Real-Time LCA:
From Sustainability Reporting to Sustainable Action

Though pharmaceutical organisations have more sustainability data than ever before, the value of this data often remains limited to one-off reporting exercises, rather than informing daily decision-making. The notion of drawing from accurate, updated data to inform each operational decision and limit adverse environmental impact currently appears complex and out of reach. Real-time, or near real-time, life cycle assessment (LCA) has the potential to make this notion a reality, as LCA already provides reliable and credible intelligence on product carbon footprint and other environmental impact categories.

Real-time LCA for the pharmaceutical industry combines standard LCA methods with routinely updated operational data from manufacturing, procurement and logistics systems. The goal is decision-grade insight that teams can use during product, process and supply-chain decisions, not just after the fact. Operational changes (for example, in transport mode, energy mix, supplier or the bill of materials) are reflected in near real-time product-level impact results, turning LCA into an ongoing decision support capability rather than a retrospective reporting exercise.

What Problem Does Real-Time LCA Solve?

As understanding of the climate crisis and urgency of action have evolved, so too have requirements for businesses and industry. The result is that sustainability action and its required data has emerged in a fragmented and uncoordinated manner, in response to evolving expectations. Environmental performance in a single organisation is expressed through multiple, disconnected data sets or certifications, whether product LCAs, B Corp certification, or data gathered for frameworks such as the Carbon Disclosure Project (CDP). The fact that different teams, as well as external consultants or specialist providers, manage distinct sustainability responsibilities further exacerbates the issue (see Figure 1).

Consequently, organisations frequently operate with:

- Duplicated data collection efforts, where similar information is requested multiple times.
- Inconsistent assumptions and methodologies, and inconsistent secondary databases (the databases converting kWh, kg or tonnekm into emission profiles, such as kg CO_2e), system boundaries (what the footprint includes/excludes), and allocation rules (how shared impacts are split).
- Limited interoperability between systems, with sustainability data stored across spreadsheets, third-party platforms and internal databases.
- Minimal cross-functional visibility, meaning insights generated in one department are rarely accessible or actionable in another.
- Low reusability of results, where studies are difficult to update and quickly become out of date for operational decisions.

Technology companies refer to a 'single source of truth': a governed way to store and manage critical activity data so it is standardised, quality-checked and accessible across functions. To address the issues outlined above, pharma can learn from this approach by

Consolidating Sustainability Strategy

At present, sustainability responsibilities are dispersed among various departments, each operating with their own reporting standards, objectives, and leadership. Establishing a unified strategy at Executive and Board level will foster comprehensive top-down transformation.

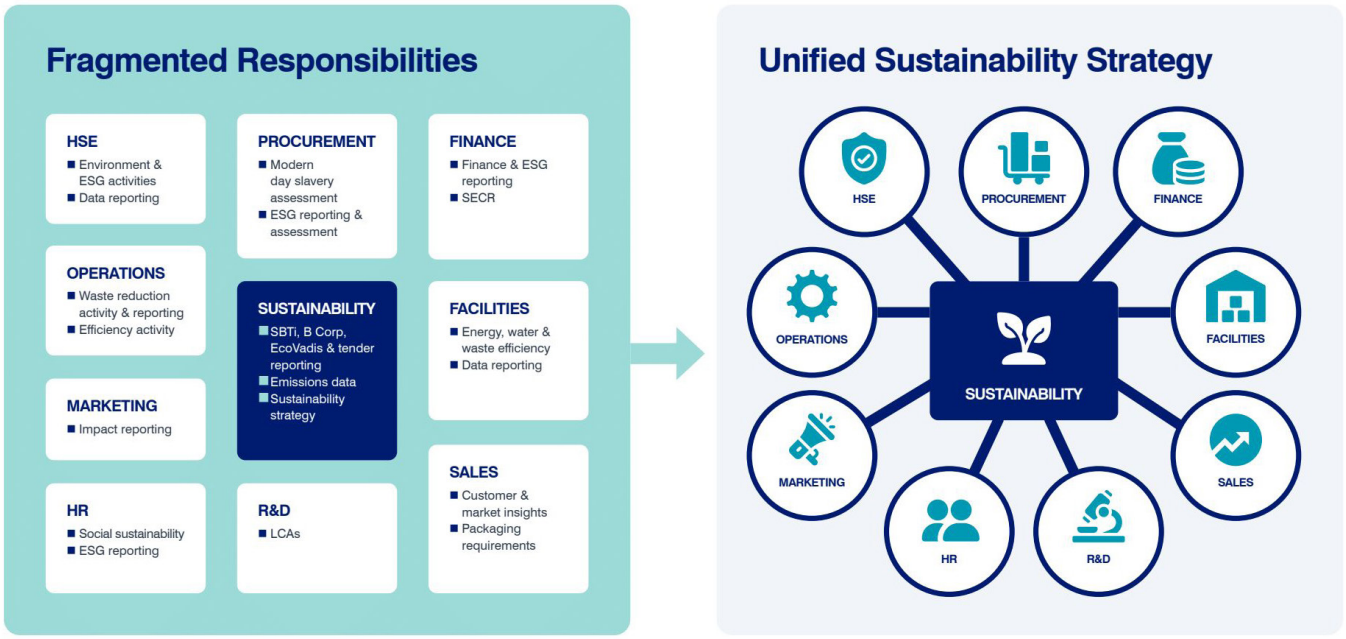

Figure 1: Consolidating Sustainability Strategy

treating sustainability activity data (materials, energy, yields, transport, waste and supplier inputs) with the same discipline as financial or operational data. LCA offers a strong foundation for this, as a comprehensive method for quantifying product- or even company-level environmental impact, underpinned by internationally recognised standards, including ISO 14040 and ISO 14044. Sector initiatives such as PAS 2090 are also emerging to improve consistency for pharmaceutical products specifically. However, for LCA to support fast-moving commercial environments, it must move beyond static, point-in-time studies and be integrated into organisational data systems so results can be refreshed when the underlying business data changes.

What Are the Steps to Enabling Real-Time LCA?

In collaboration with sustainability specialists and pharmaceutical manufacturers, work is underway to explore the development of a near real-time, product-level emissions model intended to serve as a 'single source of truth'. The initiative aims to generate practical insights and establish a blueprint that other organisations can build upon. The project has identified three core building blocks (see Figure 2) to help transform static LCAs into decision-grade models.

1. Map and Optimise Internal Data Infrastructure

The first step is bringing available data together. This entails mapping out the data collected by each team, clarifying ownership and accountability, determining which datasets are needed for sustainability and LCA purposes, and then assessing how this information should be presented and integrated. Gathering this primary data for the LCA model may appear to be an overwhelming task for some organisations; the key is to take an iterative approach, perhaps prioritising the accuracy and detail of data in the areas that contribute most to greenhouse gas emissions (e.g. energy-intensive manufacturing steps, high-impact raw materials or solvents, cold-chain transport, or particularly wasteful or low-yield processes). Ultimately, though, the goal is to create a standardised system for organising and managing sustainability data.

2. Design a Sound LCA Methodology for Relevant, Comparable and Scientifically Credible Outputs

Creating an LCA system suitable for organisational decision-making rests on three principles:

- Methodological rigour
- Parameterised LCA modelling
- System integration.

To establish methodological rigour, organisations must first analyse relevant standards, regulations and frameworks. This includes: sector-agnostic standards such as ISO 14040 and ISO 14044, ISO 14067, and the Product Environmental Footprint (PEF); sector-specific frameworks, such as PAS 2090 and other pharma and medical-related methodologies and guidance documents; and lastly supply chain-specific requirements, to align as much as possible with supplier data structures and client expectations.

'Parameterising' the LCA model is the point where it becomes dynamic. Instead of fixed inputs, features that vary across the product portfolio are defined as parameters. These parameters can include material compositions, energy consumption profiles, yields, transport distances, packaging configurations, and more. To determine what these variables should be, the model must be developed with its intended use cases in mind, such as product development, scenario analysis, supplier information or external reporting. Next, the parameters which are most decision-relevant must be selected, while allowing for future additions or modifications.

Rather than rebuilding models for each assessment, users can input product-specific data into these predefined parameter fields, ensuring that all results are generated within the same consistent modelling framework (see Figure 3). In an API-enabled environment, parameterised models can be directly connected to enterprise data systems so that product data, bill of materials, or process information flows directly into the LCA model. Once this is set up, changes in material sourcing or energy use, for instance, can be evaluated across an entire portfolio, supporting strategic decision-making and continuous improvement.

In the absence of integration with enterprise systems and user interfaces, LCA is a siloed activity, dependent on manual data collection and limited to expert users. Linking LCA models directly to internal data architectures ensures that sustainability calculations are based on the most current and consistent data available within the organisation, such as product specifications, procurement data or production metrics. Tailored user interfaces can be built on top of this integrated backend; R&D teams can explore designs through a dedicated interface, for instance, while procurement may use a separate portal focusing on supplier impacts.

Bringing these layers together not only transforms how LCAs are used by an

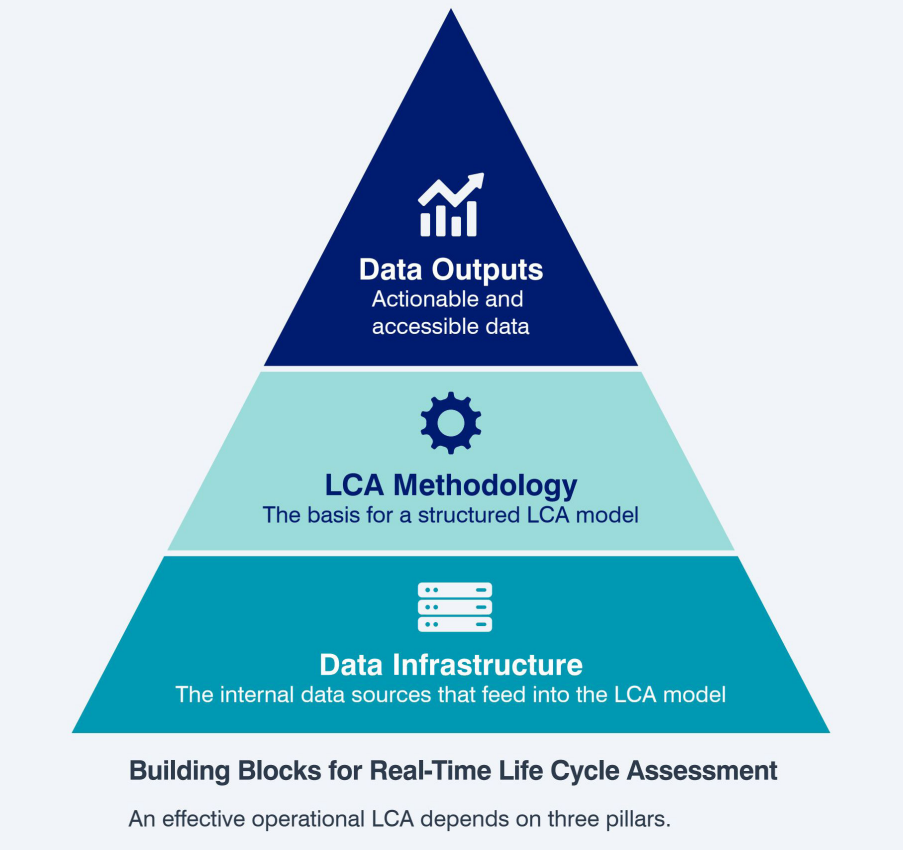

Figure 2: Building Blocks for Real-Time Life Cycle Assessment

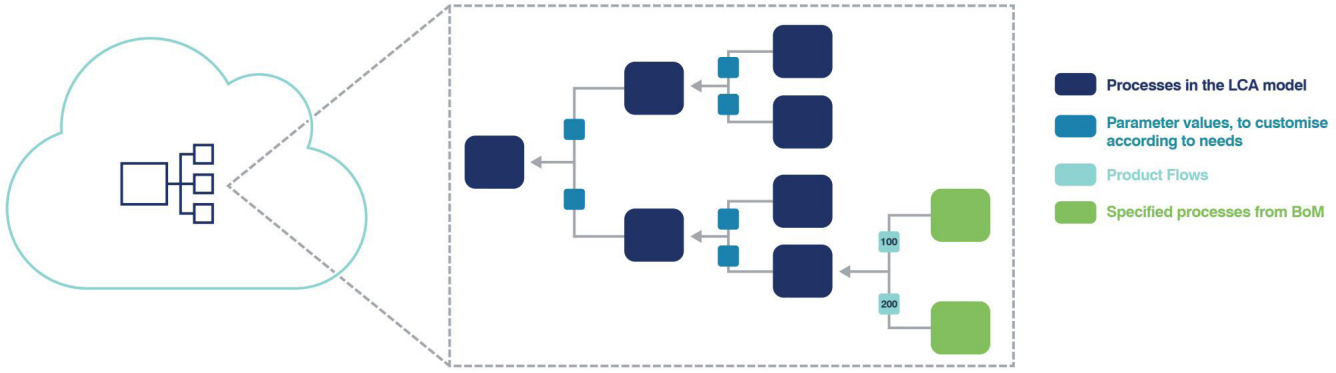

Figure 3: Configurable and Parameterised LCA Model, Simapro 2026)

organisation, it also shifts the roles of LCA experts. Rather than producing one-off assessments (a significant undertaking in its own right), they become cross-disciplinary specialists with a broader focus on building resilient systems that help to mitigate environmental impact in the long-term.

3. Make data outputs actionable

This third pillar for creating a real-time LCA model centres on usability. Without this piece, all efforts to collate and standardise data may be lost. Users across an organisation must be able to understand the system's outputs to then make informed decisions. Even the least technical user should be able to look at the data and understand what they are looking at, why it matters, and how to implement change as a result.

One practical way to make emissions information usable is to embed it into systems that teams already recognise. Lean manufacturing principles, particularly value stream mapping, where each step from order to delivery is diagrammed, are well established in pharmaceutical manufacturing. Rather than introducing a separate "sustainability language", organisations can overlay LCA results onto value stream maps so teams can see where emissions occur, what drives them, and which process changes are likely to matter most.[1] This improves the chances that footprint insights translate into operational action, because they appear in the same context as time, cost, quality and throughput decisions. Over time, using a consistent underlying dataset and method also improves comparability for internal reporting and supplier/customer discussions.

Why Are Real-Time LCAs Especially Relevant Now?

Early sustainability frameworks were primarily voluntary. However, as described earlier, layers of Environmental, Social and Governance (ESG) reporting have increased over time (see Figure 4). In parallel, there has been a shift towards mandatory, auditable compliance where each claim must stand up to scrutiny. This shift is reflected at both regional and national levels.

In the European Union, the Corporate Sustainability Reporting Directive (CSRD) substantially expands the scope and depth of sustainability reporting, demanding standardised ESG information, as well as forward-looking metrics. Meanwhile, under the Empowering Consumers for the Green Transition (ECGT) Directive, vague or unsubstantiated claims such as 'environmentally friendly' or 'carbon neutral' are prohibited unless they can be supported by verifiable evidence. In the UK, procurement frameworks are taking a stricter view on sustainability. The Evergreen Sustainable Supplier Assessment began as the National Health Service's voluntary self-assessment tool. Today, it is increasingly integrated into procurement processes, in support of the NHS' net zero goals

Figure 4: The Sustainability Compliance Journey

for 2045. Compliance is therefore a commercial necessity, not simply a 'nice-to-have'.

Manufacturers in the pharmaceutical and medical device sectors cannot respond to this cumulative reporting burden in the same manner as before. This will simply exacerbate the existing issues of repeated data collection, reliance on external consultants, and escalating costs. However, the alternative is regulatory, legal and reputational risk.

To facilitate the transition, and so that organisations can more easily respond to future sustainability requirements, the industry must transform its approach. This is the impetus for a real-time operational model: an agile system capable of absorbing live updates and producing insights ready to be translated into immediate action. The approach outlined in this article aims to move from abstract, high-level metrics to insights that teams can engage with, from single-use data to repeated scenario testing, from disengaged teams to strengthened buy-in, and from disjointed sustainability effort between customers and partners to meaningful collaboration.

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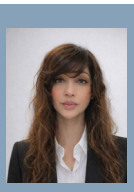

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