uncertainty analysis based on project scale, methodology complexity, and materiality considerations.

9.3.2 Propagation of Uncertainty:

For calculated values with multiple uncertain inputs:

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \ldots + U_n^2}$$

9.3.3 Conservative Adjustment:

When uncertainty exceeds target thresholds, apply conservative adjustment:

$$Adjusted\ CDR = Measured\ CDR \times \left(1 - \frac{U_{total}}{100}\right)$$

9.4 Target Uncertainty Thresholds

Per **QET Core Methodology Section 6.3**, the following uncertainty thresholds apply:

Parameter	Target Uncertainty	Maximum Acceptable
CO_2 capture quantity	±5%	±10%
Energy consumption	±3%	±5%
Carbon content (biochar, biomass)	±10%	±15%
Storage permanence factor	±5%	±10%
Overall net carbon removal	±10%	±15%

Actions Required When Thresholds Exceeded:

- Enhanced monitoring and measurement frequency
- Independent laboratory verification
- Conservative adjustment factors applied
- Notation in verification report and QET-CCS metadata

9.5 Uncertainty Documentation Requirements

All QET-CCS data submissions must include:

- Uncertainty assessment report with methodology description
- Individual parameter uncertainties with supporting calculations
- Combined uncertainty for net carbon removal quantity
- Confidence level rating per **QET Core Methodology Section 6.3**
- Description of any conservative adjustments applied

10. Verification Requirements

10.1 Verification Principles

All QET-CCS projects must undergo third-party verification in accordance with the requirements of ISO 14064-3:2019 and ISO 14065:2020, as detailed in **QET Core Methodology Section 8**.

10.2 Verification Body Requirements

10.2.1 Mandatory Accreditation:

All verification bodies must hold **ISO 14065:2020 accreditation** from a recognized accreditation body (e.g., ANAB, UKAS, DAkkS) with scope covering:

- ISO 14064-3 greenhouse gas assertions
- Project-level GHG quantification (ISO 14064-2)
- Carbon removal and sequestration projects

10.2.2 Verifier Qualification Requirements:

- Lead verifier: Minimum 3 years experience in carbon removal project verification
- Technical specialist: Expertise in specific carbon removal methodology (DAC, BECCS, biochar, geological storage, forestry)
- Independence: No financial interest in project outcomes; 2-year cooling-off period from project development activities

10.2.3 Verification Body Rotation:

- Mandatory rotation of verification body every 6 years
- Mandatory rotation of lead verifier every 3 verifications

10.3 Verification Frequency

Verification frequency is determined based on project scale, permanence risk, and methodology type:

Project Annual CDR	Permanence Risk	Verification Frequency
<1,000 tonnes	Low (geological)	Every 2 years

Project Annual CDR	Permanence Risk	Verification Frequency
<1,000 tonnes	Medium (biochar)	Annual
<1,000 tonnes	High (nature-based)	Annual
1,000-10,000 tonnes	Low (geological)	Annual
1,000-10,000 tonnes	Medium-High	Annual + mid-year review
>10,000 tonnes	All risk levels	Annual + quarterly reviews

Additional Requirements:

- Initial verification required before first QET-CCS issuance
- Permanence monitoring verification per Section 13
- Post-reversal verification if reversal event detected

10.4 Verification Scope

Following **QET Core Methodology Section 8.3**, verification must cover:

10.4.1 System Boundary Verification:

- Confirmation that all emission sources within boundary are included
- Assessment of boundary completeness per ISO 14064-2
- Review of exclusions with justification

10.4.2 Quantification Methodology Verification:

- Confirmation of methodology alignment with approved QET-CCS methodologies
- Review of calculation procedures and equations
- Validation of emission factors and parameters used
- Assessment of co-product allocation methods

10.4.3 Data Verification:

- Review of data management systems and controls
- Testing of primary measurement data (sampling approach)
- Verification of calibration records and procedures
- Assessment of data quality per Section 8.2

10.4.4 Additionality Assessment:

- Review of additionality demonstration per ISO 14064-2
- Financial additionality analysis
- Regulatory additionality assessment
- Common practice evaluation

10.4.5 Baseline and Leakage Verification:

- Baseline scenario assessment
- Leakage identification and quantification review
- Counterfactual analysis validation

10.4.6 Buffer Pool Assessment Verification:

- Review of buffer pool contribution calculation
- Validation of risk assessment methodology
- Confirmation of buffer pool withholding

10.4.7 Permanence Monitoring Plan Verification:

- Review of monitoring plan adequacy per Section 13
- Assessment of monitoring parameters and frequency
- Validation of reversal detection and reporting procedures

10.5 Site Visit Requirements

Following **QET Core Methodology Section 8.2.6** and informed by risk assessment:

Mandatory Site Visits (Initial Verification):

- All projects require an initial on-site verification visit
- Duration: Minimum 1 day for projects <10,000 tonnes CDR; 2-3 days for larger projects
- Activities: Equipment inspection, data system review, staff interviews, process observation

Ongoing Verification Site Visits:

- Annual site visit for high-risk projects (nature-based sequestration)
- Site visit every 2 years for medium-risk projects (biochar)
- Site visit every 3 years for low-risk projects (DAC, industrial CCS with continuous monitoring)
- Remote verification permitted in interim years with continuous data monitoring and remote document review

10.6 Materiality Thresholds

Per **QET Core Methodology Section 8.3**, the following materiality thresholds apply:

Individual Project Materiality:

- Threshold: ±5% of net carbon removal quantity
- Errors, omissions, or misstatements exceeding 5% individually or in aggregate require corrective action before verification statement issuance

Aggregated Portfolio Materiality:

- For producers with multiple projects: ±3% of total portfolio net carbon removal

10.7 Verification Statement Requirements

Following **QET Core Methodology Section 8.3.3**, verification bodies must issue a verification statement including:

10.7.1 Required Statement Elements:

- Verification body name and ISO 14065 accreditation details
- Project name, location, and reporting period
- Verification scope and objectives
- Verification methodology and level of assurance (reasonable assurance)
- Summary of verification activities performed
- Gross carbon removal quantity (before project emissions)
- Project emissions and net carbon removal calculation
- Buffer pool contribution and net QET-CCS tokens issued
- Material findings and corrective actions
- Verification opinion (positive, qualified, or adverse)
- Verification statement date and authorized signatory

10.7.2 Verification Opinion:

- **Positive opinion:** No material misstatements; net CDR quantity fairly stated within materiality threshold
- **Qualified opinion:** Material misstatements identified and corrected; CDR quantity adjusted accordingly
- **Adverse opinion:** Material misstatements not resolved; QET-CCS tokens cannot be issued

10.8 Verification Documentation Requirements

Per **QET Core Methodology Section 8.1**, verification bodies must maintain:

- Verification plan with risk assessment
- Evidence collection documentation (site visit reports, interviews, data testing)
- Findings register with corrective action tracking
- Independent technical review documentation
- Final verification report and statement
- All records retained for 10 years minimum

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11. QET-CCS Data Structure and JSON Schema

11.1 Key Required Fields

Following **QET Core Methodology Section 7**, all QET-CCS tokens must include the following structured metadata fields:

Token Identification Fields:

- token_id: Unique identifier for token batch
- token_type: "QET-CCS"
- token_quantity: Number of kgCO_2e represented
- issuance_date: ISO 8601 timestamp
- vintage_year: Calendar year of carbon removal
- serial_number_range: Start and end serial numbers

Project Information Fields:

- project_name: Full project name
- project_id: Unique EarnDLT project identifier
- project_location: Geographic coordinates and jurisdiction
- project_developer: Legal entity name and registration
- project_start_date: Project commencement date
- crediting_period: Start and end dates for carbon removal crediting

Methodology Information Fields:

- methodology_name: QET-CCS methodology version
- carbon_removal_type: (DAC, BECCS, Biochar, Enhanced Weathering, Geological Storage, Afforestation, Soil Carbon)

- methodology_version: Version number of approved methodology used
- storage_durability: Permanence classification (100+ years, 1000+ years)
- additionality_assessment: Summary of additionality demonstration

Quantification Data Fields:

- gross_carbon_removal: Total CO_2 captured/sequestered ($kgCO_2e$)
- project_emissions: Total project lifecycle emissions ($kgCO_2e$)
- baseline_emissions: Baseline scenario emissions ($kgCO_2e$)
- leakage_emissions: Emissions from activity shifting ($kgCO_2e$)
- net_carbon_removal: Net CDR before buffer pool ($kgCO_2e$)
- buffer_pool_contribution_rate: Percentage (5-25%)
- buffer_pool_quantity: Tokens withheld for buffer pool ($kgCO_2e$)
- tokens_issued: Final quantity issued to project ($kgCO_2e$)

Verification Information Fields:

- verification_body: Name and accreditation number
- verifier_name: Lead verifier name and credentials
- verification_date: ISO 8601 timestamp
- verification_level: "Reasonable Assurance" or "Limited Assurance"
- verification_opinion: "Positive", "Qualified", or "Adverse"
- verification_report_url: Link to full verification statement
- site_visit_conducted: Boolean and date

Permanence Monitoring Fields:

- monitoring_plan_url: Link to the permanence monitoring plan
- monitoring_frequency: (Continuous, Annual, Biennial, etc.)
- next_monitoring_date: Scheduled next monitoring event
- reversal_events: Array of any detected reversal events
- storage_site_id: Identifier for geological storage site (if applicable)

Registry and Compliance Fields:

- registry_url: "https://registry.greentruth.com"
- public_disclosure_url: Link to public project information
- regulatory_compliance: Array of applicable frameworks (e.g., EPA Subpart RR, EU ETS)
- co-benefits: Array of SDG alignments or co-benefits

Pricing and Fee Fields (per EarnDLT Pricing Structure v3):

- production_fee_per_kg: $0.0012
- transfer_fee_per_kg: $0.0005
- platform_fee_total: Calculated total fees
- revenue_share_tier: (Entry 60%, Growth 65%, Professional 68%, Enterprise 70%)

11.2 Schema Validation Requirements

Per **QET Core Methodology Section 7.3**, all JSON schema submissions must:

- Pass automated schema validation against the published QET-CCS JSON schema definition
- Include all mandatory fields with no null values for required fields
- Meet data type requirements (integers, floats, strings, booleans, dates)
- Include proper ISO 8601 date/time formatting
- Provide valid URLs for all document references
- Total token quantity must equal net carbon removal minus buffer pool withholding

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12. Documentation and Attestation Requirements

12.1 Project Description Document (PDD)

All QET-CCS projects must submit a comprehensive Project Description Document including:

12.1.1 Project Overview:

- Project name, location, and developer information
- Carbon removal technology description
- Project timeline and crediting period
- Estimated annual carbon removal capacity

12.1.2 Additionality Demonstration:

- Regulatory additionality analysis
- Financial additionality analysis (investment barrier, common practice)
- Counterfactual baseline scenario description
- Barriers overcome by carbon credit revenue

12.1.3 System Boundary and Quantification:

- Detailed system boundary diagram
- GHG sources and sinks identification
- Quantification methodology and calculation procedures
- Emission factors and data sources

- Co-product allocation methodology (if applicable)

12.1.4 Monitoring Plan:

- Monitoring parameters and measurement methods
- Data collection frequency and procedures
- Quality assurance and quality control procedures
- Data management and record-keeping systems
- Roles and responsibilities

12.1.5 Permanence and Reversal Risk:

- Storage durability assessment
- Risk identification and mitigation measures
- Buffer pool contribution calculation
- Permanence monitoring plan (see Section 13)
- Reversal event response procedures

12.2 Producer Attestation

Per **QET Core Methodology Section 8.4**, all QET-CCS issuances require a signed producer attestation certifying:

12.2.1 Attestation Statement Content:

- Accuracy and completeness of all data submitted
- Compliance with QET-CCS Methodology v1.0
- Compliance with all applicable regulatory requirements
- No double-counting or double-issuance of carbon removal credits
- Commitment to permanence monitoring requirements
- Commitment to buffer pool participation
- Authorization of data sharing with verification body and registry

12.2.2 Authorized Signatory Requirements:

- Executive officer of project developer organization (CEO, CFO, COO, or President)
- Legal authority to bind organization
- Contact information for verification and compliance purposes

12.2.3 Attestation Frequency:

- Initial attestation with Project Description Document submission
- Annual attestation with each verification cycle

- Updated attestation if project changes occur (technology modifications, ownership transfer)

12.3 Document Retention Requirements

Following **QET Core Methodology Section 8.1** and ISO 14064-2 requirements:

12.3.1 Minimum Retention Period:

- Project Description Document: Duration of crediting period + 10 years
- Raw data and monitoring records: 10 years from data collection date
- Verification reports and statements: 10 years from issuance date
- Calibration certificates: 5 years from calibration date
- Producer attestations: 10 years from signature date

12.3.2 Document Format and Accessibility:

- Electronic format with backup and disaster recovery
- Accessible to verification bodies and regulatory authorities upon request
- Version control for all calculation spreadsheets and models
- Audit trail for all data modifications

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13. Permanence Monitoring and Reporting

13.1 Permanence Monitoring Objectives

The permanence monitoring plan ensures long-term carbon storage integrity and enables rapid detection and response to reversal events. All QET-CCS projects must implement a permanence monitoring plan commensurate with storage durability and reversal risk.

13.2 Technology-Specific Monitoring Requirements

13.2.1 Geological Storage Monitoring

Pre-Injection Site Characterization:

- Geological survey and seismic imaging
- Caprock integrity assessment
- Groundwater baseline characterization

- Well construction and mechanical integrity testing
- Injection zone capacity and pressure modeling

Operational Phase Monitoring (During Injection):

- Continuous injection well monitoring (flow rate, pressure, temperature)
- CO_2 purity testing (monthly minimum)
- Wellhead pressure and temperature monitoring
- Annulus pressure monitoring for well integrity
- Surface monitoring for leaks (quarterly soil gas surveys near wellhead)

Post-Injection Monitoring:

- Annual seismic monitoring for plume migration (first 5 years)
- Biennial seismic monitoring (years 6-10)
- Groundwater monitoring well sampling (quarterly years 1-5, annually years 6-10)
- Well integrity testing (annual for 5 years post-injection)
- Surface monitoring (annual atmospheric and soil gas monitoring)

Minimum Monitoring Duration:

- 10 years post-injection completion
- Extended monitoring if required by regulatory authority (e.g., EPA Class VI permits may require 50+ years)

Reporting:

- Quarterly operational reports during injection
- Annual post-injection monitoring reports
- Immediate notification of any detection of leakage or well integrity issues

13.2.2 Biochar Permanence Monitoring

Application Site Documentation:

- GPS coordinates of application sites
- Soil type characterization
- Application rate (tonnes biochar per hectare)
- Application date and method
- Photographic documentation

Biochar Stability Verification:

- Initial biochar characterization (H:Corg ratio, carbon content, ash content)
- Periodic re-testing (every 5 years) for stability confirmation
- Soil sampling at application sites (years 1, 3, 5, 10)

Site Monitoring:

- Annual visual inspection of application sites
- Assessment of soil disturbance or erosion
- Land use change monitoring
- Sampling for carbon persistence (statistical sampling of 5-10% of sites)

Minimum Monitoring Duration:

- 10 years for H:Corg < 0.4 (high stability)
- 20 years for H:Corg 0.4-0.7 (medium stability)

Reporting:

- Annual monitoring report with site visit documentation
- Immediate notification of significant land use changes or soil disturbance

13.2.3 Afforestation/Reforestation Monitoring

Baseline Assessment:

- Pre-project land use and vegetation survey
- Soil carbon stock baseline (0-30 cm depth minimum)
- Tree species selection and planting plan
- Reference region carbon stock data

Growth Monitoring:

- Annual survival rate assessment (years 1-5)
- Biennial growth measurements (tree height, diameter at breast height)
- Periodic plot-based biomass inventory (years 5, 10, 15, 20)
- Remote sensing analysis (satellite imagery for large projects)

Disturbance Monitoring:

- Annual site inspections for fire, disease, pests, illegal harvesting
- Climate impact assessment (drought stress, storm damage)
- Land tenure verification (annual confirmation of legal protections)

Soil Carbon Monitoring:

- Soil sampling at establishment and every 10 years
- Analysis of soil organic carbon (0-30 cm depth minimum)

Minimum Monitoring Duration:

- Duration of crediting period (typically 30-100 years)
- Post-crediting monitoring recommended for perpetuity or site conversion

Reporting:

- Annual monitoring report with growth data and disturbance assessment
- Immediate notification of major disturbance events (fire, disease outbreak, illegal harvesting)
- Biomass inventory report every 5 years with updated carbon stock calculation

13.2.4 Enhanced Rock Weathering Monitoring

Application Site Documentation:

- GPS coordinates and field boundaries
- Rock type, source, and mineralogical composition
- Application rate (tonnes per hectare)
- Application date and method
- Soil baseline characterization (pH, exchangeable cations, carbonate content)

Weathering Monitoring:

- Soil sampling (annual for first 3 years, biennial thereafter)
- Analysis of soil pH, exchangeable Mg/Ca, carbonate content
- Alkalinity measurements in drainage water or agricultural runoff (if applicable)
- Crop yield monitoring (for agricultural applications)

Lab Dissolution Testing:

- Annual dissolution rate testing with updated site soil samples
- Validation of weathering rate models

Minimum Monitoring Duration:

- 10 years post-application
- Extended monitoring for projects with slow weathering rates

Reporting:

- Annual monitoring report with soil analysis results
- Updated carbon removal quantification based on actual weathering rates
- Immediate notification if weathering rates significantly lower than expected

13.3 Reversal Event Detection and Response

13.3.1 Reversal Event Definition

A reversal event occurs when stored carbon is unintentionally released back to the atmosphere, including:

- Geological storage: CO_2 leakage through wells, faults, or caprock breaches
- Biochar: Site excavation, erosion, or fire consuming biochar-amended soil
- Afforestation: Fire, disease, illegal harvesting, storm damage, land use conversion
- Enhanced weathering: Quantification error leading to over-crediting

13.3.2 Detection and Notification Requirements

Detection Timeline:

- Continuous monitoring systems: Real-time alerts
- Periodic monitoring: Detection within one monitoring cycle
- Third-party reports: Investigation within 30 days of notification

Notification Requirements:

- Immediate notification to EarnDLT (within 48 hours of detection)
- Public disclosure on registry.greentruth.com (within 7 days)
- Notification to token holders (if reversal >5% of project total)
- Regulatory authority notification (as required by applicable regulations)

13.3.3 Reversal Quantification and Verification

Quantification Process:

- Assessment of carbon quantity released
- Verification by ISO 14065-accredited verification body
- Conservative estimation approach (if exact quantity uncertain)
- Documentation of reversal cause and timeline

Verification Requirements:

- Independent third-party assessment within 60 days
- Site visit if reversal event significant (>10 tonnes CO_2e)
- Verification statement documenting reversal quantity and cause

13.3.4 Buffer Pool Compensation

Compensation Mechanism:

- Buffer pool tokens retired equal to verified reversal quantity

- Public record of buffer pool retirement on registry
- If reversal exceeds buffer pool capacity, additional tokens from project developer or insurance

Project Developer Liability:

- Intentional reversals: Project developer must replace tokens 1:1
- Unintentional reversals covered by buffer pool: No additional developer liability
- Repeated reversals: Increased buffer pool contribution or project suspension

13.4 Permanence Monitoring Reporting

13.4.1 Annual Monitoring Report Contents:

- Summary of all monitoring activities performed
- Results of measurements and analyses
- Comparison to previous years and baseline
- Assessment of any risks or disturbances detected
- Photographic documentation (site photos, equipment photos)
- Updated carbon stock calculation (for nature-based projects)
- Confirmation of continued carbon storage integrity

13.4.2 Report Submission and Review:

- Submit to EarnDLT within 60 days of monitoring period end
- Technical review by EarnDLT methodology team
- Public posting of summary report on registry.greentruth.com
- Verification body review during periodic verification cycles

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14. Integration with EarnDLT Registry and Transparency Requirements

14.1 EarnDLT Blockchain Registry

All QET-CCS tokens are issued, tracked, and managed on the EarnDLT blockchain-based registry platform at **registry.greentruth.com**, providing immutable record-keeping and full transparency.

14.1.1 Registry Platform Features

Immutable Record-Keeping:

- Blockchain-based token issuance with cryptographic verification
- Permanent audit trail of all token transactions
- Tamper-proof record of verification statements and monitoring reports
- Chain-of-custody documentation from issuance to retirement

Public Transparency:

- Public-facing project information pages
- Searchable registry of all QET-CCS tokens by project, methodology, vintage year
- Verification body information and verification statement access
- Buffer pool balance and utilization reporting
- Reversal event disclosure

Token Management:

- Secure token custody and transfer functionality
- Retirement mechanism with permanent record
- Fractional token transfers (down to 0.001 $kgCO_2e$)
- Multi-signature authorization for large transfers

14.2 Public Disclosure Requirements

Per **QET Core Methodology Section 7.4** and aligned with transparency best practices, all QET-CCS projects must publicly disclose:

14.2.1 Mandatory Public Information:

- Project name, location (jurisdiction level, coordinates optional), and developer
- Carbon removal methodology type and version
- Vintage year and issuance quantity
- Verification body name, accreditation, and verification date
- Verification opinion (positive, qualified, adverse)
- Link to verification statement (full or summary)
- Buffer pool contribution rate and quantity
- Storage durability classification (100+ years or 1000+ years)
- Permanence monitoring frequency and next monitoring date

14.2.2 Optional Public Information (Project Developer Discretion):

- Detailed project description and technology specifics
- Financial information and project economics
- Detailed quantification calculations and emission factors
- Proprietary process information

- Commercial agreements and pricing

14.2.3 Confidential Information (Not Publicly Disclosed):

- Precise geographic coordinates (if security concern)
- Proprietary technology specifications
- Commercial pricing and contract terms
- Detailed financial information
- Personally identifiable information

14.3 Registry Query and Reporting Functionality

The EarnDLT registry provides comprehensive query and reporting capabilities:

14.3.1 Search and Filter Functions:

- Search by project name, developer, location, methodology type
- Filter by vintage year, verification body, storage durability
- Filter by buffer pool contribution range
- Search by token serial number or batch ID

14.3.2 Reporting and Analytics:

- Total QET-CCS tokens issued by methodology type
- Annual issuance trends and growth rates
- Buffer pool aggregate balance and utilization rates
- Verification body performance statistics
- Geographic distribution of carbon removal projects
- Average carbon removal efficiency by methodology type

14.3.3 API Access:

- RESTful API for programmatic access to registry data
- Real-time token balance queries
- Transaction history exports
- Verification status checks
- Integration with carbon accounting platforms

14.4 Token Lifecycle Management

14.4.1 Token Issuance

Issuance Prerequisites:

- Completed Project Description Document submission and approval
- Successful third-party verification with positive opinion
- Producer attestation signed by authorized representative
- Payment of production fees per **EarnDLT Pricing Structure v3**
- JSON metadata validation and schema compliance

Issuance Process:

- EarnDLT methodology review and approval (5 business days)
- Token minting on blockchain with unique serial numbers
- Metadata attachment with full traceability
- Buffer pool withholding (automatic)
- Token custody assigned to project developer wallet

Issuance Timeline:

- Standard processing: 10 business days from verification statement receipt
- Expedited processing: 3 business days (additional fee may apply)

14.4.2 Token Transfer

Transfer Requirements:

- Source wallet authorization (digital signature)
- Destination wallet verification (KYC/AML if required)
- Transfer fee payment ($0.0005/kg per **EarnDLT Pricing Structure v3**)
- Compliance with any transfer restrictions (if applicable)

Transfer Documentation:

- Transfer transaction recorded on blockchain
- Transfer certificate generated automatically
- Chain-of-custody documentation updated
- Notification to buyer and seller

14.4.3 Token Retirement

Retirement Purpose:

- Claim of carbon removal benefit (offset against emissions)
- Voluntary climate action commitment
- Regulatory compliance (if applicable in jurisdiction)
- Buffer pool compensation for reversal events

Retirement Process:

- Retirement request from token holder
- Specification of retirement purpose and beneficiary
- Permanent removal from circulation (blockchain burn)
- Retirement certificate issuance with unique identifier
- Public posting of retirement on registry

Retirement Documentation:

- Retirement certificate with token details, quantity, date, beneficiary
- Verification statement reference
- Statement of climate benefit claim
- Integration with corporate sustainability reporting

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15. Pricing Structure and Fee Administration

15.1 QET-CCS Pricing Framework

Following **EarnDLT Platform Pricing Structure v3**, QET-CCS tokens utilize the Carbon Removal-Based QET pricing model with transparent, performance-based fees:

15.1.1 Fee Structure

Production Fees:

- **$0.0012 per kg CO_2e removed** (applied to net tokens issued after buffer pool withholding)
- Covers: Registry infrastructure, blockchain transaction costs, methodology support, quality assurance, customer support

Transfer Fees:

- **$0.0005 per kg CO_2e transferred** (applied to each secondary market transaction)
- Covers: Transaction processing, chain-of-custody documentation, registry updates

No Upfront Costs:

- Zero subscription fees
- Zero platform access fees
- Zero minimum volume requirements

- Revenue-sharing model only (fees deducted from sales proceeds)

15.1.2 Revenue Sharing Model

EarnDLT operates a dynamic revenue-sharing model where producers retain the majority of sales proceeds:

Tier	Annual Volume	Producer Share	EarnDLT Share
Entry	<100,000 kg	60%	40%
Growth	100,000-1M kg	65%	35%
Professional	1M-10M kg	68%	32%
Enterprise	>10M kg	70%	30%

Tier Benefits:

- Automatic tier advancement based on cumulative issuance volume
- Retroactive application to current year upon tier advancement
- Priority support for Professional and Enterprise tiers
- Dedicated account management for Enterprise tier

15.1.3 Fee Calculation Examples

Example 1: DAC Project - Entry Tier

- Net carbon removal: 50,000 kgCO_2e
- Buffer pool withholding (8%): 4,000 kgCO_2e
- QET-CCS tokens issued: 46,000 tokens
- Production fee: 46,000 × $0.0012 = $55.20
- Market price: $0.15/kg (example)
- Gross sales revenue: 46,000 × $0.15 = $6,900

- Producer share (60%): $4,140
- EarnDLT platform share (40%): $2,760

Example 2: Biochar Project - Growth Tier

- Net carbon removal: 1,221,667 $kgCO_2e$
- Buffer pool withholding (12%): 146,600 $kgCO_2e$
- QET-CCS tokens issued: 1,075,067 tokens
- Production fee: 1,075,067 × $0.0012 = $1,290.08
- Market price: $0.08/kg (example)
- Gross sales revenue: 1,075,067 × $0.08 = $86,005.36
- Producer share (65%): $55,903.48
- EarnDLT platform share (35%): $30,101.88

15.2 Pricing Review Mechanism

15.2.1 Semi-Annual Pricing Reviews

Per the key considerations specified in your requirements, EarnDLT implements a **semi-annual pricing review mechanism** to ensure competitiveness with evolving carbon removal market dynamics:

Review Schedule:

- **January 1** and **July 1** of each year
- Reviews assess production fees, transfer fees, and revenue share tiers
- Market analysis of competing carbon removal registries and platforms
- Assessment of operational costs and technology improvements

Review Process:

- Market data collection from Puro.earth, ACR, Verra, Gold Standard, CDR.fyi
- Analysis of pricing trends for DAC, BECCS, biochar, and other methodologies
- Cost-benefit analysis for EarnDLT platform operations
- Stakeholder input from project developers and token buyers
- Final recommendation to EarnDLT executive committee

Review Outcomes:

- Fee reductions (if operational efficiencies achieved)
- Fee increases (if necessary to maintain platform sustainability, rare)
- Revenue share tier adjustments (incentivizing larger volumes)
- Introduction of new fee categories or discounts

15.2.2 Pricing Modification Notice Requirements

Aligned with **EARN's key guarantees** for producer protection:

30-Day Advance Notice:

- All pricing modifications require **minimum 30-day advance written notice** to all active project developers
- Notice via email to primary account holder and posted on EarnDLT platform
- Detailed explanation of modifications and rationale
- Effective date clearly specified

Grandfathering Provisions:

- Projects with active verification in progress: Old pricing applies to current verification cycle
- Long-term contracts: Pricing locked for contract duration (if applicable)
- Tokens already issued: No retroactive fee changes

Producer Rights:

- Right to accelerate token issuance before new pricing effective date (if verification complete)
- Right to provide feedback during 30-day notice period
- Right to dispute pricing changes through EarnDLT producer support channels

15.2.3 Competitive Pricing Commitment

EarnDLT commits to maintaining competitive pricing relative to carbon removal market benchmarks:

Benchmark Comparisons (as of Q4 2025):

- Puro.earth: €0.03/kg administrative fee + €0.02/kg transaction fee
- Verra VCS: $0.10-0.20 per VCU (voluntary carbon unit, typically 1 tonne)
- Gold Standard: $0.10-0.25 per carbon credit
- Direct project development cost: $0.50-5.00 per tonne for traditional credit issuance

EarnDLT Competitive Advantages:

- Transparent, predictable fee structure
- Volume-based discounts through tier system
- No upfront costs or subscription fees
- Blockchain-based transparency and immutability
- Integration with the Greentruth marketplace for liquidity

15.3 Payment Processing

15.3.1 Fee Payment Methods

Accepted Payment Methods:

- Credit card or ACH for fiat currency
- Invoice billing for Enterprise tier (30-day payment terms)
- Automatic deduction from sales proceeds (default for marketplace transactions)

15.3.2 Payment Timing

Production Fees:

- Due at time of token issuance
- Can be deducted from first sale proceeds (escrow arrangement)
- Payment required before token custody transfer to producer

Transfer Fees:

- Deducted automatically from transaction proceeds
- Buyer pays transfer fee (standard practice)
- Integrated into marketplace transaction flow

15.3.3 Refund Policy

Production Fee Refunds:

- Full refund if verification results in adverse opinion
- Partial refund if token issuance quantity reduced by >10% due to verification findings
- No refund for voluntary project cancellation after verification

Transfer Fee Refunds:

- No refunds for completed transfers
- Full refund if transfer fails due to platform error

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16. Quality Assurance and Control

16.1 EarnDLT Methodology Quality Assurance

EarnDLT implements a comprehensive quality assurance and control program to ensure the integrity of all QET-CCS tokens, aligned with **QET Core Methodology Section 9**:

16.1.1 Pre-Issuance Review

Technical Review Process:

- EarnDLT methodology committee review of Project Description Document
- Assessment of methodology alignment with Section 5 approved methodologies
- Review of quantification calculations and emission factors
- Verification of buffer pool contribution calculation
- JSON schema validation and data completeness check

Review Criteria:

- ISO 14064-2 compliance
- Calculation accuracy and conservativeness
- Data quality per Section 8.2 requirements
- Uncertainty quantification per Section 9 requirements
- Additionality demonstration adequacy

Review Timeline:

- Standard review: 5 business days
- Complex or novel projects: 10 business days
- Requests for additional information extend timeline

Review Outcomes:

- **Approved:** QET-CCS tokens authorized for issuance
- **Conditional approval:** Minor corrections required before issuance
- **Rejected:** Material deficiencies require resubmission

16.1.2 Ongoing Quality Control

Post-Issuance Audits:

- Random sampling of 5% of projects annually for detailed audit
- Focus on high-volume projects and new methodologies
- Independent technical review by external ISO auditing experts
- Findings shared with project developers and verification bodies

Verification Body Performance Monitoring:

- Tracking of verification body findings and opinions
- Assessment of verification thoroughness and independence

- Annual performance review of all active verification bodies
- Suspension or removal of verification bodies for repeated deficiencies

Registry Data Quality Checks:

- Automated validation of all token metadata
- Cross-checks between verification statements and registry data
- Annual reconciliation of issued tokens vs. verified carbon removal quantities
- Buffer pool balance verification

16.2 Dispute Resolution and Corrective Actions

16.2.1 Dispute Types

Project-Level Disputes:

- Disagreement with verification findings
- Buffer pool contribution rate disputes
- Methodology interpretation questions
- Data quality or calculation methodology disputes

Registry-Level Disputes:

- Token issuance errors
- Transfer transaction issues
- Pricing or fee disputes
- Public disclosure concerns

16.2.2 Dispute Resolution Process

Informal Resolution (Step 1):

- Project developer contacts EarnDLT producer support
- Issue escalated to methodology committee or registry operations
- Resolution discussion and documentation
- Timeline: 10 business days for initial response

Formal Dispute (Step 2):

- Written dispute submission with supporting evidence
- Independent technical review by external expert (if technical dispute)
- EarnDLT management review and decision
- Timeline: 30 days for formal decision

Appeals Process (Step 3):

- Appeal to EarnDLT executive committee
- Third-party mediation (if mutually agreed)
- Final decision binding on both parties
- Timeline: 45 days for appeal decision

16.2.3 Corrective Actions

Over-Issuance:

- If tokens issued exceed verified carbon removal quantity: Project developer must retire excess tokens or return to buffer pool
- Timeline: 60 days for corrective action
- Public disclosure of over-issuance and correction

Under-Issuance:

- If tokens issued less than verified carbon removal quantity: Additional tokens issued upon request
- No additional production fees charged
- Correction documented in registry

Verification Errors:

- If verification body error discovered: Re-verification required at verification body expense
- Token adjustments as needed based on re-verification findings
- Verification body performance review and potential consequences

Reversal Events:

- Buffer pool tokens retired per Section 13.3.4
- Public disclosure of reversal event and buffer pool utilization
- Enhanced monitoring requirements for affected project

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17. Roles, Responsibilities, and Workflow

17.1 Stakeholder Roles and Responsibilities

17.1.1 Project Developer

Primary Responsibilities:

- Develop carbon removal project in accordance with approved methodology
- Collect and maintain all required data per Section 8
- Implement permanence monitoring plan per Section 13
- Engage ISO 14065-accredited verification body
- Submit Project Description Document and all supporting documentation
- Execute producer attestation per Section 12.2
- Pay production and transfer fees per Section 15
- Respond to reversal events per Section 13.3
- Maintain document retention per Section 12.3

Rights:

- Custody and control of issued QET-CCS tokens
- Ability to transfer or retire tokens
- Access to EarnDLT registry platform and support
- 30-day notice of pricing changes
- Dispute resolution rights per Section 16.2

17.1.2 Verification Body

Primary Responsibilities:

- Maintain ISO 14065:2020 accreditation with appropriate scope
- Conduct verification in accordance with ISO 14064-3:2019
- Perform site visits per Section 10.5 requirements
- Assess additionality, quantification methodology, data quality, and uncertainty
- Verify buffer pool contribution calculation
- Review permanence monitoring plan
- Issue verification statement per Section 10.7
- Maintain verification documentation for 10 years
- Participate in EarnDLT quality assurance program

Independence Requirements:

- No financial interest in project outcomes
- 2-year cooling-off period from project development activities
- Rotation per Section 10.2.3 requirements
- Disclosure of any conflicts of interest

17.1.3 EarnDLT (Registry Operator)

Primary Responsibilities:

- Maintain QET-CCS methodology document and updates
- Operate blockchain-based registry at registry.greentruth.com

- Review Project Description Documents and approve token issuances
- Implement buffer pool administration per Section 7
- Process token transfers and retirements
- Provide public transparency per Section 14.2
- Conduct semi-annual pricing reviews per Section 15.2.1
- Implement quality assurance and control per Section 16
- Provide producer support and dispute resolution
- Maintain registry platform security and uptime

Methodology Development:

- Update methodology based on scientific advances and stakeholder feedback
- Conduct 3-year periodic reviews per Section 5.3.3
- Review and approve new methodologies per Section 5.3
- Coordinate with ISO auditing experts and environmental legal counsel

17.1.4 Token Holders (Buyers)

Primary Responsibilities:

- Conduct due diligence on QET-CCS tokens before purchase
- Maintain custody of tokens in secure platform wallet
- Retire tokens when claiming carbon removal benefit
- Report token retirements in sustainability disclosures

Rights:

- Access to public registry information per Section 14.2
- Verification of token authenticity and chain-of-custody
- Transfer tokens to third parties
- Retirement certificates upon token retirement

17.1.5 Regulatory Authorities

Potential Roles (Jurisdiction-Dependent):

- Oversight of geological storage sites (e.g., EPA Class VI permits)
- Environmental permitting for carbon removal projects
- Verification of compliance with national GHG inventories
- Integration of QET-CCS tokens into compliance markets (future potential)

17.2 QET-CCS Production Workflow

17.2.1 Project Development Phase

Step 1: Methodology Selection (Month 0)

- Project developer selects approved QET-CCS methodology per Section 5
- Review methodology requirements and eligibility criteria
- Assess financial feasibility with carbon credit revenue projections

Step 2: Project Description Document Preparation (Months 1-3)

- Develop comprehensive PDD per Section 12.1
- Define system boundaries and quantification methodology
- Demonstrate additionality per Section 10.4.4
- Develop monitoring plan and permanence monitoring plan
- Calculate buffer pool contribution per Section 7

Step 3: PDD Submission and Review (Month 4)

- Submit PDD to EarnDLT for technical review
- Respond to any requests for clarification or additional information
- Receive conditional approval or approval to proceed with verification

17.2.2 Verification Phase

Step 4: Verification Body Engagement (Month 4-5)

- Project developer selects and engages ISO 14065-accredited verification body
- Provide all project documentation and data to verification body
- Schedule verification site visit

Step 5: Verification Execution (Months 5-6)

- Verification body conducts document review, data testing, site visit
- Verification findings communicated to project developer
- Corrective actions implemented if needed
- Verification statement issued with positive opinion

Step 6: Verification Statement Submission (Month 6)

- Submit verification statement to EarnDLT
- Provide any supporting documentation requested
- Execute producer attestation per Section 12.2

17.2.3 Token Issuance Phase

Step 7: EarnDLT Final Review (Month 6-7)

- EarnDLT methodology committee reviews verification statement

- Validates quantification calculations and buffer pool withholding
- Confirms JSON metadata completeness and schema compliance
- Approves token issuance

Step 8: Token Minting and Custody Transfer (Month 7)

- EarnDLT mints QET-CCS tokens on blockchain
- Automatic buffer pool withholding applied
- Production fees charged ($0.0012/kg)
- Token custody transferred to project developer wallet
- Public registry listing activated

Step 9: Market Listing and Sales (Ongoing)

- Project developer lists tokens on the Greentruth marketplace or negotiates direct sales
- Transfer fees apply to secondary transactions ($0.0005/kg)
- Revenue share per Section 15.1.2 tier structure
- Chain-of-custody documentation maintained on registry

17.2.4 Ongoing Monitoring and Reporting Phase

Step 10: Permanence Monitoring (Years 1-10+)

- Implement permanence monitoring plan per Section 13
- Conduct periodic measurements and site visits
- Prepare annual monitoring reports per Section 13.4
- Submit monitoring reports to EarnDLT (within 60 days of monitoring period end)

Step 11: Periodic Re-Verification (Annual or Biennial)

- Engage verification body for follow-up verification per Section 10.3
- Document continued carbon storage integrity
- Report any reversal events per Section 13.3
- Issue additional QET-CCS tokens for new carbon removal quantities

Step 12: Buffer Pool Management (Ongoing)

- Monitor buffer pool adequacy per Section 7.5.3
- Respond to any reversal events with buffer pool retirements
- Adjust buffer pool contribution rates if needed based on risk assessment updates

17.3 Estimated Timeline and Costs

17.3.1 Timeline from Project Start to Token Issuance

Phase	Duration	Key Activities
Methodology Selection	1 month	Review methodologies, assess feasibility
PDD Preparation	3 months	Develop comprehensive project documentation
EarnDLT PDD Review	2-4 weeks	Technical review and approval
Verification	2-3 months	Document review, site visit, statement issuance
Token Issuance	2-4 weeks	Final EarnDLT review and blockchain minting
Total Estimated Timeline	**6-8 months**	From project start to first token issuance

17.3.2 Estimated Costs (Excluding Project Capital Expenditures)

Cost Category	Estimated Cost Range	Notes
PDD Development	$5,000-$25,000	Depends on project complexity and consultant fees
Initial Verification	$10,000-$50,000	Depends on project size, methodology, and site visit requirements

Cost Category	Estimated Cost Range	Notes
EarnDLT Production Fees	$1.20 per tonne	Applied to net tokens issued ($0.0012/kg)
Annual Monitoring	$2,000-$15,000	Depends on monitoring requirements and site accessibility
Annual Re-Verification	$5,000-$30,000	Typically lower than initial verification
Total First-Year Cost	$22,000-$120,000	For 10,000 tonne/year project

Cost Recovery:

- Carbon removal credit prices: $50-$600 per tonne (as of Q4 2025, varies by methodology)
- DAC credits: $300-$600/tonne
- BECCS credits: $100-$250/tonne
- Biochar credits: $50-$150/tonne
- Afforestation credits: $10-$50/tonne (lower due to permanence risk)

Breakeven Analysis Example (Biochar Project):

- Project size: 1,000 tonnes CO_2e/year
- First-year costs: $30,000
- Credit price: $100/tonne
- Gross revenue: $100,000
- Producer share (65%): $65,000
- Net profit first year: $35,000
- Breakeven: <1 year

Appendix A: Glossary of Terms

Refer to Section 3 for comprehensive definitions of key terms used in this methodology.

Appendix B: Reference Documents and Resources

ISO Standards:

- ISO 14064-1:2018 — Organization-level GHG quantification
- ISO 14064-2:2019 — Project-level GHG quantification
- ISO 14064-3:2019 — Verification and validation
- ISO 14065:2020 — Requirements for verification bodies
- ISO 14067:2018 — Carbon footprint of products
- ISO 14080:2018 — Climate action methodologies framework

Carbon Removal Standards:

- Puro.earth — CO_2 Removal Certificate (CORC) methodologies (https://puro.earth)
- American Carbon Registry — CCS methodologies (https://americancarbonregistry.org)
- Verra VCS — Carbon removal methodologies (https://verra.org)
- Gold Standard — Carbon sequestration protocols (https://www.goldstandard.org)

Regulatory and Technical References:

- IPCC Guidelines for National GHG Inventories (https://www.ipcc.ch)
- US EPA GHG Reporting Program, Subpart RR (https://www.epa.gov/ghgreporting)
- GHG Protocol Corporate Standard (https://ghgprotocol.org)
- C2ES CCS Accounting Framework (https://www.c2es.org)

EarnDLT Resources:

- EarnDLT Platform: https://www.earndlt.com
- Greentruth Registry: https://registry.greentruth.com
- QET Core Methodology (Reference Document)
- EarnDLT Platform Pricing Structure v3
- Producer Support: support@earndlt.com

Document Approval and Effective Date

Methodology Approval:

- Approved by: EarnDLT Methodology Committee
- Approval Date: November 5, 2025
- Effective Date: January 1, 2026
- Next Periodic Review: November 2028 (3-year cycle)

Methodology Committee:

- ISO Auditing Experts
- Environmental Legal Counsel
- Carbon Removal Technical Specialists
- Registry Operations Representatives

Contact Information:

- **Methodology Inquiries:** methodology@earndlt.com
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