From Compliance to Commitment: Embedding Sustainability in Drug Development

A look at the latest developments and success stories on the pharma industry's continuing journey to a more sustainable future

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Taking Sustainability to Heart: An Interview With ten23 Health

In 2021, a CDMO launched with an unusual vision: to put the planet ahead of the profit. Here, we speak with Hanns-Christian Mahler, CEO of ten23 health, to find out exactly what the company is doing to live up to its vision.

How did your interest in science begin?
My interest in science came from a very special chemistry teacher – a real character who made the experiments really fun. I thought that perhaps I should become a teacher – but I think it's for the best that I didn't…

Ultimately, I went on to study pharmacy. My mother used to work at an institute of pharmacy and she described the field as being a combination of all different life sciences. I liked the fact it was a flexible subject that would open a lot of opportunities. For a while, I wanted to be a university professor, but, after finishing my PhD, I decided that I'd prefer to explore industry. I wanted to do more applied science, so I got my first job in the industry with Merck in Germany. After that, I went on to work for Roche and Lonza.

What inspired you to start your own company?
I was always interested in building and developing organizations. Over the years, I've been blessed with many good line managers who gave me a significant degree of freedom to create. At Merck, for example, my boss gave me the freedom to create a concept for formulation, process development, and validation for an antibody for submission. At Lonza, I was creating a new business unit – it was highly rewarding.

Soon after, I started to think I would enjoy creating a company, along with fun and rewarding jobs in Switzerland. (This bucked the trend of pharmaceutical companies shutting down departments in more expensive countries, moving them to India, China, or Eastern Europe for the sake of operational costs.)

I also have an entrepreneurial spirit and vision – and probably too many crazy ideas to apply in a corporate environment – so starting up a new company intrigued me.

Why do you feel so strongly about sustainability?
Many people – including myself – have climate anxiety. Here in Switzerland, I have noted climate changes and I often wonder what this will mean for my children.

Here's a fact I have never forgotten: in 2015, the pharma sector created more than 50 megatons of carbon dioxide emissions, which, per revenue, is more than the automotive sector. Many people in pharma hide behind the fact that the industry does such important work for human health. Yes – we must prioritize and ensure patients and safety, but we also need to ask what we can do to lessen the impact of the industry on the environment.

Have any of your former roles included a focus on sustainability?
No. Until recently, it seems to me that there hasn't been much discussion on pharma about sustainability or carbon dioxide emissions. I was always surprised why it wasn't a priority. As one example, sterile drug product companies use a lot of plastics; for example, in production, you need to have single use tubing and other disposables to avoid batch-to-batch contamination. Everything has been about moving away from stainless steel – all in the name of ensuring patient safety by reducing risks for potential cross contamination as well as reducing costs.

Taking Sustainability to Heart: An Interview With ten23 Health (cont...)

"If the planet had a seat at the board, what would it say? It may sound silly, but when you look at climate change these questions start to become essential."

But it's a lot of plastic – and it's only recently that the industry has started talking about this.

Given the unusually high focus on sustainability, did the ten23 health concept present any challenges?

I'm very passionate about the topic of sustainability, but when I started ten23 health, I was also nervous. When you talk with investors, the first discussion is typically financial in nature. We aren't a non-profit organization, so finances are definitely important! But I also believe in giving back. We want to create fun jobs for our employees. We want to give back to the region by creating jobs here. And we want to give back to the planet. Fortunately, our investors – 3i – highly appreciate this, and have also done their own training and webinars on the topic of sustainability.

The first thing I did was sign a contract for plastic offsetting. We had no operations. No people – but I purchased around 10 tonnes of plastic trash! The investors have been very happy with our approach. (And I'm very happy they didn't fire me!)

At ten23 health, we see an opportunity to go further than what existing legislation demands. We place a huge emphasis on being sustainable. My motivation is to leave a heart print for our employees, competitors, and customers, on how to do things. Earlier this year, I met with a customers' CEO; we talked about the demand forecast – which was a short conversation – and then told me he had two questions. Firstly, he asked, "How can we learn from you about your sustainability approach? We want to implement supplier selection based on sustainability criteria." I was really happy to share our documents and templates – these things should be totally open source. And I'm proud that someone wants to use what we have created. Secondly, he asked how we could help them transition to an organization based on holacracy and role-based work – but that's a whole other topic!

What specific actions have you taken to reduce your business's impact on the environment?

Sustainability goes into every corner of our organizational design and sites; we have a big focus on monitoring, measuring, and innovating around issues.

We measure and report on a facility basis for energy and water consumption, and use ratios to measure total consumption and total energy. For example, when we look at our production facility, we look at total energy usage divided by the number of output, such as batches that we've produced. We also look at total site usage divided by generated revenues and by the number of employees. As the years go on, the ratios should go down as energy utilization improves.

We also care deeply about sources. We use 100 percent natural energy sources, and we also consider things like choice of printing paper, toilet paper, and coffee. Many companies use Nespresso machines and people tell themselves the capsules are recyclable, but we have a Fairtrade coffee with local roasting – and the grounds go into our local composting at the site.

Our Fairstainability and Innovation teams are also looking at initiatives with bioplastics – we recently were part of a team submission for a Swiss innovation grant. We are also collaborating with an AI company to compare life cycle assessments for different manufacturing processes. For example, if we're developing a liquid formulation for our customers versus a freeze-dried formulation, what is the better choice from an energy consumption perspective both for manufacturing and the entire lifecycle? If you have a product with a two-week drying cycle and a machine that constantly runs compressors, it won't be the most sustainable from a carbon footprint perspective.

In time, I hope more people can think about product design and product development not only as an output of stability, regulatory compliance, and patient safety, but also in terms of what's best from nature's perspective. If the planet had a seat at the board, what would it say? It may sound silly, but when you look at climate change these questions start to become essential.

Read the full article online.

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Our efforts have been recognized with a Gold EcoVadis rating for two consecutive years, placing us in the top 5% of our industry. We've also aligned our practices with international standards including the UN Global Compact, and we actively support the UN Sustainable Development Goals. In 2024 alone, we expanded renewable energy use, reduced hazardous waste, and conducted in-depth supplier sustainability audits across more than 100 strategic partners.

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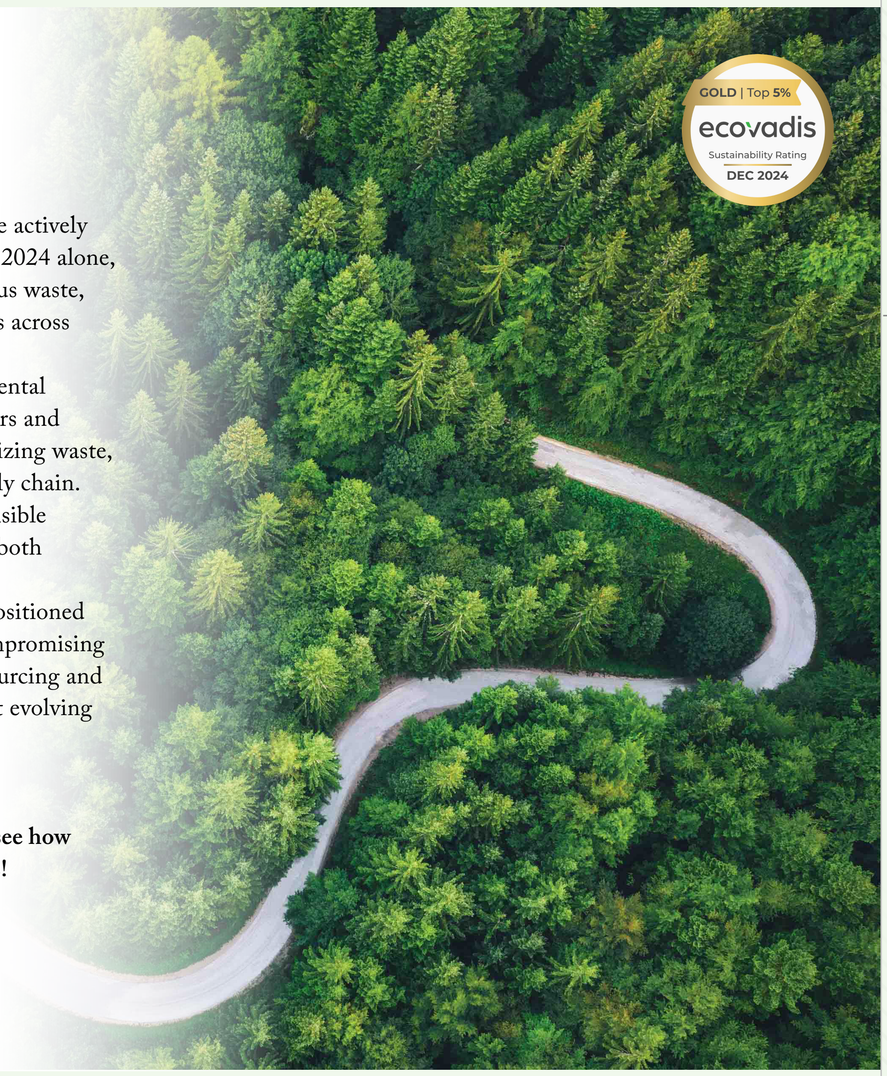
Let's shape a more sustainable future together.

Read the full 2024 Sustainability Report today and see how Actylis can help power your sustainability ambitions!



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The Practice and Delivery of Sustainability in the Pharma Industry

The increasing focus on sustainability and environmental efforts within the pharmaceutical industry, particularly amongst CDMOs, reveals the key strategies and initiatives being undertaken.

By Rob Coker

A huge topic in the pharmaceutical space right now is sustainability. Many big pharma companies have set ambitious green targets – and are also asking their suppliers to do the same. In 2022, for example, GSK announced that it would require its suppliers to "take action on sustainability commitments and make improvements on emissions, energy, heat, transport, waste, water and biodiversity."

In the CDMO space, sustainability is now a business imperative. Some companies, such as Vetter and ten23 health, have already made significant investments to be sustainable, but more and more companies are also now taking action. China-based Asymchem, for example, has recently integrated biocatalysis into its processes to enable more efficient chemical reactions, reduce reliance on hazardous materials, improve solvents recycling, and minimize water consumption. The ability to manufacture and use enzymes in situ has resulted in minimized loss of enzyme activity.

Elsewhere, other CDMOs are transitioning to more responsible sources to reduce their carbon footprints. France-based Fareva, for example, and its R&D teams support clients through the substitution of substances of concern for more environmentally friendly formulation processes, as well as through the proposition of designed-for-recycling packaging solutions, and a commitment to working with suppliers of local sustainable raw materials.

There are also larger efforts at play. The Energize supplier consortium was established in 2021 by drug developers, alongside Schneider Electric and Carnstone Partners, to help suppliers, including CDMOs, reduce their carbon footprints through the adoption of cleaner energy supply. Member companies currently number 25, including AstraZeneca, Boehringer Ingelheim, Bristol Myers Squibb, GSK, Johnson & Johnson, Novartis, Novo Nordisk, Pfizer, Roche, Sandoz, Sanofi, and Takeda, to name a few.

Speaking about a recent energy procurement deal involving Energize, GSK's Chief Procurement Officer Lisa Martin said, "We are thrilled the first Energize deal has been announced which marks an important milestone in the collaboration's history. We co-founded Energize in 2021 and the programme is an important part of our plan to reduce our value chain emissions by 80 percent from 2020 to 2030. This new solar energy deal, including four of GSK's suppliers in Europe, highlights our collective commitment to decarbonize and support the industry's transition to renewable energy."

The bigger (greener) picture

An holistic view of sustainability in the industry is being encouraged through the consideration of the entire life cycle of pharmaceutical products, known as life cycle assessments (LCAs). These include an evaluation of the environmental impact from raw material sourcing through to disposal, and CDMOs are aligning their practices with the sustainability targets set by their pharmaceutical partners, ensuring that sustainability metrics encompass the entire supply chain.

But how can the scourge of "greenwashing" be averted? CDMOs are

The Practice and Delivery of Sustainability in the Pharma Industry (cont...)

seeking recognition and certification to validate their sustainability efforts. For example, Samsung Biologics has achieved a platinum sustainability rating from EcoVadis, as well as the Honor Award from the Carbon Disclosure Project for two years running.

Elsewhere, ten23 health became the first drug product CDMO to achieve B Corp certification. CEO Hanns-Christian Mahler said, "It is not enough simply to state ethical and environmental aspirations, but it is also critical to voluntarily achieve ambitious and recognized standards … I am proud and happy to see our Fairstainability agenda at ten23 health being validated by becoming a B Corp."

Geographically, Europe leads in carbon reduction initiatives as a result of the European Commission-led carbon taxes and emissions trading systems. In the US, however, a lack of harmonized state-level policies is impacting the adoption of renewable energy. Despite this, action is still taking place. For example, the National Biotechnology and Biomanufacturing Initiative was announced in 2022 and launched in 2023 to strengthen biomanufacturing infrastructure and improve sustainability practices across the pharmaceutical supply chain, through the emphasis of collaboration between CDMOs and biotech firms. President Joe Biden himself became involved via an Executive Order to lower prices, improve access, create jobs, strengthen supply chains, improve health outcomes, and reduce carbon emissions in this sector.

In the latest *CRB Horizons Life Sciences 2024 Report*, chapter 7 focuses on the growing urgency for sustainability within the biopharmaceutical manufacturing sector. According to the authors Jochen Schmidt-Nawrot and Jeff Wegner, "the answer seems clear – the easy path is no longer viable. Sustainability is the future. Consumers and investors expect it. Regulators and legislators demand it. Our planet needs it. It may not be easy – but as the survey data shows, it's necessary."

A huge 93 percent of respondents to the survey say they have developed or are developing a formal sustainability roadmap, with 87 percent of biopharma manufactures currently utilizing renewable electricity or planning to do so by 2030.

The challenges involved in increased uptake of sustainability efforts stem from a lack of leadership, according to the report. With executive commitment being crucial to the achievement of sustainability goals, the energy and waste management challenges, regulation landscapes, and geographic disparity appear to be the most daunting and in need of clarity from C-Suite executives.

It would not be fair, however, to lay all the responsibility of sustainability on the shoulders of CEOs and board members. "Promoting sustainability begins at a grassroots level," according to Bachem Scientific Marketing Manager Philipp Markolin. "By actively engaging the workforce in sustainable innovation, industry leaders can levy collective expertise and experience to drive technological advancements, and improve processes from the ground upwards. As a result, manufacturers can better deliver products and services, while navigating the evolving landscape of sustainable manufacturing as an organization.

"This culture of continuous improvement improves efficiency, by optimizing business processes, and identifying advanced manufacturing technologies in collaboration with those that use them."

Consistency and continuity will help to embed sustainability into the very fabric of a pharmaceutical manufacturing company and, over time, it will become as common in the workplace as health and safety has. Markolin concludes: "As processes continue to improve with technological advancements, manufacturers should look to continuously evaluate and upscale their operation, with technology evolving at a rapid pace. It is their responsibility to ensure that environmental standards are met and exceeded, delivering their services at optimum efficiency, while not at the expense of the climate."

Moving forward, the manufacturing arm of the entire pharmaceutical industry and CDMOs should look to develop and sustain a leading role in sustainability, and set examples for stakeholders elsewhere in the supply chain and beyond.

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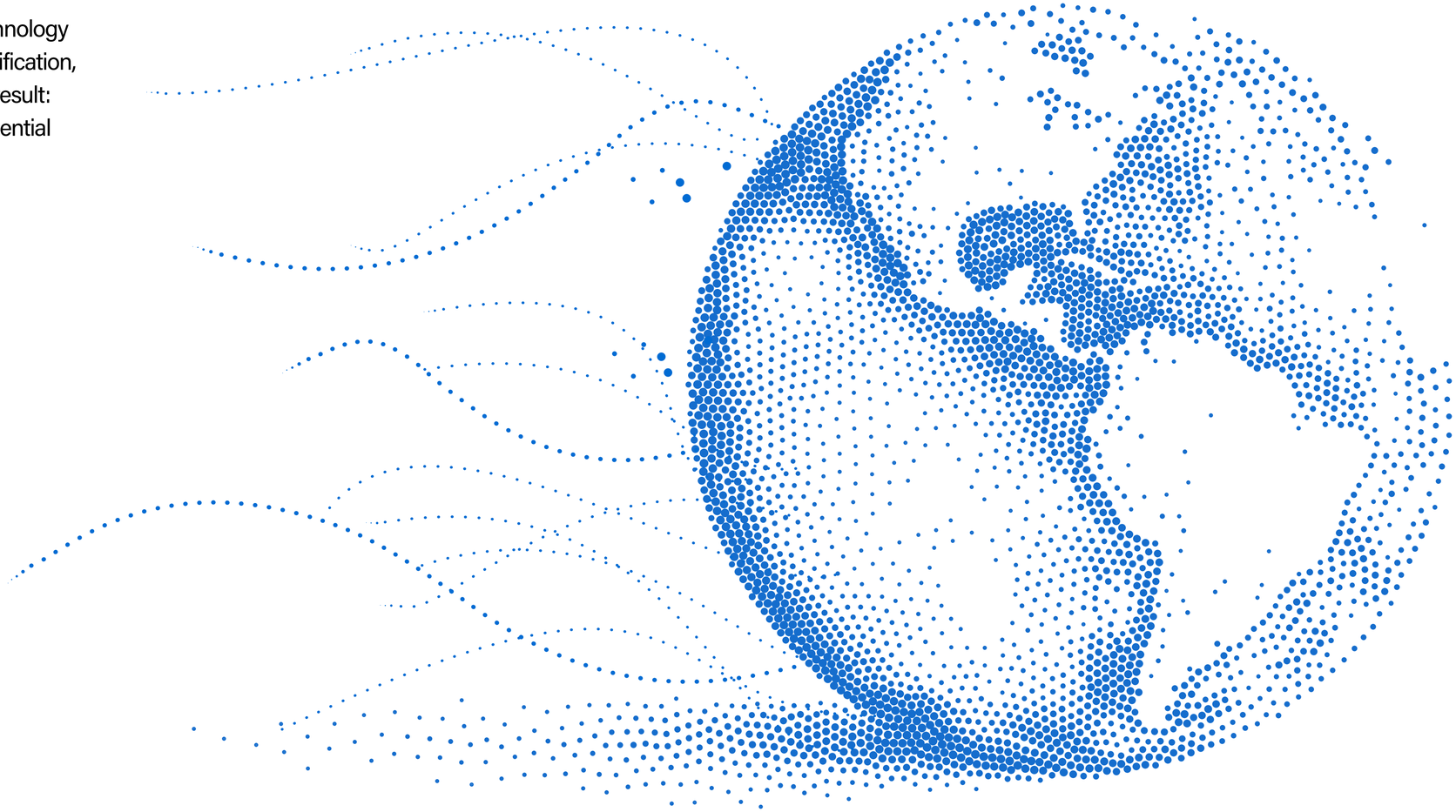

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Smart and Sustainable: Pharma's Future

Two experts from Uhlmann give their views on the future of pharma manufacturing.

What we asked: "Looking ahead to the next 5–10 years, what will be the key disruptors and/or what can be improved upon in the pharma industry?"

Response from: Michael Mrachacz, CSO & Managing Director, Uhlmann Pac-Systeme

"The pharmaceutical industry is affected by regulations like almost no other industry. Regardless of the requirements for ecological and social sustainability, we always have to fundamentally focus on patient safety. Furthermore, we are facing a rapidly changing world with a multitude of crises that will not disappear in the near future.

"We will not be able to meet these challenges with current production strategies, aimed primarily at optimizing existing processes from a cost perspective. Therefore, a fundamental revision of production strategies to find new solutions is essential to meet the challenges of sustainability, the increasing uncertainty of supply chains, and the disruptive changes in the industry. At the same time, therapies are being increasingly tailored to the individual needs of patients. This means smaller production batches and faster process conversion.

"To address all of these challenges, we must, above all, drive digitalization and automation forward. Digital production processes and smart factory concepts will enable us to respond more efficiently to the demands of personalized medicine. At the same time, digitized data analysis will help to process the large volumes of data arising from personalized medicine more quickly and to feed the results into production more efficiently. Both digitalized and automated production processes and the ability to process large amounts of data, also enable companies to operate in a more sustainable and resource-efficient manner and to respond with greater flexibility to crises.

"Flexibility is the bottom line. This also brings us to the concept of local4local, the second lever. In many manufacturing and production industries, we are seeing a shift towards local production. This is not least because of experiences surrounding the COVID-19 pandemic, though environmental disasters, trade conflicts, and geopolitical shifts also play a significant role. Local production for local markets and collaboration with local suppliers enables companies to be independent of supply chains, helps to monitor

Smart and Sustainable: Pharma's Future (cont...)

and comply with regulations, and makes sustainability easier.

"In a world facing profound changes, these are the decisive changes that we need in the next ten years."

Response from: Cristian Reiter, CTO & Managing Director Uhlmann Pac-Systeme

"In the next decade, we will need significant innovations in pharmaceutical packaging that emphasize sustainability and advanced technical solutions. Firstly, the adoption of recyclable materials for a circular economy will be decisive. Developing and integrating barrier packaging made of mono-material, such as mono PP, will reduce the ecological footprint, but these materials must still be designed to maintain the safety and stability requirements of pharmaceutical products.

"Secondly, smart packaging technology, especially automation and robotics, in packaging lines will also hopefully see advances; for example, AI-supported predictive maintenance could allow errors and signs of wear to be recognized and fixed before they cause problems. This minimizes downtimes, helping machines to remain productive for longer and work more efficiently. A significant role could also be played by AI-driven robots that can perform tasks such as sorting, filling, and sealing – enhancing precision and efficiency, minimizing human error and reducing material waste. Advanced robotics can also adapt to various packaging formats and sizes, offering flexibility and reducing the need for multiple machines, thus saving energy and resources.

"Furthermore, modular and adaptable packaging machinery will be essential. Machines that can quickly switch between different packaging formats and sizes without extensive downtime or reconfiguration will improve efficiency and reduce resource consumption. This flexibility will be particularly beneficial for small-batch production runs, which are becoming more common with personalized medicine."

Read more views on the future of pharma, biopharma, and healthcare here.

CPI leads the charge in pharma sustainability with pioneering decarbonisation project in partnership with CSIR-NCL, India

The pharmaceutical industry is at a crossroads. As global demand for medicines grows, so does the imperative to reduce its environmental footprint. Responsible for 4.4% of global greenhouse gas emissions, pharma faces urgent pressure to innovate sustainable manufacturing solutions. That's where UK-based CPI is making a game-changing impact in partnership with the CSIR-National Chemical Laboratory (CSIR-NCL) in India, through the landmark UK-India Net Zero Innovation Partnership to decarbonise pharmaceutical manufacturing and build a greener, more efficient industry for the future.

A global challenge meets global collaboration

India is the world's largest supplier of generic medicines, producing over 60% of global vaccines and supplying a quarter of all medicines in the UK. Its pharmaceutical industry is vital to global health but, like all sectors, must urgently address decarbonisation. With the NHS targeting net zero emissions for scope 1 and 2 by 2040, scope 3 by 2045 and India committed to net zero by 2070, a collaborative approach is critical.

In response, CPI has partnered with CSIR-NCL to establish a cutting-edge 'Living Lab' in Pune, India. This joint effort, supported by the UK and Indian governments, provides a unique testbed for pharma companies to explore and de-risk sustainable manufacturing technologies. By sharing data and processes, partners accelerate the development and commercialisation of low-carbon, efficient methods that reduce greenhouse gases and boost productivity.

Driving innovation with continuous flow chemistry and solvent-free manufacturing

The Living Lab focuses on two transformative technologies: continuous flow manufacturing and solvent-free chemistry. Continuous manufacturing, already widely recognised as a greener alternative to traditional batch processes, improves efficiency by running chemical reactions in a steady, controlled flow rather than in large, discrete batches. This method allows usually high exothermic reactions to take place that otherwise would be too dangerous in batch, along with reaction control and scalability while dramatically cutting waste and energy use.

Solvent-free manufacturing, including mechanochemistry, offers another leap forward by eliminating toxic, fossil fuel-derived solvents that contribute heavily to pharma's carbon footprint. Using physical grinding methods to trigger reactions without solvents, this approach significantly reduces hazardous waste and pollution.

A sustainable manufacturing roadmap

Beyond technology, CPI fosters collaboration through industry consortia involving pharma companies of all sizes, sharing insights and accelerating adoption of decarbonisation best practices. This united approach strengthens UK-India relations while building a robust, sustainable pharma ecosystem that benefits people and the planet alike.

Tangible impact for industry and society

The Indian pharma sector's move towards continuous, solvent-free processes could transform global pharma manufacturing by significantly lowering emissions and waste. This shift aligns with NHS targets and broader UK Government commitments to achieve net zero by 2050, helping reduce the environmental impact of medicines across their lifecycle.

Participating companies also gain competitive advantages such as improved productivity, reduced costs and access to markets increasingly demanding sustainable supply chains. The Living Lab's collaborative model accelerates this transition, turning sustainability from a compliance challenge into an innovation opportunity.

Empowering pharma companies to turn sustainability goals into action

CPI's leadership in the Indian decarbonisation project exemplifies how innovation, collaboration, and strategic partnerships can tackle one of the pharma sector's most pressing challenges. By combining world-class technical expertise, state-of-the-art facilities and strong government and industry networks, CPI empowers pharma companies to develop next-generation manufacturing processes that are both sustainable and commercially viable.

As the industry works towards a net zero future, CPI's Living Lab offers a unique platform to test, prove and scale breakthrough technologies. Together with partners in India and the UK, CPI is helping the world's pharmacy to build a healthier, more sustainable tomorrow.

Are you a UK-registered pharma SME with global ambitions? Join the funded UK-India delegation to India's thriving pharma sector in early 2026. This fully supported programme is your chance to scale internationally and build lasting partnerships. To express your interest, email deborah.mcelhone@uk-cpi.com

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Integrating Environmental Thinking into Clinical Trial Logistics and Packaging Operations

The industry has spent decades optimizing distribution strategies to meet faster timelines. Now, it's time to think about sustainability.

By Deahne Baker and Jonathan Fuhr, Senior Directors of Global Sustainability, Marken

Sustainability is no longer just a buzzword. It is a central focus of business operations. What was once separate from day-to-day decisions, is now woven into corporate strategy and global value chains. With increasing pressure from consumers and investors, the biopharma industry faces a growing need to prioritize environmental, social, and governance (ESG) initiatives to make a real impact whilst also minimizing supply chain footprints.

This fundamental shift is underscored by the rapid evolution of ESG standards, particularly in regulatory frameworks. In the EU and the UK, for example, sustainability and ESG compliance have become an integral part of expanding legislation, including carbon border adjustment mechanisms, emission trading schemes, extended producer responsibility requirements, and ESG disclosure standards. While many of these regulations remain in their infancy, the pattern is clear: global sustainability standards are tightening, with increasing scope and complexity.

This widespread adoption of Science-Based Targets Initiative (SBTi) commitments (founded by numerous large businesses to establish a framework for science-based net zero targets) further reinforces this transformation. Many of the largest pharmaceutical companies have already set near-term SBTi targets for their operations, suppliers, and supply chains, signaling an industry-wide shift toward sustainable practices.

In short, sustainability is no longer just a competitive advantage; it's a license to operate. Companies that fail to adapt risk losing relevance.

Clinical trial logistics: no 'one size fits all' approach

Integrating sustainability into pharmaceutical and life sciences logistics is a challenge, but the difficulties are even more pronounced in clinical trial logistics.

The unique demands of precision logistics, where small-batch, time and temperature-critical biological samples and medicines must be securely transported with cold chain integrity and expert oversight, add further challenges. The industry has spent decades optimizing distribution strategies focused on quality and faster timelines, making sustainability often fundamentally at odds with operational realities.

The unpredictability, variability and urgency of clinical trial shipments means logistics providers must make real-time routing decisions based on precision, rather than emissions savings. As a result, sustainable alternatives, such as consolidated shipments or lower-carbon transportation modes, are often deemed operationally impracticable, or take a more considered, longer-term strategy to implement in a way that will not impact operations.

Similarly, a company's infrastructure and operating model significantly influence its emission reduction strategies. Asset light businesses have vastly different options for reduction than those with owned assets.

The key takeaway is: driving impactful change requires a considered, customized sustainability approach – not a one-size-fits-all solution.

Sustainable packaging approaches

When discussing logistics, we cannot avoid talking about packaging. Anyone promising a singular sustainable packaging solution for pharmaceutical logistics is failing to grasp the intricacies of its impact. Sustainability in packaging is not only about the materials

Integrating Environmental Thinking into Clinical Trial Logistics and Packaging Operations (cont...)

"While leadership commitment to ESG is vital, it is the frontline, on the ground teams making the daily decisions that drive real change."

and production methods – the overall environmental impact also depends heavily on how the packaging performs throughout its entire lifecycle, including transportation and final disposal.

While manufacturers optimize for cradle-to-gate sustainability by using non-fossil-based resources and low-carbon production processes, these efforts will be entirely negated if logistics providers fail to consider the transportation phase in their solution design.

Major considerations in sustainable packaging include:

Weight matters! A novel, low-carbon packaging material produced 2 kg heavier than its expanded polystyrene alternative may erase any emissions savings once it enters the emissions-heavy NFO networks common in clinical trial logistics.

Circularity isn't always feasible. While reusable packaging and circular models are highly valuable, they may not be viable in low-volume trade lanes where reverse logistics and repositioning cannot be guaranteed. If the environmental cost of returning empty reusable packaging outweighs its benefits, the sustainability advantage is lost.

Inventory impact. Lower-carbon transportation modes, such as sea freight, greatly reduces emissions when repositioning reusable packaging. However, the longer transit times require higher inventory levels, increasing resource consumption and reducing reuse efficiency — factors that must be considered in a holistic sustainability assessment.

The answer to these challenges is not rigid sustainability mandates but rather a flexible, balanced packaging approach that applies the best packaging strategy for each shipment's unique needs. Continuous innovation means evaluating and implementing new solutions while proactively tackling any disruptive intricacies head on.

Also important to consider in logistics is advanced technologies. Advanced technologies enable companies to automate trade-offs, assess and select the most cost-effective and sustainable solutions from a range of reduction levers. By leveraging real-time data and automation, businesses integrate data-driven assessments into daily operations. When applied to sustainability efforts, this approach ensures decisions are continuously optimized based on refined parameters, maximizing both efficiency and environmental impact

By integrating AI-driven lane optimization and decision making, logistics operators gain instant insights into cost versus sustainability trade-offs, ensuring transport route decisions not only align with both operational priorities and ESG goals, but also translate into real-world action. While leadership commitment to ESG is vital, it is the frontline, on the ground teams making the daily decisions that drive real change.

Turning sustainability vision into action

Sustainability in logistics is not just about trade-offs and higher costs — nor is it an impossible feat. Optimizing operations while reducing environmental social impact is not only feasible, but essential. Taking the first steps toward sustainability is the beginning of a journey that brings both new solutions and fresh challenges. ESG initiatives are applicable to every facet in a business.

Some critics claim that sustainable businesses and practices in clinical trial logistics are unviable, and developing plans to reduce waste and emissions is a futile effort. However, there is no greater way to make this a certainty than accepting their narrative.

Developing a sustainability program involves a deep understanding of your organization, supply chains, and operational infrastructure, along with stakeholder buy-in and trust building through pilot programs. The key is to embrace agility, continuous learning, and a willingness to pivot when certain solutions prove ineffective. Every sustainability journey has a starting point — the real challenge is committing to the path forward.

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Nut-Based Pharmaceuticals: From Food Waste to Functional Medicine

A look at how nut-derived pharmaceutical ingredients can deliver a sustainable, natural supply of peptides and more.

Scientists at the University of the Witwatersrand (Wits), Johannesburg, South Africa, recently received an international innovation award for developing a sustainable vaccine ingredient derived from cashew nutshell waste. The Antiviral Gene Therapy Research Unit (AGTRU) and the Synthetic Organic Chemistry Unit at Wits secured one of six awards under the GIZ SAVax programme, along with a 7 million Rand (~$390,000) grant, to advance their project titled "Local large-scale production of ionizable lipids". Such lipids are considered essential for mRNA vaccines, facilitating the delivery of genetic material into cells to elicit immune responses.

Traditionally, ionizable lipids are expensive, petroleum-based, and often under restrictive patents. The Wits team transformed cashew nutshell liquid, an abundant by-product in Africa, into hydrogenated cardanol, a cost-effective and biodegradable alternative. The approach not only utilizes waste material but also avoids competition with food resources because it doesn't rely on the edible cashew nut.

Collaborating with local industry partner Chemical Process Technologies (CPT) Pharma, the team now plans to scale up production in South Africa, aligning with the African Union's goal of producing 60 percent of the continent's vaccines locally by 2040.

Earlier this year, researchers from the Pritzker School of Molecular Engineering, University of Chicago, used a similar method to the Wits development by using waste from the husks of Malva nuts to produce a hydrogel with potential woundcare applications. Steeped as a tea in China as a sore throat remedy, the residue is usually discarded, but Pritzker scientist Changzu Sun wanted to study the gel-like residue further, and stumbled upon a potentially sustainable biomedical application. The size of the husk increases 20-fold in water and produces a natural hydrogel with applications ranging from disinfection and drug delivery, to bioelectronics implantation and tissue repair.

Recent research highlights several other innovative uses of nuts and derivatives in pharmaceutical applications. For example, bioactive peptides extracted from walnuts have also demonstrated potential antiviral properties, including activity against SARS-CoV-2. A comprehensive review by an international team of researchers has also detailed the potential of upcycling various nut byproducts – from almond skins and peanut shells to pistachio hulls – into pharmaceutical ingredients. The review article "Bioactive Peptides from Nuts" looks at nut-derived peptides and their emerging roles in health, food, and pharmaceutical applications. Nuts such as pine nuts, walnuts, cashews, pistachios, hazelnuts, and pecans are rich in proteins, which can be hydrolyzed enzymatically to yield bioactive peptides. Research has shown that peptides from nuts, especially low molecular weight peptides, can potentially scavenge free radicals and modulate biochemical pathways.

Perhaps future directions in nut research could include optimizing peptide extraction, improving stability through nanodelivery systems, and generating disease-specific peptides via targeted enzymatic hydrolysis. In a nutshell, nut-derived bioactive peptides are promising candidates for use as functional ingredients.

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Measuring the Carbon Footprint of Digital Tools for Clinical Trials

Can digital tools help lower the carbon footprint of a clinical trial? First, we need more data.

Clinical trials can produce up to 100 million tonnes of CO2 each year. Although digital clinical trial technologies offer increased efficiency through improved patient recruitment and retention, increased access to remote and more diverse participants, and streamlined data collection, their environmental impact remains unknown. The Pistoia Alliance wants to establish an industry-wide standard for measuring the carbon footprint of digital tools, remote monitoring, and electronic patient-reported outcomes by collecting data from pharmaceutical companies and contract research organizations (CROs).

By incorporating these findings into a "carbon calculator", clinical trial designers can then make informed, sustainable decisions when planning trials, without compromising efficiency. We spoke with Thierry Escudier, Portfolio Lead at the Pistoia Alliance, to find out how.

What currently concerns you about sustainability in conventional clinical trials?
Conventional clinical trials have a significant environmental footprint – from travel emissions to single-use materials and energy-intensive trial sites. Yet, the industry lacks robust, standardized data to quantify this impact, particularly when comparing traditional methods with digital alternatives. Digital tools, remote monitoring, and decentralized trial models offer a real opportunity to disrupt trials by reducing waste and emissions, but only if thoughtfully implemented.

The sustainability benefits aren't guaranteed, and data on their true environmental impact is still lacking, but the Pistoia Alliance's latest initiative aims to close this gap, helping the industry to move beyond assumptions and integrate sustainability-by-design in clinical trials – underpinned by standardized and transparent carbon measurement frameworks.

Where have traditional clinical trials done well in sustainability measures?
Traditional clinical trials, while resource-intensive, have some strengths when it comes to sustainability. Processes are well established, meaning there's more experience and data to assess their carbon footprint.

Environmental impact data has supported progress in sustainability in areas such as improving local logistics, waste management, and energy efficiency. However, these efforts have often been isolated rather than systemic, and few companies have a comprehensive strategy for reducing emissions. The industry must build on early progress by integrating sustainability more holistically, using digital innovation, data sharing, and collaboration.

What are the challenges in improving sustainability in clinical trials?
Until recently, the major challenge has been the lack of reliable data and practical tools to perform accurate assessments of environmental impact. Without standardized metrics, it's difficult for sponsors and CROs to compare digital and traditional trial models or identify the true carbon hotspots in their operations.

This gap is precisely why we have contributed to the development of the Clinical Trial Carbon Calculator, launched in partnership with the Sustainable Healthcare Coalition and its industry Low Carbon Clinical Trials (iLCCT) group. This framework is a crucial step towards embedding sustainability-by-design in clinical trial planning, enabling more informed, data-driven decisions that support greener research.

What measurements are you looking for that will confirm that digital trials are more sustainable?
Thanks to the work already done on conventionals, we now have a good database to start building on by adding data on digital alternatives. Our aim is to collect operational data from pharmaceutical companies, CROs, and other stakeholders to create baseline measurements

Measuring the Carbon Footprint of Digital Tools for Clinical Trials (cont...)

"Patient-centricity and sustainability aren't competing priorities; when implemented thoughtfully, they can reinforce one another and help create a more responsible and effective research model."

for the footprint of digital technologies and even the use of tablets/mobile devices in the trial setting. We'll then use this bank of data to conduct a peer-to-peer comparison and ascertain which aspects of trials can be digitized to reduce overall carbon footprint.

How important is a sustainability advisor to a decentralized clinical trial?
Decentralized clinical trials are increasingly complex to measure the sustainability of, especially as the number of technologies available to run such trials increases. Without expert guidance, it's easy to overlook the hidden carbon costs of digital infrastructure. Hidden costs include cloud computing and data storage, conducting remote consultations via video calls and telehealth platforms, and the device lifecycle. The footprint of a device's lifecycle includes the manufacturing, distributing, and disposing of devices, as well as how often they need to be replaced.

A sustainability advisor brings the insight needed to navigate this complexity, helping teams assess trade-offs and make decisions that truly support more responsible trial design. For example, a "bring your own device" model allows participants to use their personal smartphones, tablets, or computers to take part in a trial. This approach has a very different environmental footprint compared to a provisioned device model, in which the trial sponsor or CRO supplies each participant with a dedicated device. Distributing devices can unnecessarily increase a trial's carbon footprint, especially when participants could simply use their own device to download an app. These nuances can significantly affect a trial's sustainability profile.

If decentralized clinical trials are shown to be more sustainable than traditional approaches, it could significantly accelerate their adoption. Until now, the main drivers have been improving patient experience and enhancing data quality through direct digital capture. Demonstrating a clear environmental benefit would add a powerful new incentive that aligns with the growing pressure on pharma companies to meet sustainability targets.

Tell me your hopes for the future of clinical trials in general…
My hope is that the future of clinical trials is both more patient-centric and more sustainable. Trials should be designed with participants' needs at the forefront – making them easier to access, less burdensome, and more aligned with real-life routines. Embedding sustainability by design into trial planning will directly support this patient-centric mindset. Reducing redundant visits, sample collections, or examinations makes studies less burdensome for patients, improving both recruitment and retention. At the same time, these changes can significantly lower the environmental footprint of trials. Patient-centricity and sustainability aren't competing priorities; when implemented thoughtfully, they can reinforce one another and help create a more responsible and effective research model.

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