GreenSetu™

Procurement Carbon Screening Engine

METHODOLOGY & STRATEGIC FRAMEWORK

Version 1.1 · 24 March 2026

RSustain Carbon Private Limited, India

Technical Guidance: Resilient Sustainance Limited, UK

Context: MSME Transition Finance & Scope 3 Risk Segmentation

1. Decision Context & Purpose

The GreenSetu™ Procurement Carbon Screening Engine is designed to support **early-stage decision-making** in MSME green lending and transition finance.

It enables financial institutions to **rapidly identify upstream carbon exposure patterns** across heterogeneous MSME portfolios, where traditional operational audits are **cost-prohibitive, slow, and operationally unscalable**.

GreenSetu™ is intentionally structured as a **screening and segmentation instrument**, not a measurement or verification tool.

2. Core Analytical Construct

GreenSetu™ converts **audited financial procurement data** into an **indicative upstream carbon intensity signal**, using a spend-based approach aligned with the GHG Protocol Scope 3 framework (Categories 1 and 2).

The analytical construct rests on three principles:

- **Financial traceability:** Inputs originate from audited GST procurement records
- **Standardisation:** A uniform methodology is applied across sectors and firm sizes
- **Comparability:** Outputs are normalised to enable portfolio-level interpretation

3. Analytical Workflow (Audit-Traceable)

Step 1: Procurement Data Validation

- Source: Audited GST purchase registers (B2B procurement)
- Extraction: Line-item capture of HSN codes and transaction values
- Validation: Legal entity verification through GSTIN matching
- **Missing-HSN handling (v1.1):** Invoice lines with no HSN code are excluded from scoring but tracked as excluded spend. When excluded spend reaches or exceeds **10% of total submitted spend**, a **DATA_GAP_RISK** flag is raised on the assessment record. This ensures material data gaps are visible to the assessor rather than silently omitted from the carbon estimate.

Step 2: Financial-to-Environmental Translation

Procurement spend is mapped to **environmental impact proxies** using **Environmentally Extended Input-Output (EEIO) models**.

- Emission factors are derived from EXIOBASE 3.8.2, adapted for Indian economic structure and expressed in **kg CO■e per ■1,000 spend at 2023–24 basic prices**.
- Factors are normalised using price indices to maintain temporal consistency

HSN Matching Cascade (v1.1)

Emission factor lookup follows a priority cascade to maximise precision while maintaining coverage:

- **Priority 1 — 4-digit HSN heading match:** The first four digits of the HSN code are matched against the factor table. This is the preferred match and corresponds to PCAF Data Quality Score 4 (sector-specific factor).
- **Priority 2 — 2-digit HSN chapter match:** If no 4-digit match is found, the first two digits (chapter level) are used as a fallback. A warning is logged. Spend matched at this level is tracked separately from precision-matched spend.
- **Priority 3 — Conservative fallback factor:** If neither 4-digit nor 2-digit match is available, a conservative fallback of **1.5 kg CO■e per ■1,000** is applied. This value corresponds to the Risk: High tier boundary and is intentionally conservative to incentivise provision of accurate HSN data. The fallback triggers the **LOW_DATA_CONFIDENCE** risk flag. *(v0.4.0 used 0.8 — a lenient mid-range default that has been superseded.)*

```
Factor lookup order: 4-digit HSN → 2-digit chapter → 1.5 fallback Factor source: GreenSetu_HSN_Carbon_Factor_Table_v1 (hsn-factor-v1.1)
```

Step 3: Normalisation & Indexing

Core emission formula (unchanged across all versions):

```
kg CO■e = Invoice Amount (■) ÷ 1,000 × Carbon Factor
```

Carbon intensity per entity:

```
Intensity = Total kg CO■e ÷ (Total Procurement Spend ÷ 1,000)
```

GreenScore (v1.1 formula):

```
GreenScore = round(max(0, min(100, 100 – (Intensity × 20))))
```

■ v1.1 correction: GreenScore now uses round() (mathematically correct rounding) rather than int() (truncation). This eliminates systematic band demotions at boundary intensities (e.g. intensity 1.005 previously scored 79, now correctly scores 80).

4. Scoring Benchmarks & Calibration

The scoring formula uses a **calibration factor of 20** (SCORE_CALIBRATION_FACTOR). This parameter is version-controlled, stored on every assessment record, and may only be changed by issuing a new methodology version. The following benchmarks anchor the scale:

Intensity (kg CO■e / ■1,000)	GreenScore	Tier	Interpretation
0.00	**100**	GREEN TRANSITION READY	Zero upstream carbon
0.80	**84**	GREEN TRANSITION READY	India economy average — methodology anchor
1.00	**80**	GREEN TRANSITION READY	Tier 1 / Tier 2 boundary
2.00	**60**	TRANSITION REQUIRED	Certificate issuance threshold

2.50	**50**	TRANSITION REQUIRED	Very High risk boundary
5.00	**0**	HIGH CARBON EXPOSURE	Score floor anchor (clamped)

The India economy-average intensity of **0.80 kg CO■e / ■1,000** (EXIOBASE 3.8.2 India aggregate, 2023–24 price basis) anchors the scale at score 84. An entity scoring 80 or above has supply chain carbon intensity at or below the economy average.

The calibration factor is stored on every score_run database record to ensure full reproducibility of historical scores even if the parameter is updated in a future methodology version.

5. Unified Tier Classification

v1.1 introduces a **single, unified three-tier classification** that replaces the previous binary 'Eligible / Transition Required' status. The same classification function is used in the API response, database storage, and certificate PDF — eliminating prior inconsistencies between layers.

Score	Tier Label	Meaning	Certificate Eligible
≥ 80	GREEN TRANSITION READY	Low upstream carbon intensity relative to India economy average	Yes — Tier 1
60 – 79	TRANSITION REQUIRED	Moderate exposure; entity is actively screened and transitioning	Yes — Tier 2
< 60	HIGH CARBON EXPOSURE	Material upstream carbon risk identified; transition planning required	No

Entities in **TRANSITION REQUIRED** tier (score 60–79) are eligible for certificate issuance. This reflects the assessment's purpose as a transition finance tool: a certificate at this tier confirms that the organisation has undergone a formal supply chain carbon screening and is actively managing transition risk — it does not assert carbon neutrality or best-in-class performance.

6. Uncertainty Band (v1.1)

Spend-based emission estimates carry inherent uncertainty. Per PCAF (2022), spend-based proxies correspond to Data Quality Score 4–5, implying that actual emissions may differ from estimates by **±50% or more**.

For every assessed entity, the engine computes a score uncertainty band:

```
lower_score = round(max(0, min(100, 100 − (Intensity × 1.50 × 20)))) upper_score = round(max(0, min(100, 100 − (Intensity × 0.50 × 20)))) Invariant: lower_score ≤ GreenScore ≤ upper_score
```

The score range [lower_score, upper_score] is returned in the API response and stored on the assessment record. It communicates to the assessor that a GreenScore of, for example, 75 should be interpreted as 'likely between 60 and 90', potentially spanning multiple tiers. This uncertainty does not invalidate the score as a screening signal but must be considered in credit decisions.

The PCAF Data Quality Score applicable per entity is reported as:

- **DQ-4** — when ≥75% of spend is matched at 4-digit HSN precision
- **DQ-4/5** — when ≥50% of spend is matched at 4-digit or 2-digit level
- **DQ-5** — when precision and chapter-matched spend is below 50% of total

7. Risk Flags (v1.1)

The engine populates a risk flag array on every assessment record. Flags are surfaced in the API response, stored in the database, and used to annotate the Annexure of the Supply Chain Carbon Certificate.

Flag	Trigger Condition	Implication
`HIGH_CARBON_INTENSITY`	Intensity > 2.5 kg CO■e / ■1,000	Aggregate exposure above Very High risk tier
`LOW_DATA_CONFIDENCE`	Any invoice line used fallback factor	PCAF DQ-5 applies to affected lines
`DATA_GAP_RISK`	Mapped spend < 50% of total OR missing-HSN spend ≥ 10% of submitted	Carbon estimate may be materially understated

Flags are non-exclusive: an entity may carry multiple flags simultaneously. The absence of flags does not constitute verification of data quality.

8. Data Completeness Framework (v1.1)

Every assessment record carries a data completeness rating that reflects what fraction of total submitted procurement spend is covered by an emission factor estimate (whether matched or fallback).

Match Type	PCAF DQ	Completeness contribution	Flag triggered
4-digit HSN match	DQ-4	Counted as precision-mapped	None
2-digit HSN match (chapter fallback)	DQ-4/5	Counted as chapter-mapped	None (logged warning)
Conservative fallback (no HSN match)	DQ-5	Counted as fallback spend	LOW_DATA_CONFIDENCE
Missing HSN (excluded from scoring)	—	Tracked as excluded spend	DATA_GAP_RISK if ≥ 10% of submitted

The completeness rating is computed as:

```
coverage_ratio = (precision_spend + chapter_spend + fallback_spend) ÷ total_submitted_spend
data_completeness = HIGH if coverage_ratio ≥ 0.75 = MEDIUM if coverage_ratio ≥ 0.50 = LOW if coverage_ratio < 0.50
```

Note that missing-HSN spend (rows with no HSN code) is excluded from scoring entirely and therefore reduces both the numerator and denominator of the coverage ratio relative to total submitted spend. Assessors should review the excluded_ratio field to identify suppliers systematically omitting HSN data from their invoices.

9. Interpretation Philosophy (Critical)

The GreenSetu™ Readiness Index is **not a performance score**.

It is an **exposure-orientation signal**, intended to answer a single question:

> *"How carbon-intensive is this entity's upstream procurement profile, relative to typical sectoral patterns?"*

Indicatively:

- Higher index values are **commonly associated** with lower upstream exposure profiles
- Lower index values are **commonly associated** with material- and energy-intensive supply chains

■ No eligibility or exclusion decision is automated or implied by GreenScore alone. The score is one input into a broader credit or ESG assessment process.

10. Scope & Boundary Conditions

Dimension	Purchase Data (GSTR-2 / Inward Supplies)	Sales Data (GSTR-1 / Outward Supplies)
Emissions coverage	Scope 3 Cat.1 — upstream procurement emissions of the Assessing Organisation	Proxy for total embedded carbon in goods/services sold (sector-avg Scope 1+2+upstream Scope 3 via EXIOBASE)
Counterparty scored	Supplier GSTINs (entities selling to the assessor)	Customer/buyer GSTINs (entities buying from the assessor)
Scope 1 & 2 of screened entity	Not directly measured. Implicitly approximated at sector-average level through EXIOBASE factors.	Not directly measured. Sector-average Scope 1+2 are embedded in EXIOBASE output intensity factors.
Use-phase emissions	Excluded — EXIOBASE covers cradle-to-gate (production) only. Scope 3 Cat.11 not captured.	Excluded — EXIOBASE covers cradle-to-gate (production) only. Scope 3 Cat.11 not captured.
Certificate	Issued to Assessing Organisation. Annexure lists screened supplier GSTINs.	Issued to Assessing Organisation. Annexure lists customer/buyer GSTINs screened.

The output reflects **procurement-related exposure only** and should not be interpreted as an operational or product lifecycle assessment.

The certificate is issued to the Assessing Organisation (the entity submitting procurement data — typically a lender, buyer, or supply chain manager), not to individual suppliers. Individual supplier scores, contributions, and risk flags appear in the certificate Annexure for portfolio reference.

11. Supply Chain Carbon Certificate Framework (v1.1)

v1.1 replaces the per-supplier certificate model with an **organisation-level Supply Chain Carbon Certificate** covering a complete screening batch. This reflects the correct attribution of Scope 3 Category 1 emissions: the carbon liability belongs to the buyer (assessor), not to the individual supplier.

Certificate Structure

- **Page 1 — Main Certificate:** Issued to the Assessing Organisation. Shows aggregate GreenScore, aggregate tier, total invoice value covered, total estimated carbon footprint, assessment methodology version, certificate ID, SHA-256 integrity hash, and QR verification code.
- **Page 2+ — Annexure:** Tabulates every screened supplier GSTIN with individual score, score range, tier, invoice value, estimated CO■e, percentage share of total supply chain carbon, intensity, and data quality rating. Sorted by carbon contribution (Pareto order). Risk flags annotated per entity.

Aggregate Score Calculation

The aggregate GreenScore on the certificate reflects the combined carbon intensity of the entire screened procurement portfolio:

```
Aggregate Intensity = Σ(Carbon_i) ÷ (Σ(Spend_i) ÷ 1,000) Aggregate GreenScore = round(max(0, min(100, 100 − (Aggregate Intensity × 20)))) Aggregate Tier = classify_tier(Aggregate GreenScore)
```

This spend-weighted aggregate gives proportionally greater influence to high-value suppliers, which is consistent with their relative materiality in the Scope 3 inventory.

Certificate Eligibility

- Aggregate GreenScore must be ≥ **60** (Tier 2 entry — TRANSITION REQUIRED or above)
- Applicable payment or access code conditions must be satisfied

- Certificate validity: 365 days from issue date

Certificate Tier Context

Each certificate carries a contextual statement alongside the tier label to prevent misinterpretation by buyers or banks receiving the certificate from a supplier:

- **GREEN TRANSITION READY:** This organisation demonstrates low supply-chain carbon intensity.
- **TRANSITION REQUIRED:** This organisation is actively screening for carbon transition risk.
- **HIGH CARBON EXPOSURE:** High carbon exposure identified — immediate transition planning advised.

12. Strategic Use within Financial Institutions

The methodology is designed to support three specific banking functions:

1. Origination Screening

Rapid identification of MSMEs suitable for green or transition finance pathways based on supply chain carbon intensity profile.

2. Portfolio Heatmapping

Identification of clusters with elevated upstream carbon exposure across a lender's MSME book. The Annexure enables Pareto analysis (identifying the 20% of suppliers contributing 80% of portfolio carbon).

3. Advisory & Transition Planning

Establishing a baseline signal for engagement, improvement pathways, or equipment finance. The score range and risk flags provide actionable entry points for relationship managers.

13. Risk Calibration & Limitations

- The model is **proxy-based** and sensitive to price dynamics and currency basis
- Outputs are **indicative**, not precise measurements
- The methodology is unsuitable for carbon credit issuance, compliance reporting, or public ESG disclosure without further assurance
- PCAF Data Quality Score **4–5** applies throughout. Actual emissions may differ from estimates by ±50% or more. The score range field communicates this uncertainty quantitatively per entity.
- The assessment covers **a single upload period only**. No temporal normalisation, seasonality adjustment, or base-year consistency is applied. GHG Protocol recommends a minimum 12-month data period; assessors should ensure submitted invoice data represents a representative period.
- HSN matching at 2-digit chapter level (Priority 2) may conflate materially different emission profiles within the same chapter (e.g. Chapter 84 includes nuclear reactors and hand tools). Entities are encouraged to ensure full 4-digit or 6-digit HSN codes are present on invoices.

GreenSetu™ is intentionally positioned as a **risk-screening instrument**, not a carbon accounting system.

14. Governance Statement

RSustain Carbon Private Limited maintains documented governance over:

- Emission factor selection, version control, and annual review

• HSN mapping logic and normalisation parameters

• Scoring calibration factor (**SCORE_CALIBRATION_FACTOR = 20**): changes require a methodology version increment. The active value is stored on every assessment record to ensure full reproducibility of historical scores.

• Any deviation of SCORE_CALIBRATION_FACTOR or DEFAULT_FALLBACK_FACTOR from their v1.1 defaults triggers automatic stamping of records with **scoring_model_version = "v1.1-custom"** and a startup warning in the engine.

• Annual methodological review against PCAF, GHG Protocol, and SEBI BRSR updates

• Certificate audit trail: every issued certificate carries a **SHA-256 integrity hash** of its payload and is verifiable via QR code at greensetu.rsustain.co.uk

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Standards alignment: GHG Protocol Scope 3 Cat.1 · PCAF (2022) · EXIOBASE 3.8.2 · SEBI BRSR Core 2023 · RBI Climate Risk Guidelines

Developed by: Resilient Sustainance Private Limited, India · Operated by: RSustain Carbon Private Limited, India · Technical Guidance: Resilient Sustainance Limited, UK