CHEManager INTERNATIONAL 1/2026

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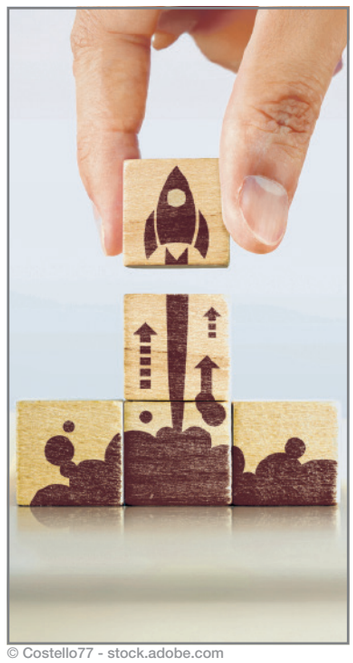
Industry Transformation

Innovation



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Driving Transformation

Outlook on Interconnected Global Chemicals Logistics

DP World is accelerating the transformation of global chemical supply chains, reshaping visibility, predictability, and operational resilience across ports, terminals, and multimodal networks. Under the leadership of Markus Kanis, Global SVP for the Chemicals sector, the company is unifying systems, deploying new technologies, and building real-time decision-making capabilities that offer the chemical industry greater efficiency and risk management. Christene Smith of CHEManager speaks with him about DP World's strategic roadmap, new technologies, and the evolving demands of global trade.

CHEManager: The chemicals industry is undergoing significant structural change, from trade-flow shifts to new customer expectations. What do you see as the biggest opportunities and challenges for DP World in serving this sector over the next 3–5 years?

Markus Kanis: The biggest opportunity lies in helping chemical producers simplify supply chains that are becoming structurally more complex. Trade flows are shifting, geopolitical and operational risks are increasing, and customers are looking to reduce fragmentation. They want fewer handovers, greater transparency and more control over critical flows. As chemicals supply chains become more interconnected and more exposed, resilience is no longer a nice-to-have - it is a commercial requirement. That dynamic plays directly to DP World's strengths and our integrated, end-to-end operating model, which connects ports, terminals, warehouses and inland networks into a single system.

The challenge is that chemicals logistics allows no margin for error. Safety, compliance, and predictability are non-negotiable. As supply chains become longer and more exposed to disruption, our role is not simply to respond when something goes wrong but to design networks that anticipate risk, absorb shocks and continue to perform. That means engineering resilience into infrastructure, processes and decision-making – so customers can focus on growth rather than constant exception management.

In which areas - infrastructure, partnerships, modal capabilities - is DP World currently investing to strengthen its global offering for the chemicals industry?

M. Kanis: We are making targeted investments in specialized infrastructure, including dangerous goods warehouses, liquid bulk storage, polymer handling facilities and ISO tank operations across key chemical hubs. Many of these facilities are Seveso-certified and purpose-built to meet the highest safety and regulatory standards, enabling customers to scale with confidence.

In parallel, we are expanding our multimodal capabilities across rail, barge, short-sea and inland terminal networks to give customers greater routing flexibility and structural resilience. This flexibility allows customers to adapt quickly to disruption, capacity constraints or sustainability requirements without redesigning their entire supply chain. Partnerships and selective acquisitions also play an important role. By adding deep chemical expertise and complementary capabilities, we can move beyond isolated services

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Markus Kanis, Global SVP Chemicals, DP World

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and deliver integrated, end-to-end solutions that reduce interfaces, risk and cost.

Digitalization is reshaping chemicals logistics. What are your top strategic priorities for accelerating DP World's digital transformation, and how do these initiatives support the chemical industry's evolving requirements?

M. Kanis: Our priority is to move from basic visibility to true operational control. Chemical customers need more than location data - they need confidence that safety, compliance and service levels are being actively managed across the entire journey. Visibility tells you what happened; control helps you influence what happens next.

To support this, we are integrating data from ports, warehouses, transport assets and external partners into unified platforms that enable better planning and faster, more informed decision-making. These connected systems allow customers to anticipate delays, manage compliance proactively and reduce manual intervention. Digitalization for us is not about deploying technology for its own sake. It is about increasing predictability, strengthening risk management and making logistics a strategic asset.

Beyond visibility, customers want automated exception handling and faster decision-making. How is DP World implementing AI, machine learning, or control-tower models to support real-time operational responses?

M. Kanis: We are developing control-tower capabilities that allow us to identify and resolve issues at an early stage. By combining real-time operational data with predictive analytics, we can flag potential disruptions before they impact safety, service or cost.

AI and machine-learning tools support areas such as forecasting, route optimization and exception management, enabling faster and more consistent responses. For customers, this translates into reduced operational noise, fewer escalations and more stable supply chains – particularly for high-risk or time-sensitive chemical cargo.

Chemical companies are under increasing pressure to demonstrate progress toward Scope 3 reductions. How is DP World supporting customers on the road to greener logistics and which initiatives do you see as having the biggest near-term impact?

M. Kanis: We focus on practical actions that deliver measurable emissions reductions. This includes shifting cargo from road to rail or barge, optimizing routes, improving asset utilization, and investing in more efficient equipment and vessels across our network. These actions have immediate impact without compromising safety or service levels.

> *"As chemicals supply chains become more interconnected and more exposed, resilience is no longer a nice-to-have – it is a commercial requirement."*

A good example is our Modal Shift Program in the UK, where customers reduced emissions by more than 17,000 tons in its first year by moving chemical and industrial volumes from road to rail and short-sea services. In the near term, modal shift and network optimization offer the greatest impact. Alongside this, we provide customers with credible emissions data and reporting, helping them track progress and meet growing regulatory and stakeholder expectations around Scope 3.

Global trade routes for chemicals are shifting due to geopolitics, new regional hubs, and emerging markets. How is DP World adapting its global network strategy to support customers through these long-term structural changes?

M. Kanis: Chemical supply chains are becoming more regionalized and diversified. In Europe, for example, we see growing use of hubs such as Constanta, where customers are rebalancing flows to improve resilience and reduce reliance on long-distance routes. This shift reflects a broader move toward redundancy and optionality in network design.

We are adapting our network by strengthening regional hubs, improving inland connectivity and creating alternative routing options. Because DP World operates globally, we can support customers as they rebalance production and distribution across regions while maintaining consistent safety, compliance and operating standards - regardless of geography.

DP World works with customers that range from specialty producers to diversified global chemical majors. How do you approach co-creating solutions with these different types of customers, and what does successful collaboration look like for you?

M. Kanis: It starts with a deep understanding of what matters most to each customer. Specialty producers often prioritize flexibility and speed, while global majors focus more on scale, governance and standardization. Our role is to translate those priorities into supply-chain design, not force customers into a one-size-fits-all model.

Successful collaboration means designing solutions together, aligning KPIs, integrating systems and reducing interfaces. When it works well, the supply chain stops feeling like a series of handovers and becomes a natural extension of the customer's own operation - delivering control, confidence and consistency at scale.

Looking ahead to 2030, what digital capabilities do you believe will differentiate leading logistics networks, and which KPIs should chemical companies monitor more closely to stay competitive?

M. Kanis: The defining differentiator will be the ability to anticipate risk and act early. Predictive analytics, digital twins and advanced control-tower capabilities will separate reactive networks from truly resilient ones. The winners will be those who can intervene before disruption becomes visible to the customer.

Chemical companies will need to look beyond traditional metrics such as cost and transit time. KPIs related to resilience, compliance performance, emissions intensity and response time to disruptions will become increasingly critical. These indicators better reflect how well a supply chain performs under pressure - not just in ideal conditions.

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To Attract Gen Z, the Chemical Industry Must Change

The Chemical Industry's Workforce is Rapidly Approaching Retirement Age. We Need Fresh Talent, Fast.

Women in Chemicals recently hosted a cocktail reception at the European Petrochemical Association (EPCA) annual meeting. During the event, Co-Founder of Women in Chemicals (WIC), Amelia Greene, gave a speech sharing "In the next five years, a quarter of the chemical workforce will be eligible for retirement. In ten years, half". This statistic should be alarming for all chemical industry leaders.

The chemical industry is at a critical crossroads. The sector is essential to global economies, yet it's facing the existential challenge of a rapidly ageing workforce. As a significant percentage of the workforce quickly approach retirement age, the industry continues to struggle to attract young, diverse talent.

Many people become involved with the chemicals industry by chance. The social media we consume about the chemical sector often features negative content. It's not until becoming involved with the industry and doing research that people realize the necessary innovations and technologies the industry is championing. The chemical industry often doesn't get the recognition it deserves for the technological advancements it drives, and consumers don't realize how significantly the chemical industry directly improves our lives.

Gen Z is extremely purpose-driven. They want to know their work contributes to a greater good. As a forward-thinking generation, greater visibility to these critical innovations is a necessity to appeal to talent. Finding a shared purpose in the industry will be vital to appealing to Gen Z. Our industry needs to attract the next generation of bright and fresh talent to ensure long-term sustainability, and that talent is looking to serve something larger than shareholders.

The Imminent Talent Shortage

Many companies are struggling to find skilled candidates to replace retiring employees. Young talent either has no visibility to the industry or sees chemical manufacturing as completely unappealing. The current demographics of our workforce are still widely male-dominated. The lack of diversity discourages young women and those from minority backgrounds from applying for jobs in the sector, as they feel they do not belong. According to a report by the National Girls Collaborative Project, women represent only 28% of the STEM workforce in the US. As we stare down an impending talent gap, the chemical industry cannot afford to deter 50% of the potential talent pool.

The lack of diversity also means there are limited visible success stories of young and successful individuals working in the industry. This is important for a generation that is motivated by emulating role models and idealizing thought leaders. In a recent 2025 Alliance of Chemical Distributors (ACD) paper, 'Understanding The Next Generation Workforce', it is reported that 43% of younger Americans don't even know what the chemical industry actually does. At Women in Chemicals, the 'Careers in Chemicals' initiative is intended to address this issue and make our industry more attractive to the next generation of talent. The WIC program aims to help students by introducing them to the breadth

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Rose Harper, Partnerships Coordinator, WIC

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and depth of opportunities available in both technical STEM career pathways and other business and manufacturing roles. With its unique storytelling format pulling in current women in the industry, the Careers in Chemicals programs gives students the necessary access to role models and leaders in the chemical industry whom they can relate to and aspire to be.

Gen Z cares deeply about sustainable practices and environmental responsibility. The wide perception that the chemicals industry is an environmental net-negative, coupled with the lack of visibility of role models, makes for an existential challenge in attracting the next generation of the chemical industry workforce. The ACD paper reports that older millennials are more interested in roles offering stability, benefits, and clear career paths, whereas over two-thirds (67%) of younger Americans said they'd be more likely to consider the industry if it emphasized environmental responsibility. There's a biased narrative associating the industry with a detrimental sustainable impact despite our industry leading and championing reductions of carbon footprints, greener and more efficient technologies, and safer alternatives to current products used in a variety of downstream sectors. In addressing this talent shortage, the chemical industry must address its fundamental marketing problem, leading to society's negative perceptions.

Attracting the Next Generation

The chemical industry is starting to make strides in attracting a younger workforce, but a disconnect still exists in the visibility of the net positive environmental & social impact organizations have and ensuring we are communicating this to the right audience. Companies must highlight the positive progress they're driving and how they impact our daily lives. Chemical companies need to reframe and remarket themselves to show how they are sustainable-led and forward-thinking to attract the next generation of talent who are seeking roles that are not only technically challenging but also meaningful.

"Gen Z is extremely purpose-driven. They want to know their work contributes to a greater good."

The 2025 ACD report shows "68% said they would be more likely to apply for a chemical distribution job if they saw someone their age and background succeeding in the industry." The industry needs a "narrative rebrand" and modernized image to attract a new generation with different values than their quickly ageing predecessors. Organizations like Women in Chemicals show that diverse, young champions exist in the chemical industry, and there are role models for Gen Z to look up to and follow in their footsteps.

The industry is making a positive impact in the world, but it's clear that unless there is intentional effort to communicate these values to the next generation, we will continue to fail to attract talent. Without this effort, we are staring down an existential talent shortage. Chemical organizations need to place focus on championing and marketing their current young and diverse talent as role models for the next generation to aspire to. Our industry depends on it.

Rose Harper, Partnerships Coordinator at Women in Chemicals & Senior Marketing Associate at Morgan Latif

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More Than Just Contacts

How Networks Further Diversity and Equity and are Essential for Scientific Progress

On 10 February 2026 and in good annual tradition, Chemistry Europe and Angewandte Chemie hosted a shared event as part of the IUPAC Global Women´s Breakfast (GWB). The Wiley-VCH offices in Berlin and Weinheim, Germany, welcomed over 60 participants, with more participants watching the live-streamed presentations.

This seventh installment in the Wiley chemistry journals' continued support of the GWB centered in on "The Power of Networks", giving participants the chance to meet, discuss, and forge new connections. Invited speakers provided different perspectives on how networks are an essential part of science.

Feeling Like You Belong

Charlotte Gerischer, currently pursuing her Ph.D. at Ludwig-Maximilians-Universität (LMU) Munich, Germany, opened the floor with a presentation on the work of the "Team Chancengleichheit", the Diversity, Equity, and Inclusion (DEI) working group of the German Chemical Society's Young Chemist Network (JFC).

Highlighting several examples of how and why chemistry and STEM at large are still less diverse than the general population, she emphasized the importance of creating welcoming environments. Networks, in this respect, are crucial for fostering a sense of belonging and self-efficacy for members of underrepresented groups. While progress has been made, achievements should not be taken for granted.

Gerischer also presented several examples of how the JCF works towards furthering DEI in the chemical sciences, such as the Diversity Talks format and providing guidelines for more inclusive meetings and conferences.

Interdisciplinary Teams Building Networks

Eva Blasco, a Professor at Heidelberg University, Germany, a recipient of the Advanced Science Young Innovator Award 2024, and involved in the Excellence Cluster "3D Matter Made to Order", showcased her team's work on functional materials—some of which are networks themselves.

She underscored the highly interdisciplinary environment that her research relies on. Science is a collaborative effort by nature, and progress relies on networks to generate, develop, and realize new ideas. Results from this work were broadly highlighted, including a panel discussion with the Spanish collaborators facilitated by a network of Spanish scientists in Germany.

Connecting Professionals

Svjetlana Jerkovic, who works with ICL Group in Amsterdam, The Netherlands, and attended the event as a member of the Advisory Board of Women in Chemicals, opened her presentation by recounting her first steps into the chemicals sector. Remembering the scarcity of visible networks and resource groups, she early-on had seen the need to build and open connections from within the industry. Thus, when discovering Women in Chemicals, she quickly engaged with this initiative launched in 2020.

What had started off as a small gathering has now evolved into a global organization counting over 7000 members, dedicated to advancing, connecting, and supporting women across the chemicals industry.

Svjetlana highlighted recent initiatives like the launch of an annual scholarship program. The program aims to support a women pursuing secondary education in a STEM field, including in accredited trade and technical schools. The awardee will be honored at the 2026 Woman in CHemicals Conference on September 14-16.

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- www.chemistryviews.org

Anti-Involution in China's Chemical Industry

Curb of Destructive Competition in Chemicals is an Indication of a Broader Transformation in China's Economic Strategy

China's chemical industry has entered a period of intense competition and declining margins. Rapid capacity expansion has created persistent oversupply in several polymers and basic chemicals, triggering aggressive price competition. As China accounted for 46% of global chemical production in 2024, these developments have major implications for global markets.

In China policy discussions, the current situation is described as "involution": companies invest in additional capacity and lower prices to maintain and increase market share. The Chinese government is concerned about this situation and promotes "anti-involution" measures to limit destructive competition and encourage higher-value industrial development.

What Is "Involution"?

Involution describes excessive competition in which increasing effort and investment do not generate material gains in productivity or profitability – the English expression "rat race" captures the dynamic reasonably well.

Typical signs of involution are rapid capacity expansion, homogeneous products, and aggressive price competition, resulting in declining profits despite output growth. The concept is now widely used in China to describe competitive dynamics in sectors such as electric vehicles, solar panels, batteries – and chemicals.

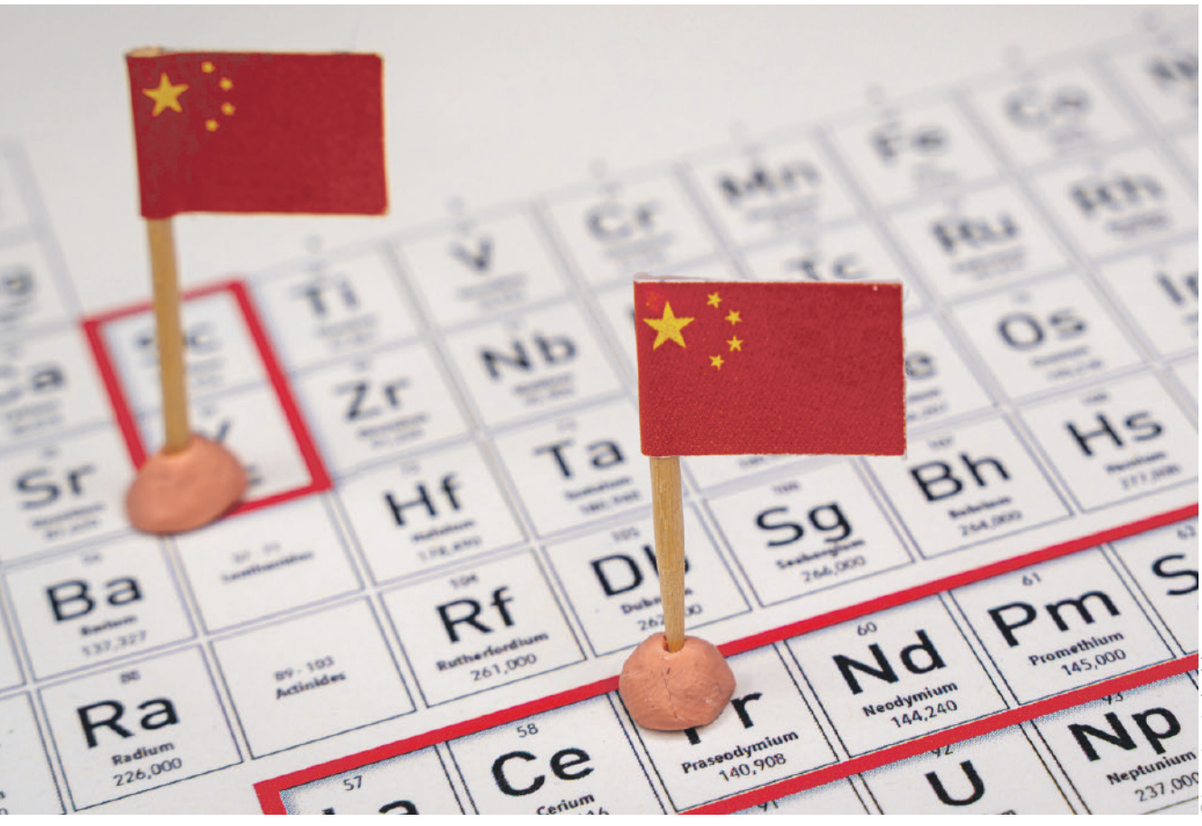
Drivers of Involution in China's Chemical Industry

Several structural factors create conditions in which capacity expansion and intense competition can persist even as profitability declines.

Local government investment incentives: Regional governments have long promoted industrial investment to stimulate economic growth, employment, and tax revenues. Large chemical projects, which are seen as focal points of regional development, receive particular support. As multiple provinces pursue similar strategies, national capacity may expand faster than demand.

Refinery expansion and value chain integration: China's buildup of large refinery–petrochemical complexes has increased capacity in downstream chemicals, particularly as refineries anticipate a shift away from gasoline and into petrochemicals and polymers. Once established, refineries ideally run at high operating rates to achieve economies of scale.

Focus on basic chemicals: China's chemical output still consists largely of bulk products such as polyethylene, polypropylene, methanol, and PVC. These materials are largely standardized and compete on price rather than differentiation. This structure makes the industry particularly vulnerable to price wars when supply exceeds demand.



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Kai Pflug, Managing Director, Management Consulting – Chemicals

Anti-Involution as a Policy Priority

In recent years, policymakers have increasingly warned against "involution-style competition". Official policy statements at forums such as the Central Economic Work Conference call for rectifying "involution-style competition", preventing disorderly competition, and improving the quality of economic growth.

In practice, anti-involution means reducing destructive competition and promoting higher-quality industrial development. Typical measures may include tighter approval for new industrial projects, encouragement of industry consolidation, reduced incentives for excessive exports, and stronger support for technological upgrading.

While the term anti-involution is very recent, it is part of a longer-term trend in Chinese government policy to move from volume-driven growth toward quality- and innovation-driven growth.

The 15th Five-Year Plan

Based on early high-level information on China's 15th Five-Year Plan (2026–2030), anti-involution will be one of its core themes – specifically, high-quality development and technological upgrading.

Within the chemical industry, the emerging policy direction suggests greater emphasis on advanced materials, specialty chemicals, and innovation-driven growth rather than continued expansion of commodity chemical production.

Examples of Involution in the Chemical Industry

Several major chemical value chains illustrate these involution dynamics in practice.

Polypropylene is one of the clearest examples. Large refinery–petrochemical complexes and coal-to-olefins plants have significantly expanded China's PP production capacity. Over the past decade, China's polyethylene and polypropylene capacity more than doubled due to massive investment in integrated petrochemical facilities. Demand has continued to grow, but capacity expansion has often grown faster, intensifying price competition and pushing margins lower.

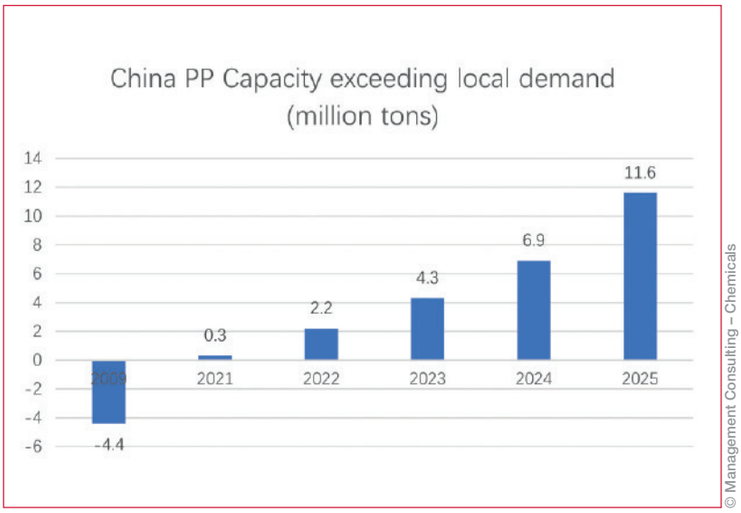
Polyvinyl chloride illustrates how policy intervention may respond to involution. China is the world's largest PVC producer, with a large share based on coal-to-chemicals technology. Weakness in the construction sector has slowed domestic demand, while capacity additions have continued. As exports increased, the government decided to eliminate the 13% export VAT rebate for PVC beginning in April 2026, reducing incentives to export surplus supply.

Purified terephthalic acid: China now accounts for more than half of global purified terephthalic acid capacity. Large coastal petrochemical complexes have added substantial new capacity in recent years. Although polyester demand continues to grow, oversupply has led to sharp margin fluctuations and intense competition between producers.

Methanol and coal-to-chemicals highlight the regional component of involution. Many plants are located in inland coal-producing regions and supported by regional development policies. Alternative uses of coal may be limited due to the cost and infrastructure requirements of transporting coal to urban consumption centres. As a consequence, even when market conditions are weak, plants may continue operating.

Implications for Global Chemical Markets

China plays a central role in global chemical markets, and domestic policies therefore have significant international implications. As domestic supply has exceeded demand, China's chemical exports have increased sharply, particularly to Southeast Asia, South Asia, Africa, and Latin America, but increasingly also to Europe. These exports have contributed to price pressure in global markets.



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In 2025, China had an excess capacity of 11.6 million tons of PP – or 46% of global PP excess capacity (source: ICIS)

Anti-involution policies aim to limit capacity expansion and improve domestic profitability, leading to reduced export pressure. However, the transition will take time, and export volumes will probably remain high in the near term as companies adjust to changing conditions.

Practical Measures

Some concrete policy measures have already begun to emerge. One example is the adjustment of export incentives for certain chemical products. The removal of the 13% export VAT rebate for PVC indirectly discourages volume-driven competition in export markets. In addition, many of the established tools of regulating the chemical industry can also be utilized to promote anti-involution, including:

Stricter environmental and safety regulation (leading to closure of smaller, outdated plants)

- Capacity controls (e.g., production capacity can only be expanded if capacity is closed elsewhere)
- Prohibition of specific production processes (e.g., carbide-based PVC)
- Encouragement of mergers and consolidation (often involving state-owned companies)
- Provision of incentives for advanced chemicals (e.g., R&D subsidies)
- Export policies (as illustrated by the removal of the VAT rebate)
- Mandated shift of chemical production into chemical parks with strict selection criteria
- Tax policy (e.g., carbon taxes)
- Energy efficiency regulation

Limits of the Anti-Involution Policy

Despite growing policy attention, the effectiveness of anti-involution measures remains uncertain. China has repeatedly attempted to reduce excess capacity in industries such as steel, cement, and coal, often with mixed results. Local governments often resist plant closures because of employment concerns, while companies may continue operating even at low margins to maintain cash flow and market share. In addition, many chemical plants are part of large integrated complexes, thus shutting down individual units may be economically difficult.

As a result, while anti-involution policies signal a shift in industrial policy priorities, their impact on supply growth and market competition may take several years to become visible.

Outlook

Anti-involution is an indication of a broader transformation in China's economic strategy. Profitability, technological innovation, and industrial upgrading are promoted over volume growth.

For the chemical industry, this shift could lead to slower capacity growth, greater consolidation, and stronger focus on advanced materials and specialty chemicals — but drivers of oversupply remain strong, so any changes will likely be gradual.

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Navigating Uncertainty and Driving Innovation

Meeting Pharma's Demand for Speed, Reliability, and Flexibility

At CPhI Frankfurt, Christene Smith from CHEManager International spoke with Arul Ramadurai, CCO, Axplora, about how the company is responding to the challenges and opportunities facing the pharmaceutical industry. Ramadurai shares insights on adapting to global uncertainty, building strategic partnerships, and advancing flexible manufacturing.

CHEManager: How is Axplora adapting to the current economic and geopolitical situation, specifically within the pharmaceutical industry?

Arul Ramadurai: The pharmaceutical industry is experiencing a period of significant uncertainty, shaped by economic and geopolitical factors. At Axplora, we see this not just as a challenge but as an opportunity to strengthen our position and better serve our customers. Unlike larger organizations with extensive public affairs teams, our approach is to stay closely connected to our clients—pharma companies and biotechs—by listening to their needs and responding quickly.

Our customers consistently emphasize the importance of speed, efficiency, and above all, reliable supply chains. In pharma, robust supply is critical, and we've made it our priority to ensure that our operations can deliver on this promise. Axplora's footprint—with multiple sites across France, Germany, Italy, and India—positions us to support customers in key markets and adapt to shifting global dynamics. We maintain a strong presence in the United States, regularly engaging with biotechs in innovation hubs like Boston, San Diego, and San Francisco. This direct engagement helps us anticipate market trends and regulatory changes, ensuring that Axplora remains agile and responsive. Ultimately, our strategy is to turn uncertainty into opportunity by focusing on what matters most to our pharma partners: reliability, speed, and tailored solutions.

How do you see the evolution of strategic partnerships between CDMOs and pharma, and what is Axplora's approach to flexible manufacturing?

A. Ramadurai: We operate in an industry with a high obligation—we're making medicines, specifically the active ingredients that transform patients' lives. Our partners, pharma companies and biotechs, have many choices. It's not just about having differentiating technology; it's about delivering reliable supply and efficiency.

Strategic partnerships require a deep understanding of our customers' needs. It's easy to talk about reliability and speed, but what does that mean in practice? For example, in chemistry, we might look at a four-step synthetic process and identify where yields can be improved. Getting deep into the subject matter is essential. Our ambition is to know our customers better than anyone else, sometimes even better than they know themselves. This enables us to offer tailored, radiated solutions that truly make a difference. We insist that our teams go beyond the surface—engaging with technical, procurement, and manufacturing teams at our partners' organizations. This depth of expertise positions us to deliver real value.

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Arul Ramadurai, CCO, Axplora

In what ways is Axplora pushing the boundaries of agile and flexible manufacturing to meet the evolving needs of pharma?

A. Ramadurai: Flexible and agile manufacturing aren't just buzzwords—they're realities for us. Our customers, especially biotechs, may be small organizations focused on getting to or through the clinic. They need the security that we can support them from R&D quantities all the way to commercial manufacturing.

> *"It's not just about having differentiating technology; it's about delivering reliable supply and efficiency."*

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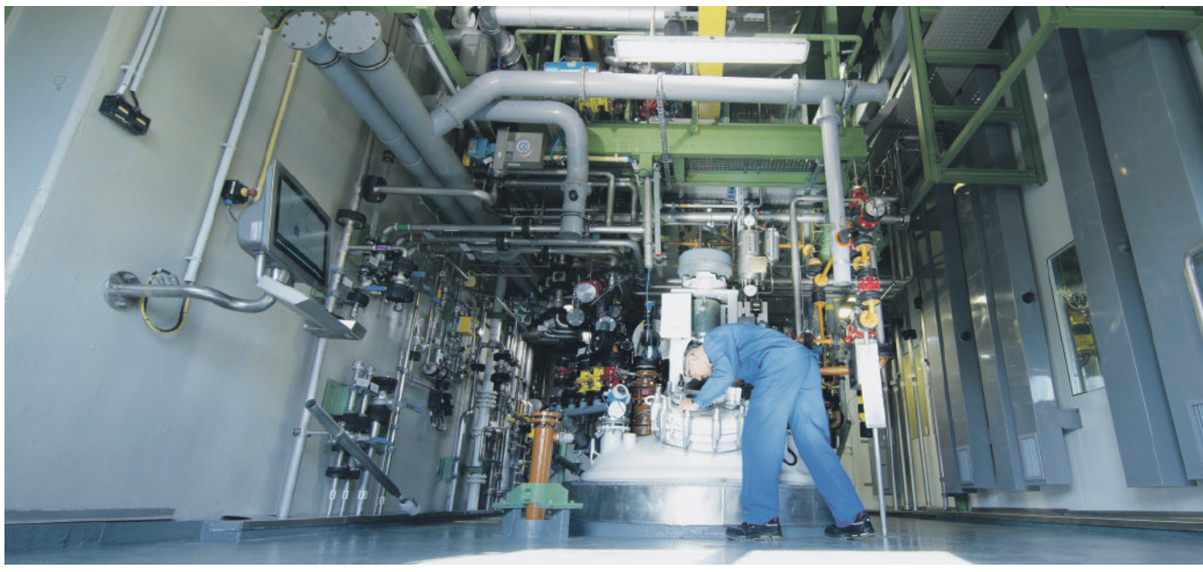
All our sites have R&D capabilities, allowing us to support process development from the earliest stages. We're world-class in industrial chemistry, helping transform small batches into commercial quantities at speed and at the right price point.

Flexibility also has a geographical dimension. When new programs come in, we consider which site is best for the customer, focusing on cycle time, yields, and asset fit. Our ability to flex between sites is a core strength.

Another aspect is investing in local communities and partnering with educational institutions. Our apprentice schemes help develop future talent, ensuring a strong workforce.

Finally, there's AI. We take a healthy, pragmatic approach—piloting AI where it can genuinely improve cycle times and yields. If it brings an advantage for our customers, we adopt it; otherwise, we don't. Agility and flexibility have many facets, and we strive to excel in all of them.



Axplora is investing heavily in expanding its global network. How are digitalization and data analytics being integrated into these ew facilities to enhance operational efficiency, regulatory compliance, and customer experience?

A. Ramadurai: Our approach to digitalisation is data-driven, science-led and anchored in customer need. As our customers develop more complex molecules, they expect not only manufacturing scale, but also robust data, consistent quality systems and clear regulatory alignment across sites.

One of our most significant initiatives is the further deployment of the Ennov platform across the CDMO business unit. This programme harmonises document management, core quality processes such as CAPA, deviations, OOS and change control, as well as learning management. We are creating a single, structured data backbone that supports faster decision-making, improved traceability and stronger regulatory compliance.

In parallel, we are strengthening our Laboratory Information Management System (LIMS), as we transition away from paper-based laboratory operations. This data-rich, science-led manufacturing approach is in line with customer expectations around a greater digital footprint.

Together, these investments bring Axplora's facilities to the state of the art expected by regulators and biopharmaceutical companies today, while ensuring all sites operate under a unified quality and data framework. This translates into a clearer, more consistent experience: one view of quality, centralised data to support product release, and greater confidence that decisions are driven by science, data and their specific project needs.

What measurable impact is Axplora's sustainability strategy having on your pharma partnerships and the communities where you operate?

A. Ramadurai: At Axplora, we are raising the bar in how sustainability is embedded into our customer partnerships. We integrate environmental and social performance objectives directly into customer dialogue, project design, and operational execution. Sustainability is addressed upstream, during development and scale-up phases, allowing us to jointly reduce environmental footprint while maintaining the highest standards of quality, regulatory compliance, and supply reliability.

> *"Flexible and agile manufacturing aren't just buzzwords—they're realities for us."*

This approach delivers measurable environmental impact. Through optimized process design, systematic use of Process Mass Intensity, improved energy efficiency, and increased use of lower-impact solvents and utilities, we reduce raw material consumption, waste generation, and carbon intensity from early project stages. At site level, improved energy contributes directly to our customers' Scope 3 reduction objectives. Today, all Axplora sites in France operate on 100% renewable electricity, with 61% renewable electricity across the Group.

From a partnership perspective, sustainability KPIs are increasingly reviewed alongside traditional quality, cost, and delivery metrics. This creates a more transparent, data-driven dialogue and supports stronger alignment with our customers' sustainability roadmaps, including through recognized ESG assessments such as EcoVadis. The result is greater trust, more resilient long-term partnerships, and positioning Axplora as a preferred partner for complex and strategic API manufacturing programs.

Beyond our customer relationships, this strategy also has tangible local impact. We continue to prioritize safe operations, workforce development, and local employment, while maintaining close engagement with local authorities and stakeholders. This reinforces Axplora's role as a responsible industrial actor, supporting both sustainable supply chains for our customers and long-term value creation in the communities where we operate.

How does Axplora's innovation strategy support the development of new modalities manufacturing like GLP-1 peptides and high-potency APIs, both within your teams and through external collaborations?

A. Ramadurai: Our innovation strategy starts with a simple question: how can we give customers reliable, scalable manufacturing solutions for increasingly complex molecules — delivered by teams with real-world experience, not just theoretical capability.

Many of today's fastest-growing modalities — from GLP-1 peptides to ADCs and other high-potency APIs — are defined by demanding requirements in purification, containment and process robustness. Being a pioneer in advanced chromatography, Axplora invested early, positioning us strongly in peptide purification long before GLP-1 demand accelerated. That foundation now enables us to support customers seamlessly as programs move from development through to commercial scale.

The same forward-looking approach applies to ADCs. Our commitment of more than 20 years in this space, particularly at Le Mans, has built deep expertise in high-potency payload manufacturing and conjugation. Today, Axplora is a trusted supply chain partner for six FDA-approved ADCs — a track record that reflects our ability to move programs successfully from clinical development into full commercial production and to support them reliably at scale.

We are now expanding these strengths through integrated peptide purification programs at Pompey and Mourenx and conjugation programs at Le Mans, supported by our wider European CDMO network. Innovation in one domain consistently strengthens our capabilities in adjacent areas — and helps us attract the scientific talent required to stay ahead.

For customers, the outcome is clear: partnership with experienced teams who understand complex modalities, reduce technical risk and accelerate the path to market with confidence.

■ www.axplora.com

Aligning AI and Laboratory Execution in Drug Discovery

From In Silico Design to In Vitro Impact

Artificial intelligence is transforming molecular design, but synthesis remains the limiting step in drug discovery. To translate computational advances into real productivity gains, organizations must better align digital design with laboratory execution. AI-driven orchestration provides a practical framework to coordinate design, synthesis, and testing within existing R&D infrastructures, accelerating the transition from in silico hypotheses to in vitro validation and improving the productivity of the DMTA cycle.

The Acceleration Paradox

Artificial intelligence is reshaping how molecules are conceived. Generative models can now explore vast regions of chemical space, proposing and optimizing candidate structures with unprecedented speed.

However, realizing the value of these digital advances requires more than algorithmic performance. Drug discovery breakthroughs still occur in the laboratory, where compounds are synthesized, tested, and evaluated. The true challenge is therefore not simply accelerating design, but aligning artificial intelligence with laboratory execution so that computational insight translates rapidly into experimental evidence.

"Many AI companies tend to forget that, however good a compound may look in silico, it still needs to be made in the lab, tested, and used to inform the next round of design. Drug discovery is ultimately about iterative learning through multiple design–make–analyze cycles. Success depends on how effective you are in the transition between the in silico and in vitro worlds — and that is where lab automation becomes critical." Yann Gaston-Mathé, CEO and Co-Founder, Iktos.

The competitive differentiator is not how many molecules can be imagined, but how effectively digital design and experimental execution operate as a coordinated system.

"The objective is not to replace chemists, but to enhance their ability to manage complexity at scale while preserving scientific judgment."

The Real Bottleneck: Integration, Not Capacity

Synthesis remains the primary bottleneck in modern design-make-test-analyze (DMTA) workflows. While laboratory automation has matured, it was historically designed for specific use cases: high-throughput reaction optimization or parallel library synthesis around a common scaffold. These approaches are efficient when workflows are homogeneous and repetitive.

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Yann Gaston-Mathé, CEO and Co-founder, Iktos

However, AI-driven design generates chemically diverse compounds spanning multiple reaction types and conditions. Traditional automation struggles in this context. Expanding internal capacity or outsourcing to contract research organizations increases throughput, but it fails to address the underlying problem that prevents acceleration. Processes often remain sequential and siloed: computational teams design molecules, chemists evaluate feasibility, inventory constraints are checked separately, and robotic systems execute predefined batches.

The limitation is not simply capacity. It is the lack of integration between design, retrosynthesis, scheduling, inventory management, and laboratory execution. The gap is not chemistry — it is integration.

"Many AI companies tend to forget that, however good a compound may look in silico, it still needs to be made in the lab, tested, and used to inform the next round of design."

From Automation to AI-Driven Orchestration

AI-driven orchestration addresses this structural disconnect. Rather than treating design, synthesis planning, and execution as separate steps, orchestration integrates them into a constraint-aware workflow.

In practice, this means that molecular design is guided by synthetic feasibility and laboratory capabilities from the outset. Retrosynthetic routes are selected with consideration of available building blocks and operational constraints. Scheduling systems account for inventory, reactor capacity, and compatible operating conditions. Experimental outputs are structured to feed directly back into subsequent design cycles.

Importantly, orchestration does not require building a fully autonomous laboratory from scratch. It leverages existing infrastructure — robotic platforms, inventory systems, analytical tools — and coordinates them through intelligent software layers. The objective is not to replace chemists, but to enhance their ability to manage complexity at scale while preserving scientific judgment.

By embedding AI into operational decision-making, AI-driven orchestration transforms laboratory automation from a task-execution tool into a strategic engine for portfolio-level learning.


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Maximizing Laboratory Capacity Through Clustering

One example of AI-driven orchestration in action is the clustering of diverse reactions based on compatible operating windows, such as overlapping temperature and time ranges. Instead of grouping reactions solely by transformation type, reactions from different chemical families can be executed in parallel when their experimental conditions intersect.

This approach increases reactor utilization, reduces fragmentation across projects, and allows greater chemical diversity per campaign. It shifts automation from supporting isolated libraries to advancing multiple hypotheses simultaneously.

A recent study applying such an orchestrated workflow across 135 diverse reactions, executed under clustered conditions, achieved an overall success rate of approximately 70% without individual reaction optimization (Le Vaillant et al., Chem. Sci., 2026). Excellent reactivity outcomes were observed for classical reactions, such as palladium catalyzed couplings (Suzuki and alkyl-Suzuki couplings at 100%, Buchwald–Hartwig amination at 84%, Boration, and Heck and Sonogashira couplings at 67%), amide bond formation (amide Schotten Baumann at 100% and peptidic coupling at 83%), and sulfonamide synthesis (71%). Considering that the objective was not yield maximization, but acceleration of experimental learning across chemically distinct targets, the study provides ample evidence of the robustness and scalability of an orchestrated high-diversity synthesis strategy.

Clustering illustrates how orchestration can translate computational diversity into experimental throughput. This capability is essential to fully leverage the structural diversity generated by AI-driven design, moving beyond traditional scaffold-based library approaches toward broader chemical exploration and, ultimately, more innovative therapeutic options for patients.

Enabling Faster Learning Cycles

For pharmaceutical organizations, the strategic impact of AI-driven orchestration lies in its effect on learning velocity. Shorter and more predictable DMTA cycles enable faster convergence from hit identification to optimized leads. Robotic assets are utilized more efficiently, and experimental data are generated in a structured, reproducible manner.

This shift moves laboratory operations from a project-based execution model to a portfolio-level learning engine. Multiple programs can advance in parallel, decision latency decreases as data flows more seamlessly between computational and experimental teams. The impact of AI-driven in silico design materializes only when experimental evidence is generated rapidly enough to inform subsequent iterations.

From In Silico Promise to Experimental Impact

Artificial intelligence has expanded what can be designed. The competitive question is whether laboratories can keep pace.

Success in AI-driven drug discovery is determined by how effectively organizations translate in silico insight into experimentally validated evidence. AI-driven orchestration provides a practical pathway to achieve this alignment — integrating design, synthesis, and testing into a coordinated, constraint-aware workflow.

AI does not transform drug discovery by generating more molecules. It transforms it by accelerating how quickly those molecules become data — and how quickly that data translates into better decisions that ultimately lead to more effective therapies for patients.

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Better Data, Better Decisions

The Next Phase of Cell Line Development

Cell line development timelines remain tightly governed by biology, even as new tools improve how efficiently teams work within those limits. While automation and digitalization are now embedded in many CLD workflows, expectations of dramatic time compression are giving way to a more realistic focus on optimization: generating better data earlier, making more confident clone-selection decisions, and reducing rework and downstream risk. These themes were highlighted at a recent virtual CLD event, where Tom Kelly of Johnson & Johnson, representing BioPhorum, outlined industry-wide constraints and opportunities for timeline optimization, and Xiaoyan Tang of Merck & Co. (MSD) shared practical experience showing how structured, automated platforms can improve predictability and decision quality.

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Tom Kelly, Director of Cell Engineering and Analytical Sciences, Johnson & Johnson

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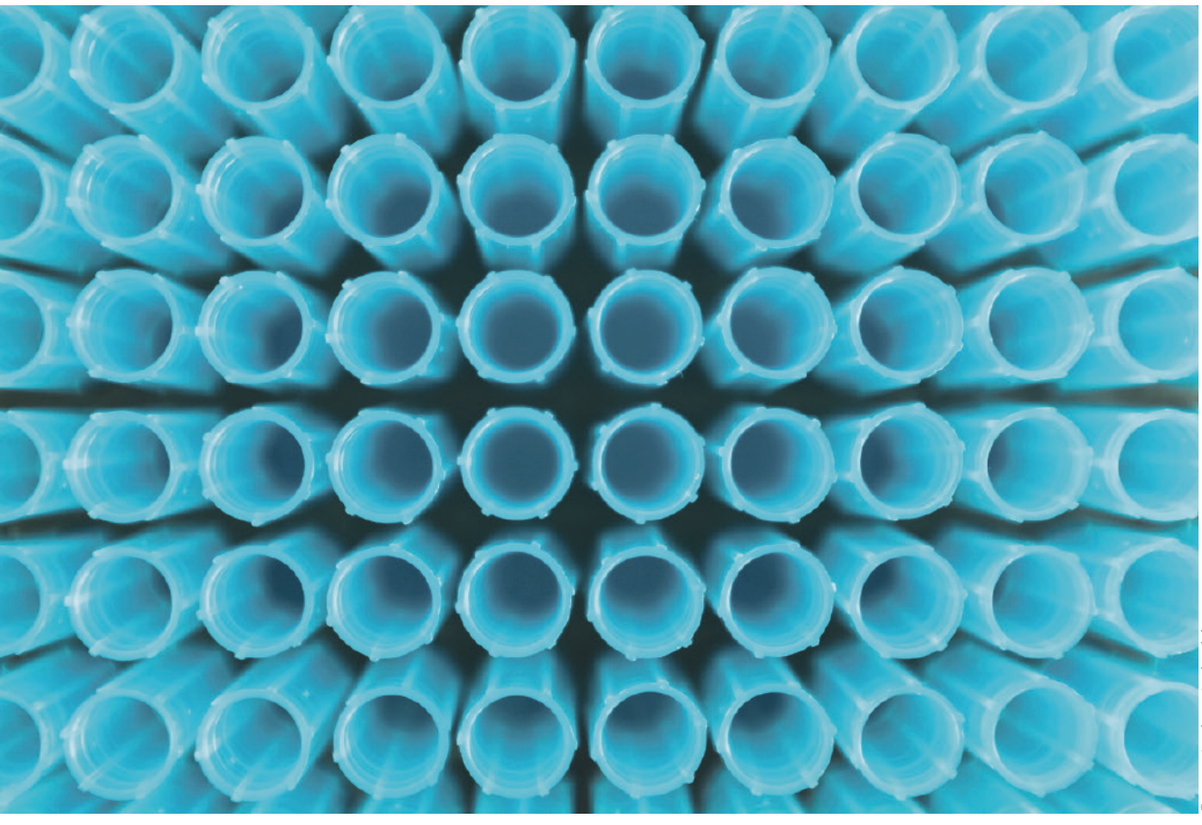
Xiaoyan Tang, Prin. Scientist, Discovery Process Biologics Group, Merck & Co. (MSD)

***CHEManager International:** Automation is often described as the key to significantly shortening cell line development timelines. How much impact is it really having?*

Tom Kelly: Automation is certainly being adopted more widely across the industry, but it's important to be realistic about what it can and can't do. What we're seeing is that automation isn't really shortening CLD timelines in a fundamental way. The biggest driver is still the doubling time of the cells. Whether someone is doing that work manually or using automated systems, you can't make the cells grow faster.

Its biggest impact is on workload rather than absolute timelines. Automation reduces the amount of hands-on work scientists are doing. It allows people to oversee more experiments and potentially work on more than one project at the same time. It can also support quicker decision-making, often within the same day. But it's not typically saving days, weeks, or certainly not months in CLD itself.



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One topic that frequently comes up in discussions about acceleration is the use of pools instead of clones. Is that approach gaining traction? Does using pools actually shorten CLD timelines?

T. Kelly: That's been a hot topic in the industry for probably the last decade, but it's also something that often comes with risk. There are clear health authority requirements that you need to have a clone for late-stage develop-

> *"For decades, the industry focus has largely been on antibodies, but over the last ten years we've seen more bispecific molecules being approved, and the number and complexity of new modalities in the clinic continues to grow."*
>
> Tom Kelly, Johnson & Johnson

ment and for commercial manufacturing, and that isn't changing.

That said, people are increasingly trying to find ways to use pools earlier in the development process. A pooled material is often representative of the final clone, and we're seeing more publications showing comparability between pools and clones. Because of that, there are discussions about where pooled material could be used, whether that's for GLP studies or, in some cases, even being considered for Phase I material.

Not much of the industry has fully moved in that direction yet, but it does seem to be a hot topic and a direction the industry is moving toward. Using pools doesn't really change when you have a clone available, so it doesn't directly shorten the CLD timeline. However, it can help shorten timelines in subsequent steps. Instead of waiting for a clone to be ready, downstream groups can move forward using pooled material, which can reduce overall program timelines beyond CLD.

What's next for the CLD Workstream at BioPhorum?

T. Kelly: Two of the main topics we're focusing on right now are genetic characterization and complex molecules.

On genetic characterization, the discussions are around what assays are done, when they should be done, how long they take, and how extensive they need to be based on health authority requirements. Almost everyone involved in cell line development is very aware of these regulatory expectations. These assays are often not required early in development, but once you reach late clinical stages and regulatory submissions, they really increase in intensity and importance. So a big focus is on understanding best practices and how to improve current approaches.

The other major topic is complex molecules. For decades, the industry focus has largely been on antibodies, but over the last ten years we've seen more bispecific molecules being approved, and the number and complexity of new modalities in the clinic continues to grow. That increased complexity is changing not only what a CLD workflow looks like, but also how CLD impacts other functions across the pharmaceutical development pipeline.

Why is an automated cell line development (CLD) platform important in industry?

Xiaoyan Tang: An automated cell line development platform is important in industry because it directly impacts speed, quality, and competitiveness. Automation lets us screen far more clones or pools than we could ever do manually. Instead of evaluating just a limited number of cell lines, we can now evaluate hundreds, and that dramatically increases our chances of finding stable, high-producing cell lines.

It also helps shorten cell line development timelines. High-throughput platforms can run around the clock, handle many plates at the same time, and remove a lot of the manual bottlenecks. At the same time, automation improves consistency and data quality by standardizing seeding, feeding, sampling, and passaging, and by reducing operating errors.

Imaging and integrated data capture give us strong evidence of monoclonality and clear traceability from the single cell all the way to the final clone, which is exactly what regulators expect. And just as importantly, automation reduces repetitive manual work. Scientists spend less time moving plates and changing media, and more time designing better experiments, integrating data, and solving problems.

What are the different categories of automated CLD platforms, and in which areas do each type perform best?

X. Tang: When we talk about automated, high-throughput cell line development platforms, we're really comparing different underlying technologies.

> *"An automated cell line development platform is important in industry because it directly impacts speed, quality, and competitiveness."*
>
> Xiaoyan Tang, Merck & Co.

One group is microfluidic single-cell systems, such as chip-based platforms. These use thousands of very small chambers to handle individual cells, image them in real time, and measure secretion or binding directly at the single-cell level. The strength of these platforms is the very rich single-cell functional data they generate, along with very strong evidence of monoclonality.

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The second group includes dedicated cell line development instrument suites. These are built around precise single-cell dispensing into plates, combined with high-resolution imaging. Technologically, they stay in the plate-based world, but they add specialized optics and software to prove monoclonality and to standardize clone screening.

The third major group combines flow cytometry-based single-cell sorting with plate-based automation. These systems focus on very high throughput and maximum assay flexibility. They typically integrate cell sorting with liquid handling, automated incubators, and plate readers. Some vendors offer these as bundled, end-to-end workflows, while many companies build customized platforms by integrating different technologies with in-house software.

What were the main challenges you encountered while designing and implementing the platform?

X. Tang: Building a high-throughput automated platform was not simple, and we faced several key challenges.

The first challenge was system integration and scheduling. We had to make sure that plates coming out of the cell sorter were correctly labelled, tracked, and handed over to the incubators, readers, and imagers at the right time. Coordinating all of these instruments on a single schedule, and handling exceptions such as instrument downtime or delayed plates, required very careful workflow design.

The second challenge was data flow and traceability. We needed end-to-end visibility from the initial single-cell sorting step through expansion and screening. That meant pulling data from the cell sorter, imaging systems, and analytical instruments into a single record, with a clear audit trail to support monoclonality and clone identity.

The third challenge was reliability and error handling. In real-world operations, plates can be misaligned and instruments can fail. We had to build in checks, alarms, and recovery strategies so that these issues would not compromise data quality or traceability.

Overall, we worked through these challenges and built a high-throughput platform that fits our long-term development needs.

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Biopharma 2026 Predictions

AI and Regulation Reshape Biopharma R&D

Over recent years, biopharmaceutical companies have made significant strides in linking data and processes across clinical, regulatory, safety, and quality functions. In 2026, the operational focus will shift further toward seamless flow: connected activity across teams supported by a robust technology infrastructure that enhances visibility, traceability, and inspection readiness. This push comes as European regulatory expectations continue to evolve. In parallel, AI will mature from early-stage capability to embedded, compliant systems. Below are four predictions for where the biopharmaceutical industry is headed in 2026.

European Regulation Drives "Inspection-Ready by Design"

In 2026, regulatory change in Europe will feel less like a series of one-off milestones and more like a steady operating reality. Clinical teams will be firmly in a clinical trials information system (CTIS)-first world under the EU Clinical Trials Regulation, which continues to raise expectations for consistency across countries, faster coordination, and complete, traceable documentation. Coupled with moves toward structured submissions such as electronic common technical document (eCTD) 4.0, this requires organizations to move beyond ad-hoc fixes and to deliver consistent quality every time, with fewer exceptions and moving beyond the need for local workarounds or fixes.

At the same time, the International Council for Harmonization, efficacy guideline number 6 (Good Clinical Practice, GCP), Revision 3 (ICH E6(R3)) will further move the industry toward a risk-based approach to GCP, with sponsors needing to show that quality is designed into a study and how oversight is executed across partners, data sources, and systems. This narrows the gap between operations and compliance, redefining "inspection readiness" as a constant operational state rather than a last-minute scramble. Achieving it depends on clearly defined process ownership, consistent documentation, and a reliable trail of decisions.

Finally, structured data requirements will also keep advancing. Initiatives, such as Identification of Medicinal Products (IDMP) are a signal of the regulatory move toward standardized product and substance data that can be reused and reconciled across the lifecycle. In practice, 2026 will reward companies that reduce manual handoffs between functions with shared data and harmonized processes – enabling both greater speed and continuous audit-readiness.

Data, Process, and AI Agents Come to the Fore

In 2026, many biopharmas will have moved beyond the initial experimentation phase with artificial intellience (AI). Early pilots in summarization, classification, extraction, and draft generation revealed the same limitation time and again: AI's reliability is only as strong as the data, processes, and governance supporting it. As expectations rise, especially under the EU AI Act for regulated industries, AI-readiness will be treated less as a collection of pilots and more as a core operational capability.

This is where the conversation shifts from "Can AI help?" to "Can AI help in a ways that are trustworthy, explainable, and scalable?" The path to that outcome is not mysterious, but it is demanding:

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Rik van Mol,
Senior VP,
Veeva Systems

- Harmonized data and metadata to produce consistent and dependable outputs
- Standardized workflows with defined control points for task execution
- Clear governance outlining responsibility, validation, and monitoring
- Audit-friendly traceability so decisions can be understood and defended

"2026 will reward companies that reduce manual handoffs between functions with shared data and harmonized processes – enabling both greater speed and continuous audit-readiness."

With these foundations in place, the next step becomes achievable: agentic AI. In 2026, organizations will begin to deploy task-driven AI agents capable of initiating workflows, validating completeness, summarizing outcomes, flagging anomalies, and directing work to the right individuals. The real gains will come when these agents operate within disciplined processes and connected datasets – improving cycle time and quality while avoiding new risks.

Improved Data Flow to Accelerate Recruitment and Enhance Patient Access and Experience

Better clinical data flow between sites and sponsors will allow trials to run faster and operate more efficiently. Physicians will receive relevant study information directly, enabling them to match patients to suitable research, Embedded AI that links datasets in real time will connect trial data between

sponsors and sites so that physicians can search treatment and trial options based on a patient's condition. This direct-to-physician approach will reduce reliance on sites for recruitment, helping to meet enrolment targets sooner and expanding patient access to clinical trials.

"Modernizing and consolidating systems, standardizing data and workflows, as well as integrating quality assurance will be key to realizing the productivity gains of QC-specific AI."

For sites, modern technology relieves much of the recruitment burden and replaces paper-based, manual source data verification (SDV) for clinical research associates (CRAs) with digital workflows. eSource tools will connect upstream and downstream clinical data sources, first with EHRs to merge patient health records seamlessly. When connected with EDC, source forms will be defined by a trial definition to speed and improve data flow to the sponsor. This streamlines study visits for patients and advances trials for sites and sponsors.

Agentic AI QC Lab Assistants Set to Enhance Speed and Connectivity

In laboratories, the use of AI will move beyond chatbots toward embedded, task-focused assistants working within regulated processes. QC labs are recognizing the efficiency potential of such agents, focusing on deploying them across personnel and processes. Yet many labs still operate with fragmented systems and paper-based processes. Modernizing and consolidating systems, standardizing data and workflows, as well as integrating quality assurance will be key to realizing the productivity gains of QC-specific AI.

"AI's reliability is only as strong as the data, processes, and governance supporting it."

In this environment, lab analysts will collaborate with AI agents capable of starting workflows, summarizing outcomes, and monitoring trends and early indicators of risk. This supports proactive quality management and fosters "right-first-time" execution. The result will be highly effective and efficient in QC labs where people and agents work in tandem to reduce batch cycle durations.

The Bigger Picture for 2026

Linking these predictions is a single thread: connected execution. European regulators are raising expectations for transparency, traceability, and consistent oversight, while AI is pushing organizations to strengthen operational foundations. AI agents cannot scale effectively if processes are inconsistent or data is fragmented. In 2026, the leaders will be those who establish continuous data flow across clinical, regulatory, safety, and quality with an inspection-ready development foundation, and deploy AI in ways that teams can trust and measure. The business outcome is clear: fewer handoffs and unexpected issues, greater compliance, and faster delivery of therapies for patients.

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Automation is Key to Maximizing AI

The Successful Lab of The Future Requires Digital Transformation

To meet the demands of accelerated discovery; accurate, reproducible results; and higher throughput, digital transformation is becoming a when, not an if, for chemistry labs. AI is generating exponentially growing volumes of data, robotics implementation is transitioning from "perhaps we'll have them one day" to day-to-day reality, and all this needs to be managed to meet challenges instead of having it bury the lab.

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Eynav Haltzi, Product Manager, Cenevo

Personal Profile

Eynav Haltzi is a Product Manager at Cenevo, which specializes in lab management systems, automation, orchestration, data management and AI technology for life sciences.

Cenevo (then Titian Software and Labguru) surveyed more than 155 lab management professionals, who enumerated their major issues as follows:

- AI adoption within the R&D process is actually secondary to focusing on the most basic of lab management challenges – inventory management. 65% of respondents said supply and reagent management is the first technology that they want to fully implement.
- More than half said that data management and overload was a major issue that needed to be addressed. High-throughput experiments, supplemented with AI, are generating more data than their labs can currently handle.
- Smarter, faster science requires increasing automation (77% of respondents) and adopting AI/machine learning (ML) (75%).
- Digitization is only somewhat in place. Only 15% are fully digitized, and half still have manual processes. Smaller organizations and academia fall into the early stages, while many of the large pharma/biotech companies are already well into the process.

Getting the Lab in Order

Automation is the first step toward streamlining lab operations. It's the best way to reduce manual work while strengthening compliance.

Even in the biggest manufacturing or pharma chem labs, resources aren't infinite. Implementing a smart scheduling tool makes it easier to prioritize equipment access and even priorities for lab personnel. When combined with AI/ML, these smart tools can analyze performance data to generate preventative maintenance alerts and adjust schedules when downtime is necessary or if parallel tests can be run on other equipment to take up the slack.

Scheduling tools can be integrated with user profiles and training records, so if an employee isn't qualified to run an experiment on a specific piece of equipment, the lab manager can be notified that the person needs to either be trained or reassigned. AI can be used to simplify digital workflows while reinforcing compliance. Lab managers can set up rules for electronic signature and audit trails for stronger traceability from raw data to results. The automated electronic record keeping creates a "paper trail," making it easier to comply with future regulatory audits.

Automated inventory tracking using a barcode reader may ensure that every time a reagent is used in an experiment, the volume and even the age of the agent is tracked. Low-stock and expiration alerts and automated ordering make sure that the chemicals needed to run the experiments are always available. The barcodes make it easier to ensure real-time inventory location tracking, maintaining hazardous material compliance.

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"Automation is the first step toward streamlining lab operations. It's the best way to reduce manual work while strengthening compliance."

Equipment automation itself, such as the automation of lab reactors and titration systems within chemical manufacturing, allows for chemical synthesis without human interaction or interference, reducing potential exposure to dangerous reagents. In life sciences, liquid handling systems and robotic workstations can more precisely perform DNA normalization, high-throughput screening, and colony picking, improving experiment reproducibility, and speeding early stage discovery.

Data Management Made Simpler

Each chemistry lab, whether in life sciences, biotech, manufacturing, greentech, etc., is working with diverse modalities beyond just small molecules, antibodies, and polymers. The complexity adds more challenges around data acquisition, storage, analyses, and compliance.

When all lab work was manual, the lab notebook served as the single source of truth. Now, a lab can have "dozens of sources of truth." Data fragmentation and the lack of context and metadata across laboratory information management systems, electronic lab notebooks, instrumentation software, data analysis software, inventory tools, and automation systems, etc., create not only significant bottlenecks but potentially incorrect results if all the data isn't analyzed together.

"Implementing the FAIR (findable, accessible, interoperable, and reusable) data principles is one key to streamlining data management."

Implementing the FAIR (findable, accessible, interoperable, and reusable) data principles is one key to streamlining data management. Findable and accessible data ensures metadata and data are both easily searchable thanks to unique identifiers and retrieved. For example, in a manufacturing lab producing pharmaceutical intermediates, each production batch is assigned a unique identifier, and all analytical results (e.g. HPLC, GC-MS, spectroscopic data) are tagged with comprehensive metadata: product code, batch number, test date, instrument ID, analyst name, and test method reference.

To enable data accessibility, the lab employs a centralized data management system, with robust search functionality, allowing authorized personnel to quickly retrieve all relevant data associated with a specific batch identifier or query parameter. Interoperable data means that it can be integrated and combined across a variety of tools and systems. Of course, all the data needs to be reusable, so it can be leveraged for other research.

All this FAIR data needs to be integrated into a single system, including all the data generated when AI is brought into the mix. While this has been a common practice in other industries, laboratories are starting to explore and adopt data lakes. Traditional data storage systems focus on structured data, with unstructured data within separate storage systems, complicating comprehensive analyses. Data lakes store massive volumes of unstructured, semi-structured, and raw data in all the original formats from across every aspect of lab operations: ELNs, LIMS, operational logs, instruments, etc. By using a data lake, detailed metadata and audit trails are preserved in their entirety, simplifying compliance. Data lakes simplify AI/ML analyses as the raw data itself can be analyzed, not summaries of summaries.

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Managing Data with AI

Many labs are sitting on "buried treasure": legacy data that's sitting dormant in seldom-used databases, historical research data, as PDFs from reports, and even paper files that haven't been touched in years. AI can be used to ingest, unify, clean, transform, and integrate old and new data across a variety of platforms, automating quality inspection, and ensuring the data is still accurate and usable. It can "seek out" data from the various instruments and orchestrate data transfer to the data lake or another centralized repository. AI can also be used to discover anomalies, revealing areas where results don't seem to match previous discoveries, as in something went wrong with the equipment, reagents, or process, or something very unique has just been discovered.

Examining the Risks of AI

AI adoption is not without its caveats. Data integrity, transparency, and regulatory frameworks need to be key considerations when approaching AI adoption.

The first goes back to the data management problem. If the data itself lacks metadata and inconsistent documentation, is low quality, or simply isn't rich or robust enough, the AI analyses will deliver flawed results.

"AI adoption is not without its caveats. Data integrity, transparency, and regulatory frameworks need to be key considerations when approaching AI adoption."

Transparency is key to AI "trust." If an anomaly is detected, an experiment fails or results fall outside acceptance criteria, for example, the AI system must be "open" enough to explain exactly what it discovered and how. Algorithm changes must be traceable, as well. Without this transparency, accountability fails. Reproducibility is also critical, with consistent, verifiable performance. If an AI system at Lab One made discovery A, the same discovery A must be made easily at Lab Two.

Furthermore, AI is advancing much faster than regulatory frameworks. What may be allowed today, simply because it isn't regulated yet, may be disallowed or may require an enhanced audit trail to be considered legitimate.

Digital Transformation with Automation & AI

Again, digital transformation is a when, not an if. The combination of automation will transform lab operations from reactive to proactive, increasing throughput with the same resources. If chemistry labs don't increase their focus on automation and AI adoption, their organizations will lose their competitive advantages. Addressing the basis – inventory and data management – is the best way to start. Automation will reduce human error, streamline operations, and reduce costs. Over time, digital transformation toward lab automation requires more advanced hardware and software (larger databases, integrations, MCP servers, etc.). This will become a "must" requirement over time to facilitate the introduction of AI more easily.

The basics need to be ever in the forefront: FAIR principles, effective and efficient data management, and comprehensive compliance. The goal is a seamless workflow: automation does the heavy lifting, and AI does the initial analyses.

The combination of automation and AI accelerates research, streamlines operations, and replaces repetitive tasks. More efficient labs allow researchers to focus on the creativity and experience that drives innovation versus spending their time on manual tasks.

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Lone Voices in the Desert

"Enough with the Snail's Pace!": Industry Leaders Urge Action to Save Europe's Chemical Sector

Who hasn't heard of the proverbial "lone voice crying out in the wilderness"? That's what we call someone who warns others in vain or whose warning message no one wants to hear.

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The German Chemical Industry Association (VCI) has launched the "Stop the Snail's Pace" campaign to show policymakers and the public just how serious the situation in the industry is and that snail's pace slows down the economy.

In 2006, former US Vice President Al Gore's bestselling book "An Inconvenient Truth" was a daring call to action, exposing the shocking reality of how humankind has aided in the destruction of our planet and the future we face if we do not take action to stop global warming.

Fast forward: In 2026, the international community is still debating whether climate change is being accelerated by man-made greenhouse gas emissions from industrial activities, transportation, and food production. Those nations that accept the need for a more sustainable way of life and are taking countermeasures now face another fundamental challenge: preserving their industrial base, which is under threat due to multiple crises. In an increasingly tense geopolitical situation marked by wars in Ukraine and the Middle East, blocked supply chains, and record-high energy prices, Europe's already dramatically weakening economy is being pushed further and further into a corner. It is no longer just slumps in production and sales that are cause for concern, but plant closures, job losses, and the destruction of entire value chains.

Politicians Move Slowly

While the runaway train races ever faster toward the abyss—that is, the deindustrialization of Europe—political leaders are moving at a snail's pace when it comes to the reforms needed to boost Europe's competitiveness in the global marketplace, particularly against the United States and China.

This is one of the concerns raised by the German Chemical Industry Association (VCI), which is therefore calling for action in a high-profile media campaign: "Enough with the snail's pace!" The association, led by its president, Markus Steilemann, CEO of polymer materials producer Covestro, argues that without a competitive domestic chemical industry that supplies precursors for nearly every other sector, value chains will collapse and prosperity will be lost. And: Without a strong domestic chemical industry that invests in innovation, we as a society will also lose the fight against climate change and environmental pollution."

Association leaders like Steilemann have been warning politicians for months (and even years) that the European chemical industry is losing its competitiveness due to expensive energy, high labor costs and exuberant regulation and time-killing bureaucracy. Although politicians have made many commitments to the region and announced plans to improve the business environment, the Chemical Industry Association says that, so far, not much has happened in favor of industry competitiveness. Many lone voices in the wilderness, it seems.

However, politicians, who often fail to see the big picture, would be well advised to listen to the experts. One, who is not heading an association but who very bluntly speaks in the interest of his own company—but also represents his industry peers—is Sir Jim Ratcliffe. Being the Founder, Chairman and CEO of Ineos, the largest British and a major global petrochemicals group, Ratcliffe often speaks out in order to shake up political leaders.

By doing it so openly and early on, he appears to be spearheading the proverbial "lone voices in the wilderness". Being who he is, one of the wealthiest persons in the UK and a charismatic personality, Ratcliffe's voice may sound louder than others'.

Energy Security Over Net Zero Ambitions

Recently, Ratcliffe stated that Europe's energy security must come before net zero ambitions. He stresses that energy independence is crucial for national security, especially during times of conflict when reliable energy is essential for critical services and infrastructure. He highlights how ongoing global conflicts have exposed the vulnerability of countries like the UK and regions like Europe to energy price shocks due to reliance on foreign suppliers. He calls for the UK to make energy independence its primary strategy, using recent disruptions like the Strait of Hormuz as a warning to take urgent action. "Energy prices in the UK and Europe have skyrocketed since the start of the Iran war. This kills industry and manufacturing and our competitiveness. Our dependency on foreign suppliers of energy increases. They have us where they want us – over a barrel if you'll excuse the pun."

And spanning the bridge from energy independence to climate protection, he explained: "Every barrel and every cubic meter we choose not to produce at home will simply be imported from somewhere else – often from countries with weaker environmental standards."

"Net Zero ambitions are good goals but should sit firmly in second place," the Ineos chief said."

Chemical Leaders Call for Urgent Reforms

Ratcliffe called on Europe's politicians to take immediate and urgent action to halt the catastrophic decline in the European chemical industry and protect Europe's economy from a total reliance on imported goods. "There is not going to be much left of chemicals in Europe unless politicians get to grips with it very soon."

At the European Industry Summit in Antwerp, the Antwerp Declaration Community representing more than 1,300 companies, trade associations and trade unions called for urgent, coordinated action to restore competitiveness and protect high-quality industrial jobs across Europe.

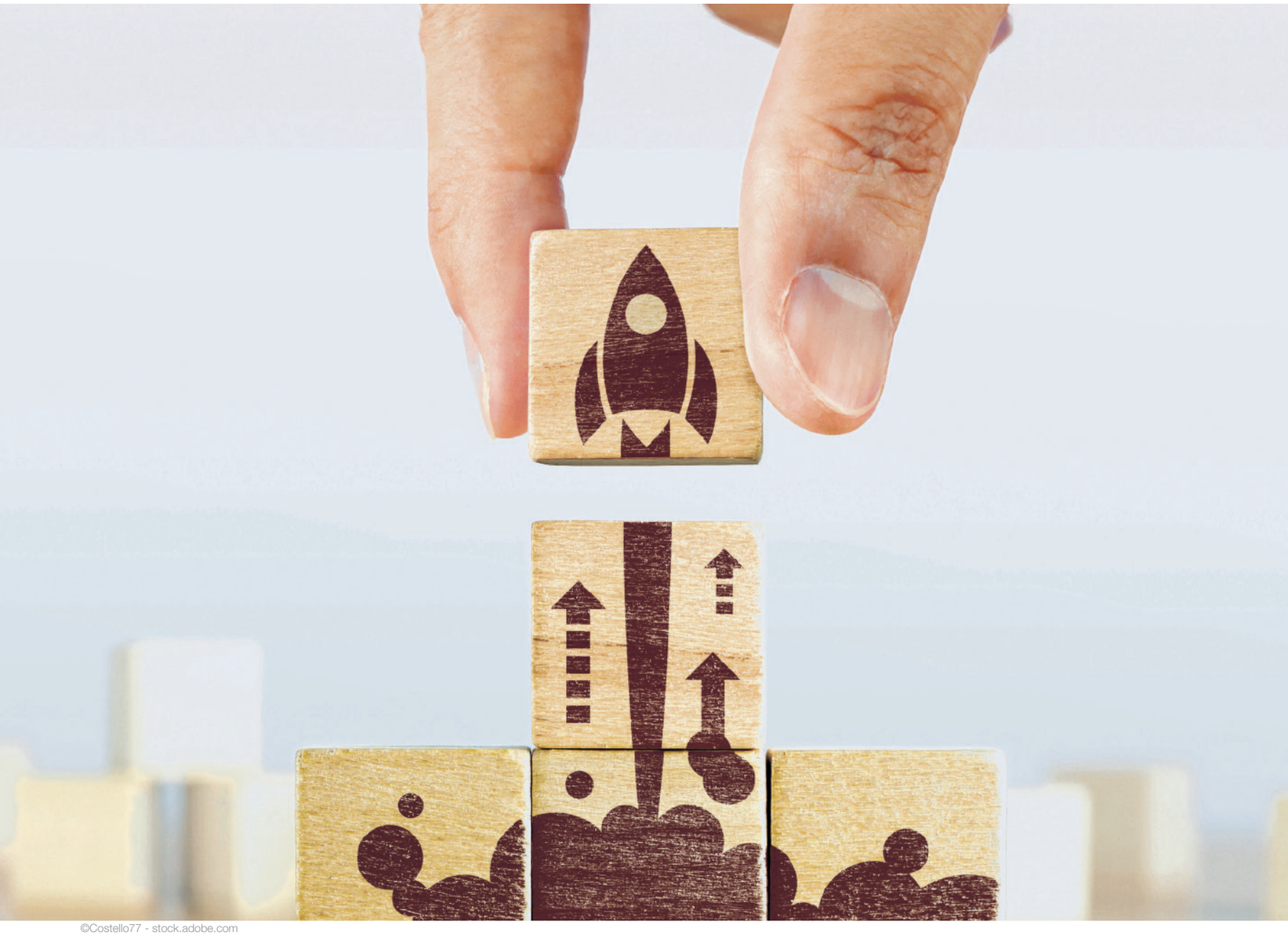
Ratcliffe set out the scale of the challenge facing Europe's industrial base explaining that since February 2024, over 100 industrial sites have closed. He also warned that Europe's current trajectory is increasing global emissions rather than reducing them: "Europe hasn't cut emissions, it has exported them. Production has moved to the US and China, where carbon intensity is far higher. As a result, global emissions have risen by more than 20 million tons of CO_2."

So, for the European chemical and pharmaceutical industries, it is to be hoped that Jim Ratcliffe and all the other business leaders and opinion makers will not end up as the proverbial biblical voices dunning in the wilderness, whose warnings go unheeded. Because there's no time to waste!

Michael Reubold, CHEManager

CHEManager INTERNATIONAL

Innovation Pitch



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From Emission to Ingredient
Viridi's Drop In CO_2 Chemistry Based on Solid-Catalyst Technology

Independence by Design
Inside MakeGood's Open-Source Assistive Technology Movement

From Waste to Application
Coco-based Oil Absorbents for Routine and Emergency Spill Response

AI Materials Discovery Engine
Entalpic's AI-Driven Chemistry & Materials Discovery

From Emission to Ingredient

Viridi's Drop-In CO_2 Chemistry

Founded by Daniel Stewart and Robert Raja as a spin-out from the University of Southampton, Viridi was established to transform how essential products are made. Building on Stewart's doctoral work and Raja's long-standing research in catalysis, they developed a solid-catalyst technology that can turn underused resources, including captured CO_2, into high-value ingredients.

What started as an academic concept soon evolved into a scalable, commercial technology that helps manufacturers reduce reliance on fossil and land-intensive oleochemical feedstocks by utilising waste CO_2 to produce key ingredients behind products for personal care, cosmetics and home care. Designed as a true drop-in solution, the catalyst integrates into existing production lines without the need for costly redesigns. It's a practical way to help companies cut their carbon footprint and move towards circular manufacturing using the infrastructure they already have.

The name Viridi comes from the Latin viridis, meaning green, reflecting the company's focus on enabling more sustainable ways of making everyday products using captured carbon dioxide as a raw material. The ambition is simple but far-reaching: to help modernise a legacy industry and support the shift towards next-generation essentials made with recycled carbon.

CHEManager: Can you explain the core innovation in simple terms for our readers?

Daniel Stewart: At Viridi, our core innovation is a solid catalyst that allows manufacturers to transform captured CO_2 into the essential ingredients that underpin so many everyday products, from surfactants to coatings and foams. In simple terms, it transforms a widely available input into something highly valuable and performance ready. What's important is that our catalyst is designed to work as a drop-in within existing industrial infrastructure. Manufacturers don't have to rebuild plants or overhaul their systems; they can use our technology to replace fossil-based carbon sources with captured carbon directly. The result is a scalable solution that makes sustainable production both achievable and commercially practical.

What specific industry problem does your solution address, and why is it urgent now?

D. Stewart: In the chemical industry, manufacturers are still dependent on raw materials that are becoming scarcer, land-intensive and increasingly exposed to regulatory pressure. These feedstocks come with high carbon footprints, price volatility, and, in many cases, environmental impacts such as deforestation. At the same time, the pressure to decarbonise is intensifying: brands are setting ambitious sustainability targets, and regulators are tightening carbon-related policies. Our technology helps companies address this urgency by substituting those conventional inputs with more sustainable sources such as captured CO_2 – a low-carbon, zero-land-intensity alternative. We view CO_2 not as a pollutant, but as an abundant, circular carbon source that can make essential materials more sustainable, without compromising on performance.

> *"Our catalyst can generate a range of ingredients - surfactants, polyols, emulsifiers – each with unique performance advantages."*

What differentiates your technology or approach from current market alternatives?

D. Stewart: What really differentiates us is how pragmatic the approach is. Many technologies in this space require major process changes or entirely new production lines, which makes adoption slow and expensive. Our catalyst is genuinely drop-in - it integrates with existing systems, enabling manufacturers to transition to captured-carbon feedstocks far more quickly. We've proven this through successful pilot work and validation on industrial sites. Another point of difference is that we're not just developing one product. Our catalyst can generate a range of ingredients – surfactants, polyols, emulsifiers – each with unique performance advantages. For example, our first CO_2-derived surfactant, Vireya, shows exceptional mildness and up to 70% lower product carbon footprint than conventional alternatives. It's a strong proof that CO_2-based chemistry can outperform, not just replace, the status quo.

What are your main drivers for business growth and how will you achieve scale in the next few years?

D. Stewart: Our immediate focus is on scaling through partnerships. We're already collaborating with ingredient manufacturers and household name brand owners to bring our next-generation materials into real-world formulations. That collaborative model helps us understand exactly how our materials behave in different systems and ensures commercial readiness. From a business perspective, the surfactants market provides our first growth engine, because of its scale and direct sustainability demand. Beyond that, the same technology can extend into polyols, coatings, adhesives, and beyond – so the addressable market is vast. In parallel, we've secured seed funding to accelerate development, and we're working toward large-scale demonstration at manufacturing sites. Over the next few years, the goal is to move from validated pilots to full production, converting thousands of tonnes of CO_2 into new materials.

© Viridi

Daniel Stewart,
Co-founder and CEO, Viridi

Which key metrics or milestones will you use to measure your success, and what targets have you set for the next year?

D. Stewart: We benchmark our progress against the same performance and adoption metrics used across the chemicals industry. A key priority is clearly demonstrating performance advantages over incumbent materials, particularly within real-world formulations. Over the next year, a major milestone will be validating the enhanced performance of our CO_2-derived surfactants, including Vireya, within brand owners' products.

From a scale perspective, another critical target is demonstrating the use of our catalyst at ton-scale, moving beyond pilot validation towards industrial relevance. Ultimately, success is measured by impact: delivering meaningful CO_2 savings for chemical manufacturers and brand owners, while enabling them to decarbonise essential products without disrupting existing production processes.

Personal Profile

Daniel Stewart is the Co-founder and Chief Executive Officer of Viridi, a UK-based company spun out of the University of Southampton that has developed patented catalyst technology to transform waste CO_2 into essential ingredients for products such as surfactants, coatings, foams, and plastics. He founded the company in 2020 during an EPSRC Impact Acceleration Award Research Fellowship focused on scaling catalysts for CO_2 utilisation, building on a PhD in Chemistry from the University of Southampton and research experience at the Georgia Institute of Technology.

Business Idea

Circular Chemistry in Action

Viridi is redefining how essential materials are made by transforming captured CO_2 into high-performance ingredients for industries such as personal care, home care, coatings, and polymers. Emerging from research at the University of Southampton, the company's solid-catalyst technology enables CO_2 to be used as an alternative feedstock - replacing fossil and land-intensive raw materials without requiring changes to existing manufacturing infrastructure.

The technology functions as a drop-in solution, integrating directly into production lines to substitute traditional petrochemical inputs. This approach allows chemical producers to cut emissions, reduce land use, and lower their dependency on volatile feedstocks while maintaining full product performance. The process has been validated at pilot scale with strong industrial-site trials and growing partner interest across Europe.

Viridi's first commercial ingredient - a CO_2-derived anionic surfactant marketed as Vireya - marks a major milestone in sustainable chemistry. It offers comparable or superior performance to conventional formulations while achieving up to 70% lower product carbon footprint and tenfold higher skin mildness. By turning what was once an emission into a raw material, Viridi shows how carbon utilization can enhance both environmental and consumer outcomes.

Built around collaboration with ingredient manufacturers and brand owners, Viridi's business model aims to accelerate the adoption of CO_2-based materials across surfactants, emulsifiers, polyols, and adhesives. With a catalyst system designed for cost efficiency and scalability, Viridi is positioning itself at the forefront of circular carbon chemistry - making captured CO_2 a mainstream raw material and a new foundation for sustainable manufacturing.

- ViridiCO2, Southampton, England
  viridico2.co.uk

VIRIDI

Elevator Pitch

Turning Captured Carbon into Circular Chemistry

Viridi is transforming the way essential chemicals are made by enabling manufacturers to use captured CO_2 as a renewable carbon source. The company's solid catalyst technology allows CO_2 to be directly substituted for fossil and land-intensive raw materials in existing production lines – without the need for disruptive infrastructure changes. Viridi's first product platform, Vireya, represents the world's first CO_2-derived anionic surfactant, offering up to 70% lower product carbon footprint and dramatically improved mildness. By combining deep chemical innovation with a scalable, drop-in approach, Viridi bridges the gap between sustainability and performance, paving the way for a truly circular manufacturing future.

Milestones

2020
- Formation of Viridi as a spin-out from the University of Southampton.

2023
- Secured £3 million seed funding led by EQT Ventures to accelerate scale-up and commercial development.

2024
- Completion of successful industrial validation trials with manufacturing partners in Europe; advancement to TRL 7 prototype demonstrations.

2025
- Launch of Vireya, the first CO_2-based surfactant platform, achieving up to 70% reduction in product carbon footprint and 10× higher skin mildness than conventional benchmarks.

Roadmap

2025-2026
- Tonne scale demonstration of CO_2-based surfactants with flagship customers.

2026-2027
- Launch of Vireya in the first commercial products

© Viridi
Viridi sample products.

© Viridi
Researchers in Viridi's laboratory.

Building Independence, One Design at a Time

Inside MakeGood's Open-Source Assistive Technology Movement

Founded in 2021, MakeGood utilizes materials technology to drive inclusive innovation through adaptive design. At Formnext 2025 in Frankfurt, Germany, CHEManager managing editor Michael "Mike" Reubold, looking for 3D-printed objects to report about, ran into Noam Platt, the Founder and Executive Director of the New Orleans-based non-profit organization. While most exhibitors of that trade show on additive manufacturing showed the usual showcase items for their 3D printers and materials, MakeGood had helpful tools for people with disabilities on display. In this interview, Noam discusses the start-up's mission to design for all using advanced digital tools, help people explore, understand, and improve their environments with the focus that everyone should be able to perform daily tasks with dignity and confidence.

© MakeGood

Noam Platt, Founder and Executive Director, MakeGood

Personal Profile

Noam Platt is an American College of Healthcare Architects-certified healthcare architect and founder of MakeGood, a 501c3 organization, that designs and fabricates assistive technology for people globally. He is an award-winning specialist in designing and producing novel technology for the disabled community. His goal is to bring people together to engage in curiosity and adaptive design to create a flourishing community of makers and need-knowers. He is inspired by the families and friends who reach out to MakeGood for help bringing independence into their lives.

CHEManager: Noam, what does MakeGood do and how did it start?

Noam Platt: MakeGood is a non-profit organization dedicated to reimagining how assistive technology is designed, built, and accessed. MakeGood brings together designers, clinicians, engineers, and people with disabilities to create custom, real-world solutions for mobility and accessibility challenges. The organization is led by a multidisciplinary team that includes disabled designers and fabricators whose lived experiences directly inform the work, ensuring solutions are both innovative and deeply practical.

Our approach is the belief that "need-knowers", the people who live with specific challenges every day, should lead the design process. Rather than designing for people, MakeGood designs with them, translating lived experience into functional, personalized assistive devices. Beyond producing devices, we focus on offering design thinking classes, adaptive making workshops, and hands-on training that teach communities how to design and fabricate their own solutions.

What was the starting point and the motivations of MakeGood?

N. Platt: MakeGood began by me repeatedly encountering the same problem: people with disabilities needed personalized assistive solutions, yet existing options were expensive, generic, or simply didn't fit real lives. Early experiments included a wooden mobility cart made on a CNC machine and we shared a vision to make the design fully 3D-printable, but skepticism followed—until one response changed everything.

> *"MakeGood is reimagining assistive technology as a shared public good."*

Industrial designer Schuyler Livingston, co-founder of LINK PBC, saw the potential and joined the effort. Soon after, Philip Dunham, now Head of Fabrication and Design and a wheelchair user himself, became a core collaborator, bringing lived experience and deep technical skill. With support from partners at TOM Global, the project evolved from an experiment into a community-driven design process. Together, the team proved that affordable, customizable, and nearly fully 3D-printed assistive devices were not only possible—but transformative. Most recently, we openly released the 3D-printed Toddler Mobility Trainer, TMT.

What were the key challenges you faced during the development of MakeGood and the establishment of the company?

N. Platt: One of the biggest challenges in developing MakeGood wasn't the technology itself—it was connection. Early on, we discovered a persistent gap in the assistive technology ecosystem: makers and designers were eager to help, but often had no way to reach the people who needed support most. At the same time, individuals with disabilities frequently didn't know that local makers could design and build custom solutions for them. Bridging this divide became as critical as building the devices themselves.

Funding presented another challenge, though not in the traditional sense. While equipment, materials, and prototyping were largely supported through partnerships with companies like Bambu Lab and CookieCAD, sustaining and scaling the organization required new ways of thinking about outreach, coordination, and long-term impact. These challenges ultimately shaped our focus on community-driven networks, open platforms, and systems that connect people—not just technology—to meaningful solutions.

Why is it relevant to society what MakeGood does?

N. Platt: What MakeGood does shines light on disability being a universal human reality where we are all on different timelines of needing assistive technology. At some point in life, everyone will rely on tools, environments, or systems that support mobility, access, and independence. MakeGood responds to this reality by reimagining assistive technology as a shared public good rather than a limited, specialized product. By creating highly designed, affordable, and open-source solutions, MakeGood helps ensure that when people need support—whether temporarily or permanently—they can continue living full, meaningful lives. Our work is not only about meeting today's needs, but about building a future where access, dignity, and independence are embedded into the way we design the world. In doing so, we aren't just serving a community—it's preparing all of us for the lives we will eventually live.

What's next for you?

N. Platt: Looking ahead, we want the future of MakeGood to be rooted in growth, connection, and cultural change. We want to scale our work and deepen partnerships with universities, healthcare providers, and local businesses. We are focused on shifting how disability is seen and celebrated—advocating for a society where accessibility is embedded into everyday life, not treated as an afterthought. Our goal is that with each new project, MakeGood continues to prove that meaningful change grows through collaboration.

BUSINESS IDEA

Maker Revolution

MakeGood leads a maker revolution with their innovative digital fabrication. The organization envisions a future where individuals with special needs, disabilities, and chronic conditions are empowered through adaptive solutions. Their core idea centers around rethinking design so it better addresses the needs of the disability population.

At the heart of MakeGood lies a mission to use advanced digital tools to deliver innovations to people with disabilities to help them comfortably conquer their activities of daily living with dignity. By embracing open-source collaboration, the organization has enabled anyone to download and create assistive tools through platforms like MakerWorld, transforming everyday challenges into opportunities for independence—at no cost to families.

The organization produces their accessible devices using 3D printers and PETG and TPU and is driven by a commitment to pairing the knowledge of disability design and 3D printing into devices that anyone can make at home for a low cost. MakeGood is expanding access to affordable, dignified mobility—turning innovation into real-world independence for individuals and children with disabilities worldwide. What sets MakeGood apart is a fundamental shift in how assistive technology is created and shared. While the commercial market often overlooks people with complex or highly specific needs, MakeGood is built on the belief that access to thoughtful, well-designed devices should be universal—and that people, not products, are the solution. By empowering designers, engineers, architects, and makers to collaborate directly with "need-knowers," MakeGood replaces one-size-fits-all products with human-centered, responsive design.

For the first time, advanced design software and 3D printing make it possible for individuals to create meaningful, life-changing devices in hours, not years. Projects like the openly released 3D-Printed Toddler Mobility Trainer demonstrate what's possible when technology is used for shared problem-solving rather than mass production. Anyone with a basic 3D printer can now produce a low-cost mobility device for children ages one to eight—transforming assistive technology from an expensive commodity into a powerful tool for social change and collective responsibility.

- MakeGood, New Orleans, Louisiana, USA
  https://makegood.design
  https://makerworld.com/en/@MakeGood

ELEVATOR PITCH

Inclusive Innovation

The non-profit has redefined how assistive technology is designed, built, and accessed through inclusive, adaptive design. Founded in 2021, the organization plans to continue to expand collaborations with designers, clinicians, engineers, and people with disabilities to transform lived experience into practical, personalized mobility and accessibility solutions. Using advanced digital tools and materials technology, MakeGood designs with "need-knowers," ensuring dignity, confidence, and real-world usability are central to every device. United by a mission to make adaptive tools affordable and accessible to all, the growing interdisciplinary team is proving that when design is led by those who need it most, innovation becomes both transformative and human. Over the next few years, MakeGood aims to scale its open-source platforms, expand distributed manufacturing worldwide, and deepen partnerships with healthcare systems, schools, and communities to make personalized assistive technology universally accessible.

Milestones

2022 — Foundation

- MakeGood was founded at Noam Platt's kitchen table after being asked by a local New Orleans family to make a portable adaptive toilet chair.

2022 — Adopted Bambu 3D Printers

- With the release of the Bambu X1, MakeGood's ability to create assistive technology exponentially increased, marking a significant expansion in fabrication capabilities.

2023 — Early Operations

- Creation of dozens of wooden TMTs with partners at Tulane.

2024 — Major Growth Year

- Delivery of over 250 assistive devices, launched the Community Printer Program (placing ten 3D printers with disabled community members), and participated in Camp Dream Street.

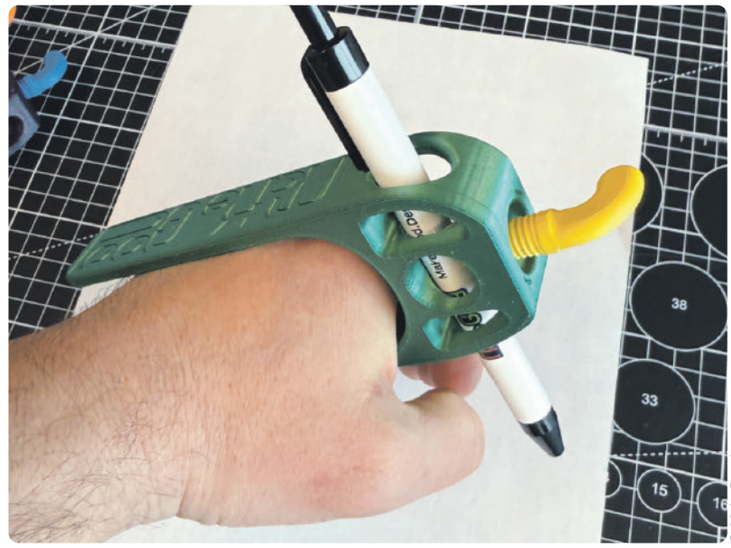
2025 — Studio Expansion & TMT Development

- Opening of the MakeGood Community Design Lab at UNO, developed the 100% 3D-printed Toddler Mobility Trainer (TMT) in partnership with LINK PBC and TOM Global, and expansion of the French Quarter Access Map project to cover all of New Orleans.

2026 — TMT Launch & National Expansion

- Official launch of the TMT with new website, establishment of an office in California, and start of shipping TMTs internationally (including to Chile for disaster relief) while planning major events across the country.

The 3D-Printed Toddler Mobility Trainer is designed for children ages 1-8 to build mobility, independence, and social skills.



The MakeGood Palm Pen Holder is an adaptive writing device that increases the surface area available to control the chosen writing implement.

From Coconut Waste to Industrial Spill Control

Aura Verde Develops Coco-based Oil Absorbents for Routine and Emergency Spill Response in Industrial Operations

Oil and fuel spills are a daily reality in industrial environments - from ports and workshops to energy, mining and logistics operations. While mineral-based absorbents remain the standard solution, they often create secondary disposal challenges and ESG concerns. Aura Verde, a Mozambique-based company founded in 2021, has developed an organic oil absorbent designed as a drop-in alternative for professional spill response. Michael Reubold asked Isabel Matola, Founder and Managing Director and Ania Valério, Co-Founder and Managing Director, to explain the technology, its industrial performance and why practical adoption matters more than sustainability slogans.

Isabel Matola, Founder & Managing Director, Aura Verde

Ania Valério, Co-Founder & Managing Director, Aura Verde

CHEManager: What did you observe in practice that motivated you to develop a new type of oil absorbent?

Isabel Matola: I have worked in industrial and environmental sectors for more than 20 years, and oil and fuel spills have always been a recurring operational issue. Over time, I experimented with different natural materials, particularly coconut by-products, and was consistently impressed by how many functional applications can be derived from the coconut. The breakthrough came when peat moss was banned in parts of Southern Africa, which accelerated the search for a biological alternative that could perform reliably under industrial conditions.

Mineral-based absorbents have been used for decades. From your perspective, where do their limitations become most visible in operations?

Ania Valério: Mineral absorbents are effective, but they also introduce secondary challenges. They can generate dust, leave visible residues and significantly increase disposal volumes once saturated. In routine spill control, this affects housekeeping standards and worker comfort. From an environmental and compliance perspective, many operators are also increasingly uncomfortable with relying on mined materials for a task that occurs every day.

Aura Verde uses coco peat as a base material. What makes it technically suitable as an absorbent?

I. Matola: Coco peat is a by-product of the coconut industry that is often treated as waste. When properly processed, it becomes highly oleophilic and offers a large surface area for oil absorption. By using this material, we are not only creating an effective industrial absorbent but also valorizing an existing waste stream. Avoiding open burning of husks is an additional environmental benefit, although our primary focus remains performance and reliability in spill response.

What operational benefits do customers typically notice first when switching to an organic oil absorbent?

A. Valério: Handling and cleanliness are often mentioned first. The material is easier to spread and sweep, with less visible residue left behind. This leads to cleaner work areas and less time spent on final cleanup. Many customers also notice reduced disposal volumes, which simplifies waste handling and documentation.

Sustainability and ESG requirements are increasingly influencing procurement decisions. How do you position your absorbents in this context?

I. Matola: We do not position our products as a sustainability initiative first. The starting point is operational performance. The fact that the absorbent is made from a renewable by-product and helps reduce reliance on mined materials supports ESG objectives as a secondary benefit. This makes it easier for companies to demonstrate credible improvements without changing established procedures or increasing operational risk.

Where do you see the strongest demand for your products?

A. Valério: Most customers start with routine maintenance. Small, frequent spills under machinery, generators or vehicles create constant workload and cost. Once teams are familiar with the material in daily use, it is often expanded into spill kits and emergency response applications. This gradual adoption reflects how industrial operations typically evaluate new materials.

What feedback have you received from industrial users?

I. Matola: During field trials and early deployments, feedback has been very practical. In one oil-on-water application, an industrial operator described the performance of Eco Max Pro as impressive, particularly in terms of rapid uptake and handling. The material has also been used in real spill situations, including a diesel cleanup in the Umbelevi River, which helped validate its behavior outside controlled conditions.

Looking ahead, how do you see the role of bio-based absorbents evolving in industrial spill management over the next few years?

A. Valério: We believe that bio-based absorbents will increasingly be seen as a standard option rather than a niche alternative. As companies face growing pressure around waste reduction, ESG reporting and supply chain transparency, materials that combine operational reliability with a lower footprint will gain relevance. The key will be proving performance consistently in real industrial environments.

Personal Profiles

Isabel Matola is Founder and Managing Director of Aura Verde. With more than 20 years of experience in industrial and environmental sectors, she has focused on developing practical, bio-based solutions for real-world operations. She led the development of Aura Verde's co-co-based oil absorbents, combining operational performance with circular use of agricultural by-products.

Ania Valério is Co-Founder and Managing Director of Aura Verde. She oversees product development, operations and customer integration, working closely with industrial users to ensure reliable performance in daily and emergency spill response. Her work focuses on scaling bio-based absorbent technologies while meeting industrial handling, safety and compliance requirements.

Business Idea

Organic Oil Absorbents from Coconut By-products

Oil and fuel spills are a routine challenge across industrial operations, including ports, workshops, mining sites, logistics facilities and energy infrastructure. While mineral-based absorbents remain the industry standard, they often introduce secondary issues such as dust, visible residue, high disposal volumes and dependence on mined raw materials.

Aura Verde has developed a portfolio of organic, coco-based oil absorbents designed as a drop-in alternative for professional spill response. The technology is based on coco peat, a by-product of the coconut industry that is frequently burned or discarded. When properly processed, coco peat becomes highly oleophilic, offering rapid uptake of oils and hydrocarbons while remaining plant-based and mineral-free.

The absorbents are engineered for different operational requirements. Eco Max Pro is optimized for emergency response and oil-on-water situations, achieving absorption rates of approximately 8–10 times its own weight while remaining buoyant and oil-selective. Eco Balance is designed for daily industrial spill control on concrete, metal and soil, with absorption rates of around 6–7 times its weight and low-dust handling. Eco Base provides a cost-effective solution for high-volume applications, absorbing approximately 4–5 times its weight and covering large areas efficiently.

Aura Verde's absorbents are fully compatible with existing spill response procedures and equipment, requiring no changes to training or workflows. This allows industrial users to improve housekeeping, reduce cleanup time and simplify disposal handling without operational compromise. In addition to performance benefits, the use of a renewable agricultural by-product supports circular economy principles by valorizing waste streams and reducing reliance on mineral-based materials.

The solution is already being applied in routine maintenance, spill kits and emergency response scenarios, demonstrating that bio-based absorbents can meet industrial performance expectations while contributing to more credible environmental and ESG outcomes.

■ Aura Verde LDA, Inhambane, Mozambique
www.auraverde.com • www.cocopeat.organic

Elevator Pitch

Milestones and Roadmap

The Inhambane, Mozambique-based start-up firm Aura Verde develops organic, coco-based oil absorbents for professional spill response in industrial environments. The solution addresses a daily operational challenge by combining reliable absorption performance with the circular use of agricultural by-products. Designed as a drop-in alternative to mineral absorbents, Aura Verde's products integrate seamlessly into existing spill response procedures without requiring process changes.

The company's development approach is grounded in field testing and gradual adoption. Most customers begin with routine maintenance applications and expand usage to spill kits and emergency response once performance is validated under real operating conditions. This step-by-step integration reflects the risk-aware nature of industrial procurement and HSE decision-making.

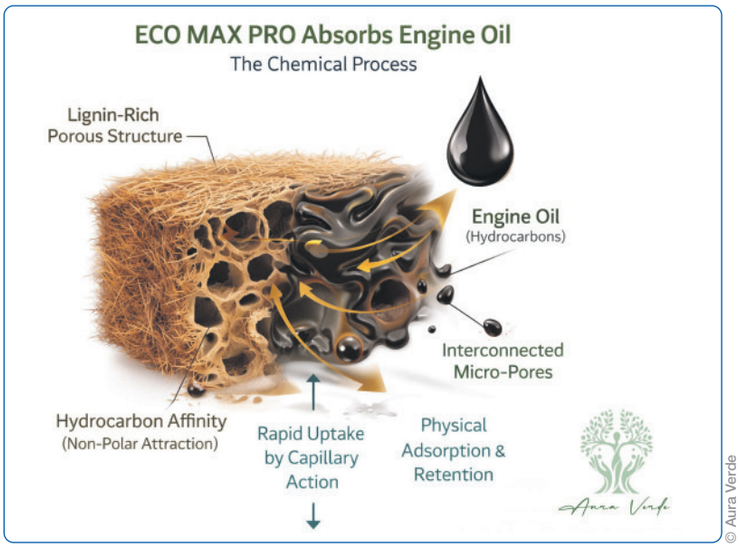
By valorizing coco peat that would otherwise be burned or discarded, Aura Verde supports circular economy principles while maintaining a strong focus on operational reliability, handling safety and compliance. The roadmap prioritizes scalable supply, product standardization and broader integration into industrial spill management systems.

Milestones

- Early experimentation: Evaluation of coconut by-products for oil absorption performance
- Product development: Formulation of graded absorbents for routine, emergency and oil-on-water use
- Field validation: Trials with industrial users in maintenance and spill response scenarios
- Portfolio launch: Introduction of Eco Max Pro, Eco Balance and Eco Base

Roadmap

- Scaling supply: Expansion of production and bulk packaging options for industrial users
- Market integration: Increased adoption in spill kits, ports, logistics and energy operations
- Product formats: Further development of socks, booms and pillows for storm-water and emergency control
- Partnerships: Private-label and reseller programs for regional and international markets



Coco peat is ideal for oil, fuel, chemical or grease spills in industrial, automotive or marine environments and water-repellent.

Biodegradable spill cleanup made from coco peat is a lightweight, fast-acting solution made from processed coconut husks.

Atomistic AI for Materials Engineering

AI-Driven Chemistry & Materials Discovery Focusing on Surface Reactions and Lab Proofpoint

Materials underpin every modern technology, yet R&D is still constrained by human bandwidth: too many possible formulations, too much scattered information, and too many objectives to optimize at once, with limited access to rapid experimentation. Entalpic built a materials discovery platform that integrates AI models, automated quantum simulation workflows, and experimental validation. CHEManager spoke with Alexandre Duval, CSO and co-founder, about turning AI insights into deployable materials.

© Entalpic

Alexandre Duval,
Co-Founder and CSO, Entalpic

CHEManager: What is Entalpic's core idea in one sentence?

Alexandre Duval: We replace trial-and-error materials R&D with an AI closed-loop discovery engine that turns millions of candidates into a few lab-validated materials, ready for industrial deployment.

What makes R&D for materials discovery so slow in the chemical industry?

A. Duval: Materials R&D is slow because chemists rely on human intuition to find a new material within an infinite search space, using slow, expensive, and often hard to reproduce lab experiments to validate their hypotheses. On top of that, teams need to optimize for multiple desirable properties under many constraints, accounting for years of prior research, which makes progress hard to scale without better tools.

Many companies claim "AI for materials." What is different about your approach, and what chemistries do you focus on?

A. Duval: There are broadly two approaches. Some teams start from the lab and use AI to support existing workflows. Others, like Entalpic, are AI-first: we design the discovery strategy computationally and use experiments to validate and refine it. Our differentiation lies in atomic-scale engineering and high-throughput quantum screening, tightly coupled to real experimental constraints. Rather than building a generic SaaS platform, we adapt models to each partner's chemical space, often training or fine-tuning on their data. We focus on surface-driven chemistries where simulation-to-lab translation is critical: semiconductors, catalysis, batteries, and especially molecules–surface interactions. We rely on best-in-class tools (DFT, quantum chemistry engines, materials libraries), but innovate in generative search, automated computational workflows, and proprietary databases that improve performance in our target domains.

What are the biggest challenges in the field?

A. Duval: The central challenge is bridging simulations to reality. That starts with correspondence: ensuring predicted 3D structures can actually be synthesized, reproduced, and characterized in the lab. But it also means learning the mapping between what a model predicts and what experiments truly measure. Without that feedback loop, you cannot reliably improve the models or build a fine-grained understanding of what drives performance. The second challenge is scaling: translating lab-scale wins into processes that meet industrial constraints on cost, manufacturability, and operating conditions.

> *"We design the discovery strategy computationally and use experiments to validate and refine it. Our differentiation lies in atomic-scale engineering and high-throughput quantum screening, tightly coupled to real experimental constraints."*
>
> Alexandre Duval, Co-Founder and CSO, Entalpic

How do you ensure predictions translate to the lab?

A. Duval: We build high-throughput, high-quality pipelines that tightly map what we simulate to what we can actually manufacture. On the lab side, we rely on advanced characterization to measure what matters and close the loop. For example in catalysis, TEM workflows let us precisely extract nanoparticle size distributions, phase, composition, and shape. This helps us quantify the gap between predictions and reality and continuously refine the models and screening criteria.

Where are you applying this today in the energy transition?

A. Duval: Three areas: (1) catalysis, to optimize reactions and reduce temperature and emissions, such as ammonia cracking for hydrogen; (2) batteries, to improve electrochemical performance while reducing reliance on critical materials; and (3) semiconductors, to enable smaller, more energy-efficient chips.

What should industrial partners expect from Entalpic in the next 12 to 24 months?

A. Duval: Two types of outcomes. First, reusable models and tools tailored to their domain, so their teams can accelerate internal R&D cycles and make faster, more confident decisions. Second, high-value discoveries, including new materials and catalysts generated through our internal research, that partners can license, scale, and deploy.

What is your preferred way of collaborating with industrial partners?

A. Duval: We typically begin with focused, goal-driven collaborations designed to deliver measurable impact. These engagements provide proof of value: a model tailored to the partner's chemical space, an automated screening workflow, or a prioritized list of candidates ready for experimental validation. Our objective is not only to generate results, but to transfer know-how and strengthen internal R&D autonomy. As our internal discovery programs advance, we will also develop patentable IP and offer licensing pathways for partners to industrialize new materials and catalysts.

Personal Profile

Alexandre Duval is Co-founder and Chief Science Officer at Entalpic. Trained in Mathematics (University of Warwick) and AI (CentraleSupélec), he earned a PhD in Machine Learning with CentraleSupélec and Inria. At Mila, mentored by Yoshua Bengio and David Rolnick, he built GNNs and generative models for materials and catalyst discovery. After working on action LLMs for Alexa at Amazon, he co-founded Entalpic to bring AI-native materials R&D into industry. He now leads its scientific vision, including open initiatives like LeMaterial, launched with Hugging Face to foster research in the field.

BUSINESS IDEA

AI Materials Discovery Engine

Materials innovation is a bottleneck for the energy transition and for competitive specialty chemicals. Breakthroughs in catalysts, battery materials and advanced materials can have a direct impact on energy efficiency, emissions and supply-chain resistance. Yet most materials R&D still runs on slow trial-and-error, weeks of synthesis and testing for each idea, with fragmented data and limited transferability between projects.

Entalpic restructures this process into an integrated computational–experimental discovery framework. The platform explores large design spaces digitally, prioritizes experimentally viable candidates, and continuously refines recommendations through simulation and laboratory feedback. For industrial teams, this translates into fewer unnecessary experiments, faster go/no-go decisions, and improved R&D productivity.

Entalpic collaborates closely with experimental partners (eg. high-throughput catalysis and battery testing) to validate candidates rapidly and is expanding in-house experimental capabilities to further shorten iteration cycles. Its models combine predictive analytics, controlled generative design, and targeted quantum-chemistry simulations to ensure recommendations remain physically grounded and aligned with industrial constraints such as stability, cost, and manufacturability.

The company's scientific focus is atomic-scale surface engineering, with applications in catalysis, batteries and semiconductors, domains where improved interface control directly translates into performance gains, energy savings and more sustainable industrial processes.

By transforming materials discovery into a closed-loop, data-driven process, Entalpic enables industrial partners to reduce development timelines and experimental costs. The platform integrates directly with existing R&D workflows, allowing teams to focus resources on the most promising candidates and accelerate the path from concept to scalable material.

■ Entalpic, Paris, France
entalpic.ai

ENTALPIC

ELEVATOR PITCH

Closed-Loop Materials AI

Entalpic develops an AI platform that helps industrial teams discover better materials faster. By combining advanced machine learning with physics-based simulations, the platform narrows vast chemical spaces to a set of experimentally viable candidates, shortening development cycles and increasing R&D hit rates.

The company originated from fundamental research at Mila and was founded in 2024 in Paris. Since then, it has built a 25-person multidisciplinary team and secured €8.5M in seed funding to industrialize its technology. The company operates at the intersection of computation and experimentation, validating results through high-throughput experimental partners, while expanding its in-house laboratory capabilities.

Entalpic focuses on atomic-scale surface engineering, with applications in catalysis, batteries, and semiconductors. Its ambition is to make industrial materials R&D more predictable, scalable, and capital-efficient.

Milestones

2022-2024
- Fundamental research on the AI platform at Mila

Spring 2024
- Entalpic founded

Summer 2024
- Seed funding round (€8.5M)

November 2024
- Station F Future-40 startups

Early 2025
- Core team scaled to 15
- First partnership signed with OCP Group (SPS unit)
- Partnership with REALCAT (Centrale Lille, high-throughput catalysis)

November 2025
- Joined French Tech 2030

January 2026
- First synthesis in lab of AI generated materials
- Joined France DeepTech
- Named one of WIRED's Top 100 startups of 2025

Roadmap
- Deliver measurable outcomes with signed industrial partnerships.
- Scale and structure in-house experimental capabilities.
- Strengthen and industrialize high-throughput screening pipelines.
- Build and expand a strategic IP portfolio.

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Entalpic's founders at Station F: Victor Schmidt (CTO), Mathieu Galtier (CEO), and Alexandre Duval (CSO)

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Entalpic's core team consists of forward-thinking scientific explorers, deeply rooted in AI expertise. Team members are machine learning, chemistry and materials experts, more than half of which with a PhD degree.

Chemspec Europe

Chemspec Europe 2026 takes place May 6-7, 2026, in Cologne, bringing together the international fine and specialty chemicals community for two dynamic days of business, knowledge sharing, and networking. The event features a comprehensive exhibition showcasing the entire spectrum of fine and specialty chemicals—from raw materials and custom synthesis to related services—alongside a first-rate conference program that delivers insights into market trends, regulatory developments, and innovative R&D projects across key industries.

■ www.chemspeceurope.com

ChemUK

ChemUK 2026 takes place May 20-21, 2026, at the NEC in Birmingham, uniting the UK chemical, process engineering, and formulated product industries for two dynamic days of business, knowledge sharing, and networking. The event features 600+ specialist exhibitors and 100+ expert speaker sessions across five focused zones—covering chemicals supply, management, process engineering, laboratory solutions, and formulated product manufacture—to showcase innovations in supply chains, R&D, compliance, and manufacturing.

■ www.chemicalukexpo.com

Specialty & Agro Chemicals America

Specialty & Agro Chemicals America 2026 takes place June 15-18, 2026, at the Savannah Convention Center in Savannah, Georgia, uniting professionals in specialty and agrochemical manufacturing, technologies, and services. The event features an expansive exhibition, general sessions on global trade trends, supply chain outlooks, and supplier vetting, plus exhibitor presentations, private meetings, and networking receptions to drive collaboration and business growth. The 2+ day networking forum features an exhibition, supplier showcases, and conference presentations.

■ chemicalsamerica.com

Pharmap

The Pharmaceutical Manufacturing & Packaging Congress (Pharmap) 2026 takes place April 20-21, 2026, at Van der Valk Hotel Schiphol in Amsterdam, bringing together over 300 decision-makers from pharmaceutical companies, CMOs, CDMOs, and service providers for two days of closed-door networking, case studies, and discussions. The congress features an executive opening panel, sessions on innovative packaging solutions, supply chain leadership, digitalization in manufacturing, sustainability initiatives, and trends in pharma outsourcing and contract manufacturing.

■ www.pharmap-congress.com

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