



# SDG BLOCKCHAIN ACCELERATOR

## ROADMAP

## **UNDP Challenge**

India generates over 13 billion liters of industrial wastewater every day, with textile clusters such as Tiruppur, Surat and Ludhiana among the largest contributors. Common Effluent Treatment Plants (CETPs) were established to manage this load, yet many struggle with high operating costs, limited resources and weak enforcement mechanisms.

Monitoring is largely manual and paper-based, creating delays and opportunities for data manipulation. As a result, untreated or partially treated effluents are often discharged into rivers, contributing to declining water quality, health risks for local communities and missed opportunities for climate impact recognition.

From a climate perspective, untreated effluents release methane ( $\text{CH}_4$ ), a greenhouse gas with 25-32 times more warming potential than  $\text{CO}_2$ . However, these emissions are rarely measured or accounted for in India's climate action pathways.

This creates a dual challenge: ensuring reliable, real-time compliance with water quality norms while also enabling recognition of climate co-benefits from improved effluent treatment.

## **Local Context**

India's textile and industrial clusters — such as Tiruppur (Tamil Nadu), Surat (Gujarat) and Ludhiana (Punjab) — depend heavily on Common Effluent Treatment Plants (CETPs) to manage wastewater from hundreds of small and medium industries. These CETPs are vital for safeguarding local rivers and groundwater, yet many face chronic underfunding, irregular operations and weak monitoring systems.

Communities downstream bear the brunt of untreated or partially treated effluents, experiencing degraded water quality, health risks and loss of livelihoods tied to agriculture and fisheries. Local governments and SPCBs are mandated to enforce compliance but lack real-time visibility, relying instead on manual sampling and delayed lab results.

Over the years, various measures — subsidies, stricter norms and inspections — have been attempted, but systemic gaps in financing, accountability and transparency remain. The private sector (industries using CETPs) often views wastewater treatment as a cost burden rather than an opportunity for sustainability.

In this context, addressing CETP performance is critical not only for India's water security but also for its climate commitments. By aligning government oversight, industry responsibility and community well-being, the challenge becomes central to advancing SDG 6 (Clean Water and Sanitation), SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action) in the Indian context.

## **Relevance to UNDP CO Priorities and Resource Mapping**

This project on blockchain-based CETP digitalization is closely aligned with the UNDP Country Office's broader objectives of advancing climate action, circular economy and sustainable industrialization. It strengthens India's climate commitments by transforming CETPs into transparent, data-driven systems that support compliance, resource efficiency and access to climate finance. The initiative is positioned under the Circular Economy vertical of UNDP India, ensuring strategic coherence with ongoing programmes on waste, plastics and resource efficiency.

The project builds on UNDP's prior work with industrial clusters and waste management initiatives, where digital tools, ESG-linked finance and inclusive approaches were introduced to enhance sustainability outcomes. It extends these learnings by integrating IoT, AI/ML and blockchain-backed MRV frameworks, enabling CETPs to move beyond compliance toward measurable environmental and climate outcomes. By linking verified water and carbon credits to green finance, the project demonstrates how UNDP can bridge innovation with systemic impact at scale.

Co-financing is currently available in the form of human resources, outreach and networking support through UNDP's circular economy programme, which will help mobilize partnerships and resources for the pilot. This foundation positions the project to leverage both internal and external financing opportunities for future scale-up and replication.

## **Expected Impact (from CO perspective)**

From the Country Office perspective, the blockchain-based CETP project is expected to generate **systemic, scalable and demonstrable impact** across UNDP's strategic priorities. It will:

- Strengthen **climate action and circular economy outcomes** by enabling transparent, verifiable monitoring of CETP operations, thereby reducing industrial pollution and contributing to India's NDC and SDG commitments.

- Enhance **governance and accountability** through blockchain-enabled traceability, ensuring compliance, reducing risks of data manipulation and building trust among regulators, industries and financiers.
- Unlock access to **ESG-aligned and climate finance** by generating credible, verifiable data on water and carbon savings, thereby positioning CETPs and industrial clusters for green investments.
- Support **inclusive development** by creating pathways to integrate gender-sensitive approaches, skill-building and fair incentives in circular economy transitions.
- Demonstrate UNDP India's role as a **knowledge and innovation partner**, showcasing the application of frontier digital technologies (IoT, AI/ML, blockchain) to solve persistent industrial sustainability challenges.

The project is expected to **position UNDP as a catalyst** for scaling innovative climate-tech solutions in India's industrial ecosystem, while contributing to global learning and replication.

## Target SDGs and SDG Indicators

### SDG 6: Clean Water and Sanitation

- **Indicator 6.3.1: Proportion of domestic and industrial wastewater flows safely treated.**  
→ CETP monitoring ensures higher compliance and transparent treatment records.
- **Indicator 6.3.2: Proportion of bodies of water with good ambient water quality.**  
→ Real-time CETP data contributes to measurable improvements in river and groundwater health.

### SDG 12: Responsible Consumption and Production

- **Indicator 12.4.1: Number of parties to international agreements on hazardous waste and chemicals that meet commitments and obligations.**  
→ Strengthened CETP operations improve hazardous effluent handling and align with national reporting obligations.

- **Indicator 12.6.1: Number of companies publishing sustainability reports.**  
→ CETP data enables industry clusters to report verified sustainability outcomes.

## ⑨ SDG 13: Climate Action

- **Indicator 13.2.2: Total greenhouse gas emissions per year.**  
→ Verification of methane ( $\text{CH}_4$ ) and  $\text{CO}_2\text{e}$  reductions from effluent treatment adds to national GHG accounting.
- **Indicator 13.3.2: Number of countries with integrated mitigation, adaptation, impact reduction and early warning into curricula and policies.**  
→ Digital MRV pilots like KarbonLedger inform national climate policies and India's NDC implementation.

## User & Problem Mapping

Understanding the users and stakeholders affected by the challenge is essential for building impactful and context-aware solutions. This section helps articulate who the primary users are, what they aim to achieve and which other actors are involved or impacted.

### Primary User Persona

CETP Operator / Plant Manager (industrial wastewater treatment facility)

#### Environment:

- Works within a **cluster-based CETP**, serving 50–200 textile or small industries.
- Operates in a resource-constrained setting with **limited staff, tight budgets** and pressure from both **industries** (for cost savings) and **regulators** (for compliance).
- Relies on **manual sampling, paper-based logs and intermittent lab results** to demonstrate compliance.

#### Goals:

- Ensure **continuous compliance** with State Pollution Control Board (SPCB) discharge norms.
- Maintain **ETP/CETP uptime** while minimizing **operational costs** (electricity, chemicals, staff).
- Build **trust with regulators and industries** by showing transparent treatment performance.
- Future ambition: unlock access to **incentives or carbon finance** linked to pollution reduction.

## Challenges:

- No real-time visibility of key parameters (COD, BOD, TDS, flow).
- Data integrity concerns — manual logs can be disputed or questioned.
- High operating costs without offsetting revenue streams.
- Regulatory burden — frequent inspections and paperwork with risk of penalties for lapses.
- Limited technical capacity to integrate advanced digital tools without external support.

## User Story

### Primary User Story (CETP Operator)

"As a CETP Operator, I want to continuously monitor and verify effluent treatment performance, so that I can ensure compliance with SPCB standards, reduce operational risk and build trust with regulators and industries."

### Supporting User Stories

#### SPCB Regulator

"As a SPCB officer, I want real-time access to tamper-proof CETP performance data, so that I can enforce compliance more effectively and ensure that untreated effluents don't harm rivers and communities."

#### Community Member (Downstream Resident)

"As a community member living near an industrial cluster, I want assurance that CETPs are operating properly, so that I can have cleaner water, reduced health risks and a safer environment."

## ESG Funder / Investor

"As a climate-focused investor, I want transparent and verified metrics of pollution reduction, so that I can channel finance into projects that deliver measurable environmental and climate impact."

## UNDP / Development Partner

"As UNDP, I want to showcase scalable digital MRV solutions for wastewater treatment, so that member states can adopt them to advance SDGs on water, climate and sustainable industry."

## Key Stakeholders/Partners

### Government & Regulators

- **State Pollution Control Boards (SPCBs)** → Compliance enforcement, oversight and data governance.
- **Ministry of Environment, Forest and Climate Change (MoEFCC)** → Alignment with national wastewater and climate policies.
- **Local Municipal/Industrial Development Bodies** → Cluster-level support and integration.

### Industry & Operators

- **CETP Operators and Associations** (e.g., in Tiruppur, Surat, Ludhiana) → Primary users of the dashboard.
- **Cluster Industries (Textiles, SMEs)** → Beneficiaries of better CETP performance and compliance credibility.

### Development Partners

- **UNDP India** → Challenge owner, policy alignment, accelerator support and scaling through SDG agenda.
- **International Development Agencies / Donors** → Potential funders for replication and scale.

### Communities & Civil Society

- **Local Communities (downstream users, farmers, residents)** → Benefit from improved water quality and reduced health risks.
- **Worker Cooperatives at CETPs** → Engage in daily operations and governance of treatment facilities.
- **Environmental NGOs** → Advocacy, watchdog role and awareness-building.

## Technology Partners

- **KarbonLedger** → Technology backbone (IoT integration, AI-driven MRV, blockchain-secured reporting, Streamline dashboard).
- **IoT Device Providers** → Sensors for COD, BOD, flow and energy.
- **Auditors & Validators (3rd-party)** → Independent verification of data integrity and environmental claims.

## Finance & Market Partners (Future Stage)

- **ESG Funds / Carbon Credit Buyers** → Monetization pathway once verified reductions can be tokenized.
- **CSR Contributors from Textile Exporters** → Potential co-financing for CETP digitization.

## Solution Summary

Streamline — Powered by KarbonLedger is a **real-time monitoring and compliance dashboard** designed for **Common Effluent Treatment Plants (CETPs)**. It integrates **IoT sensors, AI verification models** and **blockchain-backed reporting** to provide a single trusted platform for operators, regulators and stakeholders.

By automating **data capture, verification and reporting**, Streamline addresses the critical gaps of **manual monitoring, data integrity issues and delayed enforcement**. Operators gain real-time visibility and insights to optimize plant performance, while regulators receive tamper-proof compliance records to strengthen enforcement and policymaking.

The solution is **unique** in combining:

- **Real-time effluent monitoring** (COD, BOD, flow, energy) via IoT and DePIN architecture.
- **AI-driven MRV (Measurement, Reporting, Verification)** that converts wastewater treatment results into verifiable metrics, including climate-relevant CO<sub>2</sub>e reductions.
- **Blockchain-secured audit trails** ensuring transparency, accountability and trust across all stakeholders.

## Relevance:

This solution is directly aligned with **India's CETP and water security challenges**, UNDP's **climate and sustainability agenda** and provides a scalable template for **policy innovation, systems improvement and future carbon asset monetization**.

## Core Functionalities

- **Real-Time Effluent Monitoring** – Continuous capture of key parameters (COD, BOD, TDS, pH, flow and energy use) through IoT sensors, giving CETP operators and regulators live visibility.
- **AI-Driven Verification & Insights** – Automated MRV (Measurement, Reporting, Verification) that validates pollution reduction, quantifies CO<sub>2</sub>e savings and provides predictive analytics for early warnings and optimization.
- **Blockchain-Secured Compliance Records** – Immutable, tamper-proof data logs and audit trails stored on KarbonLedger, ensuring regulators (SPCBs) can trust reported data.
- **Automated Compliance Reporting** – Seamless generation and submission of reports to regulators, reducing manual paperwork and accelerating enforcement.
- **Climate Impact Tracking** – Linking effluent treatment outcomes to measurable GHG reductions, creating a pathway for future carbon credit monetization.
- **Multi-Stakeholder Dashboard** – Role-based access for CETP operators, regulators, communities and partners, ensuring transparency and alignment across all stakeholders.
- **Alerts & Anomaly Detection** – Real-time notifications for operators and regulators on equipment failures, non-compliance risks, or parameter drifts, enabling rapid intervention.

## Tech Stack Overview

### Front-End (User Interface)

- **React (with TypeScript)** – Component-driven architecture.
- **shadcn/ui + Radix UI** – Modern, accessible UI components.
- **Tailwind CSS** – Utility-first styling with custom tokens.

### Back-End (Application Layer)

- **FastAPI / Node.js** microservices for data ingestion and business logic.
- **AI models** for pollution → CO<sub>2</sub>e mapping and anomaly detection.
- APIs for reporting integration with SPCB compliance systems.

### Data Sources & Integrations

- IoT sensors (COD, BOD, TDS, pH, flow, energy).
- CETP operational logs and SPCB reporting frameworks.
- Cloud infrastructure for storage, analytics and visualization.

## Security & Infrastructure

- Encrypted IoT data pipelines.
- Tamper-proof audit logs on blockchain.
- Decentralized storage for critical compliance data (IPFS / Arweave)

## Cardano-Specific Elements

KarbonLedger leverages **Plutus v3 smart contracts** written in **Aiken** to ensure transparency, auditability and interoperability:

- **Verifiable Credentials (VCs)**: Each compliance or emissions record can be hashed and issued as a credential, referenced on-chain.
- **Token Minting / Burning**:
  - **CET (Carbon Emission Tokens)** minted by industries based on effluent/emission data.
  - **COT (Carbon Offset Tokens)** minted upon project validation and burned 1:1 with CETs for verified offsets.
- **Marketplace & Crowdfunding**:
  - Smart contracts (**marketplace.ak**, **crowdfunding.ak**) enable tokenized credit trading, campaign funding and transparent royalty flows.
- **Identification NFT**: A singleton NFT anchors the platform's **ConfigDatum** for protocol-wide settings (fees, categories, multisig validators).
- **Metadata Tagging**: All transactions carry SDG-linked metadata to tie blockchain activity directly to UNDP-aligned outcomes.
- **Multisig Validation**: Regulatory bodies and consortium members participate in project approvals and token minting via multisig schemes (**project\_validation** contract)

## Prototype Plan (Sprint-Based)

This section outlines the team's rapid prototyping plan. The goal is to build a functional and demonstrable version of the solution within 10 working days, with user feedback integrated.

## Prototype Goal

Our goal is to build and validate a **working prototype of the Streamline CETP Dashboard — Powered by KarbonLedger** that demonstrates the end-to-end workflow of **real-time effluent monitoring, AI verification and blockchain-secured compliance reporting**.

Specifically, during the sprint we aim to:

- Visualize **IoT sensor data streams** (COD, BOD, flow, energy) on the dashboard.
- Validate and map pollution reduction into climate metrics (CO<sub>2</sub>e).
- Establish **blockchain audit trails** for tamper-proof data storage and regulator-ready compliance logs.
- Deliver a **role-based interface** where operators and regulators can visualise stakeholder specific dashboards.

This prototype will serve as the **first validated instance** of the broader MVP vision — a scalable, decentralized compliance and climate-impact platform for CETPs that can be replicated across industrial clusters.

## Expected Outputs

- **data-to-ledger interaction mock** → Sensor data (COD, BOD, flow, energy) ingested into the Streamline dashboard, processed by AI and hashed on-chain.
- **On-chain or hashed compliance record with SDG metadata** → Each record tagged to relevant SDG indicators.
- **Demo-ready user interface** → Role-based dashboard for CETP operator and SPCB regulator, with data display and auto-generated compliance reports.
- **AI verification module architecture** → Pollution reduction mapped to estimated CO<sub>2</sub>e savings with explanation logs.
- **Stakeholder validation sessions** → Feedback from CETP operators and UNDP team to refine functionality and usability.

## Sprint Timeline

Day	Description	Outcome
1	Define prototype scope & map SDG indicators (6, 12, 13)	Clear sprint scope, success metrics and SDG alignment
2-3	UX flow design for operator, regulator, verifier/auditor and buyer/investor dashboards	Figma/flow mockups ready

4-5	UI implementation of core dashboard screens with role-based login	Frontend in place
5-7	Blockchain integration (hash compliance record + SDG metadata)	Tamper-proof record tested
8	Mid-sprint review & QA with UNDP team	Testing link available for review
9	Iteration & polish (UI fixes, bug resolution, incorporate feedback)	Demo-ready version completed
10	Final submission & walkthrough demo	All deliverables done, end-to-end prototype showcased

## Success Metrics & Milestones

### Sprint Phase

Focus: Rapid prototyping, initial user testing and validation of core functionality.

Category	Baseline Metric
Blockchain Interaction	<ul style="list-style-type: none"> <li><b>Metric:</b> At least one meaningful blockchain function tested → CETP data (COD/flow) hashed on-chain with SDG metadata.</li> <li><b>Milestone:</b> Blockchain integration complete (Days 5-7), tamper-proof record demonstrated.</li> </ul>
User Interface	<ul style="list-style-type: none"> <li><b>Metric:</b> Minimum one working dashboard screen with role-based login for operator &amp; regulator.</li> <li><b>Milestone:</b> Core UI implemented (Days 4-5), functional demo-ready interface in place.</li> </ul>
Stakeholder Testing	<ul style="list-style-type: none"> <li><b>Metric:</b> UNDP stakeholder testing conducted.</li> </ul>

	<ul style="list-style-type: none"> <li>● <b>Milestone:</b> Testing link shared (Day 8), structured feedback gathered and documented.</li> </ul>
SDG Integration	<ul style="list-style-type: none"> <li>● <b>Metric:</b> SDG 6, 12, 13 indicators mapped to on-chain metadata and visible in dashboard reporting.</li> <li>● <b>Milestone:</b> SDG tags embedded and validated during blockchain integration (Days 5-7).</li> </ul>
Demo Readiness	Demo link and video walkthrough prepared and submitted by Day 10.

## Post-Sprint Refinement

Focus: Iterating based on feedback, improving functionality and aligning with pilot opportunities.

Focus Area	Baseline Metric
Feedback Integration	As per feedback from the UNDP team, the dashboard was simplified further for better adaptation.
MVP Stabilization	<ul style="list-style-type: none"> <li>● Conducted <b>functional testing</b> with project registration and blockchain logging.</li> <li>● Ensure <b>no major blockers</b> in end-to-end workflow.</li> <li>● <b>Outcome:</b> Streamline dashboard powered by KarbonLedger, stable and demo-ready for pilot expansion.</li> </ul>
Stakeholder Alignment	<ul style="list-style-type: none"> <li>● <b>Follow-up sessions</b> with UNDP and one meeting with Eduward from Impact Plus .</li> <li>● Discussed pilot opportunities, regulatory integration and decided on the scaling roadmap and feasibility of the Pilot.</li> </ul>

	<ul style="list-style-type: none"> <li>● <b>Outcome:</b> Clear next steps defined for MVP → pilot transition.</li> </ul>
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## Pilot Readiness

Focus: Preparing the solution for deployment and scaling.

Goal Area	Suggested Metric
Institutional Buy-In	<ul style="list-style-type: none"> <li>● We have secured strong institutional engagement with <b>UNDP India</b> and initiated discussions with <b>textile industries in Tiruppur, Tamil Nadu, India</b></li> <li>● Early alignment on <b>pilot exploration</b> has been achieved and draft terms of reference for collaboration have been outlined.</li> </ul>
Financial Feasibility & License Explored	<ul style="list-style-type: none"> <li>● A <b>detailed cost comparison and feasibility assessment document</b> has been submitted to UNDP along with the pilot proposal, one-pager and pitch deck. This package was developed to reach <b>stakeholders and potential investors</b>, ensuring transparency and clarity of the financial roadmap. We are actively engaging with <b>UNDP partners and funding platforms such as Impact Plus</b> to mobilize resources for the pilot.</li> <li>● The licensing framework (AGPLv3 for software, ODbL for data) has also been reviewed, ensuring that Streamline operates on an open and transparent foundation.</li> </ul>
Sustainability Path	<ul style="list-style-type: none"> <li>● A sustainability roadmap has been drafted, positioning <b>Streamline as a regulator-embedded compliance dashboard</b> sustained through CETP operator contributions, SPCB adoption and future <b>carbon finance monetization pathways</b> via KarbonLedger. This ensures a transition from</li> </ul>

	<b>grant-supported pilots to a self-sustaining, climate-finance enabled solution.</b>
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## MVP Planning Table

After the prototype sprint, we have begun shaping the full MVP. This table helps identify what's already been built, what needs improvement and how each component will evolve into a pilot-ready version.

Component	Prototype Status	Improvement for MVP
UI/UX	Basic dashboard screens for operator, regulator, verifier/auditor and buyer/investor roles built	Advanced data visualizations and multilingual support for local operators
Blockchain	On-chain hash of sample CETP data on registry with SDG metadata created	Enable real-time sensor data logs, add QR code verification for compliance certificates and test multi-node validation
SDG Tags	SDG 6, 12 and 13 linked to compliance logs and displayed	Make SDG tags filterable, exportable in reporting formats and integrate with ESG/CSR frameworks
Feedback	UNDP team feedback implemented	Expand to users including CETP operator, SPCB, community reps, auditors and industry associations
AI Verification	Pollution reduction → CO <sub>2</sub> e mapping model design and validation	Expand to development of dataset, improve model accuracy and add explainability (XAI) for regulator trust
IoT Integration	Finalizing on data parameter that needs to be measured using sensors	Connect to live IoT devices in pilot CETPs, add redundancy for uptime

## Risk & Assumptions

Risk/Assumption	Description	Risk Level	Risk Mitigation Strategy
Stakeholder Engagement	CETP operators or SPCB officials may not actively participate in testing or feedback sessions.	Medium	<b>Pre-schedule demo sessions, ensure hands-on walkthroughs and involve UNDP to facilitate regulator participation.</b>
Sensor data reliability	IoT devices may malfunction or deliver inconsistent readings, affecting trust in the dashboard.	Medium	Begin with simulated data + redundant sensors; include QA protocols; run pilot with live sensors in parallel to manual records.
Limited blockchain familiarity	Regulators and CETP operators may not understand blockchain audit trails or trust their usability.	Medium	Provide simplified UI, training materials and clear audit certificates; use "hash proof" visualizations instead of technical jargon.
Integration challenges with SPCB systems	Difficulty aligning Streamline outputs with existing SPCB reporting frameworks.	Medium	Co-design reporting templates with SPCBs during prototype stage; keep export formats flexible (CSV/PDF/API).
Regulatory adoption uncertainty	Even with pilot success, formal policy uptake may be delayed.	High	Leverage UNDP advocacy role; showcase pilot results in policy forums; align with India's NDCs and SDG commitments.
Carbon monetization pathway dependency	Future revenue from carbon credits depends on external validation and market conditions.	Medium	Position monetization as <i>future potential</i> , focus on compliance and transparency benefits now; engage carbon registries early.

Team bandwidth	Small team may face limits in parallel development of IoT, AI and blockchain layers.	Low	Stagger development sprints; leverage accelerator mentors and partner networks for technical support.
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## Team Profile

Name	Role	LinkedIn
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## Challenge Owners

**Challenge Owner Organization Name:**

*Circular Economy vertical, under the Action for Climate & Environment Unit, UNDP, India*

**Team Members & Roles:**

- Dr Shilpi Karmakar, project Manager and Technical specialist

**Area of Focus:**

*Advancing Climate Action and Circular Economy Innovation through Digital Solutions and Sustainable Industrial Practices*

## Notes & Insights

- **Data reliability challenge** → Sensor calibration and consistency emerges as a key factor; pilot project should prioritize redundancy and QA protocols.
- **Climate metrics are motivating** → Stakeholders will appreciate seeing pollution reduction translated into CO<sub>2</sub>e savings linked to SDG indicators; it creates a sense of broader impact.

- Future opportunity → Potential to integrate Streamline outputs with **state-level environmental registries** and, later, **carbon credit registries** to prepare for monetization pathways.

## Pilot Vision & Scalability Plan

### Pilot Vision (3-6 months)

Success in the pilot phase will mean that Streamline proves its value in a real CETP environment, showing measurable improvements in compliance, trust and climate reporting.

Key outcomes we aim to demonstrate:

- **Operational Validation** → Live IoT sensor data (COD, BOD, flow, energy) seamlessly captured, verified with AI and logged on-chain.
- **Regulatory Trust** → SPCB officials using the dashboard for real-time monitoring, automated reporting and enforcement decisions.
- **Stakeholder Alignment** → CETP operators, regulators and UNDP collaborating on a shared, tamper-proof compliance layer.
- **Community Benefit** → Improved water quality indicators for downstream communities, creating measurable SDG impact.
- **Climate Relevance** → Pollution reduction quantified as **CO<sub>2</sub>e savings**, positioning CETPs for future carbon asset monetization.
- **Replicability** → A pilot-tested model that can be documented, standardized and prepared for rollout across multiple industrial clusters in India.

### Target Users or Communities for Pilot

#### CETP Operators & Associations

- Direct users of the Streamline dashboard.
- Benefit from **real-time monitoring, cost optimization and reduced regulatory burden**.

#### Regulators (SPCBs & Pollution Control Boards)

- Primary beneficiaries of **tamper-proof compliance data** and **automated reporting**.
- Pilot focus on **Tamil Nadu (Tiruppur), Gujarat (Surat) and Punjab (Ludhiana)** industrial clusters.

## Local Communities & Downstream Users

- Farmers, residents and small businesses relying on local rivers and groundwater.
- Benefit from **improved water quality** and **reduced health risks**.

## Industry Stakeholders (Textile SMEs & Exporters)

- Gain credibility in ESG reporting and **access to potential climate finance pathways**.
- Strengthened trust with regulators and international buyers.

## Development Partners (UNDP & NGOs)

- Showcase **SDG-linked digital MRV innovation**.
- Create an evidence base for scaling across **other industrial clusters in India** and globally

## Scalability Plan

Streamline — Powered by KarbonLedger will be piloted in select CETPs, but it is designed with scalability in mind.

### Scaling Streamline across CETPs:

- **Replicable architecture:** Once validated, the dashboard can be rapidly deployed across CETPs in other textile and industrial clusters (Surat, Ludhiana, Panipat, etc.).
- **Reusable modules:** IoT integration, AI verification and blockchain logging can be standardized and reused across plants with minimal customization.
- **Institutional adoption:** SPCBs can integrate Streamline outputs into state-level compliance frameworks, creating a unified reporting and monitoring standard.
- **Multi-stakeholder buy-in:** Scaling becomes easier once CETPs, industry associations and regulators see operational and compliance benefits.

### Beyond CETPs – KarbonLedger as a Climate Protocol:

Streamline is one instance (socio-technical context) of KarbonLedger, built specifically for industrial effluent treatment. The underlying **KarbonLedger protocol** is sector-agnostic and can be scaled across **multiple climate domains**, including:

- **Solid Waste Management** → Verifiable diversion, recycling and methane reduction.
- **Renewable Energy** → Tracking generation, usage and CO<sub>2</sub>e avoided.
- **Agriculture & Soil Health** → Measuring regenerative practices, fertilizer use and carbon sequestration.
- **Forestry & Land Use** → Monitoring reforestation, afforestation and biodiversity outcomes.

- **Air Quality & Emissions** → Verifiable reductions in particulate matter and CO<sub>2</sub> from industrial and mobility sources.

#### Vision for scale:

- **India-first adoption** → A standardized dMRV framework for regulators and industries.
- **Regional replication** → Expansion into South Asia and similar industrial ecosystems.
- **Global scaling** → Leveraging UNDP's network to align KarbonLedger with SDG-linked climate financing and reporting frameworks.

#### In essence:

Streamline shows the **proof-of-value in one domain (CETPs)**, while **KarbonLedger as a protocol** ensures scalability and adaptability across a **portfolio of climate solutions** that need trust, verification and financing alignment.

## Support Needed

### Technical Support

- Access to CETPs for **live sensor integration** and operational testing.
- Cloud infrastructure for **scalable, secure deployments**.

### Policy & Regulatory Support

- Endorsement from **SPCBs** to recognize blockchain-backed digital compliance records as valid supplementary reporting.
- Policy alignment with **MoEFCC** and state governments for adoption of digital MRV frameworks.
- Engagement with **carbon registries and climate finance bodies** to prepare for future monetization of CO<sub>2</sub>e reductions.

### Funding & Partnerships

- Seed funding to deploy **Streamline in multiple CETPs** post-pilot.
- Co-financing from **industry associations** and **CSR programs** of textile exporters.
- Development finance and **climate funds** to support scaling into other sectors through KarbonLedger.

## Ecosystem & Capacity Building

- Training and onboarding support for **CETP operators and regulators** to adopt Streamline effectively.
- Partnerships with **academic and validation bodies** for independent verification of AI and blockchain outputs.
- UNDP's convening power to bring **government, industry and community stakeholders** together for scaling.

# Sustainability & Business Model

## Business or Funding Model

- ◆ Short-Term (Pilot & Early Deployment)
  - Reliant on **grants and development funding** (UNDP, climate innovation funds, CSR contributions from textile exporters).
  - **Public-private partnerships** with SPCBs and industry associations to cover initial costs of IoT sensors and dashboard deployment.
- ◆ Medium-Term (Scaling Across CETPs)
  - **Cost-sharing model** with CETP operators and industry clusters, where digital monitoring fees are pooled through industry associations.
  - **Regulator integration:** SPCBs and state governments can support adoption by embedding Streamline into compliance frameworks, partially funding through environmental levies or regulatory budgets.
- ◆ Long-Term (Sustainability & Monetization)
  - **Carbon finance revenue streams:** Once validated, verified CO<sub>2</sub>e reductions from CETP operations can be tokenized and sold/retired in voluntary carbon markets.
  - **ESG & reporting services:** Industries can subscribe to enhanced ESG reporting and compliance analytics powered by KarbonLedger.
  - **DAO governance and reinvestment:** Future revenue flows through KarbonLedger DAO can be reinvested into improving CETPs and scaling across other climate-action sectors.

## In summary:

The model begins with **grant support and partnerships**, transitions into **cost-sharing and regulator-backed adoption** and matures into a **carbon-financed, ESG-aligned service** — ensuring both financial sustainability and climate impact.

## Key Resources & Partnerships

### Technical Resources

- **Cloud Infrastructure & Hosting** → Scalable, secure cloud services to host the Streamline dashboard and blockchain nodes.
- **IoT Devices & Maintenance** → Reliable COD, BOD, TDS, pH and flow sensors with calibration support and AAA redundancy for a fool proof system.
- **AI/ML Development Talent** → Continuous refinement of verification models and predictive analytics.
- **Cybersecurity & Data Protection** → Expertise to safeguard sensitive industrial and compliance data.

### Regulatory & Institutional Resources

- **Access to CETPs** for sensor integration, operational testing and pilot deployment.
- **Regulatory Access** → Partnership with **State Pollution Control Boards (SPCBs)** to recognize blockchain-based compliance reporting.
- **Policy Alignment** → Engagement with **MoEFCC** and state governments for embedding digital MRV frameworks into regulation.

### Partnerships for Growth

- **UNDP India** → Development partner for scaling, policy alignment and convening multi-stakeholder ecosystems.
- **Industry Associations (Textiles & SMEs)** → Co-financing and operational adoption of Streamline at cluster level.
- **Carbon Market Registries & ESG Funds** → Long-term partners for monetization of CO<sub>2</sub>e reductions.
- **Academic & Validation Bodies** → Independent verification of AI models, sensor accuracy and climate claims.
- **NGOs & Community Groups** → Ensuring transparency and community trust through awareness and reporting.

## Long-Term Ownership / Maintenance

- Pilot & Early Stage:

Managed jointly by the **KarbonLedger team** (technical backbone) and **UNDP/accelerator partners** (oversight, convening and stakeholder engagement).

- Post-Pilot / Scale-Up:

Ownership transitions into a **shared governance model**:

- **SPCBs and local authorities** → Operational adoption, regulatory oversight and integration into compliance frameworks.
- **CETP Operators/Associations** → Day-to-day usage, operations and cost-sharing for sustainability.
- **KarbonLedger Protocol Team** → Ongoing technical maintenance, updates to AI/blockchain layers and ensuring open-source ecosystem support.

- Long-Term Vision:

The solution will be sustained through a **multi-stakeholder model** where:

- **Institutional responsibility** lies with SPCBs and relevant government agencies for compliance enforcement.
- **Technical responsibility** is supported by the KarbonLedger protocol team and open-source community.
- **Financial sustainability** comes from CETP operator contributions, regulator backing and future carbon finance streams.

## Deliverables Checklist

- Prototype Instance link  
<https://karbonledgerundpinstance.vercel.app/>
- Source code / GitHub repo  
<https://github.com/KonmaORG/karbonUmbrella>
- Documentation / ReadMe  
<https://github.com/KonmaORG/karbonUmbrella?tab=readme-ov-file#karbon-umbrella-project-documentation>
- SDG metadata logic

<https://github.com/KonmaORG/carbonica-ledger/commit/86acac61c59aec5085e894fe c175deaa5b5c4ba5>

- Video walkthrough  
[https://drive.google.com/file/d/140LYjt7JG91XyGWJnSDxcM8fsqj0rMvI/view?usp=drive\\_link](https://drive.google.com/file/d/140LYjt7JG91XyGWJnSDxcM8fsqj0rMvI/view?usp=drive_link)  
[https://drive.google.com/file/d/1yBEs8xL5QNvTamqx73RFUQ\\_nK8RkoxnL/view?usp=drive\\_link](https://drive.google.com/file/d/1yBEs8xL5QNvTamqx73RFUQ_nK8RkoxnL/view?usp=drive_link)
- Next steps agreed ( pilot planning)  
<https://docs.google.com/document/d/10k9U0UWC1bLvCaCQB9BTeUlMQklLyagc/edit?usp=sharing&ouid=116047174969161310075&rtpof=true&sd=true>

## Team Reflection

### Challenge Owner's Perspective

- *Through this journey, we deepened our understanding of how blockchain can serve as a catalyst for strengthening transparency, traceability and compliance within CETPs, helping to address long-standing challenges in monitoring and reporting.*
- *Collaboration with the solution makers allowed us to refine the scope of the challenge, ensuring it responds effectively to the priorities of regulators, industries and communities, while remaining firmly anchored in UNDP's circular economy agenda.*
- *The process has also built internal capacities to foster innovation-driven partnerships and demonstrated the potential of frontier technologies to deliver scalable solutions for climate action and sustainable industrial practices.*

### Solution Maker's Perspective

- Through the Accelerator, we realized that CETP stakeholders value **regulatory trust and compliance alignment** even more than operational efficiency. This shifted our focus from purely technical features to building **tamper-proof reporting** that SPCBs can readily adopt.
- Early testing highlighted that **data simplicity and clarity** matter most to operators. We streamlined the dashboard to ensure it is accessible, multilingual and intuitive rather than feature-heavy.
- The experience of integrating IoT → AI → blockchain in a **real-world CETP context** showed us the importance of **data reliability and calibration**, shaping our next steps toward redundancy and QA protocols.

- Working within the Accelerator pushed us to think beyond compliance. We now clearly see how Streamline can evolve into a **climate finance enabler** by linking wastewater treatment to measurable CO<sub>2</sub>e reductions.
- Building on open-source infrastructure and deploying through a UNDP-supported ecosystem gave us the confidence to position **KarbonLedger not only as a product but as a protocol** that can scale across multiple climate-action domains.