

Life Cycle Assessment (LCA)

A case study exploring
Croda's new 'cradle-
to-grave' life cycle
assessment (LCA) tool.

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Croda has developed a new 'cradle-to-grave' life cycle assessment (LCA) tool. The tool assesses upstream procurement activities, production processes, downstream product use, and product end of life, to produce a holistic picture of a chemical ingredient's environmental impact.

This allows Croda and its partners to identify environmental hotspots in the product lifecycle, pinpointing stages, processes or materials that can be improved to make products (and facilities) more sustainable. This can help customers achieve their sustainability goals.

Croda's ultimate commitment is to take a leadership role in the LCA of its ingredients and their impact on the life cycle of its customers' products – helping the markets in which they operate move towards more circular economies.

As such, Croda aims to deliver at least 100 cradle-to-grave life cycle assessments by 2030.

Why LCA?

As part of its commitment to becoming a Net Zero organisation by 2050, and its alignment with the United Nations Sustainable Development Goals (SDGs), Croda intends to be Climate Positive by 2030 and contribute to a Nature Positive future.

This includes:

- **Decarbonising Croda's operations, halving its Scope 1 and Scope 2 emissions and reducing upstream Scope 3 emissions, in line with its Science Based Target to limit global warming to no more than 1.5C**
- **Reducing water impact by 50% from Croda's 2018 baseline**

And Croda is not alone in its ambitions. Companies in a variety of sectors across the world are pursuing similar environmental targets, being increasingly driven by consumer values and new legislation.

But it is difficult to manage what you cannot measure. So, to support its own sustainability targets and those of its customers, Croda saw the need to adopt a cradle-to-grave LCA approach that takes into account a wide range of environmental impacts across every aspect of a product — from concept to disposal.



The challenges

Modelling the entire environmental profile of a product from cradle-to-grave is complex. There are several barriers, including:

- Lack of data transparency
- Inventory data collection
- A lack of standardised approaches
- The complexity of supply chains
- The difficulty of communicating results to stakeholders
- Customer engagement to understand impacts in use

Croda carries out Product Carbon Footprint (PCF) assessments on a cradle-to-gate basis — ie. assessing the impact of sourcing and producing a product, but not covering its implications past the factory gate. This data has recently been released to customers for over 1,300 Beauty Care ingredients and is very helpful for customers. It allows them to understand the impact of Croda's ingredients on their scope 3 inventories and to see the reductions as we implement our decarbonisation roadmaps. However, as we move towards a Nature Positive future, looking at climate impact in isolation is no longer enough, and to achieve Net Zero we must consider the full life cycle of our ingredients, beyond the factory gate.



The solution and process

Croda's commitment to be Climate, Land and People Positive by 2030 requires life cycle thinking. Given the scale of the company's goal and the nature of its operations, two things were needed:

1. A bespoke LCA tool, based on a proven way to capture and connect the myriad of data needed to determine the true environmental impact of an ingredient or process

2. Full integration of LCA expertise across the company

The first step was to build specialist LCA knowledge; internal subject matter experts who could articulate the need for a solution to be developed and provide a detailed enough brief.

Once developed, the team identified key ingredients for case studies to build understanding across the business and increase adoption.

This approach makes Croda one of the first companies to scale LCA up from an academic exercise into a sustainability methodology that provides real, quantifiable results. The aim now is to deliver value from LCA, supporting business decisions whilst solving multiple challenges simultaneously.

The LCA tool: how it works

The LCA tool assesses upstream procurement activities, core production processes, downstream product use and product disposal, to create a full picture of the resources consumed across the entirety of an ingredient's lifecycle. This can be used to understand if an investment will result in a sustainability improvement or not.

Croda produces a wide variety of technologies and ingredients for an array of downstream uses. For this reason, the LCA tool was designed to be as flexible as possible; the tool has a framework that can be easily duplicated and filled with product-specific data.

Each process and stage in the life cycle of the ingredient is broken down into key inputs (eg. raw materials, energy, utilities) and outputs (eg. yield, co-products, waste) and primary data is used as much as possible. This ensures mass balance and energy balance are achieved, all variables in the process are accounted for and the output is specific to Croda's operations.

The environmental impacts of all these inputs and outputs are then translated into numerical results, using life cycle impact assessment methods relevant to the geographical market. For example, the European Commission's Joint Research Centre's 'EF 3.1' method, a best practice methodology likely to become an LCA standard or future regulatory requirement.

The tool also conforms to ISO 14040 (principles and framework) and ISO 14044 (requirements and guidelines) LCA standards. This ensures the robustness of the study, as well as the credibility of any LCAs conducted with the tool.

The results can be used at the ingredient level to understand individual hotspots, or to inform another LCA. But, the value of the tool really comes from being able to model comparisons against counterfactual situations and at a company level, providing evidence to support corporate sustainability goals. It's not just about generating data, but using the data to make better decisions.

This allows Croda to focus ingredient and process development decisions on the factors that will have the strongest bearing on overall environmental outcomes, helping to achieve a greater sustainability impact for its supply chains.

Accessibility and flexibility

What makes this tool so powerful is that it does not require expensive specialist third-party software to deliver effective results. Data is entered, combined and

calculated within the tool to deliver results that can be used to explore scenarios, such as:

- Changes in raw material origin or process conditions
- Scenarios for customer formulation development
- 'Benefits in use' demonstrations for customers

This allows Croda to better quantify any environmental benefits or opportunities, as well as identify new areas of innovation.

This LCA tool is also more user friendly than existing LCA software — due to its modular set up, allowing Croda to model complex chemical processes and build models to test different scenarios. This allows Croda to identify where maximum sustainability benefits lie, with minimum trade-offs. Flexibility is the tool's key differentiator, making it more applicable for understanding the impacts of specialty chemicals with multiple end-user applications.

The external process: customer engagement

As a result of the LCA tool's insights, Croda is now working closely with customers to support their lifecycle understanding. Croda is using the tool to demonstrate how companies can collaborate to identify opportunities for shared environmental benefits and share knowhow with customers on how to produce more sustainable products. This creates a platform for informed discussion and helps to determine what will be valued by a consumer, while reducing environmental impacts.

For a customer that is more advanced in its LCA thinking, Croda can model theoretical customer formulations using data generated on Croda's ingredients. This can provide guidance on the full environmental impact of their product, identify environmental hotspots for future innovation focus and highlight missing data points in their own analysis.

As LCA best practice and standardisation are developed across the industry, Croda will be able to connect its downstream data to the customer's upstream data, providing an industry-wide environmental picture that can be used for larger scale strategic decisions.

The tool can also help customers who are less advanced in their LCA thinking, by introducing more accurate data into their models, allowing them to look beyond carbon emissions. Croda's LCA data also provides benchmarking for a customer's own studies and can inform them about the benefits of using Croda's ingredients today, or in the future.

The internal process: LCA champions and the Centre of Excellence

Croda's Group Sustainability team is doing more to promote the use of the LCA tool. The challenge internally is stakeholder buy-in – undertaking an LCA requires the input of a variety of subject matter experts across the company who wouldn't traditionally deal with sustainability.

And, whilst Group Sustainability has the lifecycle expertise, it is business teams that have specialist knowledge of the ingredients, processes, customer products, and markets within their portfolio and are better placed to identify opportunities to make

Croda's ingredients more sustainable. As such, Group Sustainability is training these teams on the LCA methodology, managing progress through its own global LCA Centre of Excellence (CoE).

This CoE spans across multiple functions, including Innovation, Engineering, Marketing, and Procurement globally. The CoE is training 'LCA champions' who can generate the data within the tool directly and use it for tasks like customer engagement, operations management, risk mitigation, cost reduction, brand enhancement, and sustainable design.

LCA in practice: two examples

Below are two examples of completed cradle-to-grave LCAs undertaken by Croda's team.

Home Care:

Given the verified downstream benefits of Coltide Radiance: prolonging the lifetime of garments and reducing clothes waste by 10% — with 104 million m³ water savings and 342,800 metric tonnes of CO₂e avoided in 2023 — Croda wanted to understand the net environmental footprint of this biopolymer and get a better appreciation of its sustainability credentials.

The LCA revealed a very low environmental burden associated with the manufacturing stage of Coltide Radiance, the biggest impacts being concentrated around the 'product in use' stage (laundry washing).

The climate change and water use impacts for each 1kg of clothes washed are proven to be lower when using fabric conditioners containing Coltide Radiance than those without. This study highlighted an opportunity to collaborate with customers on pursuing environmental savings in the product in use stage, as this action (even if at the expense of higher manufacturing burdens) yields a more sustainable result overall.

Crop Protection:

Another LCA study explored the environmental impact of a Croda-produced polymeric dispersant, Atlox 4913, that is currently used in plant protection products. Initially, the LCA explored the cradle-to-gate environmental impacts of transitioning key raw materials from petrochemical to bio-based sources. Utilising only PCF data may have led to two raw materials being transitioned to sources from a different origin.

However, full LCA showed a significant burden shift on land and water use through one of the new raw materials, for marginal climate change benefit. As a result, the LCA data was used to make informed decisions about future manufacturing and supply chain purchases, reducing the product's climate change burden and resource use.

The value of the LCA was further expanded to include downstream customer operations. This showed LCA's potential as a key tool for innovating and designing future agricultural plant protection products aligned with Net Zero agriculture and corporate commitments.

The positive impacts

Across the industry, better product stewardship will be achieved by an improved understanding of where we are today, and where we must be by 2050. Some benefits are outlined below.

More informed portfolio management

The tool helps with the strategic management of sites and ingredients, allowing its users to compare offerings within a wider portfolio, to make better strategic decarbonisation and nature choices.

Quantifies the environmental benefits of using sustainable ingredients

Staying ahead of changing regulations, customer requests and market trends requires the full picture. The LCA approach helps companies make strategic decisions and build business cases with sustainability in mind from the start, quantifying the sustainability benefits of their products. This will be increasingly important as the demand and pressure for sustainable choices grows among customers and consumers.

Credible sustainability data obtained through LCA also creates commercial opportunities — allowing companies to speak authoritatively about their current footprint, and the steps they are taking to improve it.

Drives and simplifies collaboration

Thanks to the training provided by the LCA CoE, combined with the accessibility of the tool, growing numbers of employees from across the company are providing LCA input data. This data is being connected to deliver a more detailed and joined-up LCA view.

Supports R&D and future investments

Typically, LCA is undertaken on established products and processes to measure the impact of what has been done. But, to achieve 2030 targets, Croda recognises that it is important to assess the impact of new enabling technologies and new ingredients from the beginning to avoid trade-offs. Croda is adapting the tool and the training to enable predictive footprinting LCAs.

Here, LCA becomes an iterative part of the innovation process, informing the development of new ingredients, processes and technologies. LCA studies are undertaken at the idea stage, using proxy and primary lab-based data with results updated throughout the development cycle. The final development LCA iteration is used to inform scale-up and commercialisation decisions.

Predictive LCA will allow Croda to target innovation, ensuring that new offerings are more sustainable than their predecessors. By understanding the environmental hotspots ahead of a commercial launch, Croda can align with regulatory changes. Finally, predictive LCA allows the environmental burden of new technology enablers (eg. biotechnology) to be estimated and compared, and for processes to be designed that are efficient from the start.

Positions Croda for industry leadership

Due to changes in legislation and consumer priorities, external collaborators and customers also see the need to model their environmental impacts more thoroughly, and understand how these impacts can be reduced or removed. Croda's LCA tool can assist its partners and customers in their own efforts, helping them understand and target environmental improvements in the downstream use of their products.

Supports a more sustainable future

Ultimately, LCA offers the specialty chemical industry new insight into chemical products and processes, supporting the full consideration of environmental and social impacts. Clear KPIs that measure the business and societal value of LCA results will help Croda's customers, peers and the wider industry to adopt good practices around LCA — accelerating the transition to a circular economy.

Conclusion: Moving beyond carbon to contribute to a Nature Positive future

The environment is intricately interconnected and an ingredient's effects on it cannot be understood without a big picture view. This means visibility of the entire value chain, beyond the product gate, breaking the siloes between sustainability metrics — eg. carbon accounting, land use and water consumption — to fully understand an ingredient's real implications.

This will be done through LCA, initially ingredient by ingredient, eventually at the product portfolio level, and perhaps finally at the business or sector level — working towards future LCA standardisation.

Any future environmental impacts will have a cost — the obvious sustainability cost yes, but likely a financial one as further momentum and legislation comes in. Put another way, environmental costs may become business costs — and expensive ones at that. 'Natural capital' will become as important as traditional capital.

LCA is helping to create accountability and a new sustainability culture in Croda. In fact, sustainability is a new skillset that will be as important as data management and process safety — it must be integrated into the way everyone works — not limited to a single team within the business.

Croda's LCA's scope is ambitious, but it has to be. As we move into the mid-2020s, there is less time, fewer degrees of freedom, and a very small error margin in sustainability planning. The industry requires LCA to drive predictive footprinting and inform the next generation of products. With tools and techniques like Croda's in play, the entire value chain can take significant strides towards a Net Zero outcome and a more sustainable future.



“Whilst we see an immediate need for environmental data linked to product carbon footprints, the value of LCA should not be underestimated or forgotten. Focusing only on carbon emissions up to our factory gate only provides a partial perspective on the impacts of changing the way we produce our products and allows for environmental impacts to simply be passed along the supply chain, rather than absolutely reduced. Croda's pragmatic approach to LCA can provide insights into some of the unintended consequences of business decisions, before the decision has been implemented. This saves time and resources, as well as giving confidence in doing the right thing overall for the planet.”

Rebecca Wood

Life Sciences Sustainability Manager, Croda