Ara Built to Decarbonize.™

Lifecycle Assessment Playbook

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Introduction

Executive summary

Lifecycle assessments (LCAs) are no longer just compliance exercises; they unlock revenue, attract capital, and differentiate products. Realizing that value requires choosing the right type of LCA, the right provider, and the right communication strategy from the start.

Understanding LCAs

LCAs quantify environmental impact across a product's full lifecycle.

> LCAs assess potential environmental impacts from raw material extraction through disposal, covering 16 possible impact categories. Greenhouse gas (GHG) emissions are the most widely reported.

> LCAs differ from corporate GHG accounting (e.g., GHG Protocol scopes). LCAs focus on product/process flows rather than organizational boundaries, and direct/indirect effects do not map cleanly to Scope 1, 2, and 3.

LCA type and rigor should match the use case.

> There are many different types of LCAs, with different costs, timelines, and rigor/data expectations:
  > Hotspot screenings inform internal decisions (can take only days and use secondary data sources).
  > Product carbon footprints and full LCAs support customer claims and disclosures (can take weeks to months, usually need primary data).
  > Program-specific LCAs (e.g., 45Z, CA LCFS, RED III) help meet regulatory thresholds for credits and incentives (varies by program, can take weeks to months, usually need primary data).

> Time, cost, and verification requirements scale with the use case – before scoping an LCA, confirm the most stringent intended use.

LCAs as value drivers

LCAs can unlock specific, monetizable opportunities.

> Revenue: federal tax credits (e.g., 45V, 45Z), state programs (e.g., CA LCFS), voluntary carbon markets, and grant funding all require LCA-based substantiation to be accessed.

> Capital: ISO-conforming LCAs and product carbon footprints strengthen stories for equity raises, sustainable finance alignment, and investor due diligence.

> Commercial: Verified low-carbon claims enable value-based selling to decarbonization-conscious customers and can improve access to offtake agreements. LCAs may also identify internal decarbonization levers that can reduce impacts, reduce costs, or both.

Proper execution determines whether value is realized.

> The same data can produce an LCA that wins a tax credit application or fails scrutiny and creates reputational damage – the results depend on effective pre-LCA scoping, provider selection, and communication planning.

> Companies that underinvest in scoping or pick the wrong provider commonly face wasted budget, missed program eligibility, or rework that takes significant time/money to correct.

> LCAs are the beginning of value creation, not the end. Tie results into specific external applications, use to inform decisions, and/or incorporate in communications and marketing. Plan for how the LCA will be used during scoping, not after results.

Key execution points

> Confirm use case and program requirements first.

> Match LCA type and provider to the use case and audience.

> Lock scoping decisions early. Changes mid-study force restart.

> Demand transparent, reusable deliverables. Reject “black box" outputs.

> Plan communication and verification needs from day one – retrofitting for legal review, caveats, or context costs more.

> Treat the LCA as a living asset, not a one-off. Build internal capability and processes for future updates.

Introduction

This playbook helps companies understand LCA design and value

We aim to empower companies with the knowledge, tools, and strategic insight to design a lifecycle assessment (LCA) tailored to their specific needs. LCAs are a foundational tool for substantiating any environmental claim or accessing low-carbon revenue streams.

Situation

> Companies including (but not limited to) low-carbon fuels, chemicals, materials, food and agriculture, and industrial manufacturing sit on LCA-enabled revenue opportunities ranging from federal tax credits (e.g., 45V, 45Z) and state programs (e.g., CA LCFS) to EU market access (e.g., PEF, Green Claims Directive) and customer offtake agreements.

> The LCA landscape is evolving rapidly – new regulatory programs, methodology updates, and an influx of AI-powered tools are changing how LCAs are scoped, executed, and verified.

> Without a clear framework for designing and commissioning an LCA, companies risk wasted budget, missed program eligibility, results that don't survive scrutiny, or reputational damage from poorly substantiated claims.

Questions to solve

> When should my company commission an LCA, and what type do I need?

> How do I select the right provider for my specific use case, sector, and budget?

> To maximize LCA value, what are key decisions during scoping and execution?

> How do I translate LCA results into commercial outcomes and avoid common mistakes?

Scope and constraints

> In scope: Practical guidance on LCA types, provider selection, execution, results interpretation, and communication. Focused on assessments most relevant to industrial and industrial product decarbonization.

> Out of scope: Detailed LCA methodology training, software tutorials, sector-specific deep dives, and program-specific application instructions. This playbook is not a replacement for qualified LCA practitioners.

> Design: An operational guide for company leaders, sustainability teams, and operators commissioning or interpreting LCAs.

> Time: Reflects conditions as of Q2 2026; expect material shifts as EU PEF requirements mature. Periodic updates planned.

Source: ILCD Handbook; ISO 14040; ISO 14044

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What is an LCA?

What is a lifecycle assessment (LCA)?

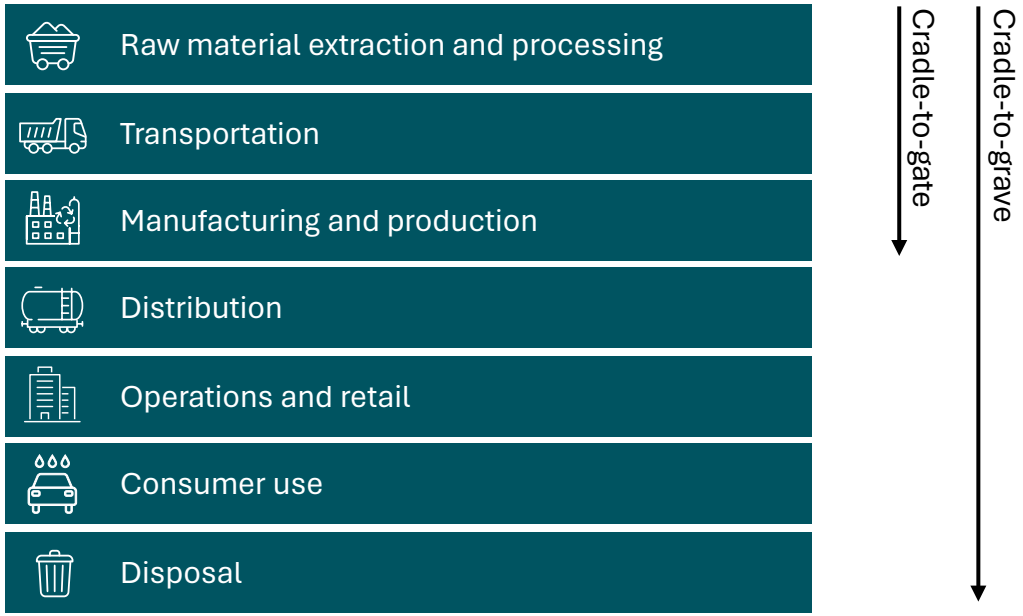
As defined by the International Standards Organization (ISO), an LCA is a technique for assessing the potential environmental impacts associated with a product across all stages of its lifecycle.

LCA scope and stages

Depending on the scope, use and goal of the LCA, specific lifecycle stages may be included or excluded.

> **Cradle-to-gate** focuses on the environmental impact of a product from extraction of raw materials to the point of leaving the manufacturing facility.

> **Cradle-to-grave** includes distribution, use, maintenance, and final disposal or recycling (end of life stages).



Key considerations for LCAs

LCAs vs. greenhouse gas (GHG) emissions accounting: While there are clear overlaps between LCAs and GHG accounting, there are important items to distinguish.

> While emission quantification through LCA can be conceptually similar to Scope 1, 2, and 3 emissions used in GHG accounting in accordance with the GHG Protocol, it is important to note that direct and indirect effects from LCAs do not map cleanly to Scope 1,2, and 3 emissions.

> LCA focuses on process flows for emissions, regardless of scope. Emissions are direct or indirect and focus on impacts of the upstream and downstream process of a product or service.

Direct and indirect effects: For each stage of a product lifecycle, the direct and indirect environmental impacts associated with the product are quantified.

> Direct impacts occur from a specific phase (e.g., emissions directly emitted in a manufacturing step such as natural gas combustion).

> Indirect impacts occur from all other stages relative to the lifecycle stage under consideration (e.g., indirect emissions from electricity used during manufacturing).

Variability among product types: These stages and nomenclature vary depending on the product/process discussed. For example:

> Building LCA includes additional phases such as construction, refurbishment and demolition as specified by the EN 15978 and ISO 21930 standards.

> LCA for transportation fuels can use other nomenclature, e.g., well-to-tank instead of cradle-to-gate, well-to-wheels instead of cradle-to-grave.

Source: ILCD Handbook; ISO 14040; ISO 14044

An LCA can look at more than just greenhouse gases

While GHG emissions are the most widely reported impact category, there are a total of 16 environmental areas that may be analyzed and evaluated in a complete lifecycle assessment.

Key points

> Some of the 16 environmental impact categories are listed in the table to the right.

> **Climate change (measured by kg of CO2 equivalent) is the most modeled impact category.**

> Other impact categories are important to quantify depending on regulatory requirements, sustainability targets, and business needs.

Impact Categories	Impact Indicator	Unit
Climate change	Radiative forcing as Global Warming Potential (GWP100)	kg CO_2-eq
Ozone depletion	Ozone depletion potential (ODP)	kg CFC-11-eq
Human toxicity, cancer/non-cancer	Comparative Toxic Unit for humans CTUh	CTUh
Particulate matter	Impact on human health	disease incidence
Ionizing radiation, human health	Human exposure efficiency relative to U_{235}	kBq U_{235} -eq
Photochemical ozone formation, human health	Tropospheric ozone concentration increase	kg NMVOC -eq
Acidification/ Eutrophication	Accumulated exceedance (AE)	mol H+ -eq
Land use	Soil quality index (dimensionless) Biotic production (kg biotic production) Erosion resistance (kg soil) Mechanical filtration (m^3 water) Groundwater replenishment (m^3 groundwater)	Dimensionless (pt)
Water use	User deprivation potential (deprivation-weighted consumption)	m^3 world -eq
Resource use, minerals and metals	Abiotic resource depletion (ADP ultimate reserves)	kg Sb -eq
Resource use, fossils	Biotic resource depletion fossil fuels (ADP-fossil)	MJ

Different product reporting merits different assessment types

Used for different purposes, LCAs, PCFs, and EPDs represent three categories of reporting declarations that vary in analytical depth, carbon focus, and requirements for third-party verification.

Lifecycle assessment (LCA)

> LCAs broadly refer to any assessment that evaluates all environmental impacts across the product/process lifecycle. These range widely based on scope, use and verification.

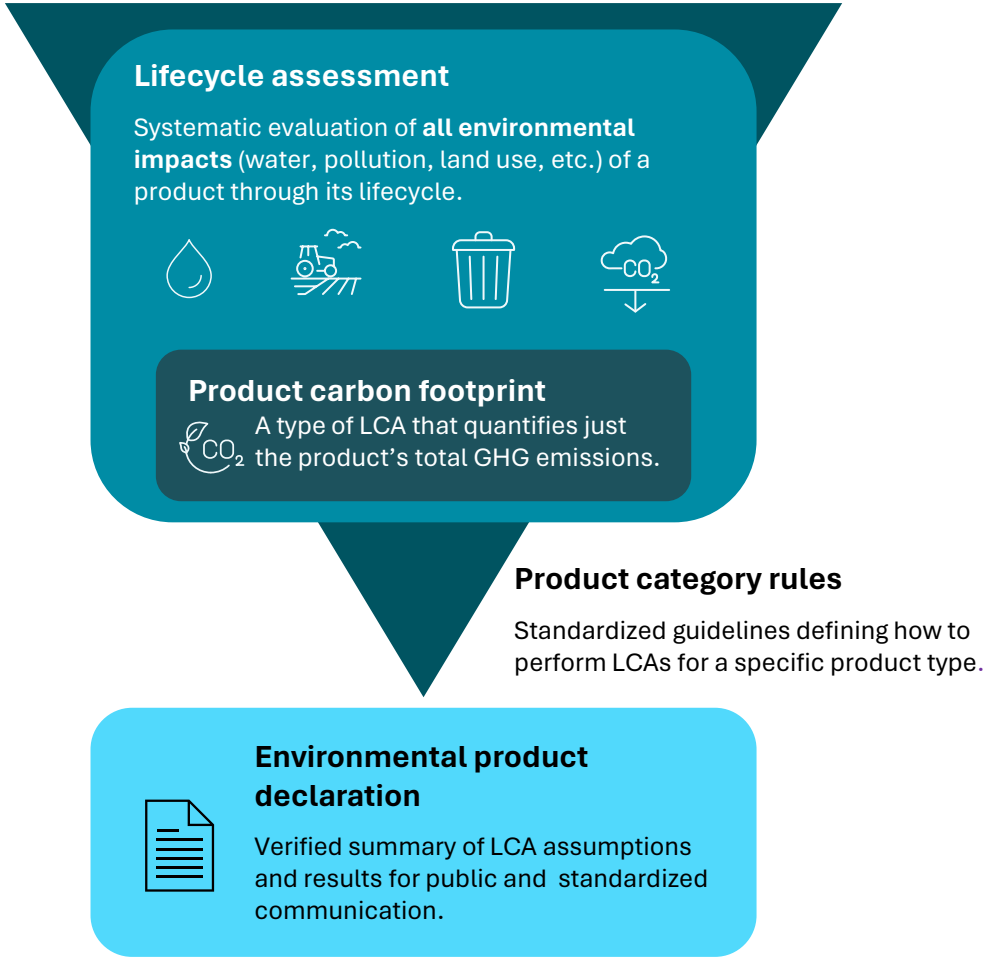
Product carbon footprint (PCF)

> Focus remains primarily on only the quantified **greenhouse gas emissions** of a single product across a specific part of its lifecycle.

Environmental product declaration (EPD)

> EPDs are documents that provide quantified environmental data based on a set of standards called Product Category Rules (PCR).

> PCRs are based on the ISO 14025 standard and serve to standardize environmental impact reporting. EPDs are commonly used in the building industry to capture the embodied carbon emissions of buildings.



Source: ISO 14025;

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LCA as a value driver

● LCA as a value driver

LCAs can provide significant value-add to a business model

LCAs bring value as they are required for accessing particular revenue streams, can attract new sources of capital or new customers/better pricing, and often find cost/risk reduction opportunities.

Unlocking revenue streams

> LCAs are often **required for accessing certain revenue streams**, such as offset monetization and access to public (state, federal) incentives.

> LCA data underpins **successful public grant applications and government incentives** by substantiating environmental impact and lowering project risk.

Operational improvements

> LCAs **identify emission hotspots across operations and supply chains**, revealing inefficiencies in energy use, material throughput, and waste generation that often translate into operational savings.

> **Ongoing LCA measurement establishes performance baselines** for continuous improvement, enabling easier prioritization of interventions by cost and carbon impact.

Equity raises and fundraising

> Differentiated decarbonization performance through quantified carbon savings enables a **stronger equity story**.

> LCA evidence supports sustainable finance alignment, essential for **attracting capital** from sustainability-focused institutional investors.

Cost reduction and customer sales

> LCAs often uncover decarbonization levers (e.g., switching inputs, supplier localization) **transforming emissions reductions into margin improvements**.

> ISO-compliant LCAs and PCFs **enable value-based selling** to decarbonization-conscious OEMs, bolstering offtake agreements.

Company strategy and exit value

> LCA insights highlight **resilience to environmental risks** (e.g., input scarcity, carbon pricing regulation), informing strategic positioning and any corporate exit narratives.

> LCAs support **asset-level analysis** of long-term value and risk-adjusted returns, helping understand opportunities to maximize value.

● LCA as a value driver

The choice of an LCA type is determined by the intended use case

Different LCA types have varying scopes of analysis, data quality expectations, requirements for verification, and project timelines.. Requirements from regulatory programs, customers, or investors often determine which to pursue.

Common LCA types (not exhaustive)

LCA type	Use case	Data sources	Third-party certification	External drivers	Timeline
Hotspot/ screening LCA	High-level, simplified LCA identifying key impact drivers ("hotspots")	Typically, Secondary Sources	Not typically certified	Internal decision making Mandatory or voluntary reporting Operating model changes	Days (tight, if data available) to weeks
Product Carbon Footprint (PCF) or LCA	Comprehensive cradle-to-grave/gate LCA following ISO 14040/14044 standards	Primary and Secondary	Dependent on use case May be third-party verified for public disclosure	Internal/external corporate reporting, public disclosure, scope 3 inventories Investor / customer engagement	Weeks to months
Comparative LCA	Side-by-side comparison of two or more products or scenarios	Primary and Secondary	Dependent on use case Must follow ISO 14044 rules for public comparative assertions	Environmental labeling, green claims, competitive differentiation, public procurement Investor / customer engagement	Days to months (Public Assertions)
Program/ regulatory specific LCAs	LCA tailored to meet the data and format requirements of a grant or regulatory body	Primary data preferred. Secondary data for data gaps	Not always formally verified. Some programs require official verification by the organization implementing the program.	Public funding programs (DOE FOAs) US federal tax credits US state/federal GHG standards, Participation in state credit programs (e.g. California LCFS) Offsets, voluntary carbon markets	Weeks (tight) to months

Increasing time, data quality, and verification demands ↓

Source: UNEP Guide to LCA; ILCD Handbook; ISO 14044

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LCA provider selection

LCA provider selection

LCA provider selection must be tailored to the application

The right provider depends on whether you need a standardized assessment, audit-ready verification, or bespoke modeling. Each need changes the required expertise, cost, and timeline.

Sector expertise and specialized model access

Selecting the right provider is one of the most consequential decisions in an LCA project. The wrong fit can mean wasted budget, missed timelines, or results that don't hold up to external scrutiny. Consider the level of customization and assurance needed:

Software-enabled practitioners:

> Best for **standardized LCAs using off-the-shelf tools** with minimal customization. This option is typically faster and more cost-effective – ideal for internal decision-making, rapid screening assessments, or projects with short timelines.

> If pricing and scope are comparable to your company's internal capabilities, consider whether an in-house screening suffices. Particularly if the external screening makes heavy use of AI tools.

Validation and assurance specialists:

> Suitable for projects needing **third-party verification, compliance with recognized standards, and audit-ready results**. These providers ensure compliance with recognized standards such as ISO 14044.

> Increasing interest in the EU's Ecodesign for Sustainable Products Regulation (ESPR) – for any company selling physical products in the EU, structured and product-level LCA data is a growing requirement.

> Since verification is non-negotiable in these cases (per ISO 14044 standards), price and timeline flexibility may be limited. Spend time to properly identify the providers best equipped to meet verification requirements efficiently.

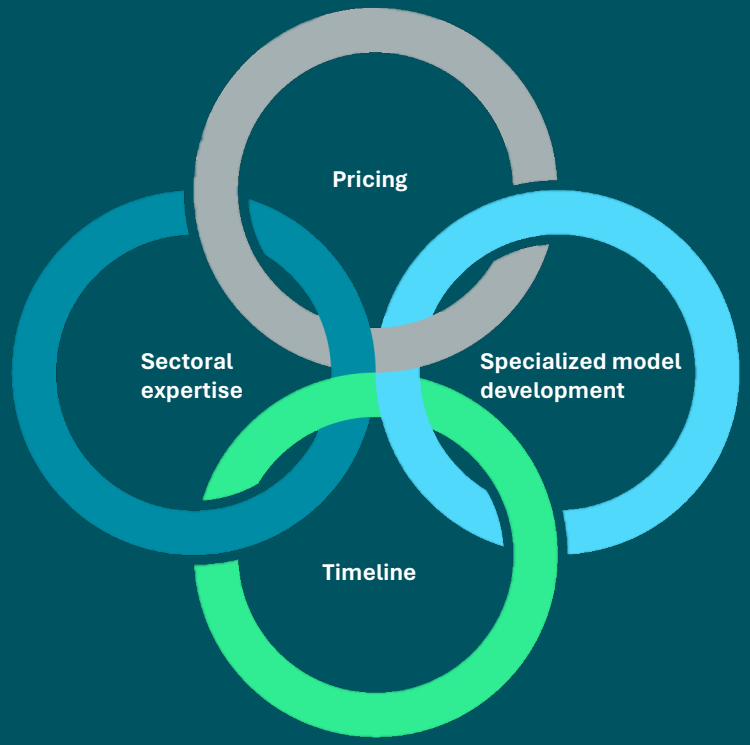
Specialized model developers:

> Appropriate for LCAs that **require novel modeling approaches or are tailored to processes not yet captured** by existing methodologies. These engagements are case-specific and often involve iterative development.

> Be wary of AI-powered LCA tools – though 2025/2026 has seen an explosion in these due to cost/time reductions, quality assurance questions are unresolved.

> Early scoping should allow time for dialogue on assumptions, interim deliverables, and the identification of providers with deep sectoral knowledge.

Key considerations in provider selection



LCA provider selection

Key considerations to develop the right LCA approach

Be familiar with the basics, understand what questions to ask, and trust the experts. Be sure you understand what items are need-to-haves for the process, and what your end objective is.

Scoping considerations

Evaluate internal capacity first:

> Internally assess whether using a consultant is necessary or if internal resources (e.g., a database subscription or in-company team) could efficiently support the need.

Define technical requirements early:

> Work proactively to define data needs, deliverable formats, and technical requirements before finalizing the scope.

> Ensure the provider has relevant industry experience, technical capabilities, and modeling skillsets aligned with your goals.

Set Clear System Boundaries:

> Clearly define system boundaries and functional unit in line with projected operations.

> Confirm alignment with internal stakeholders and regulatory expectations.

Project development considerations

Plan for data gaps and assumptions:

> Identify potential data limitations early and clarify how proxy data or assumptions will be handled in the model to maintain defensibility.

Prioritize primary data collection:

> Emphasize the importance of facility-level or supplier-specific data.

> Where unavailable, use high-quality secondary data from reliable sources, and require full documentation of data sources.

Incorporate scenario analysis:

> Include sensitivity analysis and scenarios (e.g., optimistic, conservative, status quo) to understand robustness of outcomes.

Ensure documentation throughout:

> Regardless of project scale or certification intent, require that all assumptions, data sources, and modeling decisions be clearly documented to support iteration and reuse.

Project close out considerations

Avoid black box deliverables:

> Receiving final results within a presentation without underlying assumptions or excel model files limits auditability, internal learning, and future use.

> Ensure model results are legible and assumptions/calculations transparent, particularly if this model will be presented to external parties.

Request full, reusable outputs:

> Ensure the provider delivers a defensible report alongside a reusable and auditable model file (e.g., Excel or SimaPro). Include these in the project statement of work.

> Review early iterations of the LCA, if available, to confirm expectations are being met and alignment on goals and scoping.

LCA provider selection

LCA validation and verification are critical to external expectations

Certification and third-party verification are designed to ensure rigor, transparency, and credibility in environmental impact claims.

LCA validation and verification requirements vary significantly between countries, programs, and agencies. They may involve adherence to international regulations, internal audits, independent third-party review panels, and government oversight – all aimed at reducing misrepresentation and ensuring consistency.

Key considerations and examples

Market programs (e.g. California LCFS)

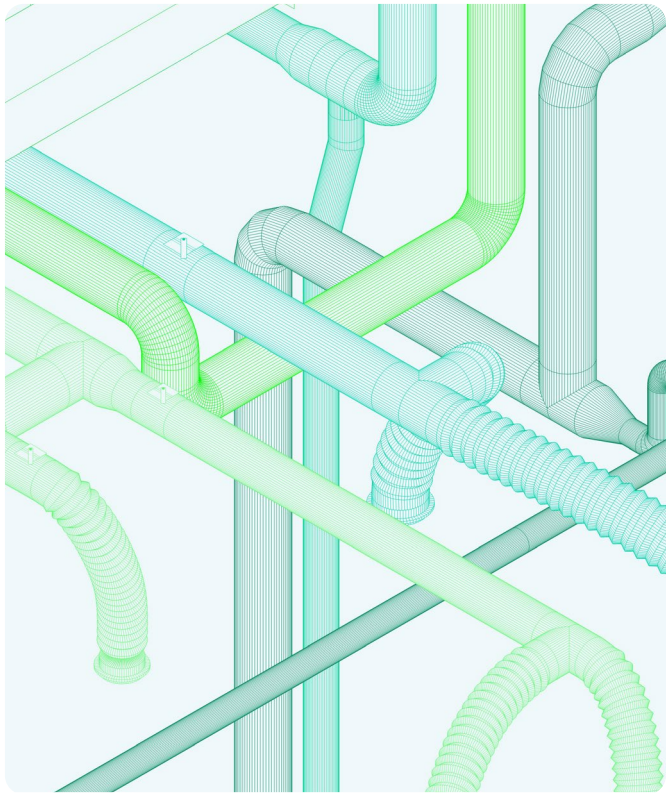
Programs like California's Low Carbon Fuel Standard (LCFS) require fuel producers to submit GHG-specific LCAs verified by approved state-appointed bodies as a condition for credit generation. These programs are highly specific in their requirements and will not accept generic LCAs – only from recognized groups under well documented requirements.

Environmental product declarations

EPDs are standardized, publicly available reports aligned with ISO 14025 that must be independently verified by accredited third parties to ensure consistent and transparent impact reporting.

Government grants and incentive programs

Federal, state, and local programs may require LCAs of varying depth. These often incorporate audits or third-party checks to confirm methodological soundness and emissions accuracy for eligibility. These vary widely by program – ensure the firm has experience with LCAs for the program and (as necessary) is accredited by any necessary bodies.



Additional considerations

Third-party review panels

> For especially novel or sensitive assessments, convening an independent technical review panel can strengthen credibility, offer expert challenge, and improve stakeholder acceptance.

> This is especially useful when publishing results externally or applying for high-profile funding or certification.

Provider roles and conflicts of interest

> Some LCA firms may offer both modeling and verification services. To avoid conflicts of interest, ensure that separate teams are used for LCA execution and for any validation or assurance services.

> Additionally, confirm that the selected provider is accredited for the relevant verification standard – many programs require verifiers from pre-approved lists.

Source: ISO 14071 ; ISO 14025

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Major steps in LCA execution

● Major steps in LCA execution

The LCA process is rarely linear – proper planning requires iteration

Early and ongoing alignment between the company and the LCA practitioner is essential to ensure that the analysis remains decision-relevant, cost-effective, and tailored to its intended application.

Steps in LCA process

LCA goals and scoping

An LCA should not be commenced without a **complete understanding of the end objective** to avoid rework, inefficiencies, or results that are unfit for use. Clearly defining the goal and scope at the outset is critical. This includes determining the intended application of the LCA (e.g., credit generation, customer claims, regulatory use), selecting system boundaries, understanding any co-product allocation, and defining the time horizon the LCA will address.

Lifecycle inventory

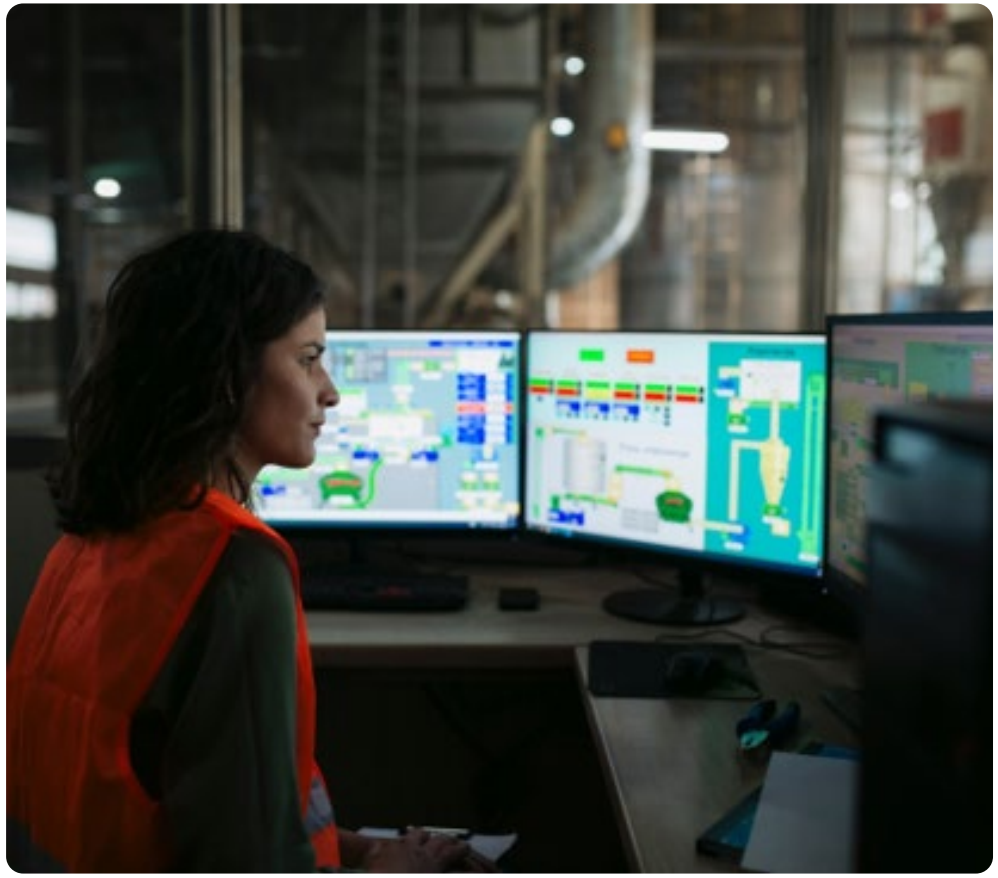
Lifecycle inventory is typically the most resource-intensive stage for the business. This involves **collecting and compiling all relevant primary and secondary data** (e.g. material inputs, energy use, emissions, process details) to enable robust modeling by the LCA practitioner. Understanding what data will be needed and getting data laid out in advance will save time and frustration in any LCA modeling process.

Impact assessment

Using the collected inventory data, the practitioner **quantifies environmental impacts across selected categories** (e.g., GHG emissions, water use, land use). This is often the most time-intensive analytical step for the practitioner and builds directly on the decisions made in the goals and scoping phase – hence the criticality of scoping to avoid wasted effort.

Result synthesis

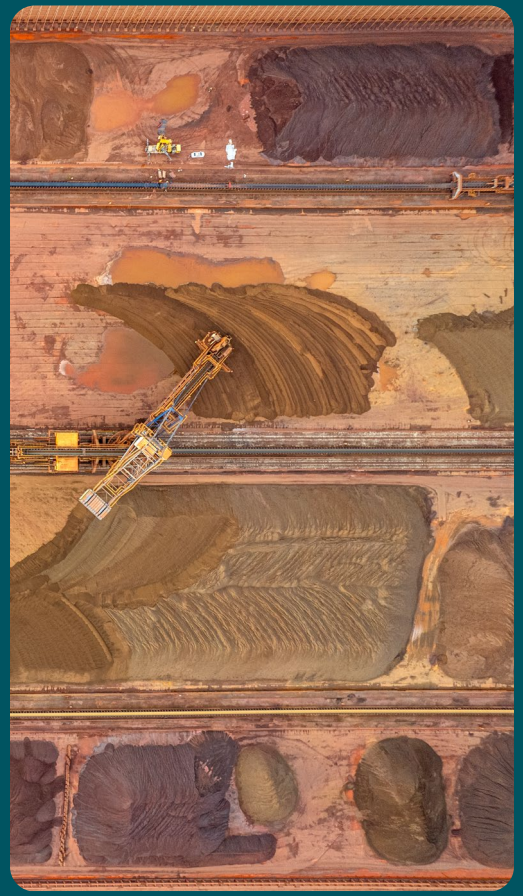
The final phase **interprets results, identifies key drivers, and presents findings** in the form of a technical report and supporting documentation (e.g., model workbooks). This deliverable may be used for internal decision-making, external disclosures, or credit applications, depending on project goals.



Major steps in LCA execution

LCA goals and scoping are driven by the use case requirements

Determining the purpose and goal of the LCA will be critical for determining which framework, tools, and data sources to use. Though there are countless potential use cases, make sure your company understands a use case (and your LCA practitioner ideally has deep experience) to ensure specific requirements are met.



Example LCA use case	Applicable reporting framework
Voluntary carbon footprint reduction › Measure the carbon footprint of a product or process – typically Scope 1, 2, or 3 emissions – with the goal of tracking reductions over time.	**GHG Protocol:** The global standard for corporate greenhouse gas accounting, foundational for Scope 1, 2, and 3 assessments. **ISO Standards (14064, 14067):** International standards for quantifying and reporting GHG emissions at the organizational or product level (respectively). **Science Based Targets Initiative (SBTi):** Provides guidance and verification for companies setting carbon reduction targets in line with climate science.
Low carbon product marketing › Develop a cradle-to-grave carbon footprint of a product and pursue third-party certification for environmental marketing claims (e.g., EPDs, eco-labels).	**Product Category Rules (PCRs):** Sector-specific rules that define how to conduct LCA and report results for a given product category; necessary for producing Environmental Product Declarations (EPDs). **Industry-specific rules:** E.g., Together for Sustainability (TfS), a consortium that defines rules for chemical and related industries to ensure comparability and credibility.
Tax incentives and regulatory requirements › Qualify for regulatory incentives or compliance schemes such as federal tax incentives, California's LCFS, or the EU's Renewable Energy Directive - RED III.	**DOE GREET guidance:** U.S. Department of Energy's GREET model is used for calculating lifecycle GHG emissions in regulatory contexts like 45Z clean fuels or SAF eligibility. **ICAO (International Civil Aviation Organization):** Sets carbon accounting criteria for Sustainable Aviation Fuels under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) framework. **RED III Certification:** The Renewable Energy Directive in the EU specifies lifecycle GHG thresholds and sustainability criteria for fuels and feedstocks in the European market.

● Major steps in LCA execution

Scoping decision: selecting boundaries before starting an LCA

To ensure full transparency and decision-usefulness, select a boundary that reflects how the product is used, marketed, or regulated, and aligns with the intended audience or disclosure framework.

Scope and system boundaries

> A complete lifecycle assessment, and therefore product carbon footprint should cover cradle-to-grave (alternatively “well-to-wheel”) impacts.

> There are many reasons why the scope may be reduced.

Example boundaries

> **Cradle-to-gate**: Appropriate for producers who lack visibility into how their products are ultimately used. Common when downstream use or disposal impacts are uncertain or vary widely.

> **Cradle-to-grave**: For products with significant use-phase or end-of-life impacts (e.g., plastics) a cradle-to-grave assessment is essential to fully capture performance. This boundary ensures the analysis includes all lifecycle stages from production to disposal or recycling.

> **Well-to-wheel vs. tank-to-wheel**: Specific to fuel producers, this is a strategic decision in how emissions are framed. Understand what your customers are looking for (or competitors are showcasing) to make sure you use like-for-like to not create artificial advantages or disadvantages. Particularly if the upstream (well-to-tank) portion of the supply chain is lower-carbon than alternatives, that advantage should be clearly communicated and differentiated.

Implications

> The choice of system boundary has a significant impact on what an LCA reveals; overly **narrow boundaries may omit critical emissions or benefits**, while **broader boundaries may introduce uncertainty or reduce comparability**.

> **Match the boundary to your intended audience and use case**. Regulatory programs (e.g., LCFS, 45Z, CORSIA) typically lay out specific boundaries – confirm requirements before scoping.

> If multiple boundaries are relevant (e.g., reporting cradle-to-gate for customers and cradle-to-grave for a program disclosure), scope both upfront rather than running two separate LCAs.

> **Avoid boundary changes mid-study!** Once results are produced, expanding or contracting the boundary essentially requires a complete LCA restart.

Source: ISO 14044

● Major steps in LCA execution

Lifecycle inventory improves with access to high-quality data

The quality of data sources directly influences both the credibility and granularity of the resulting LCA. High-quality, primary data typically requires greater time investment but enables application to more stringent programs and can aid in the robustness of assessments for decision making.

Types of data sources

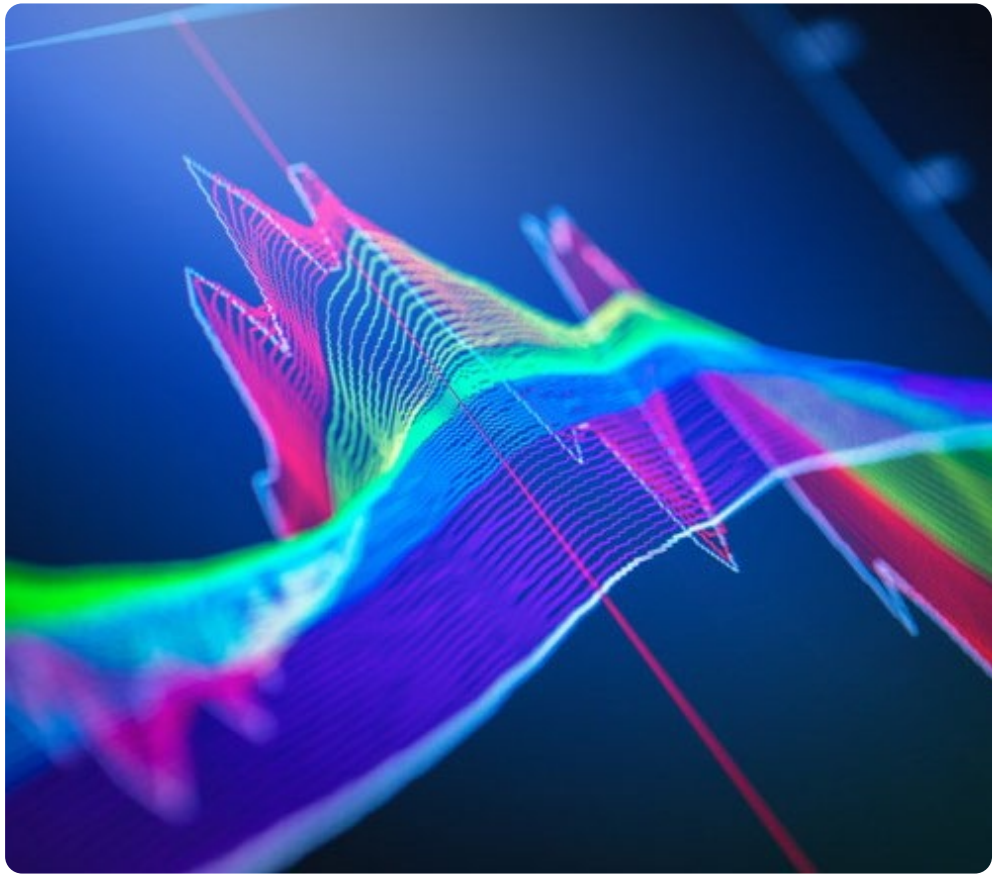
> **Primary data sources** refer to site-specific, directly measured or collected data from actual operations (e.g. fuel use, material inputs, or process emissions at a facility). Primary data sources should be prioritized for any operational facilities. Confirm with applicable frameworks to determine the range of data needed (monthly, annual average, etc.).

> **Secondary data sources** include generic or literature-based data, often from LCI databases (e.g., Ecoinvent, GaBi) or published studies. These are typically used when primary data is unavailable. When selecting secondary data, prioritize government sources or those recommended by the frameworks relevant to the intended use of the LCA.

Evaluating data quality

> The US EPA's Guidance on Data Quality Assessment for Lifecycle Inventory Data provides a framework for evaluating data quality in alignment with the **ten criteria specified in the ISO 14044 standard**.

> These criteria evaluate primary and secondary sources on **source reliability, temporal and geographic correlation, technological representativeness, completeness, and data sampling methods**.



Source: US EPA

● Major steps in LCA execution

Operational maturity will drive the depth of an LCA

LCAs for pre-operational processes are feasible but by definition will lack primary data sources. Care is needed when applying results, particularly if related to any contracts – do not make commitments involving impacts of a process that has only been measured theoretically.

	LCA for a pre-operational process	LCA for an operational process
Purpose	> Evaluate drivers of carbon footprint and ballpark expected carbon intensity.	> Gain detailed insights into drivers of carbon footprint and carbon intensity with high certainty, using primary data sources.
Data Sources	> Likely minimal primary data, but any data from a pilot plant, or process simulation that can be used/scaled is preferable. > Focus on widely available, credible data sources, such as LCA databases, government databases, published LCAs for similar processes.	> Primary operations data should be the main data source, assuming data quality is sufficient, for both quantity of inputs and outputs, as well as emissions. > Secondary data may be used for upstream and downstream supply chain inputs, as well as widely acceptable emissions factors for items such as natural gas, electricity.
Example Use Cases	> Applying for an innovation grant, requested additional funding, evaluating the location of a new manufacturing facility or expansion into a new technology.	> Contracting for a low carbon product supply, applying for a production tax credit, increasing production efficiency.
Disclaimer	> Generally, should not be used for contractual purposes unless explicitly requested.	> Can be used for contractual purposes with the appropriate legal disclaimers, however third-party certification is generally recommended.

Source: US EPA

Ensure you are leveraging your LCA's full value

A completed LCA is only valuable if it informs decisions, actions, or communications. There are several options for leveraging your LCA results – ideally you should determine your strategies for leveraging the LCA before commissioning, to ensure it is structured to support those outcomes.

White papers and thought leadership

> Translate LCA results into public-facing insights to position your company as a sustainability leader.

Regulatory program participation

> Enable engagement with mandatory or voluntary state/federal programs requiring environmental disclosure or validation.

Commercial value creation

> Show that your emissions intelligence has monetizable value

> Use LCA to quantify benefits, identify cost levers, and support investment cases.

Customer and market communication

> Support verified sustainability, decarbonization and climate claims to improve transparency, trust, and brand differentiation.

● Major steps in LCA execution

Impact assessment translates inventory data into indicators

The choice of impact assessment method and categories affects results, comparability, and regulatory acceptance. Align method selection with your intended use case – different programs and audiences may prefer or require specific approaches. Select during scoping, as switching methods requires re-work.

Common LCA impact assessment methods

Method	Use cases	Geography
TRACI 2.1 (EPA)	US regulatory context (default for most US-focused LCAs)	US-specific
EF 3.1 (EU)	EU PEF compliance, Green Claims Directive preparation, any EU-facing product claims. Increasingly required for EU market access.	EU-specific
ReCiPe	Academic and multi-impact studies requiring both midpoint indicators and aggregated endpoint damage scores.	Global
CML-IA	Older model, but still common for benchmarking against historic literature or in certain industries (e.g., metals)	Global

Safest defaults for US- or EU-specific work

Key impact categories (not exhaustive)

Requirement level	Impact category
Always reported	> Global Warming Potential (GWP)
Frequently reported	> Acidification potential > Eutrophication potential > Ozone depletion potential > Smog formation
Emerging	> Water use > Particulate matter formation > Land use > Resource depletion

ISO 14044 specifies 16 potential impact categories. For many companies, GWP will be the primary focus. EPDs, EU PEF, and certain customer/investor requests may require a broader set. **Confirm required categories during scoping.**

Source: ISO 14044 ; European Commission ILCD Handbook

● Major steps in LCA execution

Results synthesis provides context against industry benchmarks

Once your environmental impacts are quantified, the next step is to contextualize the results. Benchmarking against industry standards helps ensure results are aligned with market expectations and allows readers to understand what this impact means in a more specific perspective.

What sources can I use for comparison?

Sector	Sources for benchmark comparison[1]
Food and agriculture	**USDA LCA Commons**: United States Department of Agriculture Lifecycle Assessment Commons **COMET-Farm**: Carbon Management and Evaluation Tool **GLEAM**: Global Livestock Environmental Assessment Model **Agribalyse**: French lifecycle inventory database for agricultural and food products
Chemicals and materials	**Ecoinvent**: Comprehensive international lifecycle inventory database for environmental data **One Click LCA**: Cloud-based lifecycle assessment software for construction and manufacturing **ELCD**: European Reference Lifecycle Database **JRC PEFC**: Joint Research Centre Product Environmental Footprint Category Rules **GABI (Sphera)**: Lifecycle assessment database and software developed by Sphera
Fuels	**CA-LCFS**: California Low Carbon Fuel Standard **CORSIA**: Carbon Offsetting and Reduction Scheme for International Aviation – ICAO's default lifecycle emission values for aviation fuels **RED III default benchmarks**: EU Renewable Energy Directive III Default Benchmarks (updated to RED IV in 2027)
Manufacturing	**Ecoinvent**: (See above) **GABI**: (See above) **Company EPDs**: Environmental Product Declarations – standardized documents providing transparent data about the environmental impact of products, published by companies and third-party validated **Sector PCRs**: Product category rules for specific sectors are becoming increasingly important, particularly for recycled materials (which differ from virgin materials), waste-based products, or products with rare-earth concentrates

Key considerations

Validate directionality

> Comparing against trusted datasets helps confirm whether your LCA results are within a reasonable range for your sector and product type.

Provider roles and conflicts of interest

> Market benchmarks provide a credible reference point for disclosures, policy compliance, and communications with customers or regulators.

Select fit-for-purpose sources

> Use peer-reviewed, program-approved, or industry-recognized data depending on your use case (e.g., LCFS crediting vs. investor disclosure).

Sector-specific guidance

> Spend time or find experts/reports to identify the most appropriate and defensible benchmarks.

Note: 1. Not intended to be exhaustive

Source: ISO 14044 ; European Commission ILCD Handbook

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Key takeaways for maximizing LCA value

● Key takeaways for maximizing LCA value

Three key questions to ask before starting any LCA

A well-designed LCA is not a technical exercise – it is a strategic asset. A small number of upfront choices determine whether the final result is useful, defensible, and revenue-generating. Answering these three questions during scoping supports in the analysis delivering value rather than requiring a restart.

Does the LCA adhere to use case and program requirements?

> **An LCA designed for one purpose may be invalid for another**. Corporate GHG accounting (GHG Protocol) and regulatory programs (e.g., LCFS, 45V/45Z, RED III) often have differing requirements on what data, methods, and accounting conventions are acceptable.

> During or before scoping, identify every intended use of the LCA and confirm **the most stringent program's requirements drive the LCA design**.

> Example: Renewable energy certificates (RECs) can reduce Scope 2 emissions under GHG Protocol but cannot generally be used to reduce fuel CI under California's LCFS. These types of technical details must drive LCA design from the beginning.

What kind of data is needed to defend the results?

> The **data quality an LCA needs is dependent on how the results will be used**. Internal decision-making can tolerate secondary data and broad assumptions; tax credit applications and publicly released assertions cannot.

> It takes more time to collect, but **primary data is non-negotiable for stringent applications**. Underinvesting in data quality planning at scoping leads to rework, missed program eligibility, or claims rejected under scrutiny. At best, this is lost money/time, at worst, this is reputational damage.

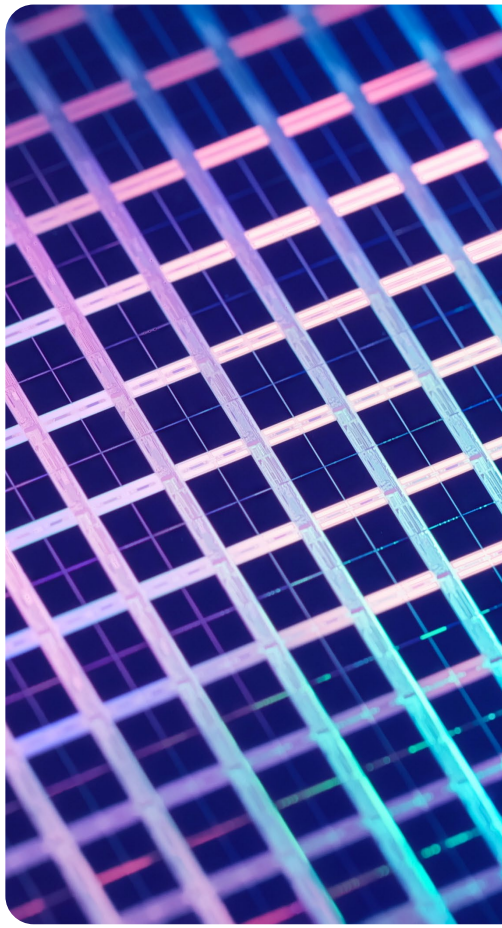
> Example test: If the LCA result was challenged by a regulator, customer, or competitor, would the data sources be considered adequate and well substantiated? If not, invest more in primary data before proceeding.

How do we plan to communicate this data, and to whom?

> A technically sound LCA has no value if results aren't presented with appropriate context, caveats, and credibility. **Define how results will be communicated** – and who will be looking at them – during scoping, not after.

> If planning on communicating your results externally, scope your LCA for third-party verification, legal review, and disclaimers from the start. **Adjusting for new layers of review retroactively is more expensive** and might lead to rework.

> Example: A comparative claim like "50% lower embodied carbon than competitors" requires ISO 14044-compliant critical review by an independent panel before public release. If not planned during scoping, this can add weeks of delay and tens of thousands in additional cost.



Source: ISO 14044 ; GHG Protocol Product Life Cycle Accounting and Reporting Standard

● Key takeaways for maximizing LCA value

Five practices separate high-value LCAs from wasted exercises

LCAs are more than compliance tools, they are strategic assets. Whether for unlocking incentives, attracting capital, or product differentiation, a well-scoped and implemented LCA can deliver measurable value. The companies that extract the most value follow a consistent set of practices, from scoping through communication.

Treat scoping as the most important phase.

> Locked scoping prevents cascading rework. Decisions on areas such as boundary, allocation, and impact assessment method should be final before inventory begins – if there are open concerns or questions, resolve them before starting or be prepared for rework.

Build in time and budget for iteration.

> First-time LCAs rarely run linearly or smoothly. Difficulties will arise. Plan schedule buffer, require interim deliverables in the statement of work so you can review progress and catch issues early, and resist the temptation to lock final results before sensitivity analyses are complete.

Demand transparent, reusable deliverables.

> Reject "black box" outputs. Require an auditable model file (e.g., Excel, SimaPro, GREET) alongside any defensible report. Without this, the LCA cannot be internally audited or iterated/updated in the future. It may have zero value if a required external agency cannot audit the model.

Treat the LCA as a living asset, not a one-time deliverable.

> Operating conditions, supply chains, and regulatory requirements will change. Plan for periodic updates, particularly if the LCA underpins credits, claims, or contracts. Build repeatable internal processes – like documented data sources – to reduce costs and difficulties in the future.

Translate results into business outcomes.

> A completed LCA is only valuable if it informs decisions, assists in revenue generating activities, and/or supports communications. Tie your results to feed into specific applications (e.g., tax credit filings, customer claims, sustainability disclosures, investor narratives). Getting the most from your LCA means treating it as the beginning of value creation, not the end.

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