INNOVATION ROADMAP

for the chemical and plastics industry in Flanders

CATALISTI

Content

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From molecules to markets: Flanders' catalyst of transformation

As the 'industry of industries', the chemical industry is a cornerstone of Flanders' industrial resilience and competitiveness. Its products are essential for providing solutions in a variety of applications and strategic sectors. This innovation roadmap provides an ambitious way forward for the innovation efforts in the chemical and plastics sector.

Our companies work tirelessly to develop and produce high-quality, high-performing molecules, products and processes for their customers on a large scale. Every other sector — agriculture, food, health, energy, mobility, construction — relies on its solutions.

In Flanders, this is supported by a uniquely dense concentration of knowledge, expertise, world-class infrastructure, and integrated production clusters. The result is high added value for our region which is a foundation for economic prosperity. In Flanders, chemistry is not just a field of science, but the catalyst for transformation, turning ideas into industrial reality to meet society's needs of today and tomorrow and enabling the chemical and other sectors to compete and grow.

The chemical industry is currently operating in a challenging economic, socio-environmental and geopolitical context. However, the industry has a proven track record of providing practical solutions that drive progress in society and industry. The expertise that has driven advances in polymers, cleaner emissions, water treatment and greener processes continues to transform challenges into opportunities. Time and again, our sector has broken new ground by optimising processes, developing new molecules and setting new performance standards.

In this challenging context, this roadmap aims to create an innovation framework for our sector. This document provides insightful guidance to engage in innovation with clarity and ambition. Innovation is approached from three perspectives:

A context perspective.
Reflecting the challenging context, consisting of **five interconnected drivers** for innovation to contribute to the mission of a sustainable, competitive and resilient industry.

A cluster's perspective.
Reflecting a role approach for our cluster, consisting of **five interconnected levers** with Catalisti as central actor, to make a positive contribution to the higher context.

A technical perspective.
Reflecting a practical approach, consisting of **five interconnected programmes** along the value chain, to make a positive contribution to the higher context.

A context perspective on innovation

Today's challenging operational context is fuelling our innovation efforts. Increasing energy costs, global competition, complex EU and national regulations and a weak demand for EU products are putting industrial companies under pressure. In addition, there are socio-environmental challenges to which companies are expected to provide answers. Innovative molecules, processes, products, and even business models will help the chemical and plastics industry cope with these challenges and will create economic and socio-environmental value.[1,2]

1. The clean industrial deal: a joint roadmap for competitiveness and decarbonisation (COM(2025) 85 final). European Commission, 26 February 2025 .
2. A European chemicals industry action plan (COM(2025) 530 final). European Commission, 8 July 2025.

Five drivers, one mission

Our innovation roadmap aims to support a sustainable, competitive and resilient chemical and plastics industry in Flanders. In addition to develop and produce high-quality, high-performant molecules, processes and products, five interconnected drivers for innovation are identified:

Answering to changing demands from markets and consumers

Creating market and business case insights act as the compass guiding industry innovation, shaping not just what we produce, but how, why and for whom we create.

Reversing the trend of declining productivity growth

Directing R&D&I to modernise the chemical industry and creating the right boundary conditions in other policy domains to increase productivity and regain competitivity.

Embracing the power of digital tools

Improving data-driven decision-making via digital tools in real time to increase efficiency, productivity and saving costs.

Moving towards a circular economy

Further strengthening industrial symbiosis, integration and value chain collaboration within the framework of a circular economy to move away from fossil-based feedstocks.

Harmonising with climate, people and environment

Transitioning towards climate neutrality while designing safe and sustainable systems for a non-toxic environment.

These interconnected drivers together describe the complex context in which companies operate and innovate. An innovation trajectory should make a positive contribution to one of these drivers without negatively impact the others. In addition, the regulatory context is an important boundary condition to take into account.

A context perspective on innovation

Answering to changing demands from markets and consumers

At the end of the day, innovation in industry only matters when the business case is right and it reaches customers and consumers. Understanding where demand is heading (creating market insight) and how we create and capture value (creating business case insight) lies at the heart of our innovation efforts.

Brand owners and consumers are asking for technical solutions (e.g. high-performance, circular and safe materials to answer demands in personal and health care, housing, mobility, etc. —they need trusted solutions that improve performance or total cost of ownership). This involves designing solutions that are fit for purpose and backed by improved products, as well as building on new business models that focus on outcomes for customers and stakeholders. Innovating products for the markets of tomorrow will require a value chain collaboration approach, hence involving them from the first design ideas until uptake by the market.

The business case will determine whether it's worth investing in new molecules, products and processes. Going from a quick back-of-the-envelope calculation with ballpark figures at the start towards a more detailed financial plan with representative numbers will give key insights in the economic feasibility of each stage of the innovation path. The identification of financial risks is helpful to adjust the business case and explore better scenario's. Moreover, economic parameters can determine to what extent technical specifications must be achieved and experimenting with these parameters can guide towards better innovation goals.

Reversing the trend of declining productivity growth

Productivity measures how efficiently capital, labour and raw materials are converted into products and services. While our Flemish industry has long been a school example of growing productivity, this growth is currently declining. Stopping and reversing this trend is pivotal to strengthen our industry's competitiveness, drive economic growth, and safeguard our future Flemish prosperity. To do so, combining higher employment rate with higher (labour) productivity is key according to the Flemish government.[3] Despite Flanders' high R&D intensity, productivity growth is not keeping pace. The reasons for this "productivity paradox" are for instance lack of valorisation, R&D that is not following the market and no alignment with existing value chains or value chains that can be developed in Flanders. VARIO, the Flemish Advisory Council for Innovation and Entrepreneurship, listed specific recommendations to reverse this trend.[4] One emphasising the leverage of cross-cutting innovation policy such as high-quality education and a flexible labour market. Another emphasising R&D&I as key driver for achieving long-term productivity growth.

At the European level, the Commission has presented an action plan for the chemical industry to strengthen its competitiveness and the modernisation of this sector.[5] The action plan addresses key challenges – high energy costs, unfair global competition, and weak demand, while promoting investment in innovation and sustainability. It proposes the following four measures: (i) Resilience and level playing field (establishing a Critical Chemical Alliance to address the risks of capacity closures in the sector and applying trade defence measures to ensure fair competition); (ii) Affordable energy and decarbonisation (swiftly implementing the Affordable Energy Action Plan to help reduce high energy and feedstock costs); (iii) Lead markets and innovation (highlighting fiscal incentives and tax measures to boost demand for clean chemicals); and (iv) Taking action on PFAS (minimising PFAS emissions through a robust, science-based restriction, while ensuring continued use in critical applications under strict conditions where no alternatives are available). The plan is accompanied by a simplification package, the so-called 6th Omnibus, to further streamline and simplify key EU chemicals legislation.

3. Vlaamse productiviteits- en competitiviteitsagenda: Visie en acties 2025. Flemish government, February 2025.

4. Advies 37: Naar een hogere productiviteitsgroei. VARIO, 6 November 2024.

5. A European chemicals industry action plan (COM(2025) 530 final). European Commission, 8 July 2025.

When particularly focussing on innovation needs/possibilities to increase productivity, the following four recommendations are often emphasised: (i) innovate for products with higher added value (specialisation); (ii) innovate for products and processes that increase resources and energy efficiency, while reducing our dependence on fossil resources (via investments in among others industrial heat, carbon capture storage and utilisation); (iii) close the innovation and valorisation gap by funding demonstration and scale-up projects; and (iv) innovate faster and smarter by accelerating the digital economy, especially via start-ups and pioneers. Some of these recommendations are discussed in more detail in the upcoming parts of the context, cluster's and/or technical perspective.

Embracing the power of digital tools

The digital transition in the chemical industry is a fundamental shift where digital technologies are integrated into every aspect of operations such as R&D, manufacturing and supply chain management to improve efficiency, accelerate innovation and drive sustainability. Key technologies driving this transition include artificial intelligence (AI) and machine learning (ML) for predictive analytics, digital twins for simulating processes, and advanced sensors and networks for real-time data collection. Also, computational chemistry is revolutionising science and industry by enabling faster, more sustainable innovation in materials, medicine, and environmental solutions through atom-level simulations and predictive modelling. This digital transition is essential for chemical companies to adapt to market demands, reduce costs, and achieve sustainability goals. Digitalisation and automation of production processes are key enablers to increase productivity in the broad sense (labour productivity as well as resource & energy productivity).

An Arthur D. Little and Cefic study[6] based on a survey among 50 companies of different types, sizes and regions, shows the great potential of digital technologies for achieving sustainability goals.

6. Digital technologies for sustainability in the European chemical industry. Arthur D. Little and Cefic, April 2023.

Looking at modelling and analytics technologies, over 70% of chemical companies already exploit conventional data modelling and simulation techniques, yet only 20% take advantage of big data analytics. In the coming years, the chemical sector is expected to face a steep learning curve, and the uptake of big data analytics will at least double. Simultaneously, the implementation of AI and digital twins in novel ways is gaining momentum.

Looking at data sharing technologies, around 70% of chemical companies either already experience benefits of internal data sharing or are currently in the process of setting up the required IT infrastructure. Enabling infrastructures such as advanced sensors, cloud computing and internet of things (IoT), are increasingly being deployed.

Looking at automation, around 35% of companies in the chemical industry have already been automating certain workflows and supporting their workers with robotic systems. This number will continue to grow as benefits of the changing face of robotics and automation develop further.

Four major technological challenges will need to be overcome to further drive and accelerate implementation of digital technologies in the chemical sector: (i) data availability, where data is often still treated as a by-product rather than a strategic asset; (ii) interoperability, where inconsistent data formats and systems hinder data sharing and; (iii) standardisation, where industry-wide harmonized frameworks are needed to balance transparency, intellectual-property protection, and cybersecurity; and (iv) IT infrastructure, where Legacy, on-premise systems are often outdated and inflexible and need to transform into modern IT environments.

Moving towards a circular economy

The chemical industry in Flanders is already highly resource-efficient because production sites reached a high level of integration, which is one of its major strengths. Especially the petrochemicals, basic inorganics and polymers subsectors are very well connected in highly integrated industrial clusters. In addition, residual heat, side and waste streams are transferred and (re)used both within and outside company's boundaries. Further strengthening this industrial symbiosis must continue to achieve gains in efficiency, productivity and cost savings.

The biggest change still needs to take place to transforming the economy into a circular model. This will require systemic approaches and collaboration across all value chains to further decouple economic growth from resource consumption, maximise resource efficiency, and address climate change. The chemical industry can reduce reliance on virgin fossil raw materials by turning to alternative carbon sources such as waste, biomass, and CO_2. In this way, we can close material loops, decrease waste and optimize resource utilisation, which ultimately supports a sustainable, resilient, and competitive industry.

In a key report from Cefic[7], a realistic scenario foresees that the total feedstock consumed by the chemical industry will increase by 15% by mass compared to 2019 (281 Mt in 2019). However, the composition of this feedstock is expected to change dramatically. Fossil-based feedstocks, which today dominate the system, are expected to decline to roughly 35% of total feedstock use, while alternative carbon sources such as biomass, captured CO_2, and recycled materials take the lead. The report states that recycling plays a central role in reducing both resource dependence and end-of-life emissions for polymers. By 2050, feedstock derived from the chemical recycling of plastics is projected to represent about 14.6% of the chemical industry's total feedstock consumption. Projections for the share of biobased feedstock differ significantly between different studies and models. Cefic projects the share of biobased feedstock for the European chemical industry to increase above 40% of total consumption by 2050, while the Flemish study "Update contextanalyse en roadmapstudie"[8] only foresees a contribution of 6% for biobased feedstock. One element defining this difference is the much more moderate fossil feedstock decline assumed in the latter study (still 62% in 2050).

Looking more detailed at plastics, Plastics Europe has developed a roadmap[9] outlining an ambitious pathway to net zero and circularity for the plastic sector. In terms of circularity, the report projects that the substitution of virgin fossil-based plastics will be gradual and could reach 25% in 2030 and 65% by 2050. It also sets out a potential pathway to GHG emissions from the overall plastics system by 28% by 2030, and towards net zero by 2050. At the Flemish level, the department WEWIS of the Flemish government, together with OVAM and VLAIO, commissioned Deloitte to develop a roadmap for plastic recycling in Flanders[10]. The "circular scenario" in this report puts forward an ambitious target of "20–50 by 2050". This means that by 2050, 20% of polymer production and 50% of plastic conversion would come from recycled materials in Flanders. The report indicates that achieving this goal will require substantial efforts, including increasing collection rates of plastic waste to approx. 800 ktonnes (compared to approx. 120 ktonnes in 2022) and importing up to 2.7 million tonnes of plastic waste. Hence, significant investments will be needed to develop sufficient recycling capacity in the region.

To reduce investment risks, structural measures are essential, such as stimulating demand for recycled materials, supporting their supply, and accelerating technological innovation. The report highlights that every link in the plastics value chain plays a critical role in the transition to a circular economy. Polymer production, plastic conversion, and waste recycling are closely interconnected. Depending on the polymer type and final application, a combination of mechanical, polymer, monomer, and feedstock recycling will be necessary to improve the environmental footprint and reduce dependence on fossil resources. Advances in logistics, pre-treatment, and sorting are vital to ensure the quality and quantity of recycled materials and enhance the economic feasibility of recycling. The concept of a plastic circular economy requires collaboration with every partner in the value chain (logistics, pre-treatment, sorting, processing, etc.) and must be coordinated. A circular plastic or material economy also applies to biobased and CO_2-based value chains.

Harmonising with climate, people and environment

The transition to a climate neutral chemical industry will play a vital role in cutting greenhouse gas emissions (GHG) and tackling climate change. Beyond its own footprint, the sector provides technologies and materials that empower other sectors to reach net zero. A shift will be made towards more low-carbon energy sources and fossil-free feedstocks. Together, low-carbon energy solutions and fossil-free feedstocks will enable the majority of the industry's GHG emissions to be reduced. Carbon capture will address the remaining hard-to-abate emissions.

Based on an analysis of technological possibilities with attention to the uniqueness of the Flemish industrial landscape, we know that our energy-intensive industries can reach a reduction between 86 and 90% of GHG emissions by 2050 (compared to 2005).[11] This will only be possible by an ambitious and fast deployment of a combination of four technological options: biomass, circularity,

7. The carbon managers. Modelling possible pathways for the EU chemical sector's transition towards climate-neutrality and circularity within iC2050, Cefic, May 2025.

8. Eindrapport – Update contextanalyse en roadmapstudie: Naar een koolstofcirculaire, CO_2-arme en competitieve Vlaamse basisindustrie. Study commissioned by Agentschap Innoveren & Ondernemen (VLAIO), 30 June 2025. Study conducted by Deloitte Belgium in collaboration with VUB-IES.

9. The plastics transition. Our industry's roadmap for plastics in Europe to be a circular and have net-zero emissions by 2050. Plastics Europe, October 2023.

10. Roadmap kunststofrecyclage. Eindrapport 2025. Study commissioned by Departement Werk, Economie, Wetenschap, Innovatie en Sociale Economie (WEWIS) in Flanders, June 2025. Study conducted by Deloitte Belgium.

11. Naar een koolstofcirculaire en CO_2-arme Vlaamse industrie. Study commissioned by Agentschap Innoveren & Ondernemen (VLAIO), November 2020. Study conducted by Deloitte Belgium in collaboration with VUB-IES, Climact and AMS.

electrification & hydrogen and carbon capture. A shift to climate neutral energy carriers such as plastic waste and biomass will reduce the dependency on carbon capture, but carbon capture is the bottom line needed in all scenarios. As the total energy demand will not decrease, electrification of heat and processes will play a crucial role. A lot of R&D is still needed, both strategic basic research and research into scaling up technologies, to make them market ready. Also, significant investments will need to be made in transport, storage and use of hydrogen and CO_2 and in strengthening the electricity infrastructure.

A recent update of the study confirmed the importance of all four technological options.[12] The importance of electrification is increasing but is dependent on non-technological factors such as cost. Carbon capture, storage and utilisation, including the production of blue hydrogen, remains extremely important on the short term. Despite modest evolution in the implementation of circular plastics, the focus and importance of recycling, in particular chemical recycling, remains high. Green hydrogen production remains limited due to high costs and availability of low-carbon electricity. Methanol and ammonia could become important platform molecules. The large-scale use of biomass for energy and feedstock remains uncertain. In conclusion, the roadmap study proposes making significant investments in CCS, heat electrification, and the development of a circular value chain for plastics by 2030.

12. Eindrapport – Update contextanalyse en roadmapstudie: Naar een koolstofcirculaire, CO_2-arme en competitieve Vlaamse basisindustrie. Study commissioned by Agentschap Innoveren & Ondernemen (VLAIO), 30 June 2025. Study conducted by Deloitte Belgium in collaboration with VUB-IES.

The results of both studies are being used to inspire and guide the Klimaatsprong programme of the Flemish government. Klimaatsprong is the transition programme for a low carbon and competitive energy-intensive industry by 2025. It works along four dimensions: regulation, financing, infrastructure & energy and innovation. Moonshot Flanders, coordinated by Catalisti, fits in the innovation dimension: it is the industry innovation programme to accelerate the transformation of the Flemish industry towards climate neutrality. The innovation agenda of Moonshot is based on the same four technological options, complemented with an extra innovation path on energy innovation.

In addition to reduce GHG emissions, other safe and responsible production has been a key priority of the chemical industry for decades. Growing awareness on the impact of our operations and products and continuously advancing insights have pushed the industry to reconsider, adjust and ameliorate products and processes towards safer and more sustainable alternatives. The industry has adopted a Safe and Sustainable-by-Design (SSbD) approach, which is an iterative process guiding innovation and the placement on the market of new chemicals, materials, products, processes and services that are safe, and deliver environmental, societal, and/or economical value through their applications.[13] It is a framework that integrates a holistic set of safety and sustainability dimensions along the innovation process, from the idea generation up to the innovation launch. Focus dimensions in addition to those related to circularity, resources and climate are dealing with human health hazard, environmental hazard and fate, biodiversity and ecosystems impacts and emissions into air, water and soil.

13. Safe and Sustainable by-design: A guidance to unleash the transformative power of innovation. Cefic, March 2024.

A recent study[14], based on literature review and stakeholder opinions, mapped the challenges that companies, scientists, and policymakers need to address given the current state of development of the SSbD approach. It identified three priority issues: (i) integration of the SSbD assessment in the innovation process, where SSbD is not a post assessment but an active design tool; (ii) improvement of data availability, quality and uncertainty by developing methodologies for generating data at the early stages of development; and (iii) integration of the safety and sustainability aspects (RA and LCA assessments) with harmonisation of input data, assumptions, and scenario construction as far as possible.

14. Elisabetta Abbate, Ad M J Ragas, Carla Caldeira, Leo Posthuma, Irantzu Garmendia Aguirre, Anne Chloe Devic, Lya G Soeteman-Hernández, Mark A J Huijbregts, Serenella Sala, Operationalization of the safe and sustainable by design framework for chemicals and materials: challenges and proposed actions, Integrated Environmental Assessment and Management, Volume 21, Issue 2, March 2025, Pages 245–262, https://doi.org/10.1093/inteam/vjae031

SSbD may lead to fewer hazardous chemicals entering the market, or existing ones being re-designed/replaced, which in turn gives a competitive edge, reduces regulatory risk, liability and reputational risk for companies. By reducing hazardous chemicals, SSbD contributes to safer working conditions (in manufacturing), safer use for consumers, and less environmental contamination (soil, water, air) or long-term effects (persistence, bioaccumulation). In applying SSbD, the chemical industry has the ambition to go beyond the legally fixed minimum requirements and go for continuous reduction of toxicological risks for humans and the environment, based on the continuous development of knowledge. This is particularly valid for consumer use and in considering the end-of-life and circularity aspects. We are committed to apply safe and sustainable by design principles in a life-cycle approach, which will underpin the development of innovative products, processes, and its applications.

A cluster's perspective on innovation

An innovation cluster is an ecosystem of all its individual stakeholders, each with their own focus, identity, and interests. Monitoring and bringing all these interests together is a continuous and challenging task. Catalisti focuses its efforts to stimulate collaboration and accelerate innovation across the cluster.

Five levers, one central actor

Catalisti aims to create additional leverage for its members. Going forward, we will organise our work around five interconnected transversal domains:

Brokering innovation projects and trajectories
Supporting trajectories from basic and applied research with collaboration among companies (along the value chain) and academia to development and demonstration by individual, collaborative or collective efforts.

Strengthening existing and creating new value chains
Supporting both disruptive and incremental innovation to strengthen existing activities as well as creating new business models and value chains.

Strengthening start-ups in our ecosystem
Supporting pioneers and start-ups with matchmaking and innovation funding, as well as connecting them with other services such as incubation and venture capital.

Collaborating across sectors and clusters
Connecting and innovating with other industrial sectors and corresponding innovation clusters.

Collaborating across regions and borders
Connecting and innovating with actors outside Flanders (companies, knowledge partners, clusters, etc.) as well as applying for European subsidies.

We believe that strengthening these five interconnected domains, will enable us to support our members in a more tailored and comprehensive way. In doing so, our role as a central actor in the innovation ecosystem will grow, and innovation in our ecosystem will accelerate.

In addition to these five levers, Catalisti is the coordinator of Moonshot Flanders, the industry innovation programme to accelerate the transformation of the Flemish industry towards climate neutrality. With Moonshot Flanders, we support breakthrough innovation to feed and nurture the innovation funnel. More importantly, Moonshot Flanders is a starting point for the adoption of new technologies. Its research, within the Flemish universities and research institutes, is focused on the agenda of the industry.

An important partner of Catalisti, especially regarding the start-up ecosystem, is BlueChem. BlueChem is the incubator for sustainable chemistry in Flanders and the ideal location for pioneers to grow and innovate. With BlueChem, industry, academics and government have the common ambition to support start-ups and growth companies grow on an industrial scale. Catalisti was a partner in the feasibility study and business plan development that led to the founding of BlueChem, is currently a member of the BlueChem governance and is located at the BlueChem premises.

A cluster's perspective on innovation

Overarching ambition:
- **Catalisti is the central actor in the Flemish innovation ecosystem around chemistry & plastics.**
- **Wherever collaboration is taking place in and with this ecosystem, Catalisti is an indispensable partner.**

Brokering innovation projects and trajectories

Brokering innovation projects with multiple partners is at the core of Catalisti. As collaboration is key, the bulk of activities is situated in the mid TRL-levels, where companies and research institutes meet each other and where companies work together.

Catalisti believes that the front end of the innovation funnel needs continuous feeding with low-TRL disruptive research at knowledge institutions with active involvement of companies. In the end, if successful, some of these projects will find their way at intermediate and eventually at commercial levels. Going from an initial idea on small scale towards a commercial plant is a long trajectory, which in chemical industry often takes at least 10 years. Investments in mid-TRL research are considered as a necessary and critical step and collaboration in our ecosystem has already proven their long-term value.

At the same time, moving from the mid TRL to the higher TRL and eventually to industrial deployment is challenging. Innovation at these levels is still highly risky and the right support mechanisms are not always in place. Therefore, Catalisti aims to increase support for pilot and demonstration projects.

Ambition:
- **The provided quality of project brokerage along the complete innovation funnel is the highest in Flanders and beyond.**
- **Catalisti acts as the preferred innovation partner for collaborative innovation projects in Flanders.**
- **All supported projects fit into an innovation trajectory with the highest chances of effectively leading to valorisation.**

Strengthening existing and creating new value chains

In order to grow our industry and remain competitive and sustainable in the long term, it is essential that we leverage disruptive innovations. Disruptive innovation can lead to greater differentiation and specialisation, as well as creating additional value. It can also give rise to new, or partially or completely different, value chains.

In addition, there is also room for incremental innovations with significant impact. It is this type of innovation that can deliver significant gains in the short term, thus improving the productivity and efficiency of companies. In some cases, this includes an industrial R&D component. In others, it is about connecting the right partners or enabling knowledge transfer and dissemination.

Both incremental and disruptive innovations are needed and not mutually exclusive. Whereas incremental innovations keep companies profitable in the short to medium term, disruptive innovations enable transformation of activities in the mid and long term.

Ambition:
- **Catalisti aims to preserve and strengthen indispensable parts of the traditional value chains as well as catalyse breakthrough innovations leading to partially or completely new value chains.**

Strengthening start-ups in our ecosystem

To fulfil their potential, pioneers and start-ups must be provided with every possible form of support, such as connecting them with suitable partners who can deliver a broad range of services, including infrastructure, incubation, venture capital and funding. Additionally, connecting pioneers and start-ups with other actors in the ecosystem, in particular large companies, is often crucial for their growth. Start-ups can take more risks and thus spark greater transformational change, while they usually lack the financial resources and partners along the value chain to make this happen. What start-ups lack, is exactly the strength of large companies and vice versa. Within the Catalisti ecosystem and its core activities, such as project brokerage, small and large companies are closely linked to accelerate the development and adoption of innovation.

Ambition:
- **Start-up support is well coordinated among different partner organisations in Flanders with Catalisti as a central network partner.**
- **Catalisti provides excellent and tailored support to start-ups with respect to partner matching and innovation funding.**

Collaborating across sectors and clusters

The chemical industry is typically the foundation of, and closely linked to, many other industrial sectors. This makes collaboration essential not only within the company and across company boundaries, but also across sector boundaries. Examples include the high energy usage in chemical conversion processes, the importance of establishing logistical value chains to collect and deliver raw materials, and the use of chemical building blocks in a broad range of downstream industries, such as agrochemicals, paints, coatings, inks, soaps, detergents, pharmaceuticals. There is still significant potential for collaboration to generate further gains across and between sectors. Catalisti's ambition is to remove innovation barriers between sectors by adopting a more strategic approach to intercluster collaboration. This will result in more and smarter activities and projects with other clusters.

Ambition:
- **Catalisti is strategically aligned across sectors and clusters regarding collaborative innovation.**
- **Catalisti enables major innovative breakthroughs and/or spillovers in other sectors with other clusters.**

Collaborating across regions and borders

Catalisti aims to contribute to strengthen the Flemish chemical and plastics sector and position Flanders as a leading chemical cluster in Europe. To this end, Catalisti will provide targeted support to its members in the form of knowledge sharing, partner connections and guidance on project proposals for European grant applications. Catalisti will also build and deepen European partnerships with clusters and organisations. These partnerships are the driving force behind European projects and are therefore essential for achieving the desired objectives.

Catalisti will further develop its existing partnerships with innovation clusters in the Netherlands, Germany, and France, while exploring new partnerships with other strong or complementary regions. Catalisti will also increase its presence on the European innovation funding scene with the aim of developing excellent support for its members in accessing targeted European innovation schemes.

Ambition:
- **Catalisti and our Flemish ecosystem are known and appreciated at the European innovation scene and are recognized as an excellent, and at moments indispensable, partner in European industrial collaboration projects.**
- **Innovation funding from the European level significantly leverages the Flemish funding.**

A technical perspective on innovation

Catalisti aims to accelerate innovation in a variety of technical domains covering the entire chemical value chain of the Flemish chemical and plastics industry. This includes feedstocks, processes, associated energy solutions, as well as unit operations and products. Innovations related to chemical production in the life sciences industry are also covered.

The end point of this technical perspective within the value chain is the applicability of various molecules (e.g. polymers in the case of plastics) in all kinds of applications. Furthermore, this endpoint is simultaneously the starting point for complementary innovation roadmaps in other sectors and opportunities for collaboration across sector boundaries.

Five programmes, one value chain

Our selected technical innovations are organised into five interconnected programmes that follow the value chain. Each programme is divided into specific areas, open to new trends and designed to evolve alongside the market. This is because our industry is constantly evolving and cannot be compartmentalised. The structure of these programmes enables us to respond to current needs while remaining open to future challenges. These programmes therefore include several inspiring tracks with a non-exhaustive list of innovation examples.

Circular Feedstocks

Bringing non-virgin fossil carbon - biomass, CO_2 and waste - (back) into value chains to reduce fossil dependency and enable circular carbon flows. Also, non-carbon-based feedstocks fit in this programme.

Energy Solutions

Electrifying chemistry, chemical processes and utilities, searching for alternative energy carriers as well as matching energy needs with energy supply to secure competitive, low carbon energy.

Future-proof Processes

Using more advanced digital technologies as well as safe, sustainable, integrated and resilient production.

Effective Unit Operations

Establishing step change efficiency in conversion, separation and purification.

Advanced Products

Designing performant non-regrettable substitutes and alternatives for hazardous chemicals as well as developing new or improved products for the value chain.

These interconnected programmes will help us to gauge the rapid changing world, clarify the challenges we face, and commit to a long-term process of adaptation and leadership. This is how we transform major technical challenges into innovation opportunities and ensure that our industry continues to thrive for decades to come. Together, these innovation programmes create a whole that is greater than the sum of its parts — each one essential and together contributing to Flanders' catalyst of transformation.

A technical perspective on innovation

Circular Feedstocks

Our industry still mainly relies on virgin fossil resources as raw material for their processes. In the search for more alternative carbon resources, three circular options are being developed. Therefore, this innovation programme encompasses three tracks: (i) biomass valorisation; (ii) waste recycling; and (iii) CO_2-utilisation. Current forecasts indicate that all three solutions are required to facilitate the transition of our industry towards circularity. The unique carbon structure and/or presence of heteroatoms of bio-based renewable alternatives can generate a competitive edge on top of the renewable character. In addition, the industry is made up of much more than just carbon atoms. Therefore, a fourth tracks focuses on the efficient usage of non-carbon-based feedstocks.

Track 1: Biomass valorisation
e.g. Fractionation; Selective (bio)chemical conversion of biobased building blocks, originating from lignin, sugars, oils & fats, proteins, chitin, etc.; Thermal conversion (e.g. gasification, pyrolysis)

Track 2: Waste recycling
e.g. Collection, identification & sorting of waste; Mechanical, dissolution and chemical recycling of all kind of plastics; Thermal conversion of plastics (e.g. gasification, pyrolysis)

Track 3: CO_2-utilisation
e.g. Carbon Capture & Utilisation (CCU)

Track 4 : Non-carbon-based feedstocks
e.g. Using water, N-based streams, P-based streams, halogens, etc. in a circular and (atom-) efficient way for reagents as well as auxiliaries

Energy Solutions

Our industry is an energy-intensive sector and a major contributor to GHG emissions. The competitiveness of our industry is, among other things, strongly dependent on the energy price. In the search for a competitive industry with minimal GHG emission, more sustainable energy solutions such as electrification, reduced energy consumption and flexibility regarding energy supply are crucial. Therefore, this innovation programme encompasses three tracks: (i) electrification; (ii) alternative energy carriers, and (iii) matching energy demand with supply.

Track 5: Electrification
e.g. Electrification of traditional chemical processes; Electrification of chemistry via electrochemistry; Electrification of heat (heat pumps, e-boilers, etc.)

Track 6: Alternative energy carriers
e.g. H_2; Microwave; Ultrasound; Photon; Plasma; Shockwave

Track 7 : Matching energy demand with supply
e.g. Reduction of energy consumption; Energy efficiency; Infrastructure for energy transport and storage; On/off principles and flexibility for chemical processes depending on energy availability

Future-proof Processes

In terms of piping, energy exchange, etc., our industry is already highly connected and integrated within big clusters. However, in terms of industry 4.0 and 5.0 our industry often still needs to catch up. In the search for integrating more advanced digital technologies as well as safe, sustainable, integrated and resilient production, this innovation programme encompasses two tracks: (i) digitalisation & automation; and (ii) reliable industrial processes.

Track 8: Digitalisation & Automation
e.g. Computational chemistry; Sensors and networks; Artificial intelligence (AI) and Machine Learning (ML) (used for process control/monitoring as well as process-related workflows); Digital twins; Design of Experiments (DoE); Augmented Reality (AR)

Track 9: Reliable industrial processes
e.g. Safety (process safety, functional safety, cybersecurity, etc.); Development of training tools for employees; Process innovations; Integration efforts within companies as well as across companies and sectors; Modular processes

Effective Unit Operations

Our industry wants to move efficiently from molecule A to B or C. Often, this requires a train of unit operations. In the search for even more efficient conversion and separation techniques, there is a toolbox of options with varying degrees of maturity. Therefore, this innovation programme encompasses three tracks: (i) catalytic conversions; (ii) separation and remediation techniques; and (iii) new unit operation designs.

Track 10: Catalytic conversions
e.g. Homogeneous, heterogeneous & bio-catalysis; Electrocatalysis; Photocatalysis; Nanozymes

Track 11: Separation & Remediation techniques
e.g. Purification via membranes, distillation, etc. ; Remediation via membranes, adsorption, etc.; Carbon Capture & Storage (CCS)

Track 12: New unit operation designs
e.g. New reaction concepts (mechanochemistry, flow chemistry, etc.); Using alternative feedstocks & solvents (e.g. water-based chemistry)

Advanced Products

Our industry manufactures products that are crucial for our quality of life. However, some products can have a significant negative impact on humans and/or on the environment. In the search for designing performant non-regrettable substitutes and alternatives or new products for our customers, this innovation programme encompasses three tracks: (i) safe by design (structure – toxicity); (ii) circular by design (structure – recycling); and (iii) performant by design (structure – property).

Track 13: Safe by design
e.g. Understanding molecular structure – toxicity relationships; Designing non-regrettable substitutions (e.g. SVHCs identified under REACH regulation, POPs governed by the international Stockholm Convention, SoC under the CLP regulation)

Track 14: Circular by design
e.g. New polymer design; Using markers for efficient recycling steps; Biodegradability

Track 15: Performant by design
e.g. Understanding molecular structure – property relationships

INNOVATION ROADMAP

A context perspective on innovation

- Answering to changing demands from markets and consumers
- Reversing the trend of declining productivity growth
- Embracing the power of digital tools
- Moving towards a circular economy
- Harmonising with climate, people and environment

A cluster's perspective on innovation

- Brokering innovation projects and trajectories
- Strengthening existing and creating new value chains
- Strengthening start-ups in our ecosystem
- Collaborating across sectors and clusters
- Collaborating across regions and borders

A technical perspective on innovation

- **Circular Feedstocks**
  - Track 1: Biomass valorisation
  - Track 2: Waste recycling
  - Track 3: CO_2-utilisation
  - Track 4: Non-carbon-based feedstocks
- **Energy Solutions**
  - Track 5: Electrification
  - Track 6: Alternative energy carriers
  - Track 7: Matching energy demand with supply
- **Future-proof Processes**
  - Track 8: Digitalisation & Automation
  - Track 9: Reliable industrial processes
- **Effective Unit Operations**
  - Track 10: Catalytic conversions
  - Track 11: Separation & Remediation techniques
  - Track 12: New unit operation designs
- **Advanced Products**
  - Track 13: Safe by design
  - Track 14: Circular by design
  - Track 15: Performant by design

Call for partners

To fulfil our important role as a solutions provider and respond to the double twin transition of digitalisation and sustainability in challenging economic times, we need a resilient, sustainable and, competitive chemical industry that creates value for society. Therefore, we propose a way forward that builds on Flanders' unique strengths: integrated production clusters, world-class infrastructure, leading-edge research institutes and a culture of collaboration and innovation. This innovation roadmap is a collective effort. It is also an invitation to recognise the role chemistry can play in turning complex challenges into practical solutions. We encourage partners to innovate, pilot and scale up with us, creating value that is based in Flanders and competitive globally. Working together across the value chain, the chemical industry in Flanders can continue to support broader economic renewal by focusing on solutions that strengthen resilience, competitiveness and long-term prosperity for companies and society.

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