

# Sustainable Chemistry as a Driver of Sustainable Innovation

## Meeting Today's Needs – Without Compromising the Future

*Sustainable Chemistry is evolving from a concept into a central engine of innovation for a climate-friendly and sustainable economy. Sustainable Chemistry goes beyond traditional circular approaches. The International Sustainable Chemistry Collaborative Centre (ISC3) supports this transformation by developing innovative solutions in collaboration with the private sector and international organizations, promoting start-ups, contributing to international policy processes and initiatives, and advancing practical implementation along global value chains.*

### Innovation in Practice

Sustainable, high-performance, and cost-efficient advanced polymers with a reduced carbon footprint. Technologies for chemically recycling hard-to-recycle plastics at low temperatures and without solvents. Integrated solutions that combine climate action, sanitation, and circular economy approaches in countries of the Global South. These examples show that Sustainable Chemistry is already a reality. ISC3 actively supports innovations like these, including the start-ups behind them: Polymer2Polymers, AC Biode, and ClimEtSan-OnTheGround. “Anyone seeking to address the global challenges of our time and achieve the goals of the 2030 Agenda needs trans-

formative ideas and innovative solutions. Sustainable Chemistry plays a key role in this, as it effectively brings together innovation, resource conservation, and economic development,” says ISC3 Managing Director Thomas Wanner: “For several years, ISC3 has been actively supporting start-ups and innovations worldwide to accelerate the transition of promising approaches into real-world applications. We work closely with the private sector, build expertise, and continuously expand it. At the same time, we develop educational and advisory materials to disseminate knowledge internationally. For us, it is essential not only to develop sustainable solutions, but also to make them scalable and integrate them into existing value chains.”

### Chemistry at the Center of Transformation

Few industries shape the economy and everyday life as profoundly as the chemical sector. Around 90% of global production depends directly or indirectly on chemical products. At the same time, the chemical industry accounts for approximately 10% of global final energy consumption and about 7.4% of worldwide greenhouse gas emissions. A sustainable and climate-friendly economy therefore requires a fundamental rethink in the design of services, substances, materials, and processes. Sustainable Chemistry provides a practical framework for this transformation.

### Sustainable Chemistry as a Guiding Principle

Sustainable Chemistry takes a systemic approach: Products are considered across their entire life cycle – from development and use to recycling. The process begins with a critical question: Is a specific function or service needed at all, or can the desired outcome be achieved differently? The next step is to reduce or eliminate negative impacts while cre-



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ating economic and societal value. This is not only about efficiency. Material flows must be reduced and approaches aligned with actual needs. Circularity alone is not sufficient; complementary approaches are essential.

“Sustainable Chemistry requires comprehensive thinking from the outset—ecological, economic, and social. It is not enough to optimize individual processes; rather, we must understand the impacts of substances and materials across their entire life cycle—globally and over the long term,” says Klaus Kümmerer, ISC3 expert, professor, and recipient of the Wöhler Award for Sustainable Chemistry. “This also means addressing fundamental questions early on: Why are we applying a given solution? What resources will be required if an innovation succeeds – in what quantities and from which sources? What by-products arise throughout a product’s life cycle, and what impacts result from large-scale application, including at end-of-life? How can negative effects be avoided from the beginning and incorporated into product design? At the same time, social and ethical aspects must be considered more strongly to develop solutions that are not only technically viable but also socially sustainable. Sustainable Chemistry is defined by systems thinking, not isolated solutions.”

One example: Under certain conditions—such as insulated and moisture-exposed façades – algae and fungi can develop. A chemical solution would be to add biocides to façade coatings. Alternatively, structural and material-based approaches – such as roof overhangs or suitable materials like sandstone, mineral plasters, or wood with natural fungicidal properties – can reduce algae growth without harming the environment.





## More Than Circular Economy

Addressing global challenges requires a fundamental shift in the chemical industry and related sectors. Sustainable Chemistry goes beyond traditional circular approaches. ISC3 promotes a global transition toward Sustainable Chemistry along chemical value chains with cross-sectoral impact: a holistic sustainability strategy that embeds future-proof services, functions, technologies, and innovative processes and products across supply chains.

Sustainable Chemistry does not consider individual products and associated material flows in isolation. Instead, it follows a systemic approach that accounts for product life cycles, closes material loops, and promotes sustainable business models. At the same time, ISC3 strengthens sufficiency approaches to reduce resource consumption.

Key focus areas include climate protection, decarbonization, and defossilisation of industrial processes, as well as responsible resource use and

waste and chemicals management. This means:

- Assessing needs and considering non-material alternatives
- Designing products that are durable, repairable, reusable, and ultimately recyclable, rather than disposable
- Developing competitive processes and products for local and global markets that require less energy and fewer resources and rely on bio-based or recycled feedstocks
- Promoting technologies that sustainably reduce or eliminate risks to humans and ecosystems

The goal of this holistic approach is to respect planetary boundaries, strengthen social responsibility, and ensure long-term competitiveness.

Another example: Plastic waste in India is an environmental, resource, and social issue, as informal waste pickers work in hazardous conditions while playing a key role in waste management. Policies must recognize their contribution, improve working conditions and social protection, and grad-

ually create safer income opportunities, or risk reinforcing inequalities and undermining long-term sustainability.

## Sustainable Chemistry – Where Change Begins

Ongoing international discussions on Sustainable Chemistry show that expectations vary across stakeholder groups. To foster a shared understanding, ISC3 has developed the “Key Characteristics of Sustainable Chemistry” and recently updated them in concise guiding statements. The result is ten simplified explanations covering the core aspects of Sustainable Chemistry – from holistic thinking and systems approaches to social responsibility, circular economy, and green chemistry.

“Sustainable Chemistry starts wherever sustainable change begins. Because this transformation takes time, it must be advanced on multiple levels simultaneously—through innovation, policy frameworks, knowledge transfer, and international partner-

ships. Our goal is to build a shared understanding and establish Sustainable Chemistry as a central approach for a future-ready economy,” summarizes Wanner.

## The Road Ahead

Sustainable Chemistry is not a vision for tomorrow; it is a prerequisite for shaping a sustainable future. It is a prerequisite for sustainable innovation, a future-ready industry, the protection of the environment and human health, and a key lever for achieving the global sustainability agenda (SDGs). The path forward requires a fundamental cultural shift. Policymakers, businesses, academia, and society must act together. ISC3 serves as a platform and catalyst – connecting stakeholders worldwide, promoting innovation, and helping bring sustainable solutions into practice.

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