



Integrating Sustainability into Product Development

Moving sustainability from retroactive reporting
to real-time decision-making intelligence

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1 Executive Summary

The fashion industry has arrived at a critical moment. As companies struggle to achieve their climate goals, they also face rising material costs, unpredictable geopolitical environments, and climate-induced supply-chain disruptions. On the textile industry's current trajectory, its emissions are projected to surpass 25% of global emissions by 2050 if left unaddressed (McKinsey, 2024)[1], which would intensify climate change beyond the world's capacity to respond.

Curbon's thesis is that industry-wide climate progress must begin with more intelligent day-to-day decisions in product development, where material, supplier, production, and logistics choices can help achieve meaningful reductions in the Scope 3 emissions that account for the vast majority of companies' carbon footprints.

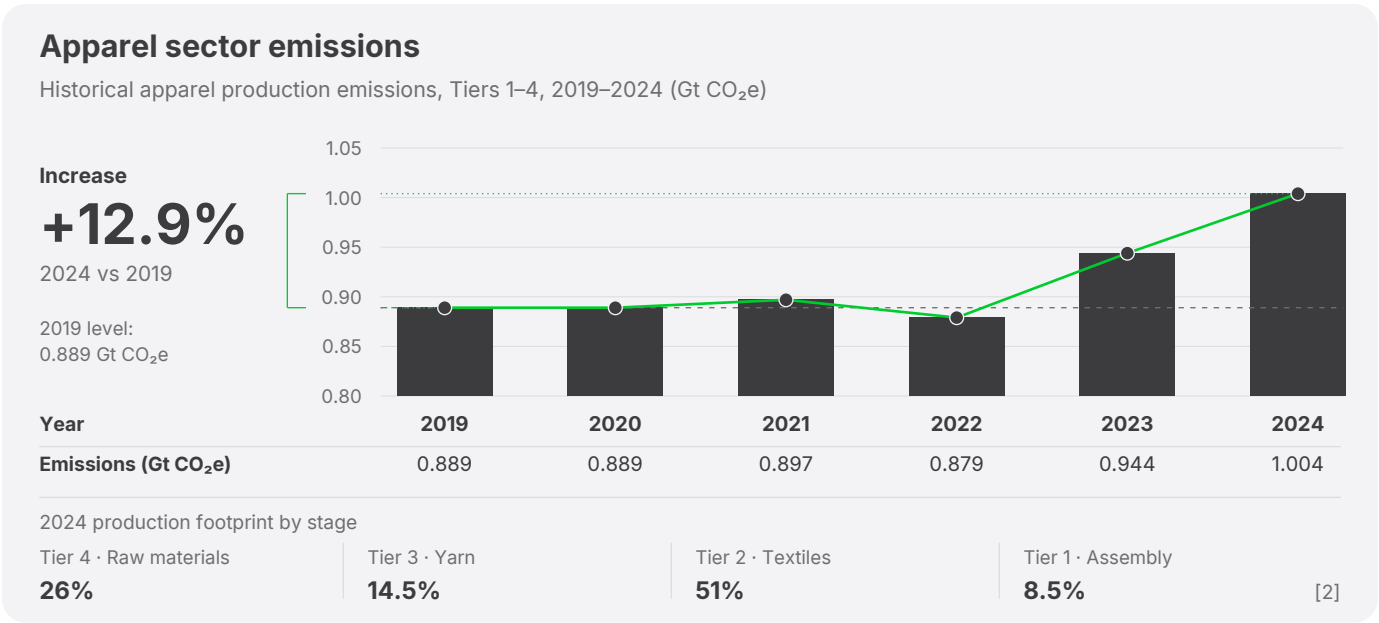
1.1 The Core Problem

A product's cost and environmental footprint are determined long before production by key decisions about material selection, supplier geography, and supply-chain logistics. However, the teams making those decisions lack a connected view of their consequences. Product, costing, and quality systems hold useful information, but combining it requires substantial coordination. Our recent conversations with some of the industry's leading companies reveal a recurring challenge: environmental analysis is separated from product development and is typically conducted for subsequent reporting. Although preferred-material indicators can provide direction to product development teams, the cost and carbon trade-offs of sourcing, processing, and transportation decisions are unavailable at the time of highest leverage.

1.2 Curbon's Solution and Intended Users

Curbon is developing an AI-native platform for product-development and sustainability teams. Our goal is to identify ways to reduce environmental impact and cost simultaneously while respecting quality, delivery, and commercial requirements. Curbon connects operational information, establishes usable evidence and business context, and then applies cost modeling, life-cycle assessment (LCA), and mathematical optimization. Our current product is operational for small and mid-sized brands, and our team is now focused on developing design partnerships to validate Curbon within a large enterprise's systems and processes. This would enable everyday decisions to benefit from environmental science without requiring users to become environmental scientists.

Apparel emissions rose 6.3% in 2024 due to higher fiber consumption and a disconnect between climate goals and day-to-day operations. While decision-making tools cannot replace clean energy or production cuts, they help brands identify impactful, cost-effective changes.[2]



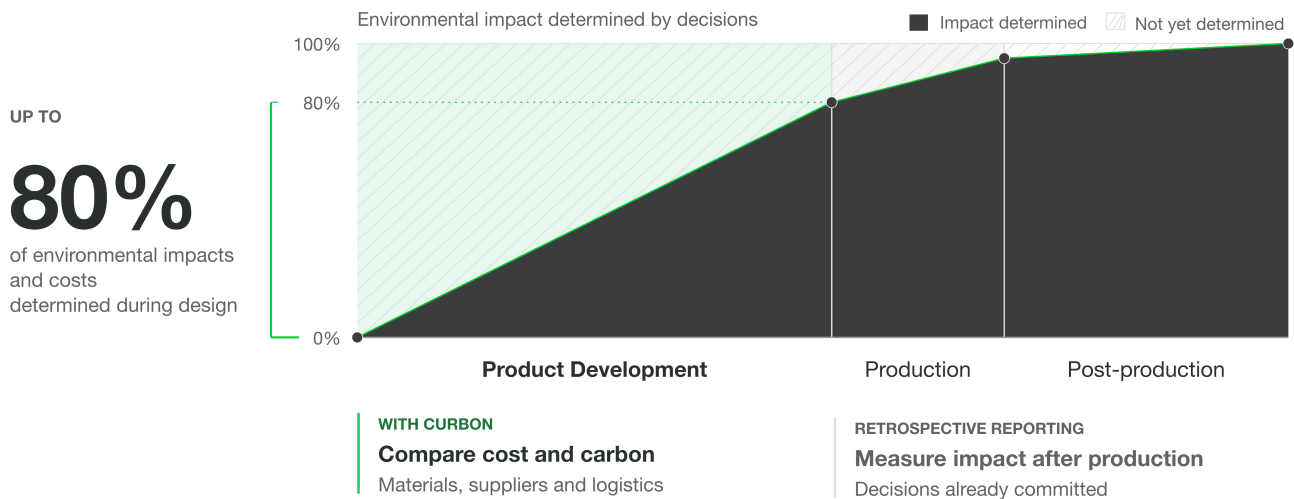
2 Decision-Making Insight Before Production

2.1 Why Integrating Sustainability into Product Development Matters

The European Commission estimates that up to 80% of a product's environmental impacts and production costs can be determined during design and product development.[3] Product-development decisions that determine a product's material composition, supplier geography, quality requirements, and supply-chain logistics are interconnected. One production leader described weighing higher manufacturing costs against freight, import costs, and time saved by avoiding distant production. We believe that, to achieve climate goals, environmental insight belongs alongside that commercial judgment.

Design Decisions shape cost and carbon before production

As material selection, supplier geography, and logistics determine downstream financial costs and environmental impacts



Source: European Commission [3]; Curbon white paper, section 2.1.
Up to 80% of environmental impacts can be determined during design.
Curve is illustrative; the percentage concerns environmental impact, not cost.

2.2 The Current State of Sustainability Analysis: Retrospective Analysis for Reporting and Compliance

Sustainability reporting asks what happened, while product development requires an understanding of what could happen next. PTC's FlexPLM team described historical environmental analysis as "sort of forensics, going back and looking, and maybe estimating things." Sustainability teams join material, product, retail, and packaging records to support reporting, but that knowledge does not automatically reach development decisions.[4] One enterprise leader described teams beginning a 2028 season before their 2026 environmental results were available; by the time those findings could inform changes, subsequent seasons would already be in development. The example illustrates a mismatch between annual retrospective analysis and development calendars running several seasons ahead.

Approved-material lists and identifiers help teams choose preferred options but do not by themselves quantify the consequences of combining a material, manufacturing location, and transport plan. Curbon aims to build on those mechanisms by bringing evidence-backed comparisons into development before product choices become supply-chain commitments.

2.3 Nike Considered

Curbon's approach has been inspired by Nike Considered's innovative work between 2008 and 2013. In a recent discussion with Noel Kinder, Nike's former Chief Sustainability Officer and Lululemon's current Senior Vice President of Sustainability, he emphasized the progress that Nike made by bringing environmental feedback directly to product development teams. Nike's Considered Index, introduced in 2007, linked a product's bill of materials (BOM) to environmental scoring through an intranet calculator. Teams could score products in roughly a minute, use the tool at development checkpoints, and receive training and specialist support. "What's hard is asking them to do good stuff and giving them zero direction." Building the Index took six tools-team members 18 months; data gaps required simplified proxies, while teams still had to meet margin, performance, and production requirements.[5]

Nike's Materials Sustainability Index was adopted by the Sustainable Apparel Coalition in 2012 and supported the MAKING design app launched in 2013.[6,7] However, the MSI was ultimately constrained by a lack of technical resources and gaps in environmental data, which limited the precision and scope of its assessments. Curbon aims to build the next generation of this approach. We believe that advances in AI, combined with more detailed environmental data and mathematical optimization, create an opportunity to model the downstream impacts of product decisions with much greater precision at enterprise scale. By connecting operational data to environmental modeling and multivariate optimization engines, Curbon leverages AI to interpret scattered information and user intent, documented inventories to support calculations, and mathematical solvers to evaluate feasible alternatives. The objective is to explain not just which design scores better, but what to change, why, and within which commercial limits.[8,9,10]

2.4 Accounting for Commercial and Operational Constraints

A recommendation that cannot be produced, delivered, or afforded is not useful. A sustainability practitioner described challenges in preserving fabric feel and qualifying suppliers, explaining that "getting our brands to make the switch to preferred materials has been difficult in the first place because it impacts margin." Curbon therefore treats cost, lead time, approved suppliers, material specifications, and other requirements as part of the analysis. The aim is to identify product configurations that reduce both cost and carbon emissions wherever feasible and highlight explicit trade-offs wherever they conflict.

3 Fragmented Product Data

3.1 Internal Product, Supply-Chain, and Financial Data Scattered Across Systems

"It exists in so many different places without the full story," a production leader said, describing product-cost history spread across bills of materials, spreadsheets, invoices, emails, and supplier conversations. Product specifications and bills of materials may sit in product lifecycle management (PLM) systems; purchasing and cost records in enterprise resource planning (ERP) and supply-chain management (SCM) platforms; budgets and margin targets in enterprise performance management (EPM) tools; and logistics and quality data in dedicated internal systems. Excel spreadsheets and communication channels—including email, Slack, and Teams—hold additional details and context needed to connect the full product story.

Separate enterprise systems can serve individual teams well while making cross-functional analysis difficult. Curbon's starting point is to connect those records without replacing existing systems: linking a material price to its specification, supplier, quantity, season, and terms, and connecting transport assumptions to the development calendar. A search box helps locate information; these relationships establish the foundation for understanding operations and evaluating alternatives.

3.2 Sustainability Goals Live in Silos

We have found that corporate sustainability goals are largely disconnected from product decisions. In other words, a company's greenhouse-gas (GHG) targets are not aligned with product development teams' priorities for delivery dates, cost, and quality. Practitioners also describe separate margin targets across divisions and business units.

To bridge this gap, Curbon connects product and collection scenarios to relevant targets, baseline years, volumes, and time horizons. Public sources such as the Science Based Targets initiative's target dashboard

can establish the stated objective, but brands are currently missing a way to define its application to product decisions. A corporate target does not automatically create a carbon budget for every garment; that translation requires explicit allocation assumptions and compatible accounting boundaries.[11]

Product development data systems

Where product specifications, costs and operational records live

PLM Product lifecycle management Bills of materials (BOMs) Product specifications Material choices	ERP Enterprise resource planning Purchase orders & invoices Negotiated & actual costs Order quantities & terms	SCM Supply-chain management Supplier records Purchasing & execution records Delivery commitments	EPM Enterprise performance management Planned volumes & budgets Cost limits Margin targets
LOGISTICS Transport & delivery Transport routes & modes Shipment history Freight & import costs	QUALITY Inspection & testing Inspection & test results Material & component issues Construction quality history	FILES & SPREADSHEETS Excel & shared drives Costing sheets & BOMs Itemized supplier quotes Locally stored records	COMMUNICATION Email, Slack & Teams Supplier conversations Product decisions Clarifications & context

3.3 Environmental Data Disconnected from Product Decisions

Environmental reference data and operational records answer different questions, but both are necessary for accurate environmental modeling. For example, ecoinvent provides life-cycle inventories for supply-chain activities; the U.S. Environmental Protection Agency publishes emission factors for activities including fuel use, electricity, and transportation. Neither identifies which process, energy source, or route a brand actually used.[8,12] Curbon has held discussions with ecoinvent and intends to combine suitable licensed data with company records and reviewed assumptions, making sources and limitations visible. The essential connection is between an operational activity and its appropriate environmental representation. A database can support better analysis only if it is connected to knowledge of the supply chain.

4 Curbon’s Product and Technical Architecture

4.1 Intended Users and Teams

Curbon’s primary users are the product-development, raw-materials, sourcing, technical-development, and production teams translating designs into manufacturable, commercially viable products. They need to compare options while managing specifications, costs, and timing. A product-operations adviser framed the challenge as helping someone who does not “eat, sleep and breathe sustainability” make better environmental choices. Sustainability teams are secondary users and important contributors of reviewed data, material classifications, methodological judgment, and targets. Merchandising, finance, and leadership contribute planning priorities and use outputs at a broader organizational level. The goal is a shared analytical foundation with different views and responsibilities—not identical dashboards or decision authority for everyone.

4.2 Data Integration, Ingestion, and Preparation

Curbon's data integration pipeline ensures that all information and context relevant to the product development lifecycle are available to users. These integrations can extend to PLM systems for specifications and bills of materials; ERP and SCM systems for purchasing and execution records; EPM systems for budgets and targets; communication systems such as Slack and email; and any other internal systems relevant to product development. Manual file uploads allow users to add Excel spreadsheets and other locally stored records, while Curbon identifies missing or conflicting information.

Discussions with PTC, Oracle, and Centric confirmed practical integration routes. PTC uses Flex Connect with custom mapping, while Oracle offers standard interfaces with customer-controlled access. Deployment requires agreed permissions, field mappings, refresh schedules, and data-handling rules, including model-provider data treatments. [4,13]

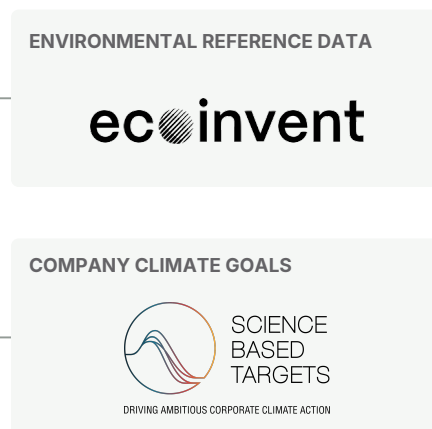
Curbon's data integrations

Connecting business records, environmental data and climate goals

PRODUCT & COST DATA



SUSTAINABILITY DATA



Cost and carbon
decision intelligence

4.3 Digital Twin: Modeling the Supply Chain

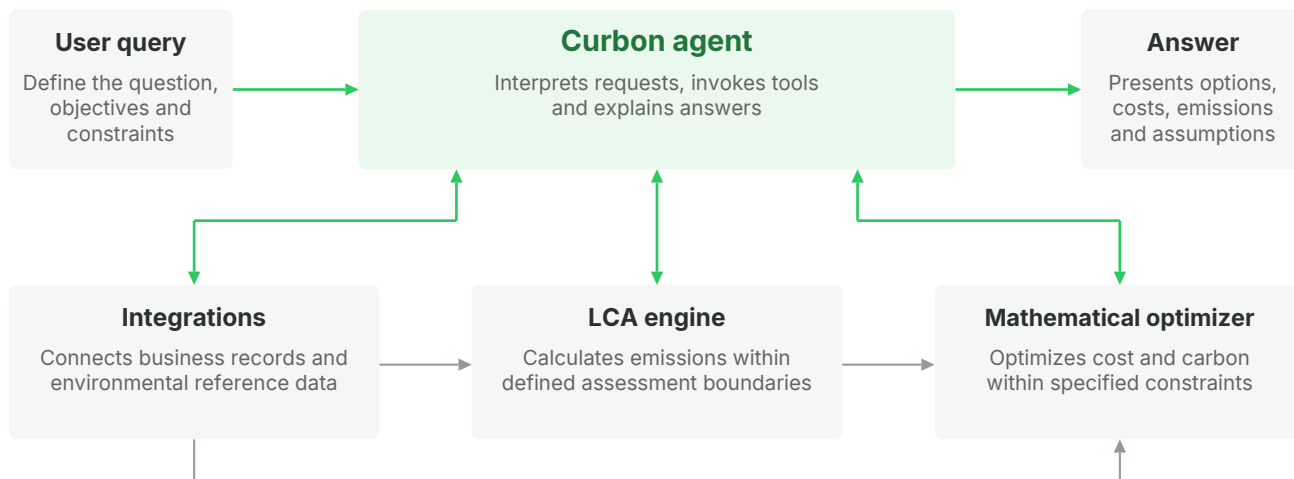
Curbon's digital twin is a structured representation of a product and its supply chain. It connects materials, quantities, suppliers, processes, locations, and commercial records so dependencies can be examined together. In the prototype, these relationships can be traced to supporting attachments and passages. The digital twin's purpose is to connect information and establish the evidence and context needed to model and improve product configurations with reduced environmental impacts. The model's coverage depends on the available records, and its assumptions are explicitly identified. Missing information becomes a question to resolve or an explicit scenario assumption, not an invisible fact supplied by the system.

4.4 The Role of the Large Language Model (LLM)

The large language model (LLM) interprets documents and user requests, retrieves context, and invokes analytical tools. Curbon's cost calculations, life-cycle assessment routines, and optimization models perform the mathematical work, allowing users to describe objectives in familiar language rather than through database queries or equations. The intended workflow presents objectives, constraints, and important assumptions for confirmation, links results to their inputs, and surfaces critical gaps before proceeding. Deterministic calculations make an analysis reproducible for the same inputs and configuration; extraction, assumptions, and models still require validation. AI makes the tools accessible without replacing the evidence on which they depend.

Software Architecture

The agent coordinates data and analytical tools to answer user queries



4.5 Cost Modeling

Cost modeling must reflect what a particular brand pays, not an average garment price. Our discovery conversations have shown that costs depend on product specifications, material consumption, order quantities, supplier relationships, and negotiated terms. A price recorded in a BOM may differ from the final price for a particular season or order, while changes in composition or dimensions affect material consumption and cost. Curbon's intended inputs include itemized supplier quotes, historical purchase orders and invoices, material and manufacturing charges, and relevant freight and import costs. Reference prices, current quotes, historical charges, and estimates must remain distinguishable.[13]

The model must define whether it compares free on board (FOB) or landed costs, recognize charges already included in bundled quotations, and align quantities, units, currencies, and validity dates to avoid double counting or misleading comparisons.[13] Where sufficient detail exists, it can combine material consumption and prices with manufacturing and logistics costs; otherwise, relevant historical records can inform explicitly labeled estimates, which are not supplier commitments. Connecting results to agreed selling-price and cost definitions supports margin analysis.

4.6 Environmental Modeling: Real-time LCA Engine

Curbon's real-time LCA engine translates product and supply-chain activities into carbon-footprint calculations. Curbon currently focuses on greenhouse-gas emissions, expressed in kilograms of carbon dioxide equivalent (kg CO₂e), rather than every dimension of sustainability. Each assessment needs a defined product unit and boundary—for example, one specified garment through manufacture and delivery to an agreed location—with excluded stages identified.[14] Calculations link materials, processes, energy, and transport to suitable inventories or emission factors, then aggregate climate impacts within that boundary. Supplier evidence can inform the model; documented background inventories support areas without direct information. Dataset selection must consider geography, technology, time period, and boundaries. Calculations must also avoid double counting impacts already included in input datasets. Reviewed data do not automatically represent a particular supplier.[8,14]

As an operations leader put it, "your calculations are only as good as the data feeding into the systems." A truck's emission factor cannot establish that an undocumented shipment traveled by truck. Curbon distinguishes missing operational evidence from missing reference data, requests clarification, and makes approved proxies, estimates, and uncertainty explicit. The goal is interactive recalculation as product or sourcing scenarios change—timely modeling, not a claim to measure every factory's emissions live. When essential data are missing, Curbon is designed to flag the gaps and prompt users to provide additional

information or upload supporting records. Doing so reduces uncertainty, improves LCA accuracy, and mitigates the risk of AI hallucinations by seeking evidence rather than inventing inputs.

4.7 Mathematical Optimization for Trade-off Analysis

With a baseline, evidence, and operating requirements established, the system evaluates combinations that are difficult to compare manually. An illustrative request is: “For a 10,000-unit order, find options that reduce unit cost and carbon emissions, preserve material specifications, and meet our delivery date.” The workflow translates this request into decision variables, objectives, and constraints. Depending on scope and evidence, the model can vary approved materials, suppliers, processes, production allocations, and transport choices while holding essential requirements fixed. It searches configurations rather than merely calculating the footprint of a choice already made: a cheaper material, for example, may require more expensive freight.[4]

Where cost and emissions reductions align, those options should appear first. Where they conflict, a Pareto set presents feasible alternatives for which improving one objective requires worsening another within the evaluated solution set. Users compare changes, costs, emissions, assumptions, and constraints. An infeasible request should produce an explanation, not an invented solution; optimality claims remain tied to the model, available choices, and solver result. Curbon’s goal is to augment human decision-making by reducing the administrative time spent finding and reconciling information across record-keeping systems. It aims to equip teams to evaluate cost, carbon, quality, and lead-time trade-offs across combinations of materials, suppliers, and logistics—a breadth of analysis that would be nearly impossible to perform manually across supply chains spanning millions of products and thousands of suppliers.

4.8 Business-Specific Rules, Constraints, and Targets

Critical operating knowledge often lives outside formal specifications and record-keeping systems. We have learned that business rules carried in a developer’s head risk disappearing when that person leaves. Inspection and testing results may also reveal problems with a particular material, component, or construction method, yet that history is not readily connected to new products moving through development. Similarly, a supplier’s record of missed delivery commitments may be known to experienced colleagues but overlooked when another team evaluates its quoted lead time. Making this knowledge accessible allows past experience to inform future decisions.

Curbon is designed to let users configure company- and team-specific requirements, priorities, and flags. For example, it could surface documented quality issues associated with a proposed material-construction combination or flag a supplier’s history of missed delivery commitments, helping teams adjust designs, compare suppliers, or revise planning allowances. Mandatory requirements would constrain feasible configurations, while historical concerns would trigger evidence-backed warnings for review. Alongside cost limits, margin objectives, and environmental targets, this context would help teams pursue cost-and-carbon improvements within their operating requirements.

4.9 Configurable Dashboard and Views

Our interface thesis is that flexibility should not require navigating an expanding catalog of rarely used features. Product developers may examine individual styles, sustainability teams may review suppliers or collections, and leadership may track progress against targets. Prototype development has explored natural-language changes to dashboard modules, with enterprise plans for role-based templates, configurable views, and sharing. A user could compare sourcing scenarios for a collection or isolate products dependent on a supplier; a team lead could establish a shared starting point. The presentation should adapt while the underlying data and calculations remain consistent. Collaboration features remain part of the development roadmap, with the objective of less setup, clearer interpretation, and a shorter path from question to decision.

5 Design Partnership Model

5.1 Proposed Objective and Scope

Curbon is seeking design partners to develop the current product into a dependable enterprise system. The goal of the partnership is to provide our team with further direction on integrations, analytical priorities, user experience, and outputs based on what fashion companies and brands value most. Curbon's engineering and modeling capabilities would combine with the brand's product knowledge to establish the data foundation, test workflows, and evaluate results with intended users. Enterprise readiness includes development calendars, permissions, governance, and understandable outputs. The objective is to develop reusable capabilities that extend beyond the initial use case and integrate Curbon where it can deliver the greatest value for company decision-making.

5.2 High-Level Contributions and Responsibilities

Curbon would provide engineering, product development, analytical implementation, onboarding, and close technical support. Benefits for design partners may include a defined period of product exclusivity and early access to agreed capabilities, meaningful influence over product design and priorities, and a lifetime subscription discount within an agreed commercial scope.

The brand would contribute a dedicated champion or team, access to agreed data, support from technical counterparts, participation from intended users, and financial support. Product-development involvement is essential alongside sustainability expertise and IT support. Responsibilities, evaluation criteria, and conditions for broader deployment would be agreed jointly.

5.3 Example Milestones and Deliverables

Success will be assessed in stages, starting with data coverage and reduced retrieval effort, followed by validating cost-and-carbon calculations against reference cases. Building on work with the Council of Fashion Designers of America (CFDA), this approach focuses on producing quantitative, traceable, and consistent results to ensure teams implement feasible improvements at the right development stage.

Ultimately, the goal is to improve decision efficiency, lower costs, and reduce carbon footprints through active use. While incumbent software only describes the environmental impacts of existing products, Curbon provides the intelligence needed to design and develop the next generation of products with sustainability at the center of decision-making.

5.4 Strategic Alignment and Long-Term Partnership Value

We have made the most progress when working directly with product development, sustainability, and technology teams to understand their priorities and translate them into capabilities that support real business decisions. A design partnership would build on this approach through a shared roadmap connecting the partner's immediate operational needs with its longer-term financial and environmental objectives. Working directly with Curbon's founding and engineering team, partners would help define the decisions to prioritize, the evidence needed to support them, and how results should be incorporated into existing workflows.

The objective is not simply to consolidate information or introduce another reporting tool. Connecting product, costing, quality, and supply-chain knowledge would provide the foundation for evaluating how changes in materials, supplier geography, production, and logistics could affect both cost and environmental impact before commitments are made. Together, we would identify opportunities to improve both outcomes and make trade-offs explicit where they cannot be improved simultaneously, while accounting for constraints such as product performance, supplier capabilities, lead times, and delivery requirements. Curbon would be developed to complement the partner's existing systems and internal technology initiatives, rather than require their replacement.

We propose establishing short, medium, and long-term goals around a jointly selected business problem. In the short term, this could involve supporting a specific product or sourcing decision using available data and validating the analysis with the responsible teams. Medium-term work would focus on testing feasible alternatives and incorporating the resulting insights into recurring development and planning processes. Longer-term collaboration would extend validated capabilities across additional products, categories, or supply-chain decisions.

Early participation would give design partners a direct role in shaping how these capabilities address their organization's priorities, while Curbon would contribute the engineering and modeling work required to develop them. The partnership would combine a focused initial scope with a longer-term development roadmap, with expansion guided by demonstrated value and the partner's readiness to adopt the capabilities. As a next step, we propose a joint working session to select the initial use case, identify the participating teams and relevant data, and agree on the evidence needed to justify broader deployment.

6 About the Team



Joe Wahba

Recent graduate from Princeton University, where his thesis focused on AI applications for fashion supply chains. Before founding Curbon, he worked on a fintech startup in the MENA region and conducted a 15-city supply chain tour across East Asia to deeply understand industry sourcing challenges. Joe has also advised the Egyptian government on technology and environmental policy, presenting his work at the UN COP27 Conference. He has lived in five global cities, speaks English, Arabic, and Spanish, and is on a mission to build Curbon into the industry standard for intelligent, cost-effective, and sustainable fashion production.



Alan Zhang

Alan Zhang is a Master of Science in Engineering candidate in Computer Science at Princeton University, having previously earned his Bachelor of Arts in Computer Science from the University of California, Berkeley. In the software industry, he has experience as a Senior Software Development Engineer for Workday's Adaptive Planning division, where his full-stack infrastructure enhancements and API developments have driven a 20% annual increase in new customer subscription revenue while decreasing technical debt by 45%. His graduate research at Princeton's Systems for Artificial Intelligence Lab focuses heavily on serving system optimizations for multimodal large language models, achieving significant compute savings through advanced image token pruning frameworks and novel hierarchical KV cache designs. Beyond his research and engineering roles, he actively contributes to computer science education as course staff at Princeton, where he develops grading infrastructure and teaches systems programming, building upon his earlier academic tutoring foundation at UC Berkeley.



Jinjin Chen

Jinjin Chen is a Ph.D. candidate in Civil and Environmental Engineering on a full fellowship at Princeton University, where she also earned her M.S.E. She has demonstrated substantial scholarly impact by amassing over 200 Google Scholar citations and authoring multiple peer-reviewed papers, including five selected publications in high-impact journals like *Environmental Science & Technology*. Her master's and doctoral research focuses heavily on life-cycle assessment, techno-economic analysis, and multi-sector optimization, which she has used to simulate urban waste circularity and develop broad decarbonization strategies. At Curbon, she applies this scientific background as Chief Science Officer, supporting the development of Curbon's real-time life-cycle assessment engine for product development to ensure data traceability and output accuracy.

Team Story

Joe, Alan, and Jinjin met at Princeton University in September 2026. Alan was Joe's teaching assistant for computer science, and Jinjin was his teaching assistant for environmental science. Through their collaborative research into how AI can support decarbonization in the fashion industry, they developed the thesis that product development teams could benefit from better insight into the downstream environmental impacts of their decisions. Together, they worked on the product, received national recognition for their research, and applied what they learned to develop Curbon.

7 Appendix

Technical terms and acronyms

Essential technical terms used in the main text.

7.1 Enterprise and product data

BOM – Bill of materials. A structured list of a product's materials and components, including quantities and specifications.

Digital twin. A structured model connecting a product's materials, suppliers, processes and commercial records to compare possible configurations.

EPM – Enterprise performance management. Systems for financial planning, budgeting, forecasting and tracking business performance against targets.

ERP – Enterprise resource planning. Integrated systems for operational records, including purchasing, finance, inventory and manufacturing.

PLM – Product lifecycle management. Systems managing product information through development and production, including specifications, materials, versions and bills of materials.

SCM – Supply-chain management. Systems coordinating suppliers, purchasing, production, inventory and delivery across the supply chain.

7.2 Modeling and optimization

Decision variable. A choice an optimization model can change, such as a material, supplier allocation or transport mode.

Deterministic calculations. Calculations that return the same result for the same inputs and configuration; repeatability alone does not establish accuracy.

LLM – Large language model. An AI model trained on large datasets to interpret and generate language, including user requests and document content.

Mathematical and multivariate optimization. Using mathematical solvers to select choices that improve defined objectives while respecting constraints; multivariate models consider several variables.

Pareto set. Alternatives for which, within the evaluated set, improving one objective requires worsening at least one other objective.

7.3 Environmental and carbon accounting

Accounting boundary. The processes and life-cycle stages included in a calculation, together with its exclusions; comparisons require consistent boundaries.

CO₂e (carbon dioxide equivalent). A common unit combining greenhouse gases according to their warming effect relative to carbon dioxide over a specified period.

Emission factor. A coefficient translating an activity, such as electricity use or material production, into estimated greenhouse-gas emissions.

GHG emissions (greenhouse-gas emissions). Releases of heat-trapping gases, such as carbon dioxide and methane, commonly reported together as CO₂e.

LCA (life-cycle assessment). Assessment of resource inputs, emissions and potential environmental impacts across a product's life cycle within a defined scope.

Life-cycle inventory. Quantified material and energy inputs, outputs and emissions for modeled processes, providing the basis for life-cycle impact calculations.

MSI (Materials Sustainability Index). Nike's approach to scoring the environmental impacts of materials, later adopted by the Sustainable Apparel Coalition.

Scope 3 emissions. Indirect value-chain emissions beyond a company's owned or controlled operations and purchased energy, including purchased goods and services.

7.4 Commercial and supply-chain terms

FOB (free on board). A sea or inland-waterway shipping term: the seller delivers aboard the buyer's nominated vessel; risk then passes to the buyer.

Landed cost. Total cost at the destination, including purchase price, freight, handling, insurance, duties and applicable taxes.

8 Citations

Interview quotations are reproduced from the supplied meeting transcripts. Except where explicitly named, interviewees and their employers are anonymized in this draft; transcript wording and permission for external quotation should be confirmed before publication. Product descriptions distinguish demonstrated elements from development intentions; partnership terms are proposals.

[1] McKinsey & Company and The Business of Fashion, The State of Fashion 2025 (November 11, 2024); see “Sustainability: The Case for Collective Action” (December 10, 2024), key insights. The projection concerns more than one quarter of the world’s carbon budget by 2050, not a share of annual global emissions.

[2] Apparel Impact Institute. Taking Stock of Progress Against the Roadmap to Net Zero (2026). Published September 2026; estimates for 2024. The 6.3% increase is the report’s modeled apparel-sector result, not a Curbon estimate or a claim about all fashion-related life-cycle emissions. Figure 2, p. 9; methodology and accounting, pp. 4–8. Modeled apparel production, Tiers 1–4; excludes Tier 0, use, end of life, downstream transport, and many trims. Fiber volumes × Higg MSI process factors; WALDB Tier 1 proxy. No quantitative uncertainty interval published. [Primary source](#)

[3] European Commission. Delivering the Environmental Commitments under the European Green Deal. Product-design discussion. The “up to 80%” estimate concerns environmental impacts generally, not a verified apparel-cost percentage. [Primary source](#)

[4] Curbon discussion with PTC concerning FlexPLM and environmental-analysis integration, September 14, 2026. Transcript: 00:07:36–00:14:13; 00:18:23–00:22:39; 00:31:27–00:34:07; 00:37:52–00:42:03. Individual anonymized. Discussion does not constitute vendor endorsement or a completed integration.

[5] Henderson, Rebecca; Locke, Richard M.; Lyddy, Christopher; and Reavis, Cate. Nike Considered: Getting Traction on Sustainability. MIT Sloan case 08-077, January 21, 2009, pp. 6–11 and 15. Internal ratings are not independently verified corporate carbon reductions; the case does not establish a lack of funding or software staff. [Primary source](#)

[6] Higg MSI. How Was It Developed? Historical account of the Nike-origin Materials Sustainability Index and its adoption by the Sustainable Apparel Coalition in 2012. [Primary source](#)

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[9] Pyomo. Official project documentation and overview. Mathematical optimization modeling in Python. [Primary source](#)

[10] SCIP Optimization Suite. Official project overview. Solver framework for mathematical optimization. [Primary source](#)

[11] Science Based Targets initiative. Target Dashboard. Corporate target information, including scope, baseline, and target years. Corporate targets require brand-specific interpretation to inform product-level allocation. [Primary source](#)

[12] U.S. Environmental Protection Agency. GHG Emission Factors Hub. Default factors supporting emissions calculations; not a complete garment-specific life-cycle inventory. [Primary source](#)

[13] Curbon discussion with Oracle concerning supply-chain applications and integration, September 14, 2026. Transcript: 00:13:13–00:16:00; 00:22:56–00:28:19. Individual anonymized. Application access remains subject to customer authorization.

[14] World Resources Institute and World Business Council for Sustainable Development. Product Life Cycle Accounting and Reporting Standard. GHG Protocol, 2011, particularly Chapters 6–8 and the uncertainty discussion. Used for methodological context, not as a claim of certification or verified conformance by Curbon. [Primary source](#)