SCERM© USER MANUAL

A Practical Guide to Supply Chain Emission Reduction Method Implementation

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Step-by-step methodology for creating verifiable, attributable supply chain emission reductions

"The bridge between impact and integrity."

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(Research supported by frameworks including GHG Protocol, ISO, ISCC, CDP and SBTi.For detailed references and research methodology, see the accompanying SCERM Whitepaper)

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Author Profile

Sonali Tamaskar is Head of Research and Development at Kyoto Network, where she leads the technical design and governance framework underpinning the Supply Chain Emission Reduction Method (SCERM©).

With a professional background in financial compliance, risk management, and audit-readiness, her work focuses on ensuring that SCERM© is built to meet the standards of rigour expected in regulated and financial environments. Her experience across banking operations, regulatory reporting, and internal controls informs the method's emphasis on data integrity, traceability, and verification.

At Kyoto Network, she has overseen the research and methodological development of the SCERM© framework and whitepaper, supporting its alignment with established global standards including the GHG Protocol, ISO 14064, and leading disclosure frameworks such as GRI, ESRS, IFRS S1/S2, SBTi, and CDP.

She continues to steward the technical evolution of SCERM©, with a focus on assurance readiness, interoperability with emerging standards, and the integration of environmental and social performance into credible supply-chain climate strategies.

Sheraz Malik is the Founder and Chief Executive Officer of Kyoto Network, a sustainability and supply-chain transformation firm focused on real-economy decarbonisation, project development, and climate data integrity.

He has over a decade of experience working across the full lifecycle of sustainability and climate initiatives, from early-stage design and stakeholder alignment through to implementation, monitoring, and verification. His work spans nature-based solutions, clean energy systems, industrial decarbonisation, and complex supply-chain interventions across Europe, Africa, and emerging market

Under his leadership, Kyoto Network has developed and supported a multi-billion-dollar global project pipeline, working with corporates, investors, and public-sector counterparts on programmes operating at national, regional, and landscape scale, including engagement with governments and public agencies on policy-aligned project development and climate finance structures.

Sheraz's perspective is grounded in execution and systems integration. His direct experience of delivering projects and aligning outcomes with corporate disclosures, investor expectations, and public-sector frameworks has shaped the development of the Supply Chain Emissions Reduction Method (SCERM©) and its emphasis on attribution, verification, and disclosure usability.

Abstract

The Supply Chain Emission Reduction Method (SCERM©) User Manual provides a comprehensive, step-by-step framework for corporations to transform supply chain decarbonization from an abstract commitment into a source of verifiable, investment-grade assets. As regulatory pressures from frameworks like the CSRD, IFRS S2, and the SEC intensify, and with Scope 3 emissions constituting the vast majority of most corporate carbon footprints, the need for a rigorous implementation methodology has never been greater.

This manual moves beyond traditional carbon accounting and insetting theory by detailing a seven-step process for creating auditable, attributable emission reductions. It guides the user through:

1. **Hotspot Assessment** to identify material supply chain interventions.
2. **Eligibility Screening** using a nine-point framework to ensure credibility.
3. **Attribution Modeling** to mathematically link project outcomes to corporate procurement.
4. **Implementation & Monitoring** using digital MRV (Measurement, Reporting, and Verification) technologies.
5. **Verification & Assurance** to secure third-party validation.
6. **Unified Data Records (RREs)** to create a single source of truth; and
7. **Disclosure Integration** to translate verified outcomes into strategic business value.

The methodology is grounded in real-world application, illustrated through two in-depth case studies: the **Great Gum Belt** agroforestry project in Sudan and the **KyoClean Green** biogas program in Kenya. These examples demonstrate how SCERM©'s principles are operationalized to generate both climate impact and tangible benefits for communities, suppliers, and corporate stakeholders. By providing a clear evidence trail from on-the-ground action to compliance-grade reporting, the SCERM© User Manual serves as

an essential guide for sustainability, finance, and procurement professionals seeking to build resilient, low-carbon, and value-creating supply chains.

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Chapter I. Introduction

1.1. Executive Summary: Why You Need This Manual

Supply chain emissions represent 75% of most companies' carbon footprint, yet fewer than 20% have auditable supplier-level data. The traditional approach of measuring, reporting, and hoping for improvement is failing.

This manual serves as the operational sequel to our foundational whitepaper, **SCERM©: Turning Voluntary Climate Action into Compliance Value**, translating the proprietary SCERM© framework from theory into a practical, step-by-step implementation guide for corporate practitioners.

Insetting— is an emerging strategy for corporations to reduce their Scope 3 greenhouse gas (GHG) emissions which often constitute over 80% of their total carbon footprint by financing and implementing emission reduction projects within their own value chains. This contrasts with offsetting, which relies on external, unrelated projects. Insetting offers a direct path to address the vast majority of its emissions while simultaneously building more resilient and sustainable supply chains.

Scope 3 emissions—indirect emissions from a company's value chain represent the vast majority of the carbon footprint for most corporations, particularly in sectors like food and agriculture. Effectively managing these emissions is not optional but essential for achieving global net-zero goals by 2050 and limiting warming to 1.5°C. The Science Based Targets initiative (SBTi) reports that 97% of companies with validated targets now include Scope 3, signalling a paradigm shift toward full value chain accountability.

The Supply Chain Emission Reduction Method (SCERM©)—developed by Kyoto Network, is a comprehensive consultancy and implementation framework designed to transform ambitious climate goals into tangible, investment-grade asset creation within your value chain. We move beyond simple carbon accounting to actively de-risk, finance, and execute the decarbonization of your most material Scope 3 emissions. SCERM© has emerged as a

way for businesses to address climate risk and to deliver against their climate goals, whilst creating positive benefits for nature and transitioning to more sustainable and resilient business models.

SCERM© is not a passive standard but an active partnership. We provide the strategic direction, technical rigor, and investment framework to help you invest directly into your supply chain, turning suppliers into partners in resilience and creating verifiable, compliance-ready emission reductions. SCERM© aims to create carbon removals and emissions reductions in agricultural supply chains, mostly through nature-based solutions such as agroforestry, reforestation and regenerative agriculture. Other interventions also involve energy and community activities that aim to improve livelihoods and reduce pressures on natural resources, such as introducing clean cookstoves. Scope 3 reduction mitigation projects can be implemented on farms, in communities or in adjacent landscapes.

Unlike carbon offsets or traditional insetting, SCERM© establishes clear attribution logic, rigorous verification protocols, and seamless integration with corporate reporting systems. This manual walks you through every step, from initial assessment through verification and reporting, with industry-specific guidance, templates, and real-world examples.

1.2. SCERM© Process Flow & Implementation Manual

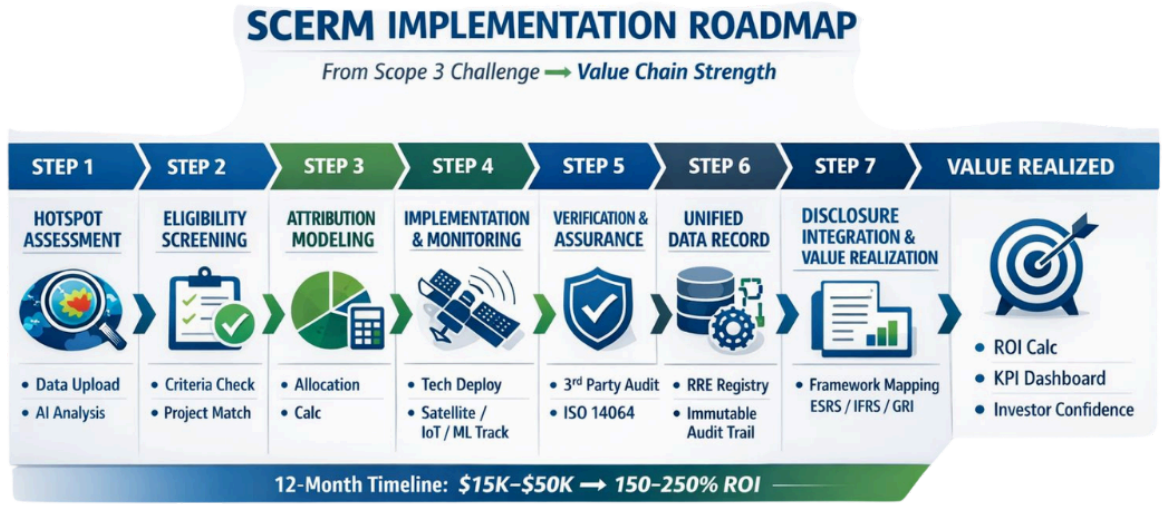


Fig 1: Complete Process Flow Diagram

1.3. Who Should Use This Manual

Primary Users:

- Corporate Sustainability Teams - For implementing and managing SCERM© programs
- Supply Chain & Procurement Managers - For supplier engagement and intervention design
- Finance & Risk Teams - For integrating outcomes into reporting and risk management
- ESG Reporting Specialists - For disclosure preparation and audit support

Secondary Users:

- Suppliers & Producers - Understanding how to participate in buyer-led programs
- Investors & Lenders - Evaluating the credibility of corporate transition claims
- Auditors & Verifiers - Understanding SCERM© evidence requirements
- Consultants & Advisors - Supporting client implementation

1.4. How SCERM© Differs from Traditional Approaches

Table 1: SCERM© vs. Traditional Scope 3 Approaches

Traditional Approach	**SCERM© Approach**
Reactive: Measuring emissions after they occur	Proactive: Designing reductions into supply chain operations
Generic: Using industry averages and estimates	Specific: Actual measurement tied to your suppliers
Isolated: Sustainability team owns the problem	Integrated: Procurement, finance, and operations collaborate
Narrative-based: Qualitative claims about progress	Evidence-based: Quantified, verified outcomes
Annual: Static reporting once per year	Continuous: Ongoing monitoring and improvement
Cost Center: Sustainability as expense	Value Creator: Risk reduction, resilience, and compliance

Chapter II. Step 1: Hotspot Assessment

2.1. Executive Summary: The Foundation of SCERM©

The first step in the SCERM© methodology transforms overwhelming Scope 3 complexity into actionable intelligence. Rather than attempting to measure everything perfectly, we identify where intervention will create the most value both environmentally and financially. This section provides the complete framework for conducting a targeted hotspot assessment that yields clear, attribution-ready opportunities.

Box 1.

Key Principle: Measure what matters, not everything.
Primary Outcome: A prioritized list of SCERM©-eligible intervention opportunities with clear ROI projections.

2.2. The Scope 3 Reality Check

Most organizations face a paradox: 70-90% of their emissions occur in their supply chains (Scope 3), but they typically have reliable data for only 10-20% of these emissions. The traditional approach of trying to measure everything perfectly before acting creates analysis paralysis and delays meaningful reduction.

SCERM©'s Alternative Approach:

1. Accept Imperfect Data initially—estimate what you must, measure what you can
2. Focus on Materiality—the 20% of suppliers that create 80% of emissions
3. Prioritize Actionability—where you have influence and opportunity
4. Iterate Toward Accuracy—start with estimates, improve with implementation

2.3. The Three-Layer Hotspot Analysis

We analyse supply chain emissions through three distinct lenses:

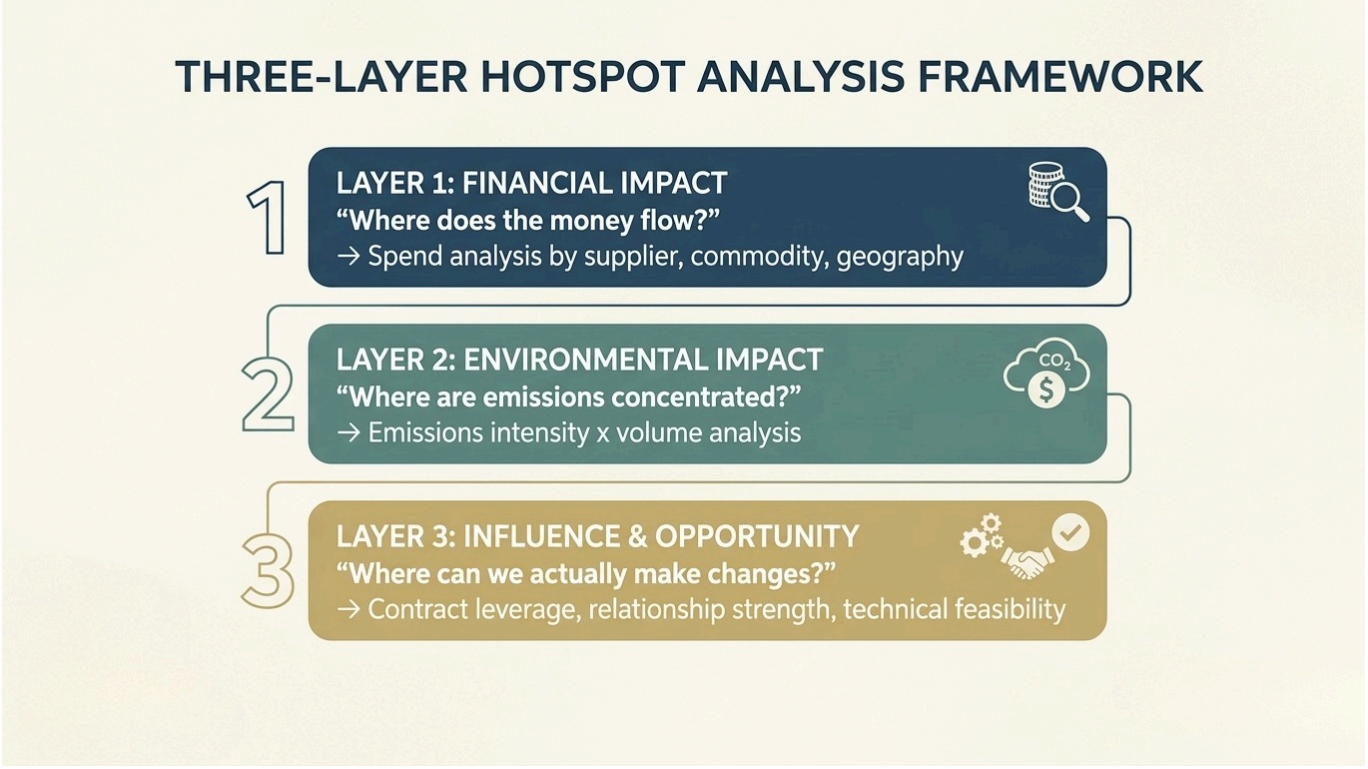


Figure 1: Three-layer hotspot analysis

Box 2:

The 3-Question Hotspot Analysis Framework

Question 1: Where Do We Spend Money?

Purpose: Identify financial concentration points in your supply chain. The Pareto Principle (80/20 rule) typically applies: 20% of suppliers account for 80% of spend.

How:

1. **Export spend data from your ERP**
2. **Sort suppliers by total spend (last year)**
3. **Highlight top 20% (they're likely 80% of your problem)**

Question 2: Where Is Emissions Concentration?

Purpose: Identify where emissions are concentrated in your supply chain, using the best available data from precise measurements to educated estimates.

How:

1. **Use simple emission factors**
2. **List suppliers by estimated emissions**
3. **Normalize emissions to 1-10 scale**

Question 3: Where Can We Actually Make Changes?

Purpose: Assess practical influence over suppliers to identify where interventions are feasible and likely to succeed.

How:

- **Rate each supplier 1-10 on:**
- **Contract terms: Long-term = high score**
- **Relationship: Strategic partner = high score**
- **Size: You're their big customer = high score**

Question 4: what is Estimate reduction potential (1-10):

- **Easy fixes available = 8-10 points**
- **Some options = 5-7 points**
- **Hard to change = 1-4 points**

2.4. Hotspot Scoring Formula

The Complete Formula:

$$Hotspot\ Score\ =\ (Emissions\ Magnitude \times 0.4)\ +\ (Supplier\ Influence \times 0.3)\ +\ (Reduction\ Potential \times 0.3)$$

The Hotspot Assessment & Data Integration phase provides the critical foundation for SCERM© implementation. By focusing on material emissions where you have influence and opportunity, you create a targeted, actionable roadmap for supply chain decarbonization.

2.5. Key Deliverables from Step 1:

1. Prioritized Supplier List: Clear identification of SCERM©-eligible opportunities
2. Comprehensive Data Foundation: Integrated financial, operational, and emissions data
3. Stakeholder Alignment: Shared understanding of priorities and opportunities
4. Implementation Roadmap: Clear path forward with estimated ROI

Next Steps:
With your hotspot analysis complete, you can now proceed to Step 2: Eligibility Screening, where you'll apply SCERM©'s rigorous criteria to determine which interventions can generate verifiable, attributable outcomes suitable for corporate disclosure.

Chapter III. SCERM© Step 2: Eligibility Screening

3.1. Check If Your Hotspots Can Become Verified Reductions

This section establishes the formal eligibility screening framework of the Supply Chain Emission Reduction Method (SCERM©), a critical gatekeeping mechanism that distinguishes disclosure-grade supply chain interventions from conventional sustainability initiatives. By establishing nine rigorous criteria grounded in financial materiality, environmental integrity, and attributional defensibility, SCERM© creates a standardized protocol for determining which supply chain interventions can generate verifiable, attributable outcomes suitable for corporate reporting under evolving regulatory frameworks including CSRD/ESRS, IFRS S1/S2, CDP and GRI climate disclosure requirements. The framework addresses the fundamental challenge of converting real-world sustainability actions into audit-ready evidentiary assets, thereby bridging the persistent gap between supply chain decarbonization efforts and credible corporate climate disclosures.

Box 3:

The Eligibility Imperative in Scope 3 Decarbonization

The Scope 3 Credibility Gap

The proliferation of corporate net-zero commitments has exposed a critical methodological void: while organizations increasingly invest in supply chain decarbonization initiatives, the majority lack standardized protocols to convert these investments into verifiable, attributable outcomes for disclosure purposes. Current approaches suffer from three systemic limitations:

1. **Methodological Ambiguity: Interventions lack consistent evaluation criteria, resulting in heterogeneous quality and credibility**
2. **Attributional Weakness: Insufficient linkage between project outcomes and specific corporate value chain exposures**
3. **Evidentiary Deficiencies: Inadequate documentation and verification structures to support regulatory and investor scrutiny**

The SCERM© eligibility framework addresses these limitations by establishing a formal gatekeeping mechanism that ensures only interventions with demonstrable attribution pathways, measurable outcomes, and disclosure-ready evidence structures proceed

through the methodology.

3.2. The eligibility criteria are grounded in four foundational principles:

Principle 1: Materiality-Based Screening
Only interventions addressing material Scope 3 exposures typically >1% of total Scope 3 inventory or aligned with significant transition risks qualify, ensuring efficient allocation of verification resources and alignment with financial materiality thresholds.

Principle 2: Attributional Integrity
Clear, defensible mathematical linkage must exist between intervention outcomes and specific corporate procurement exposures, preventing ambiguous or overlapping claims.

Principle 3: Evidentiary Completeness
Interventions must generate documentation meeting audit and assurance standards, with transparent methodologies, reproducible calculations, and verifiable monitoring data.

Principle 4: Additionally and Non-Duplication
Outcomes must demonstrate causality with corporate intervention and avoid multiple accounting across corporate inventories, carbon markets, or supplier disclosures.

3.3. The Nine-Point Eligibility Framework

Criterion 1: Value-Chain Position Verification

Definition: The intervention must occur within the reporting company's organizational or operational boundaries as defined by the GHG Protocol Corporate Value Chain Scope 3 Standard.

Methodological Requirements:

- Documentation of direct procurement relationship e.g. contracts, purchase orders, invoices
- Geographical or commodity-based linkage where direct procurement relationships are indirect
- Clear mapping to specific Scope 3 categories -Categories 1-15 under GHG Protocol scope 3 standards

Verification Evidence Required:

- Supplier identification and tier mapping
- Procurement volume documentation

- Contractual terms demonstrating influence or control
- Supply chain traceability records

Exclusionary Conditions:

- Projects outside the corporate value chain boundary
- Interventions with indirect or speculative linkage to procurement activities
- Activities occurring in unrelated sectors or geographies without defensible attribution pathways

Criterion 2: Material Scope 3 Exposure

Definition: The intervention must address greenhouse gas emission sources, sinks, or risks that constitute material exposure within the corporate Scope 3 inventory.

Quantitative Thresholds:

- Primary Threshold: >1% of total corporate Scope 3 emissions
- Secondary Threshold: High emissions intensity relative to spend >90th percentile within procurement portfolio
- Tertiary Threshold: Strategic importance due to regulatory, reputational, or transition risk considerations

Assessment Methodology:

$$Materiality\ Score\ = (Emissions\ Magnitude\ \times 0.4)\ +\ (Transition\ Risk \times 0.3\ )\ +\ (Strategic\ Importance\ \times 0.3)$$

Where:

- *Emissions Magnitude* = % of total Scope 3 emissions
- *Transition Risk* = Regulatory, physical, or market transition exposure
- *Strategic Importance* = Procurement dependence, supplier concentration, or brand impact

Documentation Requirements:

- Scope 3 emissions calculations with uncertainty ranges
- Risk assessment documentation
- Procurement strategy alignment statements
- Stakeholder materiality assessment where applicable

Criterion 3: Measurable Outcomes Protocol

Definition: Intervention outcomes must be quantifiable using recognized measurement methodologies with established measurement, monitoring, reporting, and verification (MMRV) protocols.

Measurement Standards Hierarchy:

1. Primary Standards: ISO 14064-2, GHG Protocol Project Standard scope 3
2. Sector-Specific Protocols: IPCC Guidelines
3. Technology-Specific Methods: Remote sensing protocols, IoT measurement standards
4. Proprietary Methods: AI & ML tools for accuracy of estimation, blockchain for immutable data and dashboard platforms

Monitoring Requirements:

- Frequency: Appropriate to intervention type and outcome variability
- Duration: Minimum 3-year monitoring for most interventions, 10+ years for carbon removal
- Quality Assurance: Calibration records, data validation procedures, uncertainty quantification

Outcome Quantification:

$$Quantified\ Outcome\ =\ Baseline\ Emissions\ -\ Project\ Emissions \pm Leakage\ Adjustments \pm Uncertainty\ Buffer$$

Where uncertainty must be ≤30% for disclosure use, ≤15% for high-assurance applications

Criterion 4: Additionality Determination

Definition: The greenhouse gas outcome (reduction or removal) would not have occurred in the absence of the specific corporate intervention, requiring assessment against regulatory, financial, and technological baselines.

Additionality Tests:

1. Regulatory Test: Intervention exceeds legal or regulatory requirements
2. Financial Test: Lacks financial viability without corporate support (IRR < hurdle rate)
3. Technological Test: Employs technologies or practices not commonly deployed in the sector/region
4. Timing Test: Accelerates implementation beyond business-as-usual schedules

Assessment Methodology:

$$Additionality\ Confidence\ Level\ =\ f(Regulatory\ Gap,\ Financial\ Gap,\ Technological\ Gap,\ Implementation\ Gap)$$

GAP = Business-As-Usual Barrier Level 0 = No barrier (would happen anyway) 3 = Major barrier (unlikely without intervention) Minimum total score ≥6/12 = SCERM©-eligible

Documentation Requirements:

- Regulatory compliance analysis
- Financial modeling with and without intervention
- Technology adoption baselines
- Implementation timing analysis

Criterion 5: Non-Duplication Safeguards

Definition: Mechanisms must prevent the same tonne of CO_2e (or equivalent outcome unit) from being counted by multiple entities or within multiple accounting frameworks.

Prevention Mechanisms:

1. Registry Systems: Centralized or distributed ledger tracking of claims
2. Contractual Provisions: Explicit prohibition of double claiming in supplier agreements
3. Attribution Rules: Clear mathematical allocation preventing overlapping claims
4. Verification Protocols: Third-party verification of exclusive claim rights

Implementation Requirements:

- Supplier attestation of non-duplication
- Registry checks (Gold Standard, Verra, national registries)
- Contractual language establishing exclusive claim rights
- Periodic verification of continued exclusivity

Criterion 6: Defensible Attribution Logic

Definition: Transparent, mathematically sound allocation of project-level outcomes to specific corporate procurement exposures, following conservative principles and documented assumptions.

Allocation Methodologies:

Method A: Volume-Based Attribution

$$Corporate\ Allocation\ =\ Project\ Outcome \times (Corporate\ Procurement\ Volume\ /\ Total\ Relevant\ Output\ Volume)$$

Application: Homogeneous commodities with measurable output

Method B: Economic Value Attribution

$$Corporate\ Allocation\ =\ Project\ Outcome \times (Corporate\ Procurement\ Value\ /\ Total\ Output\ Value)$$

Application: Heterogeneous products, shared facilities

Method C: Risk-Weighted Attribution

$$Corporate\ Allocation\ =\ Project\ Outcome \times \Sigma(Risk\ Factor\_i \times Weight\_i)$$

Application: Complex value chains with multiple influence dimensions

Method D: Geographic Attribution

$$Corporate\ Allocation\ =\ Project\ Outcome \times (Corporate\ Sourcing\ from\ Region\ /\ Total\ Production\ in\ Region)$$

Application*:* Landscape or jurisdictional approaches

Documentation Requirements:

- Mathematical formulation with variable definitions
- Data sources and quality assessments
- Sensitivity analysis of allocation choices
- Justification of methodology selection
- Conservative adjustment factors where uncertainty exists

Criterion 7: Strategic Alignment Assessment

Definition**:** The intervention should address priority emission sources, commodity risks, or supplier relationships critical to the company's transition strategy and long-term value creation.

Alignment Dimensions:

1. Transition Plan Integration: Direct contribution to disclosed transition pathways
2. Supply Chain Resilience: Mitigation of identified physical or transition risks
3. Competitive Positioning: Enhancement of market differentiation or customer value propositions
4. Innovation Pathways: Support for emerging technologies or business models

Scoring Framework:

$$Strategic\ Alignment\ Score\ =\ \Sigma(Dimension\ Score\_i \times Weight\_i)$$

Where weights are determined by corporate strategy and stakeholder priorities

Minimum score threshold: 7/10 for eligibility

Assessment Documentation:

- Transition plan cross-reference
- Risk register alignment
- Competitive analysis
- Stakeholder engagement records

Criterion 8: Disclosure-Grade Data Architecture

Definition: The intervention must generate structured, verifiable data suitable for integration into corporate reporting systems and capable of withstanding audit scrutiny under major disclosure frameworks.

Data Requirements by Framework:

CSRD/ESRS Compliance:

- ESRS E1-5 alignment for environmental data
- Double materiality assessment integration
- Audit trail for all material calculations
- Temporal consistency across reporting periods

IFRS S1/S2 Compliance:

- Connection to climate-related risks and opportunities
- Support for scenario analysis inputs
- Integration with financial reporting timelines
- Assurance-ready documentation

SEC Climate Disclosure:

- Materiality determination documentation
- GHG inventory integration
- Risk factor alignment

- Governance and oversight records

Technical Specifications:

- Data format: Structured (JSON, XML) with schema validation
- Metadata: Complete provenance, methodology, uncertainty
- Storage: Immutable records with access logging
- Security: Encryption, access controls, backup protocols

Criterion 9: Permanence and Risk Mitigation Protocols (where applicable)

Definition: For carbon removal or sequestration interventions, robust mechanisms must address and mitigate risks of reversal over relevant time horizons.

Risk Assessment Categories:

1. Physical Risks: Fire, pestilence, extreme weather, land-use change
2. Sociopolitical Risks: Policy changes, land tenure disputes, community conflicts
3. Financial Risks: Insolvency, changing economic conditions
4. Methodological Risks: Measurement errors, baseline uncertainties

Mitigation Requirements:

Buffer Provisions:

- Minimum 20% withholding of credited outcomes
- Tiered buffer based on risk assessment (20-50%)
- Dynamic buffer adjustment based on monitoring results

Insurance and Guarantees:

- Third-party insurance for catastrophic reversals
- Financial guarantees or bonds
- Reserve funds for maintenance and monitoring

Monitoring Duration:

- Minimum 30 years for forestry projects
- Minimum 10 years for soil carbon projects

- Project-specific for engineered solutions

Documentation:

- Risk assessment report
- Buffer calculation methodology
- Insurance policies or guarantees
- Long-term monitoring and maintenance plan

3.4. Case Study Applications

Case A: Regenerative Agriculture Program (Food & Beverage)

Intervention: Transition of 10,000 hectares to regenerative practices in corn supply chain

Eligibility Assessment:

- Criterion 1: Direct procurement relationship with 15 farming cooperatives
- Criterion 2: 8,500 tCO_2e/year reduction potential (3.2% of total Scope 3)
- Criterion 3: Soil carbon measurement via ISO 14064-2 with 25% uncertainty
- Criterion 4: Financial analysis shows negative NPV without premium payments
- Criterion 5: Contractual exclusivity for carbon claims
- Criterion 6: Volume-based attribution (25% of crop output)
- Criterion 7: Addresses 30% of agricultural emissions in transition plan
- Criterion 8: Data structure compatible with CSRD and IFRS reporting
- Criterion 9: 20% buffer for 20-year monitoring period

Determination: Eligible with conditions (strengthen monitoring protocol)

Case B: Biogas Energy Generation (Agriculture/Manufacturing)

Intervention: $3.2M investment in biogas plant converting agricultural waste to renewable energy at corn processing supplier

Eligibility Assessment:

- Criterion 1: Tier 1 supplier with $42M annual procurement of corn derivatives
- Criterion 2: 15,000 tCO_2e/year reduction (5.1% of Scope 3 Category 1 & 3)
- Criterion 3: Continuous methane monitoring with 10% uncertainty
- Criterion 4: Exceeds Clean Air Act requirements by 60% through methane capture and destruction

- Criterion 5: Exclusive carbon claim rights for 70% of biogas output (30% reserved for supplier's Scope 1 reduction)
- Criterion 6: Economic value attribution (22% of supplier's processing revenue)
- Criterion 7: Addresses both agricultural methane and fossil fuel displacement in processing
- Criterion 8: EPA (U.S. Environmental Protection Agency (EPA) compliant monitoring data with hourly reporting, ready for RFS2 (Renewable Fuel Standard) certification
- Criterion 9: Not applicable (methane destruction with 99.9% destruction efficiency)

Determination: highly eligible

Case C: Waste-to-Value Material Recovery (Consumer Goods)

Intervention: $2.8M investment in plastic chemical recycling facility at packaging supplier

Eligibility Assessment:

- Criterion 1: Tier 1 packaging supplier with $28M annual procurement
- Criterion 2: 9,200 tCO_2e/year reduction (2.7% of Scope 3, plus circular economy benefits)
- Criterion 3: Mass balance tracking with 15% uncertainty (ISCC PLUS methodology)
- Criterion 4: Exceeds EU packaging waste directive by achieving 65% recycled content vs. 30% required
- Criterion 5: Exclusive claim rights for recycled-content attribution in purchased materials
- Criterion 6: Volume-based attribution with quality premium (40% of facility output)
- Criterion 7: Addresses plastic packaging waste, a material ESG concern for the brand
- Criterion 8: Chain-of-custody documentation meeting ISCC & GRACE (Global Recycled Standard and CE) requirements
- Criterion 9: Not applicable (avoided virgin material production, not carbon removal)

Determination: highly eligible

Case D: Landscape Restoration (Consumer Goods)

Intervention: $5M investment in watershed restoration in sourcing region

Eligibility Assessment:

- Criterion 1: Indirect linkage through regional sourcing (conditional)
- Criterion 2: 15,000 tCO_2e/year removal (2.1% of Scope 3)
- Criterion 3: IPCC Tier 2 methodology with remote sensing validation
- Criterion 4: No regulatory requirements for restoration
- Criterion 5: Risk of double counting with other buyers
- Criterion 6: Geographic attribution challenged by supply chain complexity
- Criterion 7: High strategic importance for water security
- Criterion 8: Strong monitoring and data protocols
- Criterion 9: 30% buffer with 30-year monitoring

Determination: Not eligible (fails criteria 1,4, 5, 6)

3.5. Conclusion: Advancing Methodological Rigor in Supply Chain Decarbonization

The SCERM© eligibility framework represents a systematic approach to addressing the credibility challenges inherent in supply chain emission reduction claims. By establishing clear, defensible criteria grounded in existing standards while addressing specific gaps in value chain attribution, the framework enables organizations to:

1. Distinguish credible interventions from aspirational or non-verifiable activities
2. Allocate resources efficiently to high-impact, defensible projects
3. Generate audit-ready evidence for evolving regulatory requirements
4. Build investor confidence through transparent, methodological approaches
5. Drive real emissions reductions while maintaining methodological integrity

The framework's modular design allows for sector-specific adaptations while maintaining core principles of attributional integrity, measurement accuracy, and evidentiary completeness. As regulatory landscapes evolve and stakeholder expectations increase, such methodological rigor becomes increasingly critical for organizations seeking to convert supply chain sustainability investments into credible climate transition progress.

Chapter IV. Step 3: Attribution Modeling

4.1. What What Attribution Modeling Is

Attribution modeling answers the fundamental question: "Of the total emission reductions achieved, what portion rightfully belongs to us?"

This isn't about physical ownership of emissions, it's about creating a defensible mathematical link between your procurement activities and the verified reductions happening in your supply chain.

Box 4:

Why This Matters:

- **Avoids Greenwashing: Prevents over-claiming or vague "we supported this project" statements**
- **Enables Auditability: Creates clear mathematical basis for auditors to verify**
- **Supports Multiple Buyers: Allows several companies to share credit from the same intervention**
- **Creates Defensible Disclosures: Your Scope 3 reduction claims withstand investor scrutiny**

The Four Attribution Models

4.2. Volume-Based Attribution (Most Common)

Best for: Agricultural commodities, raw materials, homogeneous products

Formula:

$$Your\ Attribution\ =\ Total\ Project\ Reduction \times (Your\ Purchase\ Volume \div Total\ Production\ Volume)$$

E.g. - Total palm oil production at mill: 10,000 tons/year
Your purchase: 2,500 tons/year (25%)
Total emission reduction from biogas project: 8,000 tCO_2e/year

$$Your\ Attribution\ =\ 8,000 \times (2,500 \div 10,000)\ =\ 2,000\ tCO_2e/year$$

When to Use It:

- When you can track physical volumes
- When products are identical/commoditized
- When procurement volumes are stable

Paper Trail Required:

- Purchase orders and invoices
- Weight tickets or delivery notes
- Production reports from supplier

4.3. Economic Value Attribution

Best for: Manufactured goods, electronics, diverse product portfolios

Formula:

$$Your\ Attribution\ =\ Total\ Project\ Reduction \times (Your\ Purchase\ Value \div Total\ Facility\ Revenue)$$

Example: Supplier's total revenue: $100M/year

Your purchases: $15M/year (15%)

Total emission reduction from efficiency project: 12,000 tCO_2e/year

$$Your\ Attribution\ =\ 12,000 \times (\$15M \div \$100M)\ =\ 1,800\ tCO_2e/year$$

When to Use It:

- When products vary in value/complexity
- When financial data is more reliable than volume data
- When you purchase multiple product lines from same facility

Paper Trail Required:

- Supplier financial statements (or relevant portions)
- Your procurement spend data
- Price lists and product catalogs

4.4. Risk-Weighted Attribution

Best for: Strategic suppliers, critical materials, long-term partnerships

Formula:

Your Attribution = Total Project Reduction × Σ(Risk Factor Weight × Score)

Risk Factors: Contract duration, volume commitment, geographic concentration, alternatives

Example Calculation: Risk Factors (weights in parentheses):

- Contract Length: 5-year contract (40% weight, score 0.9)
- Volume Commitment: 60% of capacity (30% weight, score 0.6)
- Geographic Risk: Single-source region (20% weight, score 0.8)
- Alternative Suppliers: Limited options (10% weight, score 0.7)

$$Weighted\ Score\ =\ (0.4{\times}0.9)\ +\ (0.3{\times}0.6)\ +\ (0.2{\times}0.8)\ +\ (0.1{\times}0.7)\ =\ 0.77$$

$$Your\ Attribution\ =\ 10,000\ tCO_2e \times 0.77\ =\ 7,700\ tCO_2e$$

When to Use It:

- When business risk exposure matters more than pure volume
- When building strategic supplier partnerships
- When addressing supply chain resilience

Paper Trail Required:

- Risk assessment documentation
- Contract terms and conditions
- Supplier diversification analysis

4.5. Geographic Attribution

Best for: Landscape programs, regional initiatives, watershed projects

Formula:

$$Your\ Attribution\ =\ Total\ Project\ Reduction \times (Your\ Sourcing\ from\ Region \div Total\ Production\ in\ Region)$$

Example: Total cocoa production in Ghana region: 50,000 tons/year

Your sourcing from that region: 8,000 tons/year (16%)

Total emission reduction from reforestation: 15,000 tCO_2e/year

$$Your\ Attribution\ =\ 15,000 \times (8,000 \div 50,000)\ =\ 2,400\ tCO_2e/year$$

When to Use It:

- When you can trace materials to specific regions
- When participating in landscape/collaborative programs
- When addressing deforestation or water risks

Paper Trail Required:

- Supply chain traceability records
- Geographic sourcing maps
- Certificates of origin

4.6. Creating Your Proof of Linkage (PoL)

The PoL Document Must Include:

Section 1: Attribution Model Selection

- Why you chose this model (volume/economic/risk/geographic)
- Alternatives considered and rejected
- Stakeholder agreement on approach

Section 2: Data Sources & Quality

- Where the numbers come from
- Data validation procedures
- Uncertainty estimates
- Update frequency

Section 3: Calculation Worksheets

- Step-by-step mathematics
- All assumptions documented
- Sensitivity analysis (what if numbers change?)

Section 4: Audit Trail

- Version history of calculations
- Change log with justifications
- Sign-off by relevant departments

Simple PoL Template:

PROOF OF LINKAGE - ATTRIBUTION MODEL

Project: [Name]

Supplier: [Name]

Model Selected: Volume-Based Attribution

Calculation:

Your Purchase Volume: $[X]\ tons$

Total Production Volume: $[Y]\ tons$

Your Share: $X \div Y\ =\ [Z]\%$

Total Project Reduction:$[A]\ tCO_2e$

Your Attribution: $A \times Z\ =\ [B]\ tCO_2e$

Chapter V. Step 4: Implementation & Monitoring: From Intervention to Live Impact

5.1. What: Deploy interventions with real-time tracking

Implementation is the critical phase where SCERM©-aligned supply-chain interventions transition from planning to physical execution, supported by integrated technology systems and globally recognized standards that ensure full traceability, methodological integrity, and accountability. Real-time tracking captures granular data from regenerative agricultural practices and clean energy adoption to material efficiency and fuel switching validating each action against ISO-certified monitoring protocols and seamlessly linking its impact to specific corporate value chains from the outset. This creates an unbroken digital thread between on-the-ground activities and corporate disclosure requirements, transforming sustainability initiatives into auditable, decision-useful assets recognized under leading carbon accounting and certification frameworks.

How: Supplier onboarding → Technology deployment → Continuous monitoring

5.2. Supplier Onboarding & Enablement

1. Collaborative Portals: Centralized digital platforms provide suppliers with secure access to SCERM© training modules, data input interfaces, and performance feedback loops. These portals are designed to align with ISCC (International Sustainability and Carbon Certification) traceability requirements, enabling chain-of-custody documentation and mass-balance accounting for sustainable commodities. Training includes GHG Protocol Scope 3 Standard guidance to ensure consistent emission boundary setting and reporting alignment across the value chain.

2. Capacity Building: Structured capacity-building programs including virtual workshops, on-site technical assistance, and detailed implementation toolkits empower suppliers of all sizes and capabilities to engage effectively. Training focuses on SCERM© monitoring protocols, data integrity requirements, and the use of deployed technologies, referencing ISO 14064-3 for verification principles and IPCC (Intergovernmental Panel on Climate Change) emission factor databases for accurate activity data conversion, lowering the barrier to entry and fostering a partnership-based approach to emissions reduction.

3. Contractual Integration: SCERM©-specific clauses and appendices are embedded within procurement agreements and supplier codes of conduct. These clauses formally define data-sharing obligations, intervention commitments, confidentiality terms, and the framework for attributing verified outcomes to the buyer's Scope 3 inventory, creating a binding foundation for collaboration and accountability. Requirements are benchmarked against ISCC EU and PLUS certification schemas for sustainable feedstocks and GHG Protocol Corporate Value Chain (Scope 3) Standard for attribution and reporting consistency.

5.3. Technology Deployment & Integration

1. IoT & Sensor Networks: A suite of Internet of Things (IoT) devices and sensors is deployed at supplier sites to autonomously monitor key environmental and operational parameters. This includes smart meters for energy and fuel consumption, methane detectors, soil moisture and carbon sensors, and water flow monitors. Devices are calibrated and validated according to ISO 14064-2 requirements for project-level monitoring plans, and data streams are structured to support IPCC Tier 2 and Tier 3 methodological approaches for higher-accuracy emission quantification. Data is transmitted securely to the SCERM© platform, providing a continuous, high-frequency stream of primary data that replaces estimates and proxies.

2. Satellite & Geospatial Monitoring: For landscape-scale interventions such as reforestation, afforestation, or avoided deforestation, satellite imagery (e.g., from Sentinel-2, Landsat) and geospatial analytics are employed. These tools provide objective, wide-area surveillance to verify land-use practices, track biomass growth, and detect deforestation alerts, offering tamper-proof evidence for nature-based project outcomes. Methodologies align with IPCC Guidelines for National Greenhouse Gas Inventories (2006) and 2019 Refinement for Agriculture, Forestry and Other Land Use (AFOLU), and support ISCC geospatial monitoring requirements for no-deforestation compliance.

3. Mobile Data Collection Apps: In regions with limited connectivity or for smaller-scale suppliers, lightweight mobile applications enable offline data collection. Suppliers can log activities, upload photos of practices e.g., no-till farming, renewable energy installations, and record meter readings. App design incorporates GHG Protocol's Mobile Data Collection

Guidance and ISO 14064-1 principles for data management control, ensuring collected information meets audit-ready standards. Data is stored locally and automatically synced to the central SCERM© database when connectivity is restored, ensuring inclusivity and comprehensive data coverage.

4. ERP & Procurement System Links: Application Programming Interface (API) connections are established between the SCERM© data platform and the corporation's Enterprise Resource Planning (ERP) and procurement systems. This integration ensures that sustainability performance data e.g., emission intensity per supplier, per material flows directly into sourcing decisions, contract renewals, and supplier scorecards, aligning procurement strategy with verified climate performance. Data mapping follows GHG Protocol's Scope 3 Category definitions and ISCC mass balance chain-of-custody models to maintain traceability through corporate systems.

5.4. Continuous Monitoring & Data Validation

1. Automated Data Pipelines: Incoming data from all sources feeds into automated validation pipelines. Rule-based algorithms and AI-driven anomaly detection check for data completeness, temporal consistency, and outliers e.g., an implausible sudden drop in energy use. Validation rules are built on IPCC uncertainty assessment frameworks and ISO 14064-1 requirements for data quality management. Flagged discrepancies trigger automated queries for clarification or correction, maintaining a high-integrity data foundation suitable for third-party assurance.

2. Supplier Performance Dashboards: Interactive, role-based dashboards provide live visibility into the progress and impact of each intervention. Corporate sustainability managers can view aggregated metrics total tCO_2e reduced, while procurement teams can drill down to supplier-specific performance, including emission reductions, progress against targets, and associated risk indicators. Dashboard metrics are calculated using GHG Protocol-approved equations and can be filtered by ISCC-certified vs. non-certified material streams, providing clear insight into certified sustainable sourcing performance.

3. Alert Systems: Configurable alert systems notify relevant stakeholders of critical events. Alerts may signal supplier underperformance against agreed benchmarks, emerging data gaps that could jeopardize verification, or milestones indicating that an intervention is ready

for independent verification. Alert thresholds are calibrated using ISO 14064-3 materiality guidance and IPCC good practice guidance for uncertainty management, enabling proactive management and timely support that maintains methodological rigor.

Output: Live impact dashboard with verified outcomes

5.5. SCERM© Impact Dashboard

This centralized command center delivers a real-time, holistic view of supply-chain decarbonisation performance. It visualizes:

1. Real-time metrics: Live feeds of key performance indicators such as tonnes of CO_2 equivalent reduced (calculated per GHG Protocol and IPCC GWP values), hectares under regenerative management, gigawatt-hours of renewable energy generated, and water savings.
2. Supplier-level and aggregate performance: Comparative analytics across the supplier base, highlighting leaders and identifying areas needing engagement or support. Data views can be filtered by ISCC certification status and ISO 14064 verification level.
3. Verification status and audit trails: Clear indication of which datasets have undergone third-party verification against ISO 14064-3 or ISCC assurance standards, with direct links to the associated Verification Report Statements (VRS) and immutable audit logs documenting every data transaction.
4. Projected vs. actual impact trends: Dynamic charts comparing forecasted reductions from intervention models against actual monitored outcomes, enabling continuous improvement of projection methodologies. Models reference IPCC baseline scenarios and GHG Protocol projection guidelines for consistency.

5.6. Verified Outcome Records

The culmination of the monitoring process is the generation of a SCERM© Recognised Reduction Entry (RRE). This is a standardized, digital asset for each verified outcome, containing:

1. Timestamped impact data: The final, verified quantitative outcome (e.g., 1,000 tCO_2e reduced in Q1 2026), calculated using GHG Protocol-compliant methods and IPCC emission factors.
2. Attribution logic: A transparent record of the applied allocation rule (e.g., "50% of project output attributed based on Company A's 20% procurement volume share"), documented per GHG Protocol Scope 3 Standard allocation requirements.
3. Verification status: A digital seal indicating the outcome has been verified by an accredited third party against ISO 14064-3 or ISCC audit protocols, referencing the VRS identifier.
4. Cryptographic hash (SHA-256): A unique digital fingerprint of the entire RRE, stored on a blockchain or in a cryptographically secure ledger. This hash ensures the record's immutability; any alteration would change the hash, immediately revealing tampering and preserving audit integrity as required by ISO 14064-1 documentation controls.

5.7. Disclosure-Ready Exports

The platform automatically formats verified RREs into standardized reports required by various stakeholders, with built-in compliance mapping:

1. Scope 3 inventory reporting: Data is structured according to GHG Protocol Scope 3 Standard categories e.g., Category 1: Purchased Goods & Services for direct inclusion in annual greenhouse gas inventories.
2. CSRD/ESRS filings: Outcomes are mapped to the relevant ESRS disclosure requirements e.g., E1-5 on climate change, with methodologies cross-referenced to IPCC guidelines and ISO standards to meet the European Sustainability Reporting Standards (ESRS) requirement for using "appropriate EU or internationally recognized standards."
    - Investor and lender disclosures: Tailored summaries and data packs are generated to demonstrate progress against transition plans and sustainability-linked financing KPIs, highlighting ISCC certification coverage and ISO-verified data streams for risk assurance.
    - Internal transition planning updates: Verified outcomes feed directly into internal strategy tools, updating transition pathway models and informing future capital allocation toward the most effective supply-chain interventions.

All data retains its GHG Protocol and IPCC methodological pedigree for internal governance and audit committees.

5.8. Illustrative Implementation Examples:

Example 1: Biogas Clean Energy Systems (East Africa)

- What: Deployment of anaerobic digesters at dairy cooperatives and agricultural processing facilities to convert organic waste into biogas, displacing fossil fuels and reducing methane emissions.
- How – Supplier Onboarding: Training workshops for farmers on feedstock management and digester operation, integrated with ISCC PLUS certification for sustainable biomass sourcing.
- Technology Deployment:
    - IoT methane sensors in digesters and storage tanks
    - Smart meters tracking biogas production and fossil fuel displacement
    - Mobile apps for smallholder farmers to log feedstock inputs
    - ISO 14064-2 monitoring plan for baseline and project scenarios
- Continuous Monitoring:
    - Real-time tracking of methane destruction efficiency (target: >90%)
    - Automated alerts for digester temperature or pressure anomalies
- Output:
    - Verified methane destruction: 15,000 tCO_2e/year
    - GHG Protocol Scope 3 Category 1 (Purchased Goods) attribution
    - Dashboard showing real-time biogas production vs. fossil fuel displacement
    - ISCC-certified sustainable feedstock chain-of-custody records

Chapter VI. Step 5: Verification & Assurance

6.1. From Verified Data to Audited Evidence

What: Independent validation of outcomes

Verification & Assurance is the critical credibility phase where SCERM©-monitored outcomes undergo independent, third-party validation to confirm their accuracy, completeness, and methodological integrity. This process transforms internally collected data into audit-ready, defensible evidence suitable for corporate disclosure, regulatory compliance, investor reporting, and transition planning. Independent verification ensures that every tonne of CO_2e claimed—whether from emission reductions, carbon removals, or avoided emissions—is real, additional, non-duplicated, and attributable according to SCERM©'s stringent eligibility and attribution rules.

How: Third-party verification → Audit trail completion → Certification

6.2. Third-Party Verification Engagement

1. Accredited Verifier Selection: SCERM© engagements employ ISO accredited verification bodies or ANSI-approved validation/verification bodies (VVBs) with specific sectoral expertise e.g., AFOLU, energy, waste. Verifiers are selected based global expertise in greenhouse gas verification and familiarity with GHG Protocol Scope 3 and Land Sector Guidance.
2. Verification Scope Definition: A verification plan is agreed upon, covering:
    - Data sampling strategy aligned with ISO 14064-3:2019 requirements for risk-based sampling and materiality thresholds.
    - Methodology audit confirming alignment with IPCC Guidelines, ISO 14064-2, and SCERM©-specific attribution protocols.
    - Evidence review of IoT streams, satellite analytics, farmer logs, and mass balance records against ISCC or Verified Carbon Standard (VCS) traceability requirements where applicable.
3. On-site & Remote Audits: Verifiers conduct:
    - Field visits to a representative sample of project sites e.g., biogas digesters, regenerative farms, forest conservation areas to inspect equipment, interview suppliers, and verify physical implementation.

- Desktop audits of digital records, automated pipelines, and the SCERM platform's audit trail, assessing compliance with ISO 14064-1 data management controls.

6.3. Audit Trail Completion & Integrity Assurance

- Immutable Evidence Linking: Every data point included in the verification is linked to its cryptographic hash (SHA-256) and timestamp from the SCERM© platform, creating an unbroken chain of custody from field measurement to final claim. This digital audit trail meets EU CSRD assurance requirements and IFRS S1/S2 evidence expectations.
- Attribution Review: Verifiers test the application of SCERM©'s attribution logic—such as mass allocation, procurement-based weighting, or geographic correlation—against GHG Protocol Scope 3 Standard's allocation principles to ensure outcomes are correctly assigned to the corporate inventory.
- Completeness & Duplication Checks: Verification includes screening against recognized registries and corporate disclosures to ensure no double counting across projects, organizations, or jurisdictional programs e.g., under Article 6 of the Paris Agreement.

6.4. Certification & Assurance Statement Issuance

1. Verification Report Statement (VRS) Drafting: The verification body produces a detailed SCERM© Verification Report Statement, which includes:
    - Opinion Statement Reasonable or Limited Assurance level
    - Quantified outcomes verified e.g., "12,500 tCO_2e reductions from biogas methane destruction in FY2026".
    - Scope and boundary description aligned with GHG Protocol corporate reporting categories.
    - Methodologies and standards used IPCC, ISO, SCERM©.
    - Qualifications or exclusions, if any.
2. Certification Integration: Where relevant, verification outcomes are cross-walked to voluntary certification schemes:
    - ISCC Certification for sustainable supply chain claims.
    - VCS or Gold Standard certification if outcomes are also intended for voluntary carbon market instruments under strict SCERM© non-double-claim controls.

3. Assurance Mapping for Disclosures: The VRS is explicitly mapped to the requirements of:
    - ESRS (CSRD) Assurance requirements under ESRS 2.
    - SEC Climate Disclosure (where applicable) for reasonable assurance of material Scope 3 data.
    - Transition Plan disclosures e.g. IFRS S2 to underpin forward-looking assumptions with verified historical progress.

6.5. Output: SCERM© Verification Report Statement (VRS)

1. **Legal Document:** A formally issued, signed, and dated assurance statement suitable for audit committees, regulatory filings, and investor due diligence.
2. **Digital & Physical Formats:**
    - Digitally signed PDF with embedded integrity hashes.
    - Structured data version (JSON/XML) for automated integration into ESG reporting platforms and annual reports.
    - Public-facing summary for stakeholder communication (where permitted).
3. **Linked to RREs:** Each VRS is cryptographically linked to the SCERM© Recognised Reduction Entries (RREs) it verifies, enabling instant evidence retrieval during financial or sustainability audits.

6.6. Industry Application Examples:

Example 1: Biogas Program Verification (East Africa)

- Third-Party Verification: An ISO 14065-accredited verifier conducts site visits to 20% of installed digesters, cross-checks IoT methane sensor data against manual meter readings, and reviews ISCC PLUS feedstock logs.
- Audit Trail Completion: The verifier validates the cryptographic chain of custody from farmer mobile app submissions → SCERM© platform → emission reduction calculation.
- Certification Output: A VRS attesting to 15,000 tCO_2e methane destruction, which is also used to support ISCC certification of the bio-CNG produced. The VRS is cited in the corporate ESRS E1.3 disclosure on energy consumption and GHG reductions.

Example 2: REDD+ Forest Conservation Assurance (Brazil)

- Third-Party Verification: A VCS-approved validator performs remote sensing analysis to confirm deforestation rates against the baseline, and ground-truths forest carbon plots using IPCC Tier 2 methodology.
- Audit Trail Completion: Satellite imagery hash values and community patrol logs are verified for consistency and tamper-proof continuity.
- Certification Output: A VRS providing reasonable assurance on 45,000 tCO_2e of avoided emissions, which also satisfies LEAF Coalition jurisdictional REDD+ requirements and informs CSRD E4 biodiversity and ecosystem disclosures.

Example 3: Regenerative Agriculture Outcomes Assurance (Africa)

- Third-Party Verification: An ANSI-accredited soil carbon verifier conducts stratified soil core sampling across participating farms, comparing SOC change against IPCC 2019 Refinement default values and modelled projections.
- Audit Trail Completion: Verifier confirms that practice adoption evidence satellite, sensor, farmer logs is complete and aligns with the GHG Protocol Land Sector eligibility criteria for removals.
- Certification Output: A VRS on 12,000 tCO_2e of sequestered soil carbon, which supports Scope 3 removals reporting and is integrated into the corporate Climate Transition Plan as evidence of supplier decarbonization progress.

This structured approach ensures that SCERM© outcomes are not just measured, but independently assured, legally defensible, and ready for multi-stakeholder reliance—bridging the gap between operational action and financial-grade disclosure.

Chapter VII. Step 6: Unified Data Record

SCERM© replaces fragmented spreadsheets and conflicting numbers with a single authoritative record for each verified supply chain outcome. This unified data record is the backbone for audit-ready Scope 3 claims and internal decision-making.

Box 5:

Purpose: One Record, Every Use

Most organizations keep separate datasets for sustainability, finance, procurement, and audit, so teams repeatedly rebuild the same numbers in different formats. This creates reconciliation problems, inconsistent disclosures, and higher audit risk.

The SCERM© solution is simple: one intervention, one verification, one number, used everywhere. All functions—sustainability, finance, procurement, risk, and audit—consume their data from the same unified record instead of recreating it.

7.1. The Recognised Reduction Entry (RRE)

The Recognised Reduction Entry (RRE) is the official SCERM© output for one verified, attributed reduction linked to a specific intervention and reporting period. Conceptually, it functions as a digital certificate of authenticity for a company's Scope 3 reduction claim.

Each RRE is a standardized, structured data object that combines four components:

- Intervention details: what the project is, where it operates, when the reduction occurred, and which suppliers and buyers are involved.
- Attribution logic: how the buyer's share of the project outcome was calculated, including the attribution model and percentage share.
- Quantified outcomes: the verified tCO_2e reduction or removal, the applied uncertainty, and any buffers.
- Verification status: who verified it, when, the assurance level, and the Verification Report Statement (VRS) reference.

Once issued, the RRE becomes the single source of truth for that outcome across all reporting and assurance uses.

Minimum Viable RRE: Required Fields

At minimum, each RRE must contain the fields in Table 2.

Table 2: RRE Data Structure — Core Fields

Field	Description	Example
RRE ID	Unique identifier for the reduction entry	RRE-2026-0042
Intervention name	Clear project/intervention name	Kenya Biogas
Reporting period	Period in which the reduction occurred	FY2026 Q4
Attribution model	Volume, Economic, Risk-weighted, Geographic	Volume
Your share (%)	Attribution percentage allocated to the buyer	25%
Total project reduction	Verified project-level outcome (tCO_2e)	8,000 tCO_2e
Your attributed reduction	Your share × project total (tCO_2e)	2,000 tCO_2e
Verification body	Accredited verification body	Verra VVB
VRS reference	Identifier of Verification Report Statement	VRS-2026-0471
Verification date	Date of final verification	2027-02-15

Optional but recommended fields include Scope 3 category, Supplier ID, uncertainty range (±%), and a SHA-256 hash for tamper-proofing.

7.2. RRE Template and Formats

For implementation, SCERM© recommends a simple text template that can be rendered in Excel, PDFs, or JSON without changing the core content. A typical RRE might look like this:

- RRE ID: RRE-2026-0042
- Intervention: Kenya Biogas – Dairy Cooperative
- Reporting Period: FY2026 Q4

Attribution

- Model: Volume-based
- Your purchase: 2,500 tonnes
- Total production: 10,000 tonnes
- Your share: 25%

Outcome

- Project reduction: 8,000 tCO_2e
- Your attribution: 2,000 tCO_2e
- Uncertainty: ±8.5%

Verification

- Body: Verra Accredited Verification Services
- VRS ID: VRS-2026-0471
- Date: 2027-02-15
- Assurance: Reasonable

Supported formats are kept deliberately simple so that organizations can adopt RREs without major system changes:

- Excel/CSV: for tracking many RREs in a registry.
- Word/PDF: for audit packs and board files.
- JSON: for integration into ESG, ERP, or data warehouse systems.

7.3. Simple RRE Registry: In practice, companies maintain one master RRE registry that lists all Recognised Reduction

Table 3: Example RRE Registry for Corporate Tracking

RRE ID	Intervention	Period	Attribution %	Project tCO_2e	Your tCO_2e	Verifier	VRS ID	Status
RRE-2026-0042	Kenya Biogas	FY26 Q4	25%	8,000	2,000	Verra	VRS-0471	Verified
RRE-2026-0043	Gum Belt Regen	FY26 Q4	16%	15,000	2,400	SCS	VRS-0482	Verified
RRE-2026-0044	Plastic Recycling	FY26 Q4	40%	9,200	3,680	DNV	VRS-0495	Verified

Entries in a single protected sheet or table. A minimal registry structure is shown in Table
All external reporting—Scope 3, CSRD, CDP, procurement scorecards, and audits—pulls directly from this registry, eliminating hidden spreadsheets and manual recalculation.

Box 8:

One Record, Five Uses

A single RRE can be reused across multiple disclosure and management processes without modification. Typical applications include:

- **Scope 3 inventory: directly adding the "your tCO_2e" value to the relevant Scope 3 category.**
- **CSRD/ESRS: populating ESRS E1-5 climate tables with verified, assurance-ready data.**
- **CDP: filling CDP climate questions e.g., C11 using the same verified reduction.**
- **Procurement: updating supplier sustainability scorecards and preferred supplier lists.**
- **Audit: providing the RRE plus its VRS as complete evidentiary support.**

By replacing five parallel data efforts with one reusable record, SCERM© materially reduces internal workload and audit friction while improving consistency of external disclosures.

Chapter VIII. Step 7: Disclosure Integration & Value Realization

8.1. From Verified Evidence to Strategic Value

What: Convert verified outcomes into business value

Disclosure Integration & Value Realization is the phase where SCERM©-verified outcomes are systematically translated into compliance-grade reporting, strategic communication, and measurable financial returns. This process transforms audit-ready evidence into tangible business value across regulatory compliance, investor relations, brand positioning, and operational decision-making. By automating the flow of verified supply-chain data into corporate disclosure systems, SCERM© enables organizations to monetize sustainability investment through reduced compliance costs, enhanced market credibility, optimized procurement, and strengthened stakeholder trust.

How: Automated reporting → Strategic communication → Performance tracking

8.2. Automated Reporting & Compliance Integration

1. API-Driven Disclosure Engine: SCERM©'s automated reporting module uses standardized API connectors to push verified outcome data directly into:
    - ESG reporting platforms
    - Financial reporting systems for integrated annual reports
    - Regulatory submission portals for climate disclosures
    - Voluntary disclosure frameworks CDP, GRI, TCFD/IFRS S2
2. Compliance Mapping & Gap Analysis: The system automatically maps SCERM©-verified outcomes to specific disclosure requirements:
    - CSRD/ESRS: Direct mapping to ESRS E1 (Climate Change), E4 (Biodiversity), and S1 (Own Workforce) indicators
    - IFRS S2: Automated alignment with Climate-related Metrics and Targets disclosures
    - SEC Climate Disclosure Rule: Generation of Scope 3 data tables with appropriate assurance statements
    - EU Taxonomy: Screening and reporting of eligible activities based on verified environmental performance
3. Audit-Ready Documentation Packages: System generates complete disclosure packages including:

- Source data verification trails from SCERM© VRS and RRE records
- Methodology alignment statements GHG Protocol, ISO, IPCC references
- Assurance documentation third-party verification statements
- Data lineage reports showing complete audit trail from supplier to disclosure

8.3. Strategic Communication & Stakeholder Engagement

1. Tiered Communication Frameworks:
    - Investor-Grade Reporting: Detailed, quantitative disclosures in annual reports and investor presentations, highlighting:
        - Scope 3 reduction progress vs. targets
        - Capital efficiency of supply-chain interventions (ROI metrics)
        - Risk mitigation achieved through supplier diversification and resilience building
    - Customer & Market Communications: Certified claims for sustainable sourcing, supported by:
        - ISCC and other certification-backed product claims
        - Environmental Product Declarations (EPDs) incorporating SCERM©-verified data
        - Digital traceability solutions (QR codes, blockchain explorers) allowing end-consumer verification
    - Regulator & Policy Engagement: Evidence-based submissions demonstrating:
        - Compliance with emerging due diligence regulations EU CSDDD, German Supply Chain Act
        - Progress toward national and international climate commitments
        - Contributions to just transition and sustainable development goals
2. Dynamic Content Generation: AI-powered tools create context-appropriate communications:

- Automated sustainability report sections updated quarterly with latest verified outcomes
- Real-time investor Q&A briefs based on current performance data
- Supplier recognition programs highlighting top-performing partners
- Crisis communication templates for addressing supply-chain disruptions with verified resilience data

8.4. Performance Tracking & Value Optimization

1. ROI Dashboard & Analytics:
    - Financial Value Tracking: Quantification of:
        - Compliance cost avoidance reduced audit fees, penalty avoidance
        - Premium pricing realization for certified sustainable products
        - Capital cost benefits from improved ESG ratings and sustainability-linked finance terms
        - Risk mitigation value through supply-chain diversification and resilience
    - Strategic Value Metrics:
        - Brand value impact through sustainability perception tracking
        - Talent attraction and retention metrics linked to employer branding
        - Market access and retention through regulatory compliance and customer requirements

2. Continuous Improvement Loop:
    - Performance benchmarking against industry peers and science-based targets
    - Intervention effectiveness analysis to optimize future capital allocation
    - Supplier performance scoring influencing procurement decisions and contract renewals
    - Predictive analytics for forecasting future compliance requirements and market expectations

8.5. Output: Compliance-ready disclosures + ROI realization

1. Regulatory Compliance Packages:
    - CSRD/ESRS-ready digital reports for EU filings
    - SEC-compliant climate disclosures with appropriate assurance statements
    - EU Taxonomy alignment reports with substantial contribution and documentation
    - National regulation compliance
2. Strategic Business Value Deliverables:
    - Sustainability-linked finance reporting for loan covenant compliance and interest rate optimization
    - ESG rating agency submissions with verified data improving scoring (MSCI, Sustainalytics, S&P)
    - Investor relations dashboards showing real-time progress against climate transition plans
    - Procurement optimization insights identifying highest-value supplier partnerships for renewal and expansion

8.6. Industry Application:

1. All Industries: CSRD/ESRS, IFRS S2, SEC Compliance

- Manufacturing: Automated generation of ESRS E1 (Climate) and E4 (Biodiversity) disclosures using verified supplier decarbonization data, with direct integration to annual financial reports
- Consumer Goods: Streamlined SEC Scope 3 reporting with built-in assurance documentation, reducing preparation time by 60% and audit costs by 40%
- Financial Services: Portfolio-level IFRS S2 reporting aggregation using SCERM© data from investee companies

2. All Industries: Investor Communications and Annual Reports

- Energy & Utilities: Dynamic investor dashboards showing real-time progress on supplier transition programs, supporting sustainability-linked bond reporting
- Technology: Integrated annual reporting combining financial performance with verified Scope 3 reductions, demonstrating capital efficiency of climate investments

- Agriculture & Food: Investor-grade disclosures showing farm-level regeneration outcomes linked to procurement volumes, supporting premium valuation for sustainable sourcing

3. All Industries: Marketing and Brand Differentiation

- Retail: Digital product passports with SCERM©-verified sustainability claims, increasing consumer trust and enabling premium positioning
- Apparel & Fashion: Blockchain-enabled traceability solutions showing verified water savings and emission reductions at material level, supporting circular economy claims
- Automotive: Supplier sustainability scorecards in marketing materials, demonstrating comprehensive value-chain decarbonization to environmentally conscious consumers

8.7 Example: Multi-Industry Value Realization

A global beverage company using SCERM© achieves*:*

- Compliance: Automated ESRS reporting saving €500K in consultant fees annually
- Investor Value: ESG rating upgrade reducing cost of capital by 35 basis points
- Market Value: 12% price premium on products with SCERM©-verified sustainable sourcing claims
- Operational Value: 18% reduction in procurement risk through supplier resilience insights
- Brand Value: #1 ranking in sector sustainability indices, increasing market share by 3.2%

This structured approach ensures that every verified supply-chain outcome translates into defensible compliance, strategic advantage, and measurable financial returns—turning sustainability from a cost center into a value-creation engine across all stakeholder dimensions.

Chapter IX. Methodological Outcome

SCERM©'s methodological outcome emerges after completing its five core stages: hotspot assessment, eligibility screening, attribution modeling, implementation monitoring, and verification assurance. This outcome is a transformed organizational state where supply chain interventions produce verifiable corporate assets that support all disclosures and decisions with audit confidence.

9.1. Definition and Core Transformation

The methodological outcome is not a single document but a repeatable system that converts real-world supply chain actions into disclosure-grade evidence. Supply chain interventions become attributable reductions backed by RREs (Recognised Reduction Entries), VRS (Verification Report Statements), and Proof of Linkage (PoL) documentation.
Key transformations include replacing vague claims with defensible numbers, fragmented datasets with a single registry, and annual reporting panic with automated ingestion. Sustainability investments shift from cost centers to strategic assets that enhance investor confidence and procurement leverage.

9.2. SCERM©'s methodological outcome

Outcome 1: Attributable, Defensible Reductions

Before SCERM©, claims like "we supported a biogas project" failed audits due to unclear attribution. Auditors demand precise shares based on procurement data, not funding proportions.
After SCERM©, each reduction is documented in an RRE with explicit logic, such as "RRE-2026-0042: 2,000 tCO_2e via 25% volume-based attribution, confirmed by Verra VVB with supporting purchase orders and production reports." This delivers a verified tonne ready for Scope 3 inventory without reinterpretation.

Outcome 2: Verification-Grade Evidence

Pre-SCERM© evidence often consists of ad-hoc supplier emails or unverified spreadsheets, leading to limited assurance or qualifications. Finance and procurement teams scramble for proof during reporting deadlines.

SCERM© produces a complete evidence triad: RRE + VRS + PoL, where the VRS independently assures data integrity, methodology, and attribution per ISO 14064-3 and GHG Protocol standards. Auditors accept this package at reasonable assurance levels, eliminating gaps and March rushes.

Outcome 3: One Dataset, Multiple Disclosures

Organizations previously rebuild Scope 3 data for each framework, spending weeks on CDP, CSRD/ESRS, and annual reports with reconciliation errors.
With SCERM©, the RRE registry serves as the single source: filter by period, copy attributed tCO_2e values, and paste into templates for CDP C11, ESRS E1-5, or GRI tables. This cuts preparation from six weeks to one hour per cycle, ensuring temporal consistency across filings.

Outcome 4: Cross-Functional Alignment

Conflicting numbers across sustainability 2,000 tCO_2e, finance 1,850 tCO_2e, and procurement 2,200 tCO_2e trigger endless reconciliation meetings.

SCERM© enforces one immutable number per RRE, pulled identically by all teams from the protected registry. C-suite dashboards show unified progress, freeing time for strategy over data fights.

Outcome 5: Strategic Value Creation

Beyond compliance, SCERM unlocks business advantages as shown in Table

Table 4: Strategic Value Creation — Before and After SCERM©

Value Type	Before SCERM	After SCERM
Investor Confidence	Vague claims without verification	CDP responses citing specific RREs and VRSs
Procurement Leverage	Requests to decarbonize	Scorecards tied to verified reduction performance
Transition Plan Credibility	Aspirational 30% by 2030 targets	8% achieved via verified supplier interventions
Brand Differentiation	"We support sustainable farming"	"2,400 verified tCO_2e from gum arabic chain"
Cost Avoidance	Annual consultant fees for reporting	In-house from live RRE registry

9.3. Input to Output

SCERM takes one verified supply chain intervention and outputs one RRE usable across functions, disclosures, and stakeholders. Below table captures the core shift.

Table 5: The SCERM© Shift — Before and After

Problem	SCERM Solution
Can't prove Scope 3 reductions	RRE + VRS = proof
Teams report different numbers	Single immutable registry
Annual audit gaps	Built-in verification
Months of reporting effort	Instant RRE population
Sustainability as cost center	Verified assets for strategy

This outcome ensures supply chain actions directly fuel credible reporting, investor trust, and operational decisions without new claims—just rigorous evidence.

Chapter X. Great Gum Belt Project: Ground Implementation of SCERM©






Source: Kyoto Network

10.1. Transforming degraded land through technology-enabled agroforestry:

With Mahgoub Sons & Group as our on-ground partner, we deploy remote sensing, IoT, and AI to measure the direct impact of Acacia Senegal reforestation and deliver transparency for corporate supply chains.

Scalable MRV is key to enabling sustainable Gum Arabic supply chains:

With an urgent need to restore degraded land across Sudan's gum belt while securing ethical supply chains for food and pharma industries, D-MMRV (Digital Measurement, Monitoring, Reporting and Verification) is the critical capability for any corporation committed to deforestation-free sourcing and Scope 3 reduction.

Box 9:

Carbon Markets

Generate high-integrity removal credits from verified agroforestry practices

10.2. Gum Arabic Value Chain

Gum Arabic (Acacia Senegal) appears in hundreds of industrial applications across multiple sectors. Below is a comprehensive list of industries that source Gum Arabic directly or indirectly, and how each can participate in the Great Gum Belt restoration project to reduce Scope 3 emissions through supply chain intervention.

1. Beverage industry

How Gum Arabic Appears in Their Value Chain:

- Emulsifier & Stabilizer: Used in soft drinks, energy drinks, and flavored waters to suspend flavors and prevent sedimentation
- Foam Stabilizer: Critical for root beer and other foaming beverages
- Clouding Agent: Provides opaque appearance in citrus and fruit drinks
- Syrups & Concentrates: Prevents sugar crystallization in beverage syrups

SCERM© opportunity:

Intervention	Scope 3 Category	Reduction Mechanism
Fund Acacia reforestation in Sudan	Cat 1: Purchased Goods	Sequester carbon in trees supplying your gum purchases
Support women-led nurseries	Cat 2: Capital Goods	Generate removal credits from nursery infrastructure
Invest in community processing hubs	Cat 4: Upstream Transport	Reduce transport emissions through local processing

Reporting Value:

- CSRD/ESRS E1-5: "Verified carbon removals from Gum Arabic sourcing regions"
- CDP Forests: "Deforestation-free supply chain with verified restoration"
- SBTi FLAG: "Land-based removals in agricultural supply chain"

2. Confectionery & candy

How Gum Arabic Appears in Their Value Chain:

- Gummy Candies: Primary texturizing agent in gummy bears, fruit chews
    - Hard Candy: Prevents sugar crystallization and provides smooth texture
    - Chocolate Coatings: Stabilizes chocolate panning coatings
    - Marshmallows: Provides structure and chewiness
    - Licorice: Binding agent and texture modifier

SCERM© opportunity:

Intervention	Scope 3 Category	Reduction Mechanism
Support agroforestry conversion	Cat 1: Purchased Goods	Soil carbon sequestration under Acacia stands
Fund farmer training programs	Cat 1: Purchased Goods	Yield improvements reduce land-use intensity
Invest in gum collection infrastructure	Cat 9: Downstream Transport	Consolidation reduces transport emissions

Reporting Value:

- "Our gummy bears now support verified reforestation in sourcing regions"
- Science-based target progress through supplier interventions
- EU compliance documentation for all gum shipments

3. Pharmaceutical

How Gum Arabic Appears in Their Value Chain:

- Excipient in Tablets: Binder and disintegrant in pharmaceutical tablets
- Suspension Agent: Stabilizes liquid medications and syrups
- Cough Syrups: Provides viscosity and soothing properties
- Wound Healing: Traditional medicine applications (emerging)
- Encapsulation: Microencapsulation of active ingredients
- Renal Disease Treatments: Emerging applications in kidney disease management (proven health benefits)

SCERM© opportunity:

Intervention	Scope 3 Category	Reduction Mechanism
Fund high-purity gum traceability	Cat 1: Purchased Goods	Blockchain-tracked emissions from source
Support organic certification	Cat 1: Purchased Goods	Reduced synthetic input emissions
Invest in women's cooperatives	Cat 1 + SDG Co-benefits	Social premium funding verified reductions

Reporting Value:

- CSRD ESRS S1: "Supporting women's health through clean cooking and gum collection"
- ESG Rating uplift through ethical sourcing verification
- Regulatory compliance with EU deforestation regulations

4. Cosmetics & personal care

How Gum Arabic Appears in Their Value Chain:

- Lotions & Creams: Natural emulsifier and thickener

- Hair Products: Provides hold in gels and styling products
- Mascara: Film-forming agent for long-wear formulas
- Facial Masks: Binding agent in peel-off and clay masks
- Natural Cosmetics: Preferred over synthetic alternatives for "clean beauty" positioning
- Lipsticks: Texture modifier and gloss enhancer

SCERM© opportunity:

Intervention	**Scope 3 Category**	**Reduction Mechanism**
Fund regenerative agriculture	Cat 1: Purchased Goods	Soil carbon in Acacia agroforestry systems
Support biodiversity monitoring	Cat 1 + TNFD	Verified biodiversity uplift claims
Invest in women harvesters	Cat 1 + Social	Gender-lens insetting with verified outcomes

Reporting Value:

- "Verified carbon neutral lip balm through supply chain restoration"
- TNFD-aligned biodiversity disclosures
- CDP Forests: "Forest-positive sourcing" leadership

5. Paint, inks & coatings

How Gum Arabic Appears in Their Value Chain:

- Watercolor Paints: Traditional binder that suspends pigment
- Printing Inks: Stabilizer and viscosity modifier
- Industrial Coatings: Emulsifier in water-based formulations
- Ceramic Glazes: Suspension agent for metallic oxides
- Textile Inks: Binder for fabric printing
- Art Supplies: Premium watercolors, gouache, and calligraphy inks

SCERM© opportunity:

Intervention	Scope 3 Category	Reduction Mechanism
Fund Acacia restoration	Cat 1: Raw Materials	Carbon removals in sourcing landscape
Support sustainable harvesting	Cat 1 + Biodiversity	Verified sustainable yield management
Invest in local processing	Cat 4: Transport	Reduced transport emissions through local value-add

Reporting Value:

- "Your watercolor paints restore the landscapes they come from"
- ESG narrative: Preserving cultural heritage through sustainable harvesting
- CSRD-aligned biodiversity and restoration metrics

6. Textiles & fabric printing

How Gum Arabic Appears in Their Value Chain:

- Fabric Printing: Thickener for textile printing pastes
- Natural Dyes: Binder and fixative for plant-based dyes
- Silk Screen Printing: Viscosity control in printing inks
- Batik Production: Resist agent in traditional fabric dyeing
- Sustainable Textiles: Natural alternative to synthetic thickeners

SCERM© opportunity:

Intervention	Scope 3 Category	Reduction Mechanism
Fund Acacia reforestation	Cat 1: Raw Materials	Carbon removals from fiber sourcing region
Support women dyers	Cat 1 + Social	Gender-lens investment with verified co-benefits
Invest in water-efficient processing	Cat 3: Fuel & Energy	Reduced energy emissions in gum processing

Reporting Value:

- "Verified sustainable sourcing from African drylands"
- TNFD biodiversity disclosures for textile supply chains
- CSRD ESRS E4: Biodiversity and ecosystem restoration metrics

10.3. D-MRV implementation & Agroforestry

Our MRV capabilities are deployed across the Great Gum Belt project in Gedaref State, Sudan, and are available to corporate partners seeking cost-effective, reliable monitoring of their supply chain restoration initiatives.

Samsam Forest, Gedaref State, Sudan (2025)

1. **Field boundary detection**

   Accurate field boundaries are fundamental to any agroforestry project. For the Great Gum Belt, they are pivotal for linking Agroforestry to carbon and Gum Arabic revenues. Using satellite imagery from Sentinel-2 captured across multiple growing seasons (2014-2025), we deliver data across forest and gum collection zones.

   Each parcel receives a unique digital ID (e.g., GGB-SUD-SAMSAM-0042), creating a permanent geospatial fingerprint that links trees, harvest, and carbon removal.

   This data is available as a stand-alone API product for integration with supply chain traceability systems.

2. **Tree planting verification:**

A key practice of the Great Gum Belt project is large-scale planting of native Acacia Senegal trees to restore degraded land and sequester carbon. Via satellites and mobile apps, we verify every planting event.

Growers log planting activities using a simple mobile application that works offline. They record:

- Number of trees planted
- GPS location of planting
- Photo evidence of saplings in the ground

Satellite imagery 30-60 days post-planting confirms the presence of new vegetation within planted parcels. This dual-layer verification ensures that every tree claimed is actually in the ground and surviving.

3. **Survival rate monitoring:**

Minimising tree mortality is critical for both ecological outcomes and carbon accounting. We classify survival rates by analyzing high-resolution satellite and drone imagery to detect gaps in planting grids and identify areas requiring replanting.

Our AI models compare expected planting density (900 trees/hectare, 5m x 5m spacing) with actual canopy cover detected in subsequent imaging runs. Areas with survival rates below our 80% threshold trigger automated replanting alerts for field teams.

4. **Biomass growth & carbon sequestration:**

By applying our biomass estimation models to analyse geospatial and temporal trends in vegetation indices and advanced satellite imagery, we are able to quantify carbon sequestration at the parcel level. Using high-precision satellite data as our primary stocking index (validated against field measurements), we generate annual carbon stock estimates for every hectare of the project.

This allows users to monitor carbon removal performance at scale, as a component of Verra VM0047 certification and corporate Scope 3 reporting.

5. **IoT-enabled environmental monitoring**

For deeper insights into tree health and environmental conditions, we deploy IoT sensor networks across representative sample plots within the project area.

Soil moisture sensors at 30cm and 60cm depth track real-time water availability, validating drought resilience claims and optimising any supplemental irrigation.

Sap flow sensors on sample trees measure real-time transpiration and health, providing early warning of pest attacks or water stress before visual symptoms appear.
Micro-climate stations record hyperlocal precipitation, temperature, and wind speed to calibrate growth models and verify climate resilience outcomes.

6. **Drone LiDAR validation**

Quarterly drone flights equipped with LiDAR sensors provide high-resolution 3D mapping of tree growth across key project and control plots.
Canopy volume analysis measures exact tree height and biomass accumulation, not just trunk diameter, enabling precise carbon stock calculations.
Ground truth for satellites calibrates Sentinel-2 data, removing false positives and reducing uncertainty in biomass estimates.
Fire risk modelling identifies deadwood buildup before dry seasons, enabling preventive management.
Deployment covers a statistically significant sample of project plots plus all control plots required for VM0047 dynamic baselining.

7. **Blockchain traceability**

End-to-end traceability from tree to factory is essential for ethical sourcing claims and compliance. Every batch of gum arabic harvested receives a unique QR code that logs:

- Tapper ID and parcel ID (linking harvest to specific farmer and location)
- Harvest date and weight
- Grade and quality test results (moisture content, purity)
- Chain of custody from village collection hub to Port Sudan export

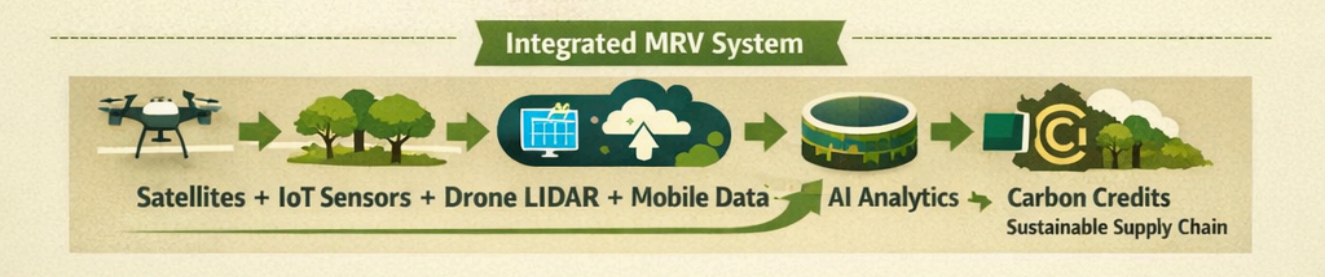
This data is stored on an immutable blockchain ledger, accessible to buyers via a simple QR code scan. For corporate partners, this delivers:

- Proof of deforestation-free sourcing
- Verification of ethical community grower payments
- Direct linkage to carbon insetting claims

8. **Mobile-first community engagement**

For ground-truthing and inclusive participation, a lightweight mobile application enables community enumerators and women's cooperative members to:

- Log tree planting and nursery activities with GPS-tagged photos
- Record gum harvest weights against specific parcel IDs
- Submit patrol reports for illegal grazing or fire events
- Verify practice adoption through simple digital checklists



Data is stored offline and syncs automatically when connectivity is available, ensuring complete documentation from even the most remote areas of the gum belt.

10.4. SCERM© Dashboard: Live Agricultural Outcomes

For corporate partners sourcing gum arabic from the Great Gum Belt, every shipment comes with access to a live dashboard showing verified on-farm impact metrics. Below are the agricultural outcomes delivered per reporting period.

Table 6: Field-Level Agricultural Metrics

Metric	Per 100 Hectares Restored	Per 1,000 Hectares Restored	Verification Method
Soil Organic Carbon (SOC)	+4.2 tonnes C	+42 tonnes C	Laboratory soil sampling (0-30cm)
Soil Organic Matter (SOM)	+0.8% absolute	+0.8% absolute	Loss on ignition testing
Water infiltration rate	+15 mm/hour	+15 mm/hour	Double ring infiltrometer
Water holding capacity	+12,000 litres/ha	+12 million litres	Pressure plate analysis
Nitrogen fixation	+36 kg N/ha/year	+36,000 kg N	Acacia biological fixation
Fertilizer replacement value	$45/ha/year	$45,000/year	NPK equivalent calculation

Groundwater recharge	+8% annual	+8% annual	Well monitoring network
Canopy cover	35%	35%	NDVI satellite analysis
Pollinator activity	+23 species	+23 species	Biodiversity transect surveys
Soil erosion reduction	-85%	-85%	RUSLE modeling

Table 7: Per-Hectare Annual Improvement Rates

Indicator	Baseline	Year 3	Year 5	Year 10
Soil Organic Matter	1.20%	1.60%	2.00%	3.50%
Soil Organic Carbon (tC/ha)	8.5	11.2	14.8	24.5
Water infiltration (mm/hr)	8	15	22	35
Nitrogen availability (kg N/ha)	12	28	45	70
Gum yield (kg/tree)	0	0.25	0.5	1

Table 8: Sample Dashboard View: Per 1,000 Tonnes Gum Arabic Purchased

Agricultural Outcome	Value	Equivalent Benefit
Hectares transitioned	32 hectares	80 football fields
Trees established	12,800 trees	400 trees/ha
Soil carbon accumulated	+42 tonnes C	154 tonnes CO_2e
Soil organic matter gain	+0.8% absolute	1.2% → 2.0%
Nitrogen fixed	1,152 kg N	$690 fertilizer value
Farmers supported	80 individuals	40% women
Food security (intercrops)	25.6 tonnes grain	Sorghum for 80 families

Table 9: Soil Health Trajectory: 10-Year Projection

Year	SOM (%)	SOC (tC/ha)	N Fixation (kg N/ha)	Infiltration (mm/hr)	Gum Yield (kg/tree)
0	1.2	8.5	0	8	0
2	1.4	10.1	15	12	0
4	1.8	13.4	28	18	0.2
6	2.4	17.2	42	24	0.5
8	3	21	58	30	0.8
10	3.5	24.5	70	35	1

10.5. Great Gum Belt: By the Numbers

Table 10: Great Gum Belt — Scaling Restoration and Impact

Metric	Phase 1 (Complete)	Full Project (2030)
Trees planted	5 million	125 million
Area restored	2,100 hectares	52,500 hectares
Survival rate	94%	Target >90%
Farmers engaged	800+	15,000+
Women in leadership	40%	40%
Annual CO_2 sequestration	—	3–6 million tonnes
Annual gum production	—	62,500–125,000 tonnes

Information accurate as of 2026. The Great Gum Belt project is implemented by Kyoto Network in partnership with Mahgoub Sons & Group and the Sudanese Ministry of Production and Economic Resources. Agricultural outcomes are verified annually through soil sampling, biodiversity surveys, and third-party audits.

XI. KyoGreen Clean Energy Systems: Ground Implementation, MRV & SCERM©

Source: Kyoto Network

11.1. Transforming organic waste into clean energy through distributed biogas infrastructure

We deploy IoT-enabled biogas systems to measure the direct impact of methane destruction, fossil fuel displacement, and health improvements across Kenyan homes, schools, and communities.

Scalable MRV is key to enabling clean energy transitions

With an urgent need to address energy poverty, deforestation, and indoor air pollution across Kenya, D-MRV (Digital Measurement, Reporting and Verification) is the critical capability for any corporation committed to Scope 3 reduction, community development, and verified climate impact.

Box 10:

Carbon Markets

Generate high-integrity thermal application based on avoidance of fossil fuel credits from verified biogas installations

Health & Development

Track reductions in respiratory illness and improvements in indoor air quality for women and children

11.2. Biogas Value Chain Industry Applications

Biogas systems (anaerobic digestion) convert organic waste into renewable energy. Below are industries with organic waste streams that can host biogas interventions, plus industries that can purchase the outputs.

1. Dairy processors

How Biogas Appears in Their Value Chain:

- Manure from Supplier Farms: Dairy farms generate significant manure
- Whey Processing: Cheese production creates high-strength organic wastewater
- Processing Waste: Milk solids, fats, and cleaning wastes
- Refrigeration Systems: Biogas can power absorption chillers
- Truck Fleet: Biogas can be upgraded to bio-CNG for milk collection trucks

SCERM© Opportunity:

Intervention	Scope 3 Category	Reduction Mechanism
Install digesters at supplier farms	Cat 1: Raw Milk	Methane capture from manure
Install on-site digester at processing plant	Cat 1 + Cat 3	Replace diesel/ LPG with biogas
Upgrade to bio-CNG for logistics	Cat 4: Transport	Fossil fuel displacement in milk collection

Reporting Value:

- SBTi FLAG: "Methane reduction in dairy supply chain"
- CSRD ESRS E1-5: "Verified emission reductions from manure management"
- ESG Investor metrics: "Leading dairy on methane action"

Beverage manufacturers (juice, soft drinks)

How Biogas Appears in Their Value Chain:

- Fruit Processing Waste: Peels, pulp, rejected fruit
- Wastewater: High-strength organic wastewater from washing and processing
- Spent Yeast: From fermentation processes
- Sludge: From wastewater treatment systems
- Packaging Waste: Organic residues from recycling operations

SCERM© Opportunity:

Intervention	Scope 3 Category	Reduction Mechanism
Install digester at processing plant	Cat 1: Raw Materials	Methane capture from fruit waste
Co-digestion with agricultural waste	Cat 1 + Cat 3	Regional waste processing hub
Bio-CNG for distribution fleet	Cat 4: Transport	Replace diesel in logistics

Reporting Value:

- "Circular economy: Our orange peels power our processing"
- CDP Climate: "Waste-to-value emission reductions"
- EU Taxonomy alignment: "Substantial contribution to circular economy"

2. Breweries & distilleries

How Biogas Appears in Their Value Chain:

- Spent Grain: Primary byproduct of brewing
- Wastewater: High-strength organic wastewater
- Spent Yeast: From fermentation
- Trub: Hot break and cold break material from brewing
- Distillery Slop: From spirits production (high organic load)

SCERM© Opportunity:

Intervention	Scope 3 Category	Reduction Mechanism
On-site digester for brewery waste	Cat 1: Raw Materials	Methane capture + biogas for steam
Co-digestion with local farms	Cat 1 + Cat 3	Regional organics processing hub
Bio-CNG for distribution	Cat 4: Transport	Replace diesel in beer delivery trucks

Reporting Value:

- "Our beer is brewed with renewable energy from our own waste"
- SBTi validation for waste-to-energy pathway
- CSRD ESRS E1-5: "Verified emission reductions from circular economy"

3. Tea & coffee processors

How Biogas Appears in Their Value Chain:

- Coffee Pulp: 40-50% of coffee cherry weight
- Coffee Wastewater: From wet processing
- Tea Factory Waste: Dust, stems, rejected leaves
- Worker Housing: Firewood replacement in staff quarters
- Factory Boilers: Biogas can replace firewood in drying operations

SCERM© Opportunity:

Intervention	Scope 3 Category	Reduction Mechanism
On-site digesters at factories	Cat 1: Raw Materials	Methane from processing waste
Household digesters for workers	Cat 1 + Cat 3	Firewood displacement in worker housing
Bio-CNG for leaf collection	Cat 4: Transport	Replace diesel in tea/coffee collection
Digestate as fertilizer	Cat 1 + Cat 2	Replace synthetic fertilizer on estates

Reporting Value:

- "Deforestation-free tea: Worker housing now biogas-powered"
- SBTi FLAG: "Land-use change avoided through clean cooking"
- Ethical trade certifications: Verified worker health improvements

4. Food service & catering

How Biogas Appears in Their Value Chain:

- Food Waste: From restaurants, cafeterias, hotels
- Cooking Oil: Used cooking oil (FOG - fats, oils, grease)
- Kitchen Waste: Pre-consumer food preparation waste
- Employee Housing: Staff quarters in remote locations
- Hotel Laundries: Biogas can provide hot water

SCERM© Opportunity:

Intervention	**Scope 3 Category**	**Reduction Mechanism**
Support municipal food waste digesters	Cat 5: Waste in Operations	Methane avoidance from landfill
Fund digesters in supplier farms	Cat 1: Food Purchases	Manure methane capture from meat/dairy supply

On-site digestion at major sites	Cat 5: Waste	Biogas for kitchen operations

Reporting Value:

- "Our food waste becomes renewable energy"
- CSRD ESRS E5: Resource use and circular economy
- Science-based target progress through waste management

5. Petrochemical & fertilizer

How Biogas Appears in Their Value Chain:

- Bio-CNG Sales: Biogas upgraded to pipeline quality
- Bio-LNG: Liquefied for heavy transport
- Digestate as Fertilizer: Nutrient-rich residue
- Green Chemistry: Biogas as renewable feedstock
- Refinery Co-processing: Biogas in existing infrastructure

SCERM© Opportunity:

Intervention	Scope 3 Category	Reduction Mechanism
Purchase bio-CNG for operations	Cat 1: Energy	Fossil fuel displacement
Fund digesters producing bio-fertilizer	Cat 1: Raw Materials	Replace synthetic fertilizer (Scope 3 Cat 1)
Invest in biogas upgrading facilities	Cat 2: Capital Goods	Scale renewable gas infrastructure

Reporting Value:

- "Circular nutrients: Replacing fossil-based fertilizer"
- ISCC PLUS certification for renewable content
- CSRD ESRS E1-5: "Verified emission reductions in supply chain"

11.3. Technology and Bioenergy

1. Biogas digester installation

Accurate installation verification is fundamental to any clean energy project. For KyoGreen Kenya, it is pivotal for linking avoided fossil fuel to carbon credits and health outcomes. Using GPS-coordinated installation records and photographic documentation, we verify every biogas system deployed.

Each installation receives a unique digital ID linked to:

- GPS coordinates of the household, school, or community
- Photographic evidence of the complete system (digester, piping, stove)
- Installation date and technician identification
- Beneficiary registration details

This data is available as a stand-alone API product for integration with carbon registry systems and corporate supply chain platforms.

2. Methane destruction verification

A key practice of the KyoGreen program is capturing methane from anaerobic digestion that would otherwise be released to the atmosphere from manure management. Via IoT sensors and automated monitoring, we verify every tonne of methane destroyed.

IoT methane sensors installed at the digester outlet continuously measure:

- Methane concentration in the biogas stream
- Volumetric flow rate of gas produced
- Temperature and pressure for standardisation

Annual methane destruction is calculated as:

$$Methane\ captured\ (m^3) \times methane\ density\ (kg/m^3) \times GWP\ of\ methane$$

This dual-layer verification ensures that every tonne of CO_2e claimed is actually destroyed.

3. Fossil fuel displacement monitoring

Minimising firewood consumption is critical for both deforestation prevention and carbon accounting. We monitor displacement by tracking:

Baseline firewood consumption established through:

- Pre-installation household surveys (kg firewood used per day)

- School kitchen records (tons firewood purchased annually)

Post-installation displacement verified through:

- Smart meters on biogas stoves tracking hours of use
- Mobile app logs from users recording meals cooked
- Automated alerts for systems operating below expected levels

Each KyoGreen Clean Cookstove displaces approximately 1.5 tonnes of firewood per year, saving an average of 20 trees annually per household.

4. Indoor air quality improvement

Thousands of Kenyans die prematurely or have their health impaired by indoor air pollution which causes respiratory illnesses, especially among women and children. We measure health impacts through:

Baseline health assessments conducted pre-installation:

- Reported respiratory symptoms (cough, shortness of breath)
- Clinic visits for respiratory issues (household recall)
- Hours per day spent in proximity to cooking fire

Post-installation monitoring conducted quarterly:

- Follow-up health surveys using WHO-validated questionnaires
- Indoor particulate matter (PM2.5) spot measurements in a sample of homes
- Reduced clinic visit tracking

Target: Zero indoor smoke exposure for all beneficiary households.

5. IoT-enabled continuous monitoring

For deeper insights into system performance and emission reductions, we deploy IoT sensor networks across all installed systems.

KyoGreen Clean Cookstove (Household) sensors track:

- Daily cooking hours
- Biogas consumption (m^3)
- Stove temperature (for usage verification)

KyoGreen Biogas System (School) sensors track:

- Methane production (m^3/day)
- Feedstock input (kg manure, logged manually via app)

- Digester temperature and pH (for process efficiency)
- Gas storage pressure

KyoGreen Biogas Microgrid (Community) sensors track:

- Total gas production (m^3/day)
- Distribution to each connected household (individual meters)
- Fertiliser output (kg digestate, a high-quality soil amendment)

6. Mobile-first community engagement

For ground-truthing and inclusive participation, a lightweight mobile application enables community enumerators and women's cooperative members to:

- Log daily feedstock inputs (kg manure, food waste)
- Report any system maintenance issues with geo-tagged photos
- Record cooking events and meals prepared
- Verify continued use through simple digital checklists

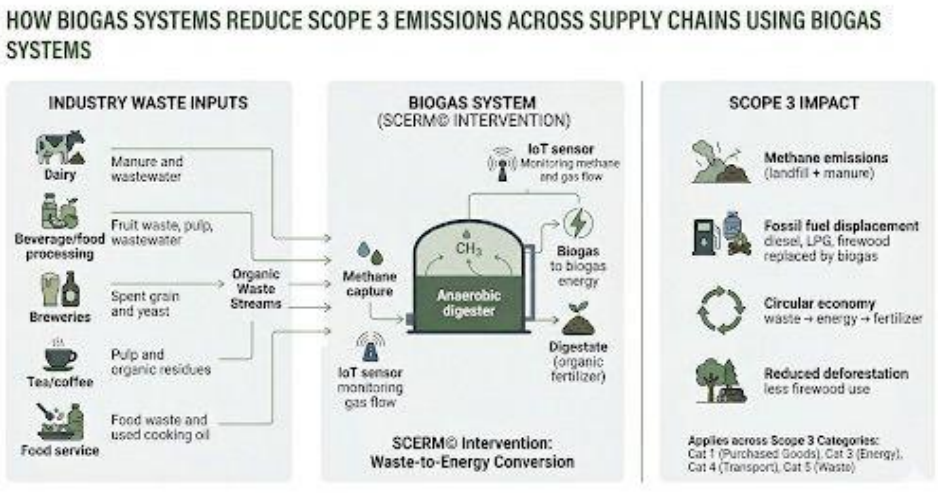
Data is stored offline and syncs automatically when connectivity is available, ensuring complete documentation from even the most remote areas.

7. Fertiliser production tracking

A secondary benefit of anaerobic digestion is the production of nutrient-rich digestate, a high-quality organic fertiliser. We track:

- Volume of digestate produced (litres or kg per day)
- Nutrient content (N-P-K analysis from laboratory sampling)
- Fertiliser replacement value ($ equivalent of synthetic fertiliser displaced)
- Distribution to farmers (linked to agricultural plots)

For the KyoGreen Biogas Microgrid model, farmers who bring manure to the digester receive digestate in return, creating a circular economy that improves soil health while providing clean energy.



11.4.SCERM© Dashboard: Live Biogas Outcomes

For corporate partners supporting the KyoGreen Kenya program, every investment comes with access to a live dashboard showing verified clean energy and agricultural outcomes.

Table 11. Per-Unit Impact Metrics Across KyoGreen Deployment Models

Metric	Household Cookstove	School System	Community Microgrid
Trees saved annually	20 trees	1,600 trees	2,133 trees
Woodland retained annually	0.2 acres	19 acres	25 acres
Firewood displaced annually	1.5 tonnes	120 tonnes	160 tonnes
CO_2 saved annually	5.7 tonnes	400 tonnes	535 tonnes
Methane destroyed annually	230 m^3	18,400 m^3	24,500 m^3
Health improved	4+ persons	300+ persons	400+ persons
Manure processed annually	16.4 tonnes	1,300 tonnes	1,750 tonnes
Digestate produced annually	16.4 tonnes	1,300 tonnes	1,750 tonnes
Fertiliser value (N-P-K)	$410/year	$32,500/year	$43,750/year
Cow equivalents supported	1-2 cattle	56 cattle	75 cattle

Table 12. Crosswalk of Project Data to Corporate Reporting Frameworks

Reporting Framework	How to Apply the Data
GHG Protocol Scope 3 Category 1	Report supplier-specific emission reductions from agricultural waste processing
GHG Protocol Scope 3 Category 3	Report fuel- and energy-related emissions avoided in value chain
SBTi FLAG	Count methane destruction toward near-term reduction targets
CSRD / ESRS E1-5	Disclose tonnes CO_2e avoided through clean energy deployment

CDP Forests	Report verified deforestation avoided through firewood displacement
GRI 305	Document emission reductions with third-party verification

11.5 Verification & Assurance

All dashboard metrics are backed by third-party verification aligned with international standards:

- ISO 14064-2: Quantification, monitoring and reporting of GHG emission reductions
- ISO 14064-3: Third-party verification by accredited bodies
- Gold Standard: For projects with documented SDG co-benefits
- Annual independent audits including in-person site visits to a statistically significant sample

11.6. Comparison: KyoGreen vs. Traditional Fuels

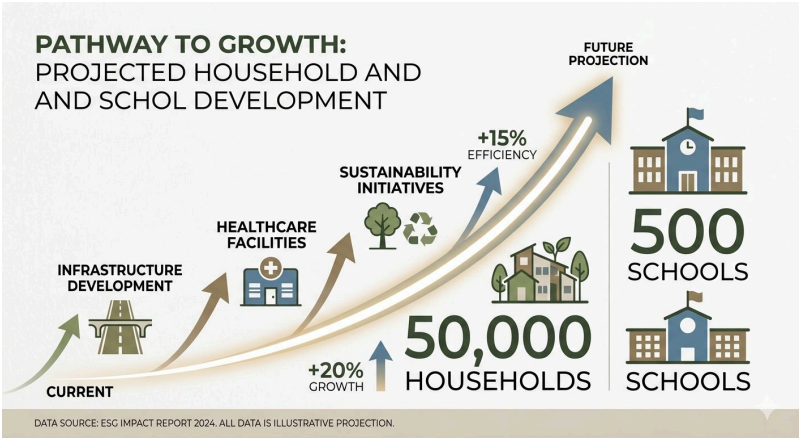
Table 13. Comparative Outcomes of Three-Stone Fire and KyoGreen Clean Cooking

Metric	Three-Stone Fire	KyoGreen Clean Cookstove	Improvement
Fuel source	Firewood (1.5 t/year)	Biogas (renewable)	100% renewable
Trees consumed	20 trees/year	0 trees	100% reduction
CO_2 emissions	2.7 tCO_2e/year	0 tCO_2e	100% reduction
Methane emissions	0 (firewood)	Methane captured + destroyed	Net negative
Indoor air pollution	High (PM2.5 > 300 $\mu g/m^3$)	Zero	100% elimination
Respiratory illness risk	High	Eliminated	Lives saved
Fertiliser produced	Ash (low value)	Digestate (high N-P-K)	$410/year value
Cooking time	Hours collecting wood	Instant fuel	Time saved

11.7. KyoGreen Kenya: By the Numbers

Table 14. Projected Five-Year Environmental and Social Outcomes

Metric	5-Year Target
Household cookstoves	50,000 units
School biogas systems	500 units
Community microgrids	100 units
Total trees saved annually	2,013,300 trees
Total woodland retained	22,000 acres
Total CO_2 saved annually	540,499 tonnes
Total health improved	390,000+ persons
Total manure processed	1.65 million tonnes/year
Total fertiliser value	$41.1 million/year
Cow equivalents supported	56,250 cattle



*Information accurate as of 2026. The KyoGreen Kenya program is implemented by Kyoto Network in partnership with MicroBiogas Italia, REREC, and Kaptagat Integrated Conservation Initiative (KICI). Outcomes are verified annually through IoT monitoring, third-party audits, and community health surveys.

Chapter XII. The Policy Landscape and Strategic Imperative for Supply Chain Decarbonization

12.1. Introduction: From Voluntary Action to Regulatory Mandate

The preceding chapters established that Scope 3 emissions constitute the majority of corporate carbon footprints and that methodological frameworks like SCERM provide a structured pathway for deep, verifiable value chain transformation. However, corporate action does not occur in a vacuum. This chapter examines the evolving ecosystem of drivers—spanning voluntary initiatives, hardening regulatory mandates, and innovative policy mechanisms—that is transforming Scope 3 management from a voluntary leadership exercise into a strategic and compliance imperative.

The transition from voluntary corporate responsibility to mandatory regulatory compliance represents one of the most significant shifts in the history of environmental governance. Where once climate action was the domain of pioneering sustainability leaders, it is now becoming a baseline requirement for market participation. This chapter maps this evolving landscape and demonstrates how SCERM© provides the operational infrastructure to navigate it successfully.

12.2. The Magnitude of the Challenge: Why Scope 3 is Unavoidable

A company's supply chain emissions are, on average, 11.4 times larger than its direct (Scope 1 & 2) emissions according to CDP supply chain data. In sectors like fuels, chemicals, and consumer goods, this proportion can exceed 80-90% of the total lifecycle footprint. The implications are stark: for most corporations, achieving net-zero is impossible without addressing Scope 3.

Illustrative Sector Examples

1. Chemicals & Plastics:

Scope 3 emissions represented 69% of its total value chain footprint in 2020. Its reduction strategy focuses on circular economy initiatives like chemical recycling, which avoids fossil feedstock and incineration emissions, reducing emissions by approximately 2 kg CO_2e per kg of product. This demonstrates that meaningful Scope 3 reduction requires fundamental business model innovation, not incremental efficiency gains.

2. **EU Refining Sector (FuelsEurope):**

For a typical refinery, downstream combustion of sold products (Scope 3, Category 11) constitutes approximately 79% of total Well-to-Wheels emissions. Abatement requires fundamental shifts in product portfolios, such as replacing fossil carbon with biogenic or recycled carbon in fuels, sustainable aviation fuels, and petrochemical feedstocks.

3. Food & Agriculture:

For a typical food company, Scope 3 emissions from agriculture, land use change, and processing represent 80-95% of total emissions. A single multinational food company may have supply chains touching millions of farmers across dozens of countries—each with different practices, data availability, and reduction potential.

12.3. The Risk Landscape

The associated risks—regulatory, financial, physical, and reputational—are immense:

Table 15. The Scope 3 Risk Landscape — Key Categories and Impacts

Risk Category	Manifestation	Estimated Impact
Regulatory	Carbon taxes, border adjustments, disclosure mandates	Up to $100/tonne carbon pricing in major economies by 2030
Financial	Stranded assets, cost of capital increases	$120 billion in costs from environmental supply chain risks by 2026 (CDP)
Physical	Supply chain disruption from climate impacts	25-30% of agricultural sourcing regions facing heightened climate risk by 2050
Reputational	Greenwashing accusations, consumer backlash	68% of consumers expect brands to help them live sustainably

Conversely, the opportunities for resilience, innovation, and cost savings are equally significant. Companies that proactively address Scope 3 are positioning themselves to benefit from green procurement preferences, preferential financing terms, and regulatory first-mover advantages.

12.4. Voluntary Frameworks: The Foundation

Voluntary initiatives have created the playbook, built the capacity, and generated the momentum for value chain accountability. These frameworks established the conceptual infrastructure upon which regulatory mandates are now being built.

Table 16: Voluntary Frameworks and Initiatives with Relevance for Scope 3 Emission

Framework/Initiative	Function	Description & Inclusion of Supply Chain (Scope 3) Emissions
GHG Protocol Corporate Value Chain (Scope 3) Standard	Accounting & Measurement Standard	Provides methodology for accounting and reporting emissions across the entire value chain. Divides Scope 3 emissions into 15 categories (upstream and downstream) with specific guidance for quantification and reporting. Foundational for all subsequent frameworks.
Science Based Targets initiative (SBTi)	Target Setting	Guides companies in setting emissions reduction targets aligned with climate science. Requires Scope 3 targets if emissions constitute ≥40% of total. Provides sector-specific guidance (FLAG for land-based sectors, chemicals) for value chain decarbonization. Over 4,000 companies now have science-based targets.
Carbon Disclosure Project (CDP)	Disclosure & Reporting	Global disclosure system for companies, investors, and governments. Encourages reporting across all 15 Scope 3 categories. Over 23,000 companies disclosed through CDP in 2024, with Scope 3 disclosure growing rapidly. Supply chain membership includes 300+ major purchasers with $6.4 trillion procurement spend.
Task Force on Climate-related Financial Disclosures (TCFD)	Risk Disclosure	Recommends disclosure of climate-related financial risks, including Scope 3 emissions where material. Widely adopted by financial

		institutions and corporations; now integrated into ISSB standards. Over 4,000 organizations expressing support.
International Sustainability Standards Board (ISSB) – IFRS S2	Global Reporting Standard	Requires disclosure of Scope 1, 2, and 3 emissions if material, building on TCFD recommendations. Aims to create a global baseline for sustainability disclosures. Effective 2024, with jurisdictional adoption underway (UK, Australia, Japan, Brazil).

The SCERM© Connection:

While the frameworks in Table 6.1 establish essential accounting rules, disclosure standards, and target-setting protocols, they primarily define what should be measured and reported, not how to achieve and finance deep, verifiable reductions within complex value chains. SCERM© addresses this critical implementation gap. It operates as the applied, investment-grade execution layer for these voluntary frameworks. SCERM© translates ambition into action by providing the strategic guidance, custom protocol development, financial structuring, and digital MRV required to turn commitments into owned, auditable assets. In essence, where other frameworks provide the map and destination, SCERM© builds the vehicle, secures the fuel, and navigates the journey to transform supply chains from emission sources into strategic carbon assets.

12.5. The Strategic Value of SCERM©

1. Ensures Compliance:
SCERM© generates the auditable data and verified assets required by CSRD, GRI, IFRS, and emerging frameworks globally. Rather than scrambling each reporting cycle to assemble defensible numbers, companies with SCERM© have ready-to-use RREs.

2. De-risks the Future:
By building resilient, low-carbon supplier networks, SCERM© hedges against:

- Future carbon prices (expected to reach $50-200/tonne by 2030 in major economies)
- Supply chain disruptions from climate impacts

- Regulatory changes that could strand carbon-intensive assets
- Reputational risks from association with high-emission suppliers

3. Unlocks Value:

SCERM© positions companies to benefit from:

- Green procurement preferences (both B2B and consumer)
- Preferential financing terms (green bonds, sustainability-linked loans)
- Premium pricing for verified sustainable products
- Enhanced ESG ratings (MSCI, Sustainalytics, S&P) reducing cost of capital

4. Solves the Attribution Problem:

SCERM© provides a clear, defensible methodology for claiming reductions that addresses the double-counting concerns highlighted by policy bodies. This methodological rigor is essential as regulators scrutinize climate claims.

5. Creates Strategic Assets:

Unlike offsets purchased from unrelated projects, SCERM© interventions create owned assets within the company's value chain:

- More resilient suppliers
- Verified low-carbon sourcing options
- Intellectual property from intervention methods
- Data and insights for transition planning
- Community and stakeholder relationships

12.6. SCERM© embodies this conclusion. It is a sector-adaptable, implementation-focused methodology that enables corporations to take direct responsibility for their most material emissions. Rather than treating Scope 3 as an accounting exercise or purchasing offsets from unrelated projects, SCERM© transforms the supply chain from the single greatest source of emissions into a platform for innovation, resilience, and verified leadership.
As regulatory deadlines approach and stakeholder scrutiny intensifies, the question is no longer whether to address Scope 3, but how effectively. The corporations that adopt frameworks like SCERM© will not only be compliance-ready but will define the competitive landscape of the low-carbon economy. They will have moved beyond reactive compliance to proactive value creation—owning their transition rather than being owned by it

Chapter XIII. Roles and Partners in SCERM© Implementation

Successful SCERM© implementation requires a coordinated ecosystem of specialized partners, each bringing distinct expertise to ensure interventions generate verifiable, attributable outcomes. Below is a comprehensive overview of the key roles and partners involved in the SCERM© framework.

1. Program Operator / Standard Setter

Role: Establishes and maintains the methodological framework, eligibility criteria, and governance rules that ensure consistency and integrity across all SCERM©-aligned interventions.

Key Responsibilities:

- Develop and publish SCERM© methodology, protocols, and guidance documents
- Maintain the Recognised Reduction Entry (RRE) registry framework
- Accredit verification bodies and approve validation/verification bodies (VVBs)
- Ensure methodological alignment with GHG Protocol, ISO 14064, and regulatory frameworks (CSRD, IFRS S2)
- Govern non-duplication safeguards and prevent double counting
- Provide training and certification for SCERM© practitioners

Example: Kyoto Network is the SCERM© Governance Body / Standards Board

2. Project Developer

Role: Originates, designs, and implements supply chain interventions, managing the end-to-end project lifecycle from feasibility through to verification readiness.

Key Responsibilities:

- Conduct feasibility studies and site assessments
- Develop project protocols and implementation plans aligned with SCERM© criteria
- Secure landholder, supplier, and community agreements
- Manage project budgets, timelines, and stakeholder relationships
- Oversee technology deployment and data collection systems
- Prepare projects for validation and verification

- Ensure ongoing compliance with SCERM© eligibility and permanence requirements

Example (Great Gum Belt): Mahgoub Sons & Group (on-ground implementation partner in Sudan) & Kyoto Network (Project management) together are developing the Great Gum Belt project.
Example (KyoGreen Kenya): MicroBiogas Italia (biogas technology partner) + REREC (Rural Electrification and Renewable Energy Corporation) & Kyoto Network (Project management) together are developing the Kyo clean green project

3. Technical Consultant / Advisory Partner

Role: Provides specialized technical expertise to project developers and corporate buyers, bridging gaps between project implementation and corporate reporting requirements.

Key Responsibilities:

- Advise on SCERM© methodology application and attribution modeling
- Conduct pre-feasibility and feasibility studies
- Support protocol development and methodological alignment
- Train project owners on monitoring requirements and data collection
- Assist with Proof of Linkage (PoL) documentation
- Guide corporate buyers on insetting strategy and Scope 3 integration
- Facilitate stakeholder engagement and capacity building

Example: Kyoto Network serves as technical consultant across Great Gum Belt and KyoClean Green Biogas programs, providing SCERM© methodology expertise, attribution guidance, and corporate integration support

4. Technology & MRV Provider

Role: Deploys and maintains the digital infrastructure for monitoring, reporting, and verification, ensuring data integrity and audit-readiness.

Key Responsibilities:

- Deploy IoT sensor networks (methane detectors, soil moisture sensors, flow meters)
- Implement satellite and drone-based monitoring systems (LiDAR, NDVI analysis)
- Develop and maintain mobile applications for field data collection

- Operate data platforms with automated validation and anomaly detection
- Generate immutable audit trails with cryptographic hashing (SHA-256)
- Provide API integrations with corporate ERP and ESG reporting systems
- Deliver real-time dashboards and performance analytics

Example: Kyoto Network (technology deployment) & D-MRV solutions partner (MRV platform) together provides latest technology integration.

5. Validation & Verification Body (VVB)

Role: Provides independent, third-party assurance that interventions meet SCERM© eligibility criteria and that reported outcomes are accurate, complete, and conform to methodological requirements.

Key Responsibilities:

Validation (Pre-Implementation):

- Review project protocols for methodological soundness
- Assess eligibility against SCERM© nine-point framework
- Evaluate baseline assumptions and additionality justification
- Confirm alignment with ISO 14064-2&3 and GHG Protocol standards
- Issue Validation Opinion Statement

Verification (Post-Implementation):

- Audit historical data and underlying documentation
- Conduct site visits to representative sample of project locations
- Test data integrity, including cryptographic audit trails
- Review attribution logic and Proof of Linkage documentation
- Confirm non-duplication through registry checks
- Issue Verification Report Statement (VRS) with assurance level (Limited/Reasonable)

Accreditation: ISO 14065 accredited or ANSI-approved verification bodies with sectoral expertise (AFOLU, Energy, Waste)

Examples: Verra-accredited VVBs, SCS Global Services, DNV, TUV SUD,

6. Project Owner / Supplier

Role: The entity where the intervention physically occurs—typically a farm, processing facility, manufacturing plant, or cooperative that hosts the emission reduction activities.

Key Responsibilities:

- Implement intervention activities (tree planting, digester installation, practice changes)
- Collect and submit primary data via mobile apps or IoT systems
- Grant access for verification site visits
- Maintain records of operations, inputs, and outputs
- Comply with SCERM© monitoring and reporting protocols
- Attest to non-duplication of claims

Examples:

Gum Belt: Mahgoub Sons & Group along with smallholder farmers, women's cooperatives, village collection hubs

Biogas: Dairy farmers, schools, tea estates, household beneficiaries

7. Corporate Buyer / Offtaker

Role: The organization purchasing materials or products from the project supply chain, seeking to attribute verified reductions to its Scope 3 inventory.

Key Responsibilities:

- Identify material sourcing hotspots (Step 1: Hotspot Assessment)
- Fund or support interventions in supplier operations
- Provide procurement data for attribution modeling
- Maintain Proof of Linkage (PoL) documentation
- Integrate verified RREs into corporate reporting (CSRD, CDP, etc.)
- Communicate outcomes to stakeholders (investors, customers, regulators)

Examples**:** Food & beverage companies sourcing Gum Arabic, dairy processors funding biogas.

8. Investor / Financier

Role: Provides capital for intervention deployment, often seeking verified outcomes to report against sustainability-linked finance commitments or portfolio decarbonization targets.

Key Responsibilities:

- Conduct due diligence on project viability and SCERM© eligibility
- Structure financing (debt, equity, results-based finance)
- Monitor performance against investment covenants
- Report verified outcomes to regulators or LPs (Limited Partners)
- Support scaling of successful interventions

Examples: Development finance institutions (DFIs), impact investors, commercial banks with sustainability-linked loans, green bond holders

9. Certification Body (Voluntary Standards)

Role: Provides additional assurance through recognized sustainability certifications that complement SCERM© verification, often required for specific market claims.

Key Responsibilities:

- Audit against certification standards (ISCC, Gold Standard, Verra, Fairtrade)
- Issue certificates for sustainable sourcing, carbon credits, or social claims
- Maintain certification registries
- Conduct periodic surveillance audits

Examples: ISCC (International Sustainability and Carbon Certification), Gold Standard, Verra (VCS),

10. Regulatory Body / Government Agency

Role: Sets and enforces legal requirements that intersect with SCERM© interventions, including deforestation regulations, emissions reporting mandates, and renewable energy policies.

Key Responsibilities:

- Establish regulatory baselines (additionality reference)

- Enforce compliance with national laws (e.g., EUDR, Clean Air Act)
- Provide jurisdictional data and emissions factors
- Recognize SCERM© outcomes for regulatory reporting (where applicable)
- Support landscape-level coordination and permitting

Examples: Sudanese Ministry of Production and Economic Resources, Kenyan Ministry of Energy, European Commission (EUDR), US EPA, national statistical agencies

11. Community Representative / Local Partner

Role: Ensures inclusive participation, safeguards community rights, and facilitates benefit sharing with local populations affected by interventions.

Key Responsibilities:

- Represent community interests in project design
- Facilitate free, prior, and informed consent (FPIC) processes
- Support grievance mechanisms and conflict resolution
- Coordinate local capacity building and training
- Verify community-level co-benefits (health, income, gender equity)

Examples: Women's cooperative leaders, village chiefs, community-based organizations (Kaptagat Integrated Conservation Initiative - KICI in Kenya) & Mahgoub Sons group (Community based organization)

Chapter XIV. Abbreviations List

AFOLU	Agriculture, Forestry and Other Land Use
AI	Artificial Intelligence
ANSI	American National Standards Institute
API	Application Programming Interface
CAPEX	Capital Expenditure
CDP	Carbon Disclosure Project
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CSRD	Corporate Sustainability Reporting Directive (EU)
DFI	Development Finance Institution
D-MRV	Digital Measurement, Monitoring, Reporting and Verification
EPD	Environmental Product Declaration
ERP	Enterprise Resource Planning
ESG	Environmental, Social, and Governance
ESRS	European Sustainability Reporting Standards
EU	European Union
EUDR	EU Deforestation Regulation
FLAG	Forest, Land and Agriculture (SBTi Guidance)
FPIC	Free, Prior, and Informed Consent
GHG	Greenhouse Gas
GRI	Global Reporting Initiative
GWP	Global Warming Potential
IFRS	International Financial Reporting Standards
IPCC	Intergovernmental Panel on Climate Change
IoT	Internet of Things
IRR	Internal Rate of Return
ISCC	International Sustainability and Carbon Certification
ISO	International Organization for Standardization

JSON	JavaScript Object Notation
LiDAR	Light Detection and Ranging
LP	Limited Partner
ML	Machine Learning
MMRV	Measurement, Monitoring, Reporting, and Verification
MRV	Monitoring, Reporting, and Verification
NDVI	Normalized Difference Vegetation Index
NPV	Net Present Value
PoL	Proof of Linkage
QA/QC	Quality Assurance / Quality Control
REDD+	Reducing Emissions from Deforestation and Forest Degradation
RFS2	Renewable Fuel Standard (US)
ROI	Return on Investment
RRE	Recognised Reduction Entry
SBTi	Science Based Targets initiative
SCERM©	Supply Chain Emission Reduction Method
SDG	Sustainable Development Goal
SEC	Securities and Exchange Commission (US)
SOC	Soil Organic Carbon
tCO_2e	Tonnes of Carbon Dioxide Equivalent
TCFD	Task Force on Climate-related Financial Disclosures
TNFD	Task Force on Nature-related Financial Disclosures
VCS	Verified Carbon Standard
VRS	Verification Report Statement
VVB	Validation & Verification Body
XML	Extensible Markup Language

Glossary of Terms

Additionality	A criterion ensuring that a project's GHG reductions or removals would not have occurred without the specific corporate intervention. It is assessed against regulatory, financial, and technological baselines
Attribution Modeling	The mathematical process used to determine the portion of total verified emission reductions from a project that can be rightfully claimed by a specific corporate buyer based on their procurement activities.
Biogas	A renewable energy source produced through the anaerobic digestion of organic matter (e.g., manure, food waste), which can be used to displace fossil fuels.
Buffer	A risk mitigation mechanism for carbon removal projects where a percentage of credited outcomes is withheld to protect against potential future reversals (e.g., from fire or disease).
Carbon Dioxide Removal (CDR)	The process of capturing carbon dioxide (CO_2) from the atmosphere and storing it durably in geological, terrestrial, or ocean reservoirs, or in products.
Chain of Custody	A documentation system that tracks and records the movement of a product or material through the supply chain from production to final sale, essential for traceability and certification claims.
Co-benefits	The positive social, economic, and environmental outcomes generated by a SCERM intervention beyond GHG reductions, such as improved biodiversity, water security, farmer livelihoods, or gender equity.
Disclosure-Grade Data	Structured, verifiable, and auditable data that meets the requirements of major reporting frameworks (e.g., CSRD, IFRS) and can withstand scrutiny from auditors and regulators.
Double Counting	The risk that the same tonne of CO_2e reduction or removal is claimed by more than one entity (e.g., by both a buyer and a supplier) or within

	multiple accounting frameworks. SCERM© includes non-duplication safeguards to prevent this.
Eligibility Screening	The second step of the SCERM© methodology, a rigorous gatekeeping process using nine criteria to determine if a supply chain hotspot can generate a verifiable, attributable reduction suitable for corporate disclosure.
Hotspot Assessment	The first step in SCERM©, involving a three-layer analysis (Spend, Emissions, Influence) to identify the most material and actionable areas for intervention within a company's supply chain.
Insetting	A strategy where a company implements GHG reduction or removal projects within its own value chain, as opposed to purchasing offsets from unrelated external projects. SCERM© provides a methodological framework for this
Materiality	A principle used to focus efforts on the most significant issues. In SCERM©, an intervention must address a material Scope 3 exposure, typically defined as >1% of total Scope 3 emissions or a significant transition risk.
Nature-Based Solutions (NBS)	Actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges (like climate change) effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits (e.g., reforestation, regenerative agriculture).
Offsetting	A climate action where a company compensates for its emissions by purchasing carbon credits from projects outside its value chain. This is distinct from insetting, which focuses on interventions within the value chain.

Proof of Linkage (PoL)	A formal document that details and justifies the attribution logic used to allocate project-level outcomes to a specific corporate buyer, serving as a key piece of audit trail evidence.
Recognised Reduction Entry (RRE)	The official, standardized digital output of the SCERM© process. It is a single, authoritative record for a verified, attributed emission reduction, containing all key details (ID, amount, attribution logic, verification status).
Regenerative Agriculture	A set of farming practices (e.g., no-till, cover cropping, agroforestry) aimed at improving soil health, increasing biodiversity, and sequestering carbon, while producing food and fiber.
Scope 3 Emissions	All indirect greenhouse gas emissions that occur in a company's value chain, excluding scope 2 emissions. They are categorized into 15 distinct upstream and downstream activities by the GHG Protocol.
Supply Chain Emission Reduction Method (SCERM©)	A comprehensive consultancy and implementation framework developed by Kyoto Network to enable corporations to decarbonize their supply chains, creating verifiable, attributable, and investment-grade emission reduction assets.
Verification Report Statement (VRS)	The formal, legally defensible document issued by an accredited third-party Validation & Verification Body (VVB) after a successful audit, confirming the accuracy, completeness, and integrity of SCERM© outcomes.
Validation & Verification Body (VVB)	An independent, accredited organization (e.g., ISO 14065 accredited) responsible for auditing SCERM© interventions and issuing the Verification Report Statement (VRS).

Chapter XV. References

- Marcu, A, Mehling, M & Monciatti, M 2021, *The role of supply chain emissions in decarbonization and compliance*, ERCST, Brussels
- Coca-Cola Europacific Partners (CCEP) 2024, *2024 CDP corporate questionnaire response*, Coca-Cola Europacific Partners plc, viewed 3 March 2026, from attached file
- Krishnan, A. and Connolly, K. (2025) *A Practical Approach to Scope 3 Greenhouse Gas Management*.
- Greenhouse Gas Protocol (2011) Corporate Value Chain (Scope 3) Accounting and Reporting Standard: Supplement to the GHG Protocol Corporate Accounting and Reporting Standard. World Resources Institute and World Business Council for Sustainable Development
- Science Based Targets initiative (SBTi) (2024) Aligning corporate value chains to global climate goals: SBTi Research: Scope 3 Discussion Paper