

## Preread workshop on the technical perspective on the 24<sup>th</sup> of March

### Context

On Tuesday, March 24, we will host eight parallel workshops (three in the morning and four in the afternoon) dedicated to strengthening and sharpening the **technical perspective** of the Innovation Roadmap.

These sessions are designed to be highly interactive and strategic. Together with industry experts and experts from knowledge institutions, we will work concretely on defining the direction for the coming decade. During each workshop, we will:

- Define the **10-year ambition** for the topic and clarify where we, as an industry, want to position ourselves;
- Identify the **key challenges and bottlenecks** that could hinder progress;
- Determine the **innovation needs and concrete next steps** required to move forward;
- Agree on **priorities and indicative timelines** for action.

Your participation is essential. The outcomes of these workshops will directly shape Catalisti's strategic focus and activities in the coming years. By contributing your expertise, you actively help steer the innovation agenda and ensure that the roadmap reflects real industry needs and opportunities.

Below, you will find an overview of the topics that will be addressed during the different workshops.

### Description of the different topics that will be addressed during the workshop

1. Circular Feedstock – Biomass valorisation
  - A. **Biorefinery (incl. downstream processing)** – *The pretreatment and refinery of biomass, dealing with its complexity, rigidity and variability (impurities and diversity of building blocks), makes bio-based streams available. This refinery step can involve extraction, selective fractionation as well as thermal conversions. The downstream chemical conversion of all kind of bio-based building blocks (lignin, sugars, fats & oils, amino acids & proteins, etc.) can be considered. Also, downstream processing of bio-based molecules, involving the recovery, concentration and purification of target molecules to meet the required specifications for further processing or end use, can be crucial to achieve this.*
  - B. **Biotechnology** – *Industrial biotechnology for the chemical industry involves using whole-cell microorganisms (bacteria, yeasts, fungi) and/or isolated enzymes (biocatalysis) to produce molecules and products from all kind of bio-based (waste) streams. It also includes genetic engineering, metabolic engineering, and synthetic biology approaches to design microorganisms and/or enzymes for specific and efficient production paths.*
  - C. **Value chain approach, techno-economics & implementation of bio-based content** – *Business barriers are addressed by how value is generated through biomass conversion, the value distribution across the value chain (alignment between biomass resources, conversion technologies, and end-use applications), collaboration with key partners, and matching supply and demand. The right quality, performance and functionality specifications of the product must be met when incorporating bio-based content.*
2. Circular Feedstock – EoL material recycling
  - A. **Sorting & pre-treatment** – *Effective recycling critically depends on identification (type of polymer and presence of impurities), (advanced) sorting, and pre-treatment (removal of other polymers, impurities/contaminations such as (legacy) additives and non-intentionally added substances). These are key steps in producing high-quality secondary materials and/or chemicals.*
  - B. **Recycling technologies (incl. downstream processing)** – *Effective recycling depends on reliable and robust processes where polymers are physically reprocessed without changing their chemical structure as well as chemical processes that alter the polymer structure. When impurities are present, recycling technologies should be able to handle and preferably even valorise them. Downstream processing, involving the recovery, concentration and purification of target molecules, is also taken into account.*

- C. **Implementation of recycled content** – The right quality, performance and functionality specifications of the recycled product must be met when incorporating recycled content. Here, the usage of additives, control of material characteristics, etc. are considered to fit the intended application.
  - D. **Value chain approach & techno-economics** – Business barriers are addressed by how value is generated through EoL material recycling, the value distribution across the value chain (alignment between plastic availability, recycling technologies, and end-use applications), collaboration with key partners, and matching supply and demand.
3. Circular Feedstock – CO<sub>2</sub>-utilisation
- A. **Carbon Capture** – Prior to the utilisation of CO<sub>2</sub>, it should be collected/captured and purified from a variety of sources – either from industrial point sources or directly from the air. In addition, also transportation and storage will be taken into account.
  - B. **Upgrading and utilisation of CO<sub>2</sub>** – Transforming the captured CO<sub>2</sub> into a variety of value-added molecules and products. Reactions to transform CO<sub>2</sub> require additional energy input, which must come from a sustainable source and should be transferred in efficient way.
  - C. **Value chain approach & techno-economics** – Business barriers are addressed by how value is generated through CO<sub>2</sub>-utilisation, the value distribution across the value chain (alignment between availability of CO<sub>2</sub> sources, upgrading and utilisation technology and applications), collaboration with key partners, and matching supply and demand.
4. Energy solutions
- A. **Electrification** – Electrification in the chemical industry refers to replacing fossil-based energy with renewable electricity to drive processes more sustainably. This includes electrifying traditional chemical processes, using electrochemistry for direct chemical transformations, and supplying heat through electric technologies such as heat pumps or e-boilers.
  - B. **Alternative energy sources & carriers** – Unconventional sources or carriers of energy, used to drive chemical processes more efficiently or sustainably, are considered. Examples include hydrogen (carriers) but also physical energy inputs such as microwaves, ultrasound, photons, plasma, etc. to activate reactions. These carriers enable novel reaction pathways, reduce reliance on fossil resources, and can improve selectivity, speed, or energy efficiency in chemical manufacturing.
  - C. **Matching energy demand with supply** – Matching energy demand with supply means designing chemical processes to use energy efficiently while adapting to availability, improving energy efficiency, reducing overall consumption and carbon intensity.
5. Future-proof processes
- A. **Digitalisation & Data management** – Applying digitalisation and data management concepts to the specific needs of the industry. It involves integrating advanced technologies such as computational chemistry, sensors and networks, Artificial intelligence (AI), Machine Learning (ML), Digital twins, etc. for process control and optimization.
  - B. **Automation** – Applying automation concepts to the specific needs of the industry. It involves integrating advanced technologies such as Programmable Logic Controller (PLC), Supervisory Control and Data Acquisition (SCADA), Artificial Intelligence (AI), Functional Safety, Internet of Things (IoT) to enhance production efficiency, safety and precision. Key applications include automated dosing, process control, robotics for product handling, etc. to improve accuracy and reduce downtime.
  - C. **Reliable industrial processes** – Reliable industrial processes are designed to operate safely, consistently, and efficiently under real-world conditions. They integrate safety aspects (process safety, functional safety, cybersecurity, etc.) with continuous process innovation, and strong integration across teams, companies, and sectors. In addition, reliable operations are supported by effective training tools that equip employees with the skills needed to manage complex and evolving industrial systems. Areas for improvement and opportunities for collaboration in the process industry are identified.
6. Effective Unit Operations
- A. **Design of improved catalysts** – Catalysts enable reactions to proceed faster, more selectively, and with lower energy input. The activity, selectivity and stability (robustness against impurities, lifetime, etc.) of a catalyst often determines its industrial success.

Examples include homo- and heterogeneous catalysis, biocatalysis using enzymes, and electro- and photocatalysis where electricity or light, respectively, drives the conversion. Also, emerging concepts such as nanozymes can be considered.

- B. **Design of improved separation and remediation techniques** - Separation and remediation techniques are processes used to purify streams (solids, liquids and gasses), and remove contaminants (from air, soil and water) by exploiting differences in physical or chemical properties. Examples include distillation and membrane separations for product purification, adsorbents and membranes for waste water and air treatment. In addition, these techniques can also enable the recovery of valuable components from side and waste streams of the chemical industry, thereby supporting circular and atom-efficient use of resources (water, N-based streams, P-based streams, halogens, critical raw materials, metals, etc.).
- C. **Design of improved reactor concepts** - New unit operations focuses on rethinking traditional process steps by introducing novel reaction and separation concepts and by using more sustainable inputs. New concepts can enable more efficient, better controlled, and often less energy-intensive reactions compared to conventional batch processes. At the same time, the use of alternative feedstocks (e.g. bio-based) and solvents (e.g. water-based chemistry), supports safer and more environmentally friendly operations.

## 7. Advanced products

- A. **Substances to seek an alternative for** - Safe and sustainable by design is an innovation approach to design molecules, products and processes to minimize, and preferably eliminate, harmful effects on health and environment throughout the full life cycle. It includes understanding molecular structure-toxicity relationships and designing non-regrettable substitutions. Digital tools can be useful to design these (new) safe and sustainable molecules and products. Here, we will identify needs regarding alternative substances and necessary applications based on the existing ecosystem and capabilities in Flanders.
- B. **Improving performance characteristics and applications** - In the chemical and plastics sector, being “performant by design” means using a deep understanding of molecular structure/polymer structure-property relationships to build performance directly into molecules and products from the outset. Here, applications areas and performance characteristics where added value can be created with the right molecules, processes and products will be identified. Emerging trends as well as strengths of Flanders are taken into account to identify these areas. Digital tools can be useful to design these (new) effective molecules and products.
- C. **Recyclability of polymer flows** - The Circular Design topic focuses on integrating circularity at the product and polymer design stage to enable closed-loop value chains. It includes new polymer design, design for recycling and reuse—such as the use of markers to improve sorting and recycling efficiency—as well as design from recycling, where recycled streams are used as feedstocks for new products. In addition, the development of biodegradable materials enables circular solutions for applications where recycling is challenging or environmental leakage is likely. Digital tools can be useful to design these (new) polymers and products.