chemstars

THE CHEMSTARS PORTFOLIO

5 Years of Startup Support

Current Partners

Funded by:
Ministry of Economic Affairs, Industry, Climate Action and Energy of the State of North Rhine-Westphalia

Supported by:
Federal Ministry for Economic Affairs and Energy
on the basis of a decision by the German Bundestag

The chemstars ecosystem

The European chemical industry is undergoing a structural transition. For over a century, the industry has been optimized for a steady-state regime of stable energy and guaranteed supply chains. **Today, that equilibrium has vanished.** Energy volatility, tightening regulation, and geopolitical instability are transitioning the industry from a century of stable optimization into a new era where adaptability is the primary competitive advantage. While incumbent innovation architectures are masterpieces of scale and reliability, the current climate requires a parallel layer of agility and resilience.

We recognize that **startups are playing an indispensable role in managing this inflection point**. By mobilizing venture capital and public funds, these agile teams reduce the risk profile of new technologies and achieve development speeds that incumbent cycles cannot reach. But startup teams cannot do it alone, they need to interface with existing infrastructure, knowledge, and supply chains in order to scale.

This report is designed for chemical industry stakeholders including **founders, industry veterans, investors, policy-makers, and academics**, serving as an entry point and a navigation tool to understand how chemistry startups within and across interconnected innovation verticals are driving the transformation of the chemical industry.

We can use the framework of an innovation funnel to conceptualize how ideas are filtered and refined to become market ready products, with startups being the agents that carry ideas in to, out of, and through the funnel. At chemstars, our role is to widen the innovation funnel from top to bottom by making the chemical industry and its resources more transparent and accessible to up-and-coming teams. By providing the network and know-how to ambitious founders, we accelerate the translation of deployable technologies into a deeply entrenched industrial system. **The chemstars portfolio reflects a reconfiguration of the entire value chain.**

Incremental change is no longer sufficient; the industry requires a series of disruptive innovations that reshape infrastructure and value chains. This ecosystem map is a blueprint for a more resilient, adaptive, and sustainable chemical industry.

We invite you to join us in shaping this next generation of chemical innovation.

Chemical Manufacturing

Deployment of novel platform technologies that utilize the next generation of circular and carbon neutral feedstocks.

Support Services

Leveraging AI, machine learning, and advanced hardware to translate vast seas of industrial data into operational productivity.

Energy Management

Driving green electrification and heat recovery to stabilize costs and abate emissions in an era of consistent supply volatility.

Carbon Capture

Transitioning from lab demonstration to industrial deployment, fueled by new regulatory frameworks and infrastructure.

Polymer Recycling

Scaling chemical recycling to bridge the gaps in mechanical processes and provide alternatives to virgin petrochemical feedstocks.

Water Treatment & Material Recovery

Turning compliance into a value stream by recovering critical raw materials (CRMs) from wastewater.

The road so far

Over the last four years, chemstars has provided network and know-how to ambitious teams daring to take on the toughest problems facing the chemical industry. At the time of writing, **78 teams over 15 cohorts** have made their way through our support program. Together, they have raised **more than a quarter of a billion Euros**. These alumni represent the European effort to make chemistry cleaner, safer, cheaper, and more resilient than ever before.

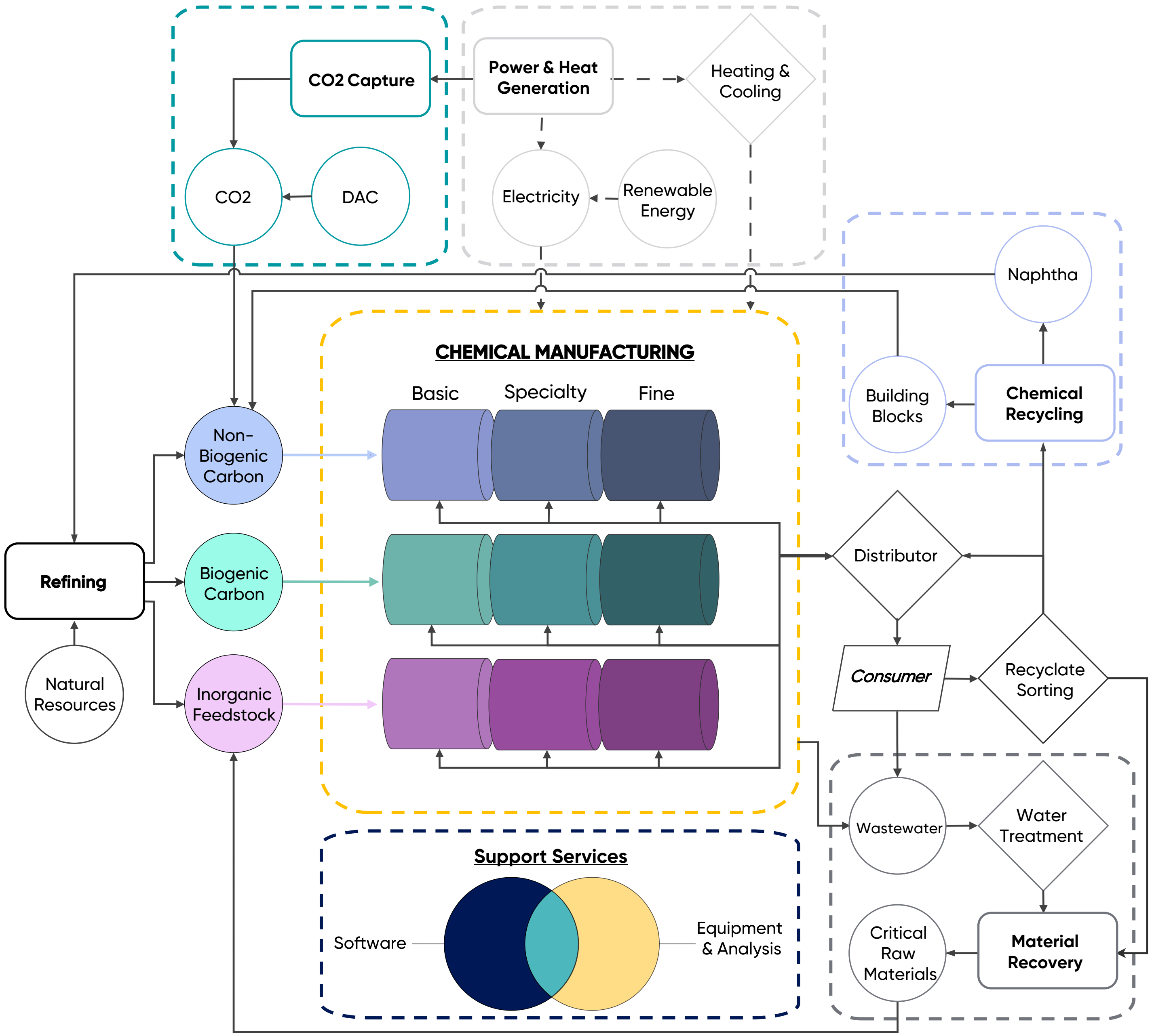
The challenge in the chemical industry is balancing today's massive, optimized scale with the radical innovation required for tomorrow. While many incumbents are already exploring new models to overcome the systemic lock-in effects that favor incremental gains over high-payout R&D, the sheer complexity of these interconnections can slow the pace of transformation. At this stage, the goal is to shift from merely buying time through efficiency toward more aggressive competitive leaps. By building on the groundwork already laid by industry leaders, we can help accelerate this evolution, ensuring that regional product performance stays well ahead of international price pressures.

Startups provide a solution that allows for the sharing of risk among multiple stakeholders, decreasing the burden on chemical industry incumbents. They bring the best and brightest from academic labs and transform ideas into deployable technologies. **By mobilizing public funds and venture capital, startups significantly expand the traditional R&D investment base of established companies.** Their agility and development speed bring value to the industry that incumbent development cycles cannot match.

But still, building a startup is a monumental task and founders need all the help they can get. The chemstars ecosystem is a comprehensively integrated network of founders, industry veterans, investors, policymakers, and academics. Individually, each personal and organizational node in the chemstars network brings a distinct skillset and knowledgebase to the table. Together, **the chemstars ecosystem is a profound force for the collective advancement of European chemical innovation**.

chemstars advises startups working on innovations that interface with every point in the chemical value chain. The flowchart that accompanies this article is a navigation tool for chemical industry stakeholders to understand how different innovation verticals connect, reinforce each other, and drive industrial transformation together. Keep reading to understand more about how we view the interconnected layers of the chemistry start up ecosystem and how it interfaces with existing chemical industry infrastructure.

The chemstars portfolio at a glance



Chemical Manufacturing

	Basic	Specialty	Fine
Non-Biogenic Carbon	D-CRBN, DAHLIA BIOTECH, enaDyne, oxylum, spark	Excellence Coatings, NANOLOOM, POWER2POLYMERS, pure additives, TENO, TEXTERIAL	CYNIO, SIXONIA, WESTRA
Biogenic Carbon		A&B Smart Materials, Biophelion, Biotreasure, carbon cell, CIYANO, LIGARO, SAGES, SIMPLYFINED	BIOWEG, LipiTune, NorFalk, lifebloom, mycoLever, PureSurf
Inorganic Feedstock	CENTEON, Direct Matter, ionysis	alteva, CeraSleeve, IONKRAFT	ELYTE, Level Nine., MechSyn

Energy Management

blue activity, HyperHeat, REGASCOLD, RIZM, SolidWatts

Carbon Capture

Black Capture, UCANEO

Water Treatment & Material Recovery

Water Treatment: microbubbles, nerou, Porelio

Material Recovery: aeonus technology, Amovion, naiontech, retein

Support Services

Software: akeno, juna.ai, New Wave Biotech, Sybilion, tulanā

Equipment & Analysis: BIOTHRUST, DNTOX, SOLARFOIL, xemx

Hybrid: findiQ, MRS, NXT SPECTRA

Polymer Recycling

Chemical Recycling: REVOLOOP, AKIN, cyclize, eeden, Plastic Back, PolymerActive, Radical Dot, re.solution, SECARA

Recycle Facilitation: Circulania, RESYCURE

Chemical Manufacturing

Chemical manufacturing is the engine of the industry, converting raw materials into intermediates and intermediates into the finished products that underpin modern life. Every polymer, solvent, fertilizer, coating, pharmaceutical, and specialty material is created through a sequence of reactions, separations, and refinements.

For more than a century, Europe's chemical industry has optimized these transformations into one of the most efficient industrial systems ever built. German chemical parks are the pinnacle of this optimization. The plants on chemical park grounds are integrated at the most fundamental level. Furthermore, each one is interconnected by rail, river, and pipeline networks. **The Verbund principle** ensures that material and energy byproducts from one process become the inputs for another, minimizing waste, capital intensity, and inefficiency.

That system achieved extraordinary scale and stability. But it was optimized for a steady state where reliable energy supplies and supply chains are all but guaranteed. **Today, that equilibrium is no more.** Chemical product overcapacities from China have depressed prices and slashed margins. Feedstock security, energy volatility, regulatory pressure, and geopolitical risk are reshaping how manufacturing systems must be designed. Chemical manufacturing startups are the vanguard to develop the next generation of systems.

Manufacturer Classification

New ventures seeking to innovate in the chemical manufacturing space must solve the same fundamental equation as any other chemical process: **the material balance**. What goes in and what goes out, feedstock and product, have cascading effects on everything else about a venture. The core technology, business model, scaling strategy, capital requirements, and industry partnerships all derive from these two variables. For classifying the chemstars portfolio, material balance decisions provide us with a **simple two-axis framework**.

What Goes In

On one side, we can look at what materials startups choose to feed into their process. Many ventures that have gone through the chemstars support program have circularity or resilience as a part of their unique value proposition. They do so by keeping carbon and other raw materials in the loop, decreasing reliance on imports. The integration of these new feedstock streams is therefore essential for our system map. To accommodate new feedstock streams, we cluster our startups into three different feedstock categories: non-biogenic carbon, biogenic carbon, and inorganic feedstocks.

Non-biogenic carbon feedstocks are traditionally derived from fossil sources like **oil and natural gas**. These materials remain central to the chemical industry, but the logic of carbon sourcing is changing. Some ventures still use conventional hydrocarbons for advanced materials. Others replace fossil inputs entirely through CO_2 conversion technologies, producing hydrocarbons from **captured carbon**. Chemically recycled monomers also enter this stream as drop-in carbon sources, allowing circular materials to integrate directly into existing production systems.

Biogenic carbon feedstocks are typically those that are grown or obtained as byproducts from other processes. Materials derived from **food waste, plant oils, and agricultural residues** already contain molecular complexity, shifting innovation toward refining, separation, and functionalization rather than bulk synthesis. These pathways lend themselves to specialty and fine chemical markets, where product values are high and scale requirements are lower. In contrast, large-scale conversion of biological feedstocks into fuels and commodity chemicals remains structurally constrained by energy intensity and economics, particularly in Europe.

The third and final input class is the **inorganic feedstocks**. These are non-carbon inputs including **gases** such as hydrogen and nitrogen, and **materials** derived from minerals like metals, acids, bases, and salts. These resources supply critical sectors such as energy storage, electronics, semiconductor manufacturing, and agriculture. Increasingly, they are shaped not only by environmental constraints but by geopolitical and supply-chain risk.

What Comes Out

On the other axis we can consider the continuum from **basic** to **specialty** and on to **fine chemical** products. Each of these represents a different balance of scale and value. Basic chemicals are commodity products that command massive volumes and are often used as feedstocks to make more complex compounds and formulations. At the other extreme, fine chemicals are characterized by high value, high purity, and low volumes. Typically going into pharmaceutical, cosmetic, and food products, fine chemicals are often more sophisticated materials. They can face considerable quality and regulatory requirements but command high prices. Specialty compounds land somewhere in the middle. Adhesives, polymers, surfactants, and coatings that are used for specific industrial applications land here.

Chemical product class has profound consequences for the specific scaling strategy of a venture. Startups targeting commodity materials often depend on integration with incumbents, where drop-in compatibility and infrastructure access determine success. For those producing fine chemicals, focusing on optimization and purity, alongside higher performance and additional functionalities that translate to lower cost per use for downstream clients, may be a faster path to return on investment.

Our View

These dimensions form a simple matrix: three product categories and three feedstock types, producing nine manufacturing archetypes. This framework offers a structured way to understand how chemical manufacturing innovation is emerging across the chemstars ecosystem.

Reality, of course, is more complex. Industrial systems are not linear. Multiple feedstocks, processes, and products coexist behind the same gates. Value chains overlap, loop, and interconnect. **Incumbents, startups, distributors, formulators, and end users interact across dense industrial networks**. As a systems lens and an entry point, this framework provides a map of how chemical manufacturing innovation is evolving as a reconfiguration of inputs, processes, and outputs, but anyone interacting with the industry will know that there is boundless nuance to take into account. Startups entering this space must break into a deeply entrenched network where every change to the status quo has knock-on effects that cascade up, down, and sideways through connected processes. The Verbund systems that make up the German chemical industry mean that **side-streams and waste from one process become the feedstocks for another**. Energy and logistics too are enmeshed, creating a comprehensive network that prohibitively expensive to unwind. This is a heavy weight on the decision balance of the incumbent organizations that are the most promising potential clients or partners.

To tilt the scales in favor of a business relationship with incumbent players, startups need to bring solutions that integrate with existing infrastructure. Startups producing drop-in products that are chemically identical to existing materials streams are well positioned for this reason.

For those who are making altogether new products with improved properties, it is not enough to make a single compound more sustainable, with better performance, or even more cheaply. A single new product or process is often simply a nuisance in such an interconnected system.

Successful teams bring platform technologies to market that can produce whole families of products. **Bioweg** is a clear example of the power of this strategy, having recently raised a **€16M Series A round** to build their new production facility. Their technology has enabled them to penetrate cosmetic, home care, and agriculture technology markets, replacing fossil-based, microplastic generating polymer compounds with their bio-based cellulose solutions.

In the coming years, **regulatory pressure and volatile supply chains** will continue to incentivize both organic and inorganic circular feedstocks. Ventures can take advantage of these pressures by exploiting unused waste streams to replace broad categories of conventionally derived products. In doing so, they must show a clear path to cost parity with conventional chemical families. This goes for both novel compounds and drop-in molecules.

Support Services

The complex operations behind chemical manufacturing rely on a wide range of logistical, operational, technical, and equipment services. To **avoid diverting resources from core production activities**, chemical companies frequently rely on specialized third-party providers to supply these capabilities.

Across the chemstars ecosystem, support service startups contribute tools and expertise that strengthen critical functions without requiring incumbents to build these systems in house. Advanced software and hardware solutions provide targeted improvements in research, operations, and analysis.

Software, hardware, hybrid

Artificial intelligence and machine learning (AI/ML) have enabled a new class of products that can process large volumes of industrial data and translate them into practical operational insights. These tools are applied across a broad range of use cases, from materials discovery and R&D to plant level optimization, process control, maintenance planning, and procurement.

Alongside software ventures, hardware focused startups develop new analytical equipment, materials, and process technologies that deliver bespoke solutions for industrial clients. These services are typically deployed as focused interventions, providing specific capabilities without restructuring entire production systems.

Combining hardware and software advancements yields new, integrated approaches for reducing equipment downtime, stabilizing quality, and monitoring performance.

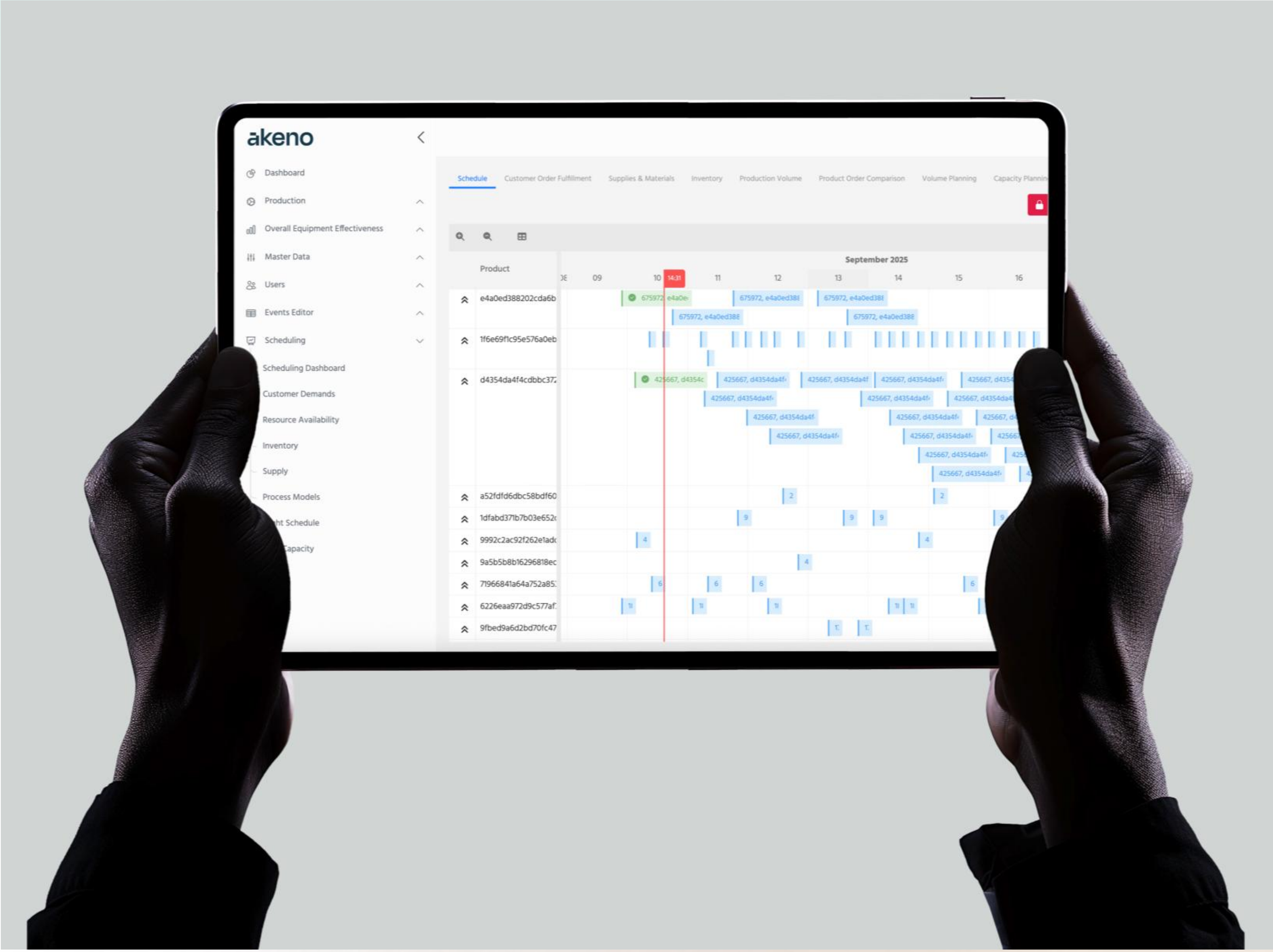
Within the ecosystem map, support services do not function as a standalone sector. They operate across the value chain, enabling operators and innovators to focus on what they do best.

chemstars

Our View

The AI/ML wave has produced a cohort of startups that are testing where and how large-language models (LLMs) and machine learning can be best leveraged to improve industry productivity.

As the initial hype begins to die down, we are starting to be able to see where these technologies can be most successful. **Akeno** is a model case for how cutting-edge software can work in the chemical industry. Their automated production planning and scheduling platform has been proven in collaboration with high-profile clients like BASF Coatings and Sun Chemical. With its software already running in Europe, Asia, and North America, akeno's expansion is imminent. Akeno's solution works because it handles the enormous amount of data produced by large industrial companies and autonomously executes on it, allowing clients to shift their focus from manual operational oversight to more strategic priorities.



Sourcing and structuring high-quality industrial data will remain a primary growth driver for digital support ventures. The limiting factor is not model capability but data quality. Much of the existing data in industry is unstructured and unlabeled, and has been generated in such limiting its usability for model training. The right balance between simulation, legacy datasets, and newly generated data must be struck to create value.

This constraint is even more pronounced in materials discovery. Models depend on experimental data that is both well-documented and reproducible, yet much of the scientific literature fails on both counts. Simulated data can help fill gaps and accelerate iteration, but its value is limited by how closely it reflects real-world operating conditions, and empirical validation isn't going anywhere anytime soon. As a result, companies must invest in generating or validating their own datasets to achieve reliable model performance.

Energy Management

The backbone of any chemical manufacturing process is the energy that drives material conversion and processing. In Europe, energy is not just a part of the infrastructure that makes these transformations possible, but also a major cost driver. In many cases, in fact, **energy is *the* cost driver that determines margins**.

As of February 2026, European energy prices remain roughly double pre-2022 levels in the aftermath of COVID-19 and the Russian invasion of Ukraine.[1] Energy costs affect every single production step, from upstream refining to downstream separations. Several important energy-intensive processes to produce base chemicals have been especially affected. **Steam cracking of hydrocarbons, Haber-Bosch production of ammonia, and chlor-alkali electrolytic production of chlorine** are just a few examples with disruptive knock-on effects downstream.

[1]Eurostat, https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20260212-2

Efficiency & Electrification

In addition to cost pressures, energy use is also a key driver of CO_2 emissions. In the case of many German chemical parks, electricity is produced at an onsite power plant fired with either gas or coal, often co-generating heat in the form of steam. Increasingly, electricity is being supplemented with renewable sources such as wind and solar. However, intermittency, grid constraints, and legacy process design limit how well it can be integrated. The guarantee of supply stability and the need for high-temperature steam are the two main reasons for the persistence of fossil combustion in the chemical industry.

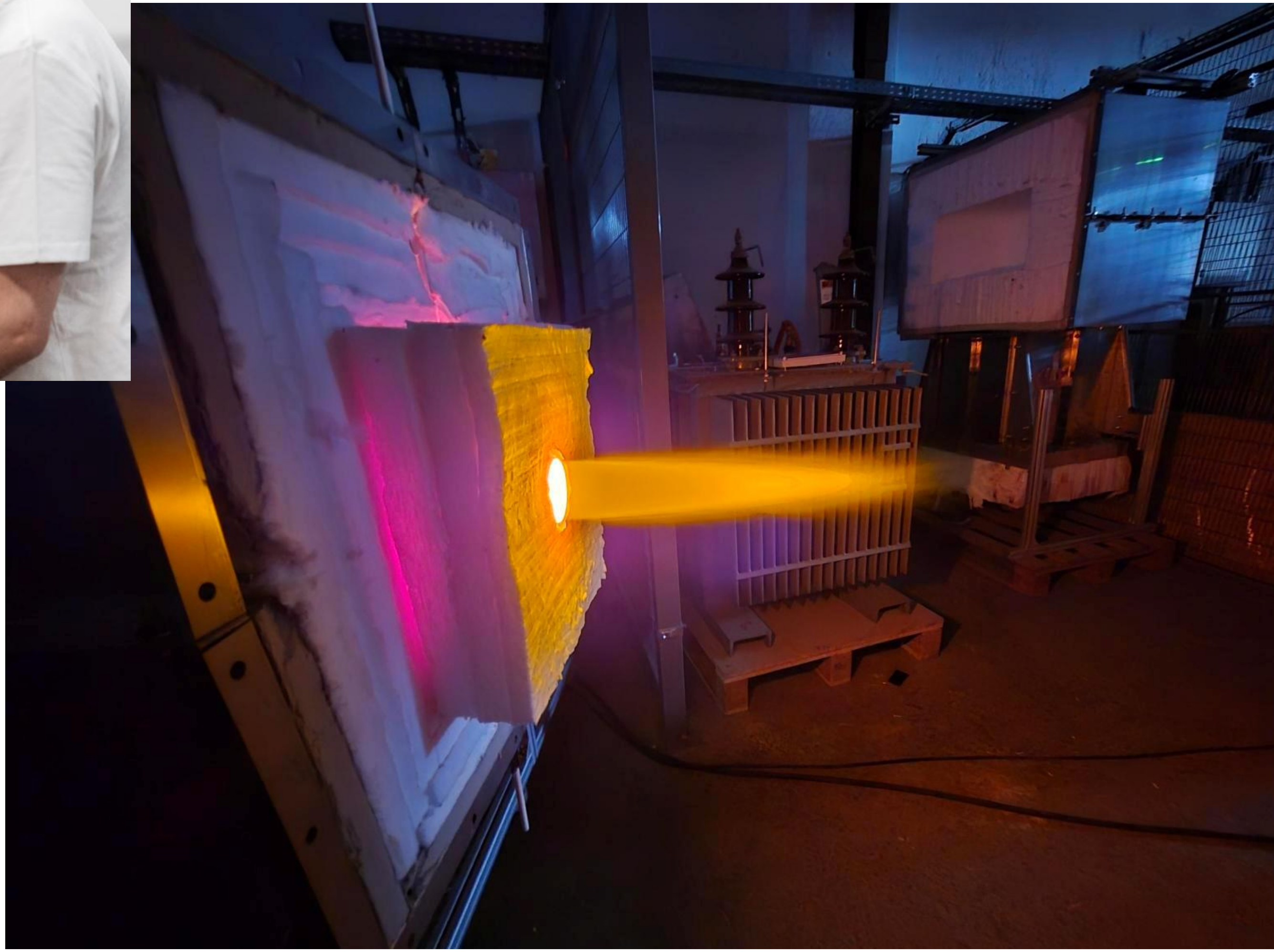
To push forward green electrification, startup technologies facilitate the **integration of intermittent renewables** into the power supply strategy of chemical plants and parks. Software solutions optimize procurement and load flexibility, and novel hardware electrifies existing processes. Together, these approaches stabilize electricity price volatility and reduce emissions intensity. Advances in battery technologies and other methods of energy storage promise to stabilize renewable electricity loads as well, though the manufacturing of these products at scale in Europe is still largely uncompetitive with current technologies.

Efficiency-focused startups **reduce energy consumption and decrease utilities costs**. Some new technologies cleverly recover unused heat gradients within a process; others enhance the efficiency of heat transfer within existing equipment to reduce energy waste. Because of the ubiquity of heat demand throughout the chemical industry, any incremental efficiency improvement can scale into considerable cost and emissions reductions.

Our View

Ventures looking at energy management in the European chemical industry need to be aware of the unique regional and sectoral circumstances. Although energy prices spiked in 2022, they have been higher in Germany than in other industrial nations since the 1990s. Longstanding energy related cost pressures mean that efficiency has been an incumbent priority for a long time, and opportunities for optimization, while still present, are hard to come by.

In fact, many of the most important technologies for circularity and green chemistry consume massive amounts of power. It is one of the main cost drivers that can prevent them from being competitive. By bridging the gap to provide a steady supply of green energy, ventures can both provide value to existing players and unlock new markets as circular value chains mature.



Technologies like high-temperature electric heaters from **HyperHeat** have cross-cutting impacts that can replace combustion in multiple hard-to-abate sectors. The heaters can be retrofitted into existing ovens and operated in parallel with conventional gas burners, enabling a seamless switch between energy sources while keeping costs to a minimum. As emissions standards tighten and renewable energy becomes increasingly cost-competitive, electrification technologies will continue to see a boost. Public funding for grid retrofitting and private data center investments provide additional markets and avenues for obtaining capital for ventures that focus on moving and integrating renewable electricity supplies at scale.

Carbon Capture

As a hard-to-abate sector, **the chemical industry faces a steep climb to achieve the EU's carbon neutrality targets**. Aggressive carbon pricing imposed by the EU's Emissions Trading System (ETS) adds additional pressure to cost of production, which is already stressed by high energy prices. The European Commission has recently signalled support for carbon capture and utilization (CCU) technologies to both abate emissions and increase the competitiveness of the European chemical industry. The European Chemicals Industry Action Plan, published in July 2025, identifies CCU as an essential technology for sourcing clean carbon to replace virgin fossil feedstocks.[2]

On a national level in Germany, the amended Carbon Dioxide Storage and Transport Act (Kohlendioxid-Speicherungs- und Transportgesetz, KSpTG) came into force in November 2025.[3] The new provisions present new methods for enabling carbon capture technologies. For the first time, CO2 storage is now permitted both offshore and onshore, with each Federal State having the choice on whether to opt-in. To support these new CO2 endpoints, a regulatory framework for CO2 transport infrastructure has also been put into place. These developments are critical because the CO2 emissions that are permanently stored or utilized are exempted from EU ETS certification as long as they do not originate from coal combustion. The scaling of efficient and economical carbon capture technologies therefore provides a much-needed route for **reducing regulation-driven emissions costs**.

Point-source and direct-air capture

To feed the nascent CO2 conversion technologies that enable utilization, advanced carbon capture technologies are needed to provide green CO2 feedstock. Point-source capture technologies provide essential separations that transform flue gases into high-quality CO2. Innovations for point capture focus on **selectivity and durability** to avoid expensive exhaust pretreatment steps. Energy efficiency is also a focus, as traditional carbon capture using liquid amine scrubbing requires high temperatures to strip the CO2 and regenerate the absorbing solution.

[2] Eurostat, https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20260212-2
[3] Bundesministerium der Justiz und für Verbraucherschutz, https://www.gesetze-im-internet.de/kspg/BJNR172610012.html

Also of emerging importance is Direct Air Capture (DAC). While currently only suitable for offsetting present day emissions, DAC technologies coupled with green energy sources strive to provide economic sources of green CO2 for conversion into basic chemical feedstocks. Although DAC is still in its infancy, with capture costs an order of magnitude higher than conventional biogenic sources, its development receives considerable support from public funding. In the long-term, point-source carbon capture alone is insufficient to reach net-zero 2050. Even on the most aggressive pathways, CO2 overshoot is now certain. **DAC has moved from "Nice-to-Have" to "Must-Have"** for developing circular carbon value chains.

Our View

Over €17 billion has been committed for developing carbon capture technologies in Europe.[4] Despite this, less than 5 Mt/a is currently deployed, just 10% of the EU's 2030 carbon capture target. Now, an additional wave of funding in the tens of billions of Euros is in the process of being rolled out. Why should we expect a return on this new investment?

While the initial wave of funding failed to produce large-scale products, it was never really intended to. The infrastructure and legal frameworks needed for meaningful CO2 logistics did not exist. What the initial wave of funding did succeed at was creating a technology base that is ready to be scaled.

Alongside the jump in tech readiness, the financial engine for these technologies has shifted. Major corporate players are no longer just observing; they are acting as anchor tenants for the carbon economy through massive offtake agreements. Large multinationals like Microsoft and Shell have already contracted tens of millions of tonnes of carbon removal to meet their 2030 net-negative goals. This influx of private capital provides a demand pull that was entirely absent during the first decade of development.

With the passage of the new KSpTG in Germany paving the way for meaningful CO2 logistics and pressure from the EU ETS mounting, there are solid tailwinds for both point-source and direct-air carbon capture. Technology maturation and economies of scale will further **push captured CO2 prices down** and synergize with greater deployment of utilization technologies.

[4] Oil Change International, https://oilchange.org/publications/mapping-the-money-behind-carbon-capture-public-subsidies-and-industry-ties/

Black Capture is a prime example of how start-ups are innovating for better CO_2 capture. Conventional liquid amine CO_2 sorbents require significant energy for regeneration, which is counterproductive when your goal is decarbonizing energy intensive processes. Liquid amines also break down over time, creating frequently recurring reagent costs. Black Capture's ceramic membranes require less energy to regenerate and are far more stable than liquid sorbent-based systems to make CO_2 capture financially accessible.

Polymer Recycling

At present, the vast majority of plastics recycling is done through mechanical means. Consumer waste is collected, cleaned, sorted, and crushed before being reintegrated with virgin polymer feedstocks to create new packaging and products. While mechanical recycling has done an admirable job of enabling the circularity of plastics, with a rate of 52% of plastic packaging being recycled in Germany in 2023, there are still major gaps that need to be addressed.[5] Many waste streams are **too dirty or too complex** to be properly sorted. At least 50% of collected plastic packaging is consequently incinerated, with another ~10% being exported to nations in the global south where enforcement of recycling practices is questionable at best. At the same time, the global demand for plastic packaging and products is higher than ever.

[5] Bundesministerium für Umwelt, Klimaschutz, Naturschutz, und nukleare Sicherheit, https://www.bundesumweltministerium.de/WS7321-1

The new EU Packaging and Packaging Waste Regulation (PPWR) is slated to replace the old Packaging Directive in August 2026. To harmonize national policy before the new EU regulation takes effect, the draft Packaging Act (VerpackDG) is under inter-ministerial review and will take effect before August 2026 when the old VerpackG is scheduled to be overridden by the PPWR. Although still in the draft form, the current bill includes a critical change from the previous policy: **chemically recycled waste will now count toward recycled content quotas**.[6] In the past, chemical recycling was discounted because of the high energy cost of the technologies involved (most often pyrolysis).

Combine increasing demand with ever climbing quotas for recycled materials, and the amount of waste that needs to be collected, sorted, and successfully reincorporated into new products will continue to rise. For those on the collection side, more robust technologies that can work with mixed and dirty waste streams enable them to more **cheaply recirculate difficult waste streams**. For those producing plastic products, **drop-in feedstocks** allow them to meet their obligations for recycled material content without having to do expensive retrofits.

In addition to circularity regulation pressure, plastics producers are also being stressed by energy and emissions pricing. The steam crackers that produce vital precursors for plastics (and many other organic compounds) from crude oil rely on high temperatures for operation. These temperatures are supplied by gas furnaces, which is why steam cracking is the number one source of emissions for the chemical industry. If more base chemicals can be sourced from circular processes, fewer fossil sources need to be used for both feedstock and energy.

An impressive roster of chemical recycling companies are pioneering new approaches to offer higher recyclate flexibility, contamination tolerance, and more mild reaction conditions. Teams are focusing on producing circular feedstocks that can re-enter the value chain at multiple points. Virgin-like monomers and re-refinable naphtha mixes are two examples. Other companies are unlocking value in new waste streams such as **textiles, tires, and end-of-life technical polymers**. Still more are introducing new chemistries to the plastics market to improve the recyclability of polymers from the start without changing the physical properties.

[6] Bundesministerium für Umwelt, Klimaschutz, Naturschutz, und nukleare Sicherheit, https://www.bundesumweltministerium.de/gesetz/gesetz-zur-anpassung-des-verpackungsrechts-und-anderer-rechtsbereiche-an-die-verordnung-eu-2025-40

Our View

Because of the pressures from emissions and circularity regulations, energy prices, and geopolitical instability, chemical recycling has been a major focus across the industry in recent years. A comparatively large cohort of startups have taken a shot at the problem, with varying levels of success. The ventures that have scaled the fastest target either very difficult to separate, or very niche waste streams and produce drop-in products that facilitate adoption.

The next test for growth is how these ventures will be able to scale **beyond their initial geographic markets**. German recycling startups benefit from some of the most advanced collection and sorting infrastructure in the world. But to scale internationally, startups need to deal with not just less developed infrastructure, but also disparate regulatory frameworks, circularity targets, and sorting practices.

A standout company in this space is **Radical Dot**, which has developed a low temperature catalytic process to convert mixed plastic waste into carboxylic acid and ester building blocks. Their success is in large part due to three factors. The first is feedstock resilience and versatility. They process mixed waste that allows them to cut sorting costs. The second a process that does not require external energy input, decoupling cost from energy prices. Finally, by producing fundamental building block chemicals, they can provide drop-in solutions to large markets where there is plenty of demand.

Wastewater Treatment & Material Recovery

Water is a foundational input to the chemical industry. It enables heat transfer, separation, cleaning, and process control across nearly every production step. For decades, abundant supply and predictable discharge pathways allowed water to remain a background utility.

Now, tightening environmental standards and increased scrutiny of industrial effluents are transforming water from an operational detail into a major constraint. At the same time, the prospect of recapturing valuable materials from these waste streams is more attractive than ever before.

Asset-light compliance

Regulatory focus has shifted decisively toward contaminants that challenge conventional treatment processes. **PFAS, microplastics, and genotoxins** are persistent, chemically diverse, and regulated at increasingly low thresholds. These materials do not behave like the bulk pollutants legacy wastewater infrastructure was designed to treat.

As a result, incremental upgrades to existing systems often fail to deliver compliance at acceptable cost. New solutions must be selective, modular, and retrofit-friendly. This gap has created space for startups developing novel adsorbents, membranes, physical separation techniques, and advanced sensing technologies that enable targeted intervention rather than brute-force treatment.

Once selective separation becomes viable, the boundary between wastewater treatment and resource recovery begins to dissolve. Industrial effluents routinely contain valuable ions and compounds, such as phosphorus, lithium, and other strategic raw materials, that have historically been lost due to dilution and processing costs. Supply chain risk, geopolitical concentration of mineral production, and new policy mandates are reframing wastewater streams as secondary resource reservoirs. Technologies that can recover materials economically at low concentrations align compliance with supply security.

Recapturing strategic value

The regulatory push for cleaner water intersects directly with Europe's growing concern over material security. The Critical Raw Materials Act mandates that EU member states supply a significant and growing share of strategic raw materials through recycling, reflecting not only environmental goals but also heightened geopolitical risk.

While battery recycling has scaled rapidly, conventional refining routes (typically pyro- or hydrometallurgical) remain energy-intensive and capital-heavy. These approaches only become economical at large scale, making them difficult to deploy flexibly across distributed or dilute streams. For many material classes, these approaches are never profitable.

This gap has created an opportunity for startups pursuing novel recovery technologies. Electrochemical, membrane-based, and surface-driven separation methods can operate at lower concentrations and scale modularly within existing infrastructure. By integrating directly into wastewater and byproduct streams, these technologies reduce capital risk while aligning compliance with supply-chain resilience.

As regulatory pressure tightens and supply risk persists, materials recovery is shifting from a niche optimisation to a strategic necessity. Ventures that can pair selective separation with low-capex deployment are best positioned to turn regulatory obligations into durable competitive advantages.

Our View

Remediating industrial effluent waters and/or recovering materials from them is one of the most regulatorily driven verticals covered by chemistry startups. If a team times their market entry well, with technology that enables economical compliance, they can rapidly capture a large share of the new market that was created by policy change.

Compliance-first models showcasing easy integration can be a blueprint for the next generation of high-value materials recovery ventures as well, but reliance on regulation for commercial viability is a double-edged sword. Political pullback or simple bad timing can result in entering a market that doesn't exist. Northvolt's bankruptcy and the repeated delays of EasyMining's Schkopau phosphorous recovery plant are high-profile examples of the perils of scaling without enough material to process, sufficient regulatory pressure, or a product that is economically viable independent of regulatory help.

In contrast to those cautionary tales, the new wave of materials recovery ventures focuses on asset-light products that integrate with existing value chains to lower risk. We are confident that these technologies will continue to receive policy support for the foreseeable future. Unlike many other regulatory schemes, SRM policies are being driven by not just environmental concerns, but **resilience and regional defence priorities** stemming from heightened supply chain risk. Those who manage to successfully scale and integrate recovery technologies will receive a sustained helping hand from public funds on the road to economies of scale and cost parity with virgin materials.

Microbubbles GmbH is successfully executing on a lightweight compliance facilitation strategy. Their solution for microplastics removal is easy to integrate with existing systems, cheap to operate, and comes at a pivotal time when the first wave of microplastics compliance obligations is slated to take effect. By combining recognition of an imminent industry pain point with an agile, asset-light business model, the team has been able to strike while the iron is hot with rapid commercial traction.

The road ahead

The European chemical industry is entering a structural transition rather than a cyclical one. To cope with the new paradigm, incremental change will not be sufficient. A series of disruptive innovations that build on existing infrastructure to reshape chemical processes and value chains must be fostered to ensure European competitiveness. This transformation requires not only technological advances but also a fundamental shift in mindset across all stakeholders.

At this moment of accelerated change, clarity and coordination matter as much as technological breakthrough. By mapping where innovation is emerging and how it connects to existing industrial systems, we aim to make complexity navigable. This report serves as a practical lens through which the first glimpse of a new model for the German chemical industry can be observed.

The startups within the chemstars ecosystem reflect this transformation. They operate at different points in the system, but they are linked by a common language of **resilience, circularity, and adaptability**. Chemical manufacturing, energy management, carbon capture, polymer recycling, material recovery, and support services are all interdependent layers of the same industrial transition.

The chemstars initiative exists to reduce the friction between innovation and deployment. Our ecosystem aligns research, capital, industry expertise, and policy to accelerate the translation of new technologies from the lab to market. This portfolio map is a blueprint for how a more resilient, lower-carbon, and adaptive chemical industry can take shape. Come along with us to shape the next generation of chemical companies, **this is only the beginning of the conversation**.

About chemstars

chemstars is a public-private partnership accelerating the transformation of the European chemical industry through entrepreneurship and innovation. We are creating a lighthouse ecosystem for startups in the chemical space through three main pillars of activity:

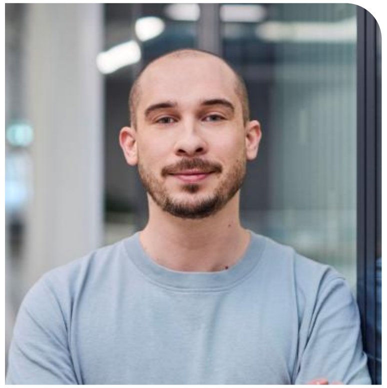
1. Inspiring the brightest minds to turn research into scalable chemical companies.

2. Accelerating the most promising startups to scale and create impact faster.

3. Enabling collaboration at scale across companies, borders, and disciplines.

chemstars is supported by the German Federal Ministry for Economic Affairs and Energy and our corporate sponsors from the European chemical industry.

Whether you're a scientist or entrepreneur looking for a home to grow, a policymaker looking to support breakthrough technology in chemistry, an innovation manager looking into new partnerships, or if you are just someone who is looking for new opportunities to make an impact, we invite you to join us in solving the industry's most challenging problems.



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