CARBON INDEX PROTOCOL

WHITEPAPER · VERSION 1.0

Carbon Index Protocol

The integrity-first benchmark, token, and on-chain settlement layer for the global carbon economy.

CI100 Index · CIP Score · $CUT Token · Proof-of-Carbon-Action · The Vault

Base L2 · EVM-compatible · EIP-712 retirement receipts · AI-verified MRV

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SECTION 1

Executive Summary

The voluntary carbon market (VCM) is projected to grow from roughly USD 2 billion in transacted value today to USD 50–250 billion by 2030. Yet the underlying infrastructure — fragmented registries, unverifiable claims, opaque PDFs, and double-counted retirements — is structurally incapable of supporting that scale with integrity. Every major net-zero scandal of the last three years has had the same root cause: **no canonical, programmable record of what a company actually did**.

Carbon Index Protocol (CIP) is the integrity-first benchmark, token, and on-chain settlement layer designed to fix that. It is built on three load-bearing primitives, each addressable both off-chain (as data) and on-chain (as state):

- **CI100 Index** — a quarterly-rebalanced benchmark of the 100 most carbon-material listed companies, scored 0–100 on integrity, not narrative.
- **CIP Score** — a composite seven-pillar metric (Carbon Activity, Credit Quality, ESG Compliance, Transition Execution, Financial Strength, Sentiment, Innovation) powered by an AI due-diligence stack.
- **$CUT Token** — a hard-capped 1,000,000,000-supply utility token whose burn loop is mathematically tied to real-world retirements via the **Proof-of-Carbon-Action (PoCA)** EIP-712 standard.

> **Thesis**
>
> Carbon markets must be *verifiable*, or they are theater. CIP makes every credit, retirement, score change, and methodology decision a first-class on-chain object on Base — cryptographically signed, publicly queryable, and immutable.

What is new

CIP is not another registry, not another rating agency, and not another carbon token. It is a **settlement layer** that sits above the existing registries (Verra, Gold Standard, ACR, ART TREES, Puro.earth, Isometric, Climate Action Reserve) and below the corporate consumers of credits. Registries remain the source of truth for issuance; CIP becomes the source of truth for *what happened after issuance* — transfer, custody, retirement, claim, and contradiction with corporate disclosures.

Key numbers at a glance

Metric	Value	Notes
Index universe	300–500 carbon-material listed cos.	Quarterly rebalance
CI100 constituents	100	Top by CIP Score
Scoring pillars	7	Weighted, audited
Token supply	1,000,000,000 $CUT	Hard-capped

Metric	Value	Notes
Retirement fee	1.0% of credit notional	50% burned, 50% to Vault
Settlement L1/L2	Base (primary), Ethereum (mirror)	EVM-compatible bridges
Score refresh	Weekly off-chain, monthly on-chain	Merkle-rooted
Audit cadence	Quarterly, third-party	Open methodology

SECTION 2

Market Context

2.1 The structural integrity gap

The VCM today is a constellation of independent silos. Verra alone holds more than a billion issued credits across hundreds of methodologies. Gold Standard, ACR, ART TREES, CAR, Puro.earth, and Isometric add hundreds of millions more. None of these registries are interoperable in a programmatic sense: their public APIs are limited, their data formats differ, retirements are reported as PDFs or CSV exports, and corporate claims live entirely off-registry.

The result is an integrity gap that has produced, in just the last 24 months, multiple front-page failures: rainforest projects over-crediting by 9–12x against satellite biomass; cookstove methodologies revealed to over-estimate avoided emissions by 4–10x; and Fortune 500 buyers claiming net-zero against retirements that double-counted across registries.

2.2 Demand vs. trust

Corporate net-zero demand is not the bottleneck. The Science Based Targets initiative has validated targets for more than 4,000 companies covering roughly USD 38 trillion of market capitalization. The bottleneck is **trust**: CFOs, sustainability officers, and auditors cannot verify that a retired credit corresponds to a real, additional, permanent removal or avoidance — and cannot prove to regulators that they have not been deceived.

> **The scaling problem**
>
> If the VCM 10×s by 2030 on its current substrate, the integrity failures will 10× with it. CIP exists because solving this with PDFs and trust-me APIs is no longer acceptable to capital markets or to regulators.

2.3 Regulatory tailwinds

- **EU CSRD & ESRS E1** require structured climate disclosures with assured data, taking effect in waves 2024–2028.
- **SEC climate rule** (paused but framework-defining) and California SB-253/261 mandate Scope 1–3 reporting for large issuers.

- **IFRS S2 / ISSB** are converging on a global baseline; assurance providers need machine-readable evidence.
- **ICVCM Core Carbon Principles** and **VCMI Claims Code** have set the integrity bar — but enforcement requires data infrastructure that does not yet exist at internet scale.

2.4 Why on-chain, why now

Public blockchains — specifically EVM L2s like Base — solve exactly the parts of this problem that databases cannot: **shared state, cryptographic finality, programmable composition, and adversarial auditability**. CIP does not put credit issuance on-chain (that remains the registries' job). It puts *everything that happens after issuance* on-chain, where every actor — buyer, seller, auditor, regulator, journalist — can verify it with the same query.

SECTION 3

Design Principles & Non-Negotiables

CIP is opinionated. Every architectural choice flows from five non-negotiable principles. When a design trade-off arises, these principles — in this order — are how it is resolved.

3.1 Integrity over inclusivity

CIP will exclude credits, projects, methodologies, and companies that do not meet the integrity bar, even when their exclusion shrinks notional market activity or revenue. A smaller, trusted market is more valuable than a larger, suspect one.

3.2 Verifiability over throughput

Every state-changing action on CIP — retirement, score update, governance vote, methodology change — must produce evidence sufficient for an independent third party to reproduce the result. We will accept slower confirmation, smaller batch sizes, and higher gas costs to preserve verifiability.

3.3 Open methodology, closed-loop accountability

The CIP Score formula, weights, data sources, and scoring code are public. Score producers are also pseudonymously identified on-chain, and their reputation — measured by ex-post accuracy — is a first-class metric.

3.4 Composability with traditional finance

CIP outputs (the CI100 index value, individual CIP Scores, PoCA receipts) are designed to be consumed by traditional financial infrastructure: index licensees, ETF issuers, audit firms, banks, and corporate ERPs. The on-chain representation is canonical; off-chain consumption is fully supported.

3.5 Progressive decentralization

CIP launches under a multisig council with publicly identified members. Governance is migrated to a token-weighted DAO with mandatory minority protections, time-locks on all critical operations, and an independent oracle committee. There is no founder backdoor, no upgrade trapdoor, and no privileged key.

What CIP is not

CIP is not a registry, an offset broker, a project developer, or an investment product. It does not issue credits, it does not advise on retirements, and $CUT is a utility token — not a security, not a carbon credit, and not a claim on carbon removal.

SECTION 4

The CI100 Index

4.1 Universe construction

The Carbon Company Universe (CCU) is the screening pool from which the CI100 is selected. The CCU starts from the global universe of listed companies with market capitalization > USD 500m and primary listing on a recognized exchange. From there, three filters are applied:

- **Materiality filter** — the company must have a documented, non-trivial relationship to carbon: as an emitter (Scope 1 > 100 ktCO■e), as a credit producer, as a credit consumer (> 10 ktCO■e retired in trailing 12 months), as climate-tech infrastructure, or as a financier of climate transition.
- **Disclosure filter** — the company must publish at minimum Scope 1 and Scope 2 emissions audited or assured to a recognized standard (GHG Protocol, ISO 14064, ISAE 3410, or equivalent).
- **Liquidity filter** — 90-day median dollar volume > USD 5m and public float > 25%.

This typically yields a CCU of 300–500 companies. The CI100 is then the top 100 by CIP Score, subject to the constraints in §4.3.

4.2 Constituent selection

Selection runs quarterly. The full CCU is rescored using the latest data snapshot (rebalance date T). Companies are ranked by CIP Score (descending). The top 100 are admitted, with the following modifications:

Rule	Description
Sector cap	No single GICS sector may exceed 25% of index weight.
Region cap	No single region (NA, EU, APAC, EM) may exceed 45%.
Single-name cap	No constituent > 5% of index by weight.
Buffer rule	Incumbents within rank 1–120 are retained; new entrants must rank ≤ 100. Reduces turnover.
Liquidity guard	Constituent dropping below USD 3m 90-day median volume is removed at next rebalance.
Integrity gate	CIP Score < 40, or any unresolved Severe controversy (§6), forces immediate removal.

4.3 Weighting scheme

CI100 uses a **CIP-weighted** scheme that blends carbon materiality with integrity. The raw weight of constituent *i* is:

```
w_raw_i = (CIP_i / 100) ^ alpha  *  log10(1 + CarbonNotional_i)

w_i     = w_raw_i / sum_j(w_raw_j)   subject to caps in 4.2

alpha   = 1.5    # integrity emphasis
```

The exponent *alpha* = 1.5 means a company with CIP Score 80 has roughly 1.7× the unconstrained weight of an otherwise-identical company at 60. CarbonNotional is the trailing-12-month sum of credits produced + consumed + financed, denominated in tCO■e.

4.4 Rebalancing

Rebalancing is quarterly on the third Friday of March, June, September, and December (effective the following Monday). Constituent changes and weight changes are published one week in advance. The historical index series is never restated; instead, every rebalance produces a new immutable record with the prior state hash referenced.

4.5 Index value calculation

```
CI100_t = CI100_(t-1) * sum_i( w_i * (P_i_t / P_i_(t-1)) * IntegrityAdj_i_t )

IntegrityAdj_i_t = 1 + 0.5 * (CIP_i_t - CIP_i_(t-1)) / 100
```

Daily index values are calculated at exchange close in USD and published both to the public website and to the on-chain oracle (§11). The IntegrityAdj term means that a constituent whose CIP Score collapses mid-quarter drags the index even if its stock price holds — a deliberate feature, not a bug.

SECTION 5

CIP Score — Seven-Pillar Integrity Engine

The CIP Score is a composite 0–100 metric. It is the single most important number CIP produces. Every weight, sub-metric, and data source below is public and versioned.

```
CIP =  0.25 * CarbonActivity
     + 0.15 * CreditQuality
     + 0.20 * ESGCompliance
     + 0.15 * TransitionExecution
     + 0.10 * FinancialStrength
     + 0.10 * SentimentIntegrity
     + 0.05 * InnovationPremium
```

#	Pillar	Weight	What it measures
1	Carbon Activity	25%	Credits produced, consumed, retired, held, financed, or enabled.
2	Credit Quality	15%	Registry, vintage, methodology, removal vs avoidance, permanence, CCP alignment.
3	ESG Compliance	20%	SBTi, CDP, emissions reporting, net-zero target quality, ISSB/TCFD, board oversight.
4	Transition Execution	15%	Actual emissions reduction, intensity improvement, capex alignment, renewables.
5	Financial Strength	10%	Market cap, liquidity, revenue quality, balance-sheet resilience.
6	Sentiment Integrity	10%	News, litigation, greenwashing risk, NGO flags, regulator scrutiny.
7	Innovation Premium	5%	AI, MRV, tokenization, climate-tech infrastructure, new methodologies.

5.1 Carbon Activity (25%)

Six sub-metrics, equal-weighted within the pillar: tCO■e produced, tCO■e consumed (retired), tCO■e held in inventory, tCO■e financed (Scope 3 cat. 15), tCO■e enabled by sold products, and 5-year activity growth. Each sub-metric is winsorized at the 1st and 99th percentiles of the CCU and rescaled 0–100 via empirical CDF.

5.2 Credit Quality (15%)

Each credit a company touches is scored on six dimensions: registry tier (A: ICVCM-aligned, B: established, C: provisional), vintage (newer = better, capped at 7 years), methodology robustness (peer-reviewed protocol score), removal vs. avoidance (removals weighted 1.5×), permanence (perpetual > 100yr > 40yr > biological), and CCP-label status. The company's Credit Quality is the volume-weighted average.

5.3 ESG Compliance (20%)

- SBTi target status (validated 1.5°C / near-term / long-term net-zero) — 25%
- CDP disclosure score (A/A-/B/B-/C/C-/D/D-) — 20%
- Scope 1, 2, 3 reporting completeness & assurance level — 25%
- Board climate oversight & exec compensation linkage — 15%
- ISSB / TCFD / CSRD alignment of latest report — 15%

5.4 Transition Execution (15%)

Backward-looking, not promise-based. Measures the trailing 5-year delta in absolute and intensity-based emissions against a science-based pathway (1.5°C linear or sectoral SDA where applicable). Companies *missing* their own stated trajectory are penalized more heavily than companies without a target.

5.5 Financial Strength (10%)

Market cap, 90-day median dollar volume, free cash flow margin, net debt / EBITDA, and Altman Z-score. CIP is not an equity-quality model — this pillar exists only to ensure that an index constituent is investable and that a high-scoring company is not on the brink of insolvency.

5.6 Sentiment Integrity (10%)

AI-classified news and litigation flow. Severe classifications (proven greenwashing, environmental crime, material misstatement) can apply a multiplicative penalty up to –5 score points on the composite and trigger an immediate Integrity Gate (§4.2).

5.7 Innovation Premium (5%)

Forward-looking. Rewards investment in MRV, dMRV, AI-assisted accounting, durable removals (DAC, enhanced weathering, biochar at scale), and open standards contribution. Capped at 5 points to prevent narrative inflation.

> **Anti-gaming**
>
> Every input that affects CIP Score is sourced from at least two independent providers, with a third break-tie source for any discrepancy > 5%. Score producers who repeatedly disagree with consensus are slashed (see §11, oracle committee).

SECTION 6

AI Due Diligence & Greenwash Detection

CIP's AI stack is the connective tissue that turns unstructured carbon data (project design documents, monitoring reports, corporate disclosures, news, satellite imagery) into structured signals consumed by the score and the on-chain oracle. It is deliberately positioned as a *decision support* system, not an autonomous one — every material score change is human-attestable before it goes on-chain.

6.1 Pipeline overview

- **Ingest** — registry crawlers, SEC/EDGAR + EU OAM filings, NGO reports, satellite tiles, news APIs.
- **Normalize** — OCR + layout-aware document parsing; entity resolution against the CCU master.
- **Extract** — LLM-based extraction of claims, numbers, methodologies, and cross-references with confidence scores.
- **Reason** — contradiction detection against prior filings, peer data, and physical reality (satellite, energy mix).
- **Attest** — a human reviewer signs off on every score change > 3 points or any Severe classification before on-chain publish.

6.2 Greenwash detection heuristics

CIP runs a battery of pattern detectors that flag claims for human review. None of these alone determines a score; in aggregate they tilt the Sentiment Integrity pillar and surface in the public Vault.

Pattern	Trigger
Claim-action gap	Public net-zero claim, but Scope 1+2 retirements < 5% of stated trajectory.
Vintage stacking	Buying old (> 5yr) credits while marketing 'high-quality removals'.
Methodology drift	Project switches to lower-rigor protocol mid-crediting period.
Disclosure asymmetry	Improvement claims in glossy report not present in audited 10-K.
Satellite contradiction	Forest-protection credits where biomass loss > 2 SD vs. baseline.
Retirement double-claim	Same credit serial referenced in claims from two distinct buyers.

6.3 Model governance

Models, prompts, and evaluation suites are versioned in the public CIP-AI repository. Every score-producing model passes a pre-release evaluation against a held-out, human-labeled gold set with required precision and recall thresholds. Model lineage hashes are written to chain so any score can be traced back to the exact pipeline that produced it.

6.4 Adversarial robustness

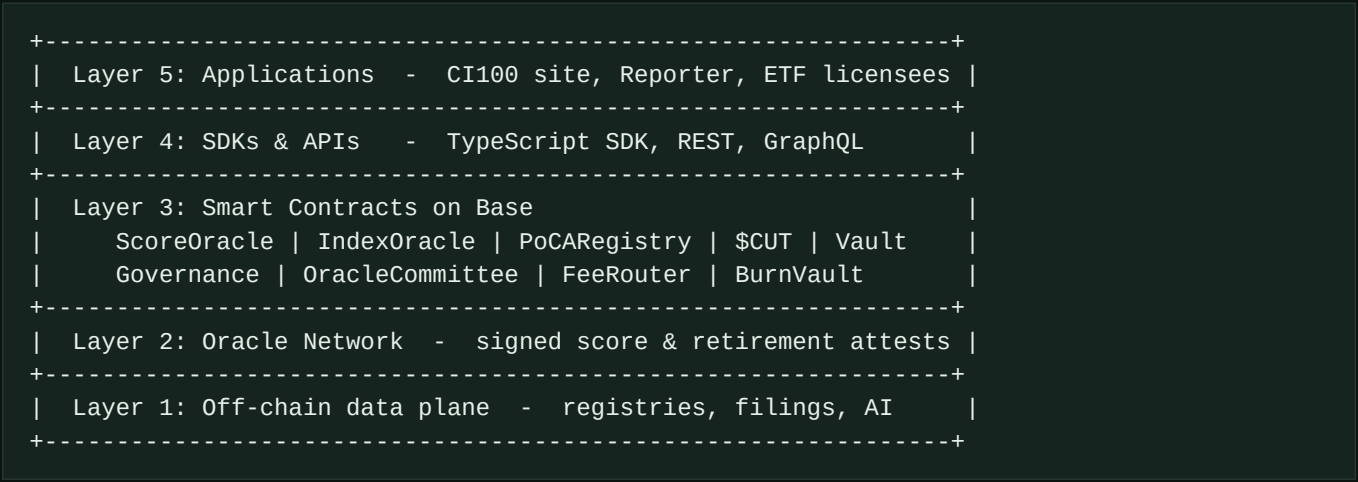
CIP assumes adversaries will try to manipulate the score — via fabricated reports, registry spam, or coordinated news campaigns. Defenses include source reputation weighting, cross-source agreement requirements, anomaly detection on input distributions, and a public bug bounty for demonstrating score manipulation.

SECTION 7

Protocol Architecture — On-Chain Stack on Base

CIP runs natively on **Base**, Coinbase's Ethereum L2. Base was chosen for predictable sub-cent transaction costs, deep USD-stablecoin liquidity (USDC native), open-source Optimism Bedrock stack, and regulatory clarity from a US-domiciled L2 operator. Ethereum L1 is used as a settlement mirror for canonical state roots.

7.1 Layered view



7.2 Core contracts

Contract	Responsibility
ScoreOracle	Stores latest CIP Score per ticker as Merkle root; updated monthly via committee threshold signature.
IndexOracle	Publishes daily CI100 index value & constituent weights; sourced from ScoreOracle + price feeds.
PoCARegistry	Mints EIP-712 retirement receipts; immutable, with credit serial, registry, buyer, claim string.
CUT (ERC-20)	Hard-capped utility token. Permit (EIP-2612), burnable, votes-enabled (ERC-20Votes).
FeeRouter	Routes 1% retirement fees: 50% to BurnVault, 50% to public Vault treasury.
BurnVault	Executes $CUT burns against attested PoCA volume; emits CarbonBurn events.
Vault	Append-only log of every score change, retirement, controversy flag, governance action.
Governance	OpenZeppelin Governor + TimelockController; 48h minimum delay on all upgrades.
OracleCommittee	BLS threshold-signature multisig for score & index publication; rotation every 6 months.

7.3 Upgradeability

CIP uses the OpenZeppelin Transparent Proxy pattern **only** for the off-chain-facing oracles (ScoreOracle, IndexOracle), and only behind a 48-hour timelock controlled by Governance. The token, PoCARegistry, BurnVault, and Vault are **non-upgradeable** by design: their guarantees are worthless if they can be retroactively changed.

7.4 Multi-chain strategy

- **Base** — primary settlement, all user actions, all economic activity.
- **Ethereum L1** — weekly state-root anchoring for regulatory-grade durability; PoCA receipt mirroring.

- **EVM L2s (Arbitrum, OP Mainnet)** — read-only mirrors via standard bridges for cross-ecosystem composability.
- **Non-EVM** — deliberately out of scope for v1.0; revisited if a credible enterprise demand case emerges.

7.5 Gas & performance

Typical operation costs on Base at 2026 baseline gas: PoCA mint ≈ 110k gas, score-root publish ≈ 65k gas, $CUT transfer ≈ 35k gas, burn ≈ 30k gas. Retirement throughput at sustained pricing is > 50 receipts per second — ample for projected VCM volume even under aggressive growth scenarios.

SECTION 8

Proof-of-Carbon-Action (PoCA)

PoCA is the canonical EIP-712 typed-data standard for recording the retirement of a carbon credit on-chain. Every PoCA receipt is a cryptographically signed, immutable record that links a registry-side retirement to an on-chain claim. PoCA is open: any wallet, any registry bridge, any ESG platform can mint receipts — they do not have to use CIP's UI or pay $CUT to do so. The fee applies only when the buyer wants the retirement to count for CIP Score and Vault indexing.

8.1 Receipt structure

```
struct PoCAReceipt {
  bytes32 serialHash;        // keccak256(registry || projectId || vintage || serialRange)
  bytes32 registryId;        // VERRA, GOLDSTANDARD, ACR, ARTT, CAR, PURO, ISO
  uint256 quantityTonnes;    // tCO2e, fixed 6 dp
  uint16  vintageYear;       // e.g. 2024
  uint8   creditType;        // 0 = avoidance, 1 = reduction, 2 = removal
  address beneficiary;       // who claims the climate benefit
  bytes32 claimHash;         // keccak256 of the human-readable claim string
  uint64  retiredAt;         // unix seconds, registry-side
  uint64  mintedAt;          // unix seconds, on-chain
  bytes32 cipScoreRoot;      // ScoreOracle root at time of mint
  bytes   attestation;       // BLS aggregate signature of attesters
}
```

8.2 Mint flow

- Buyer (or their broker) executes the retirement on the source registry.
- Registry bridge agent observes the retirement event and prepares the receipt payload.
- At least **3 independent attesters** from the Oracle Committee verify the retirement against the registry's public record and sign EIP-712.
- PoCARegistry verifies the aggregate signature, deduplicates against the serialHash (no double-mint), and emits a PoCAMinted event.
- FeeRouter collects the 1% fee in USDC, splits 50/50 between BurnVault and the public Vault treasury.

- BurnVault computes the $CUT burn quantity from the attested tCO■e via the burn curve (§10.4) and executes the burn in the same transaction.

8.3 What PoCA prevents

Failure mode	PoCA mitigation
Double-claim	serialHash is unique; second mint reverts.
Phantom retirement	3-of-N attester signatures required; attesters are slashable.
Claim drift	claimHash is bound to the receipt; the human-readable text is publicly resolvable.
Registry rugpull	Registry-side reversal is recorded as a PoCA invalidation event; never silently deleted.
Beneficiary swap	Beneficiary is set at mint and cannot be transferred; secondary 'claim transfer' is a separate event.

SECTION 9

The Vault — Append-Only Public Ledger

The Vault is CIP's public memory. Every state change that matters — PoCA mint, score update, controversy flag, governance vote, registry bridge incident — produces a Vault entry. Entries are append-only, content-addressed (keccak256), and indexed off-chain into a public GraphQL endpoint mirrored across multiple providers.

9.1 Entry types

- **RetirementEntry** — wraps a PoCA receipt with denormalized fields for human consumption.
- **ScoreEntry** — per-ticker score change with prior value, new value, delta drivers, and model version.
- **ControversyEntry** — surfaced AI signal with classification, source URL hash, severity, and reviewer attestation.
- **GovernanceEntry** — proposal, vote tallies, execution result, and timelock metadata.
- **IncidentEntry** — oracle disagreement, registry data outage, attester slash, or methodology change.

9.2 Why append-only matters

In conventional ESG data, history is silently rewritten. A vendor restates a methodology, a score from two years ago is overwritten, and the audit trail vanishes. The Vault forbids deletion: a correction is itself an entry that references the prior entry's hash. The full lineage of every score, every retirement, every controversy is reconstructable forever.

9.3 Consumption

```
query {
  retirements(ticker: "MSFT", first: 50) {
    serialHash registry quantityTonnes vintageYear creditType
    beneficiary claim mintedAt poca { txHash }
  }
  scores(ticker: "MSFT", first: 12) {
    asOf cip carbonActivity creditQuality esg transition
    financial sentiment innovation drivers { name delta }
  }
}
```

SECTION 10

$CUT Tokenomics & Deflationary Burn Loop

$CUT (Carbon Utility Token) is the gas of the CIP protocol. It is hard-capped, non-inflationary, and structurally deflationary as PoCA volume grows. It is not a security, not a carbon credit, and confers no claim on carbon removal. Its purpose is to align the long-term incentives of protocol participants — oracle attesters, governance voters, integrators, and end users — with the integrity of the on-chain record.

10.1 Hard parameters

Parameter	Value
Name / symbol	Carbon Utility Token / $CUT
Standard	ERC-20 with EIP-2612 permit, ERC-20Votes
Total supply	1,000,000,000 (1B) — hard-capped, no mint function
Network	Base (canonical), Ethereum L1 (bridged mirror)
Decimals	18
Initial circulating	120,000,000 (12%)

10.2 Allocation

Bucket	Allocation	Vesting
Ecosystem & Integrators	30%	6-yr linear, 0 cliff
Protocol Treasury (Vault)	20%	Governed; 4-yr linear unlock
Community & Liquidity	15%	Programmatic, milestone-gated
Team	15%	12-mo cliff, 36-mo linear

Bucket	Allocation	Vesting
Early Backers	10%	12-mo cliff, 24-mo linear
Oracle & Validator Incentives	5%	5-yr linear, performance-gated
Public Sale / TGE Liquidity	5%	Unlocked at TGE

10.3 Utility

- **Gas for premium operations** — PoCA minting fees, score-data subscriptions, ETF index licensing.
- **Oracle staking** — attesters bond $CUT; misbehavior is slashed proportional to economic harm.
- **Governance** — 1 $CUT = 1 vote on protocol parameters via OpenZeppelin Governor.
- **Discounts** — fees paid in $CUT receive up to 20% discount vs. USDC equivalent.

10.4 Burn loop

The burn loop is the mathematical link between real-world climate action and $CUT scarcity. For every tonne of CO■e retired through a PoCA receipt, a deterministic quantity of $CUT is burned from the BurnVault:

```
burn_amount = min(
  BurnVaultBalance,
  k * tCO2e_retired * (1 / max(1, sqrt(months_since_TGE)))
)

k = 0.50 $CUT per tCO2e at TGE
```

The decay term ensures that burns are denser in the bootstrap years (rewarding early integrators) and asymptote toward a sustainable long-run rate. Burns are executed atomically with PoCA mints, are publicly verifiable, and emit CarbonBurn(serialHash, tonnes, burned) events indexed in the Vault.

10.5 Fee economics

Every paid PoCA mint pays a 1.0% notional fee in USDC (or 0.8% if paid in $CUT). 50% is routed to the BurnVault; 50% accrues to the public Vault treasury, governed by token holders to fund integrator grants, audits, and public goods. CIP itself takes **zero** protocol-level rent beyond what governance approves.

SECTION 11

Oracles, Data Pipeline & Registry Bridges

11.1 Oracle Committee

Score and index data move from the off-chain world to on-chain state through the Oracle Committee — a rotating set of 9 independent attester nodes operated by qualified third parties (audit firms, data vendors,

climate-research institutions, the CIP foundation). Publication requires a BLS aggregate signature from at least 6 of 9. Attesters bond $CUT and are slashed for proven misreporting, censorship, or extended downtime.

11.2 Registry bridges

Each major registry has a dedicated bridge agent that polls the registry's public retirement endpoints (or, where available, signed exports), normalizes the event into the PoCA schema, and submits to attesters for verification. Bridges are open-source; anyone can run one. Bridges do not custody anything: they translate, they do not authorize.

Registry	Bridge status v1.0	Notes
Verra (VCS)	Production	API + scraped CSV reconcile
Gold Standard	Production	Public API
American Carbon Registry	Production	Public API
Climate Action Reserve	Production	Scraped, dual-source
ART TREES	Beta	Manual snapshot until API
Puro.earth	Production	API
Isometric	Beta	Direct partnership

11.3 Price & reference data

The IndexOracle consumes equity prices from Chainlink-compatible feeds with a fallback to a CIP-operated, multi-source aggregator (3 vendors, median, 5% outlier reject). FX is sourced identically. All price inputs are timestamped and stored alongside the index value so any published CI100 print can be replayed.

11.4 Liveness & failure handling

- If < 6 attesters sign within a publication window, the prior on-chain value persists and an IncidentEntry is written.
- If a registry bridge is offline for > 6h, affected tickers are flagged *stale* in the Vault and excluded from score updates until reconciliation.
- Emergency pause is governance-only, time-locked 24h, scoped to specific contracts — there is no global kill-switch.

SECTION 12

Security Model & Audit Plan

12.1 Threat model

- **Economic** — attacker mints fake PoCA receipts to manipulate burn rate or inflate index activity.

- **Oracle** — collusion of ≥ 6 attesters to publish false scores.
- **Registry-side** — malicious or compromised registry employee reverses a retirement post-mint.
- **Data** — fabricated PDFs or AI-generated reports designed to fool the extraction pipeline.
- **Governance** — hostile token concentration attempting an upgrade that breaks integrity guarantees.

12.2 Mitigations summary

Layer	Mitigation
Contracts	Two independent audits pre-mainnet (Trail of Bits, Spearbit or equiv.); formal verification of PoCARegistry & BurnVault.
Oracles	9-of-9 attester rotation, BLS threshold 6/9, slashing, public liveness dashboard.
Bridges	Open-source, reproducible builds; bug bounty up to USD 250k via Immunefi.
AI	Held-out evals, model lineage on-chain, human attestation gate for material changes.
Governance	48h–168h timelocks scaled to action severity; minority veto on token-economic changes.
Process	Annual third-party SOC 2 Type II for the off-chain data plane.

12.3 Disclosure

CIP runs a coordinated disclosure program (security@cip). Hall-of-fame published. Critical fixes receive a 7-day pre-announcement to integrators and a public post-mortem within 30 days of patch deployment.

SECTION 13

Governance & Decentralization Roadmap

Governance is the slowest-moving part of CIP on purpose. Score formulas, index methodology, and economic parameters are powerful tools — changes ripple through markets, into ETFs, and onto corporate balance sheets. CIP's governance is therefore designed for legitimacy first, agility second.

13.1 Three-stage path

Stage	Window	Authority
Foundation	TGE → Y1	Multisig council of 7 publicly identified signers; all actions time-locked 48h; methodology committee advisory.
Hybrid	Y1 → Y2	Token holders vote on parameters; council retains veto on integrity-critical changes; methodology committee binding on score formula.
Decentralized	Y2+	Token-governed with constitutional protections; council dissolved; methodology committee elected.

13.2 Constitutional protections

- **Hard caps** — $CUT supply, fee rate ceiling (2%), and burn-curve k cannot be raised by any vote.
- **Append-only** — the Vault contract is non-upgradeable. Period.
- **Sector/region caps** on the index can be tightened but not loosened beyond v1.0 baseline.
- **Minority quorum** — changes to scoring weights require > 30% turnout and 67% approval, with a 168h timelock.

13.3 Methodology committee

A standing committee of 11 experts (climate science, accounting, finance, registry operations, AI/ML) is the binding authority on CIP Score formula changes. Members serve staggered 2-year terms; appointment moves from foundation-selected to community-elected during the hybrid stage.

SECTION 14

Risk Framework

Risk	Likelihood	Impact	Mitigation
Methodology error in CIP Score formula	Medium	High	Open methodology, quarterly third-party review, version-pinning, replay tooling.
Registry API outage / data drift	High	Medium	Multi-source ingest, stale flags, manual reconciliation SLA < 48h.
Adversarial AI inputs (fabricated docs)	Medium	Medium	Source-reputation weighting, anomaly detection, human attestation.
Smart contract vulnerability	Low	Critical	Two independent audits, formal verification of PoCA/Burn, bug bounty USD 250k.
Regulatory reclassification of $CUT	Medium	High	Designed-utility token, no profit-share, legal opinions in major jurisdictions.
Index licensee misuse (synthetic ETF)	Medium	Medium	License terms require IntegrityAdj disclosure; revocation rights on misuse.
Governance capture	Low	High	Constitutional caps, methodology committee, minority veto, timelocks.
Carbon-credit reversal at registry	Medium	Medium	PoCA invalidation events, transparent in Vault, score penalty automatic.

SECTION 15

Roadmap 2026 — 2028

2026 — Mainnet & CI100 v1

- Mainnet launch on Base; ScoreOracle, IndexOracle, PoCARegistry, $CUT live.
- CI100 v1 published daily; web app, Reporter, and Vault GraphQL in production.
- First two registry bridges (Verra, Gold Standard) operating with 3 independent attesters.
- Two-firm contract audit + formal verification of PoCA/BurnVault complete.

2027 — Index licensing & expansion

- Index licensing to first qualified ETF / structured-note issuers.
- All major registries (ACR, CAR, ART TREES, Puro.earth, Isometric) in production bridge.
- Oracle Committee expanded to 9 attesters; first community-elected seats.
- Hybrid governance stage begins; methodology committee binding on score-formula changes.

2028 — Decentralization & institutional scale

- Foundation council dissolved; full DAO governance with constitutional protections.
- CI100 + sectoral sub-indices (CI-Energy, CI-Industrials, CI-Tech, CI-Financials).
- Cross-chain canonical mirrors on Ethereum L1 + selected EVM L2s.
- Public, audited integration with at least one G7 sovereign sustainability disclosure regime.

SECTION 16

Conclusion

The first phase of the voluntary carbon market was built on trust and PDFs. It produced real climate action and real scandals in roughly equal measure, and it cannot be the substrate on which a USD 100B+ market is built. The second phase requires infrastructure that makes integrity the default, not the exception.

Carbon Index Protocol is that infrastructure. The CI100 makes climate-material companies comparable. The CIP Score makes integrity measurable. PoCA makes retirements verifiable. The Vault makes history honest. $CUT aligns the economic incentives of everyone who participates with the long-term credibility of the system. And by running on Base, with open source and open methodology, CIP is governed by its users — not its founders.

There is a version of the 2030 carbon market that is mostly theater: bigger numbers, same problems, periodic scandals, eroding policy support. There is another version that is verifiable: every claim traceable, every retirement final, every score reproducible, every actor accountable. CIP is built for the second version.

Get involved

Read the open methodology, run a registry bridge, attest as an oracle, license the index, or contribute to the AI evaluation suite. Everything is public. **c100.w3ai.io**

APPENDIX A

EIP-712 Schemas

A.1 PoCAReceipt typed data

```
domain = {
  name: "CarbonIndexProtocol",
  version: "1",
  chainId: 8453,                    // Base mainnet
  verifyingContract:
}

types.PoCAReceipt = [
  { name: "serialHash",      type: "bytes32" },
  { name: "registryId",      type: "bytes32" },
  { name: "quantityTonnes",  type: "uint256" },
  { name: "vintageYear",     type: "uint16"  },
  { name: "creditType",      type: "uint8"   },
  { name: "beneficiary",     type: "address" },
  { name: "claimHash",       type: "bytes32" },
  { name: "retiredAt",       type: "uint64"  },
  { name: "cipScoreRoot",    type: "bytes32" }
]
```

A.2 ScoreAttestation typed data

```
types.ScoreAttestation = [
  { name: "asOf",         type: "uint64"  },
  { name: "merkleRoot",   type: "bytes32" },
  { name: "modelVersion", type: "bytes32" },
  { name: "snapshotURI",  type: "string"  }
]
```

APPENDIX B

$CUT Emission & Burn Curve

The table below illustrates expected circulating supply under a base-case assumption of 25 MtCO■e retired through PoCA in Y2, growing 35% YoY. Actuals will differ; the curve is fully deterministic given inputs.

Year	Unlocks (M $CUT)	Burns (M $CUT)	End circulating (M)
Y0 (TGE)	120	0	120
Y1	180	8	292
Y2	170	11	451

Year	Unlocks (M $CUT)	Burns (M $CUT)	End circulating (M)
Y3	150	13	588
Y4	130	14	704
Y5	110	15	799
Y6+	Tapering	Compounding	Approaches 880–920M, then declines

With base-case adoption, burns overtake net unlocks by Y6 and supply enters secular decline. Under aggressive adoption (50 MtCO■e Y2, 50% YoY), the crossover occurs by Y4.

APPENDIX C

Glossary

Term	Definition
Additionality	Whether emissions reductions would have occurred without the carbon-credit incentive.
Attester	An oracle-committee node that cryptographically signs CIP state transitions.
Avoidance	Credits from preventing emissions that would otherwise occur (vs. removal).
Base	Coinbase's Ethereum L2; CIP's canonical settlement layer.
CCP	Core Carbon Principles — ICVCM integrity benchmark.
CI100	CIP's flagship index of 100 most carbon-material listed companies.
CIP Score	Composite 0–100 integrity metric, seven-pillar formula.
CSRD	EU Corporate Sustainability Reporting Directive.
EIP-712	Ethereum standard for typed, structured-data signatures.
MRV	Monitoring, Reporting, Verification — the lifecycle of project data.
PoCA	Proof-of-Carbon-Action — CIP's on-chain retirement-receipt standard.
Removal	Credits from actively removing CO■ from the atmosphere (durable preferred).
SBTi	Science Based Targets initiative — corporate target validator.
Vault	CIP's append-only, public, on-chain ledger of state changes.
VCM	Voluntary Carbon Market.

Carbon Index Protocol c100.w3ai.io · Whitepaper v1.0 · May 2026

This whitepaper is informational and does not constitute investment, tax, or legal advice. $CUT is a utility token, not a security, not a carbon credit, and confers no claim on carbon removal. Forward-looking statements are subject to change as the protocol evolves under public governance.