

ROADMAP FOR CLIMATE-NEUTRAL
COMPETITIVENESS

The Innovation and Chemical Industries



The research-based
pharmaceutical
industry

IKEM

*Innovation and Chemical
Industries in Sweden*



Fossilfritt
Sverige





Foreword

As part of the national Fossil Free Sweden initiative, 23 industries have produced road maps to show how they can improve their competitiveness by becoming fossil free or climate neutral. The industries covered by this particular Road Map are the chemical, plastic and pharmaceutical industries. They account for 3 percent of Sweden's total direct greenhouse gas emissions. In addition to the climate transition, the Road Map also addresses the chemical transition which is focused on ways to provide society with more sustainable and safer chemicals.

The Road Map was produced by IKEM (representing companies in the innovation and chemical industries in Sweden) in cooperation with Lif (the organisation for research-based pharmaceutical industries). IKEM is an industry and employer association that represents several different industry sectors that work with chemicals in a broad sense. In addition to the chemical, plastic and pharmaceutical industries, IKEM also represents other industrial branches, some of which have their own road maps, including road maps for cement and fuel. Lif members mainly develop new medicines, but they are also involved in development within biotech and med-tech. Their members also manufacture a large percentage of all pharmaceuticals that are sold in Sweden. This Road Map covers the manufacturing and research-based pharmaceutical industry in Sweden.

The purpose of this Road Map is to show how the chemical, plastic and pharmaceutical industries can become climate neutral and help Sweden become a world leader in the green transition. This Road Map is unique in that it also shows how these three industries will accelerate the chemical transition while also remaining competitive. They will do this through faster substitution and by creating the necessary conditions for solving environmental and health issues. To achieve consensus around how to measure and monitor the chemical transition, IKEM invites stakeholders in society to produce common key performance indicators (KPIs) to monitor progress in development and substitution to facilitate safer use of chemicals and increase circularity in society.

One crucial factor in reaching the climate goal by 2045 is to find inputs that can replace fossil raw materials. The chemical, plastic and pharmaceutical industries need climate-neutral inputs in the form of carbon atoms that are either recycled or bio-based. To secure a supply of these inputs, products that have reached the end of their useful life must go to recycling rather than being incinerated and released into the atmosphere as carbon dioxide, as is the case today. Carbon atoms need to be recycled from waste or re-used from incineration and industrial processes by using carbon capture and utilisation (CCU) technology. There is also a need for bio-based carbon atoms obtained from the forest and agriculture, for example in the form of biogas or biomass. One of the goals of the Road Map is therefore to ensure that 80 % of the fossil inputs used today are replaced by recycled or bio-based raw materials. To achieve this goal, policymakers must create the right conditions and industry actors need to meet their commitments. After 2045, continuing efforts to replace the remaining fossil raw material will depend on innovation in new technologies and new materials. Policymakers need to provide incentives for investments and promote this type of research and innovation.

The industries own the Road Map and all its parts, and all significant content and conclusions are shared with Fossil Free Sweden. The Road Map is our contribution to accelerating the climate and chemical transitions. All of the road maps are focused on removing carbon emissions, but this particular Road Map also aims to phase out society's dependence on fossil raw materials and find ways to produce the next generation of sustainable chemicals. This makes it unique.

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Summary

GLOBAL INDUSTRIES' WANT TO ACCELERATE TWO HISTORIC TRANSITIONS, CLIMATE AND CHEMICAL TRANSITIONS

By 2045 Sweden can be the world's first climate-neutral, circular and competitive welfare society, while also being focused on increasing chemical security. Chemistry has a pivotal role to play in bringing about the climate and chemical transitions. Almost all of the goods we produce – a full 96 percent – are in some way dependent on chemistry. Chemical products and materials are part of all value chains, which means that the inputs produced by companies in the innovation and chemical industries are indispensable for all industrial activity. Our chemical, pharmaceutical and plastic industries in Sweden are therefore ready to do their part and take on the challenge to realise the vision of Sweden becoming the first climate-neutral, circular and competitive welfare society.

The supply of raw materials will be a crucial factor in achieving the vision of Sweden becoming the world's first climate-neutral, circular and competitive welfare society. Our industries are facing a paradigm shift, with virgin fossil raw materials being replaced by bio-based and/or circular ones. If we are to meet the increased demand for carbon atoms, we need to close the carbon cycle and create a cycle of carbon atoms where waste and carbon dioxide are regarded as resources. We also need to take advantage of the full potential of biogenic raw materials. To achieve our vision it is therefore important to have a raw material goal (Scope 3) for 2045. The three industries covered by this Roadmap account for 3 percent of Sweden's total greenhouse gas emissions. For many years the industries have been determined – and they continue to be determined – to work on finding new sustainable, circular and efficient solutions to reduce their own emissions to achieve net zero emissions by 2038 (scope 1 and 2).

Chemicals must be used safely and sustainably. The chemical, pharmaceutical and plastic industries in Sweden

are constantly developing and launching new chemicals that are safer, more economical or more sustainable, without compromising on their effectiveness. We want to accelerate these efforts in order to achieve climate neutrality and also contribute to the Riksdag (Swedish parliament) reaching its objective of a non toxic environment, while also improving the competitiveness of our innovation and chemical industries. To achieve the chemical transition we need to prioritise reforms in the following areas:

- **Strengthen innovative capacity to be at the forefront and promote development of safe and sustainable chemicals**
- **Regulations that lead to development and innovation to increase substitution**
- **Strengthen enforcement and encourage compliance to ensure commercial competitiveness and exclude irresponsible and non-compliant actors**

There is also a growing need for talent and expertise to bring about the climate and chemical transitions. Sweden is facing a major wave of retirements, and these two factors combined will increase the recruitment needs of the process industry (which includes the chemical and plastic industries) and the pharmaceutical industry. Over the next few years companies in these industries will need to recruit more than 20,000 employees.

With the right conditions provided by policymakers, both the climate and chemical transitions can be accelerated, and Sweden and its industries can become more attractive and competitive. These conditions and the actions needed by policymakers are described in specific lists in this Roadmap. In addition, three fundamental and key conditions need to be in place to reduce the industries' process-related climate footprint and accelerate the chemical transition.

¹ This Roadmap covers three industries represented within IKEM: the chemical, plastic and pharmaceutical industries. IKEM also has member companies in the petroleum fuels and cement industries. These have their own roadmaps through the national Fossil Free Sweden initiative and thus have not been involved in producing this Roadmap.

- Access to the power grid for the electricity supply required
- Permit processes that are predictable and fast
- Access to raw materials and energy at competitive prices

OUR VISION AND GOALS TO ACHIEVE CLIMATE NEUTRALITY AND ACCELERATE THE CHEMICAL TRANSITION

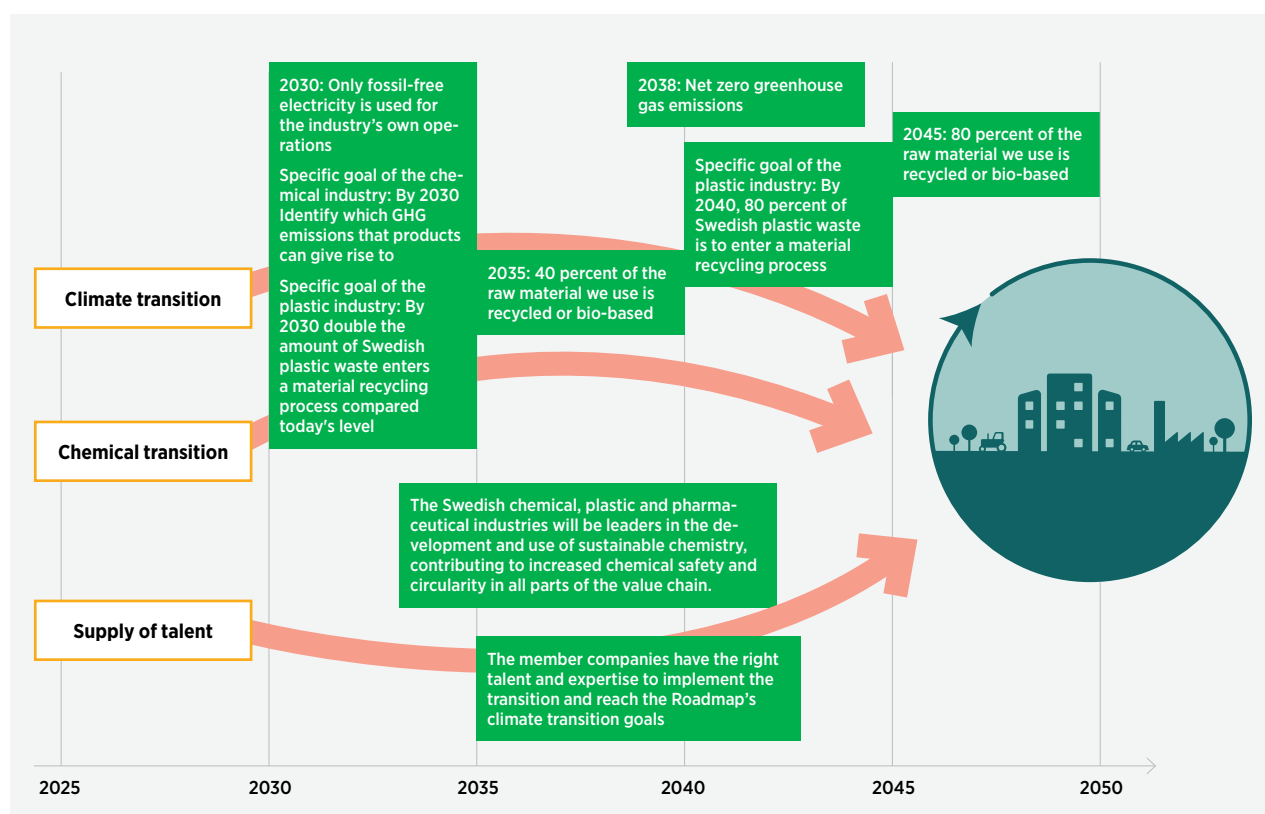
As part of the national Fossil Free Sweden initiative, we as the industry and employers' organisation IKEM have produced this Roadmap to show the crucial role that

the chemical, plastic and pharmaceutical industries play in Sweden and how they can be part of the solution in attaining a sustainable and circular society. The Roadmap was developed together with many stakeholders in a thorough and collaborative process.

NECESSARY CONDITIONS AND PROPOSED ACTIONS FOR POLICYMAKERS – AND INDUSTRY COMMITMENTS

Below is a list of conditions that need to be in place and the actions that policymakers need to take, as well as the commitments of the three industries,² in order to achieve the goals set out in Figure 1 and the overall vision. The commitments and necessary conditions/proposed actions are not listed in any particular order.

Figure 1: The chemical, plastic and pharmaceutical industries' goals to achieve climate neutrality and accelerate the chemical transition



Climate transition

2035: 40 percent of the raw material we use is recycled² or bio-based

2045: 80 percent of the raw material we use is recycled³ or bio-based

The Government and/or Riksdag (parliament) is urged to:

- Ensure that there is sufficient access to circular and bio-based raw materials at a world market price.
- Encourage industry's use of sustainable bio-based raw materials from agriculture and forestry with competitive prices.
- Create incentives to increase demand for recycled and bio-based raw materials by means of, for example, a quota obligation at the EU level and through public procurement.
- Promote demand for materials/products with no climate footprint.
- Advocate for no EU limits on the use of bio-based raw materials.
- Reform the entire waste system to facilitate circularity.
- Promote mechanical and chemical recycling of materials before energy extraction or landfill deposit.
- Actively support municipalities and private actors in developing recycling plants that make use of recycled materials as a resource.
- Encourage and promote the production of biogas for industrial use to meet industry demand at a competitive price.
- Actively promote technical and regulatory development and innovation in the use of recycled and alternative raw materials.
- Develop and offer reliable and comparable calculation methods to show the difference between the emissions of virgin fossil, bio-based, recycled raw materials/products through a full lifecycle approach. This needs to be based on comparable lifecycle assessments and third-party certification.

We also would like to encourage commercial customers and brand owners to set high internal goals to increase demand for recycled and bio-based raw materials.

2038: Net zero greenhouse gas emissions

No later than 2030 the Government and/or Riksdag (parliament) is urged to:

- Secure access to fossil-free, baseload electricity at competitive prices in all parts of Sweden.
- Enable and secure connection to the power grid within reasonable timeframes in all parts of Sweden.
- Adopt new laws and provisions for faster and more predictable permit processes.
- Task county administrative boards with providing support to businesses in the permit process.
- Guarantee storage of carbon dioxide for Swedish industry at a price that is equivalent to the price in other EU countries.
- Ensure that infrastructure is in place for the fossil-free transition.
- Ensure that cross-border infrastructure is in place for transportation of carbon dioxide.

2030: Only fossil-free electricity is used for the industry's own operations

The Government is urged to:

- Secure access to fossil-free, baseload electricity at competitive prices.
- Enable connection to the power grid in all parts of the country within a reasonable timeframe.

² Recycled raw material means waste that is converted into new inputs through a recycling process. No distinction is made between industrial waste and consumer waste. Industrial residuals that have never become waste are, however, not counted as recycled waste.

³ Ibid.

Specific goal of the chemical industry: By 2030 Identify which GHG emissions that products can give rise to

For the chemical industry to reach the goal, the following is necessary:

- By 2027 the Government/European Commission offers an European standardised and comparable method for measuring and reporting product emissions.
- The Government needs to ensure that guidelines are developed and support is provided no later than 2029 to avoid double counting of emissions as far as possible.

Specific goals of the pharmaceutical industry: By 2030 the largest emission sources in pharmaceutical lifecycles and will have been determined and appropriate steps to reduce them identified

The goal includes supplies delivered to pharmaceutical companies as well as pharmaceutical use in outpatient care, inpatient care and in clinical trials.

For the pharmaceutical industry to reach the goal, the following is necessary:

- By 2027 the Government/European Commission offers an European standardised and comparable method for measuring and reporting product emissions.
- The Government needs to ensure that guidelines are developed and support is provided no later than 2029 to avoid double counting of emissions as far as possible.
- The regions and pharmacies must be active participants in efforts to identify emissions on the user side, and identify appropriate actions to reduce these emissions.

- The Government needs to initiate public procurement reform to promote pharmaceuticals with low impacts according to established standards, ensuring that patient benefits are safeguarded.

THE PLASTIC SPECIFIC INDUSTRY'S GOALS

2030: Double the amount of Swedish plastic waste enters a material recycling⁴ process compared to today's levels

2040: 80 percent of Swedish plastic waste is to enter a material recycling process⁵

For the plastic industry to reach the goals the following conditions need to be in place:

- The entire waste system needs to be reformed to reduce the use of fossil raw materials. The waste management system needs to first regard used materials and products as raw materials before they become waste.
- Reusing and mechanical and chemical recycling of materials are to be encouraged before energy extraction or disposal in landfills.
- The Government needs to steer the municipalities towards using their waste monopoly to bring about the development of recycling plants to the same extent as they did for waste incineration.
- Incineration of plastic waste should only take place when all other methods using the best available technology are no longer possible.
- The Government actively promotes technology development, innovation, upscaling and new ventures within plastic recycling and the use of recycled and alternative raw materials – both for research and upscaling.
- The Government ensures that long-term ground rules are in place for the recycling industry to strengthen the investment appetite.
- The Government clearly defines consumer responsibility to ensure that waste is sorted on the consumer side.

⁴Material recycling: According to Chapter 15, Section 6 of the Swedish Environmental Code, material recycling means processing waste to produce new substances or items that are not be used as fuel or filler materials.

⁵Ibid.

Industry commitments to reach the three common climate transition goals

- Increase the share of renewable and circular raw materials.
- Increase and expand electrification of industry processes.
- Develop and invest in technology for carbon capture such as CCU (carbon capture and utilisation) and CCS (carbon capture and storage).
- Invest in expanding recycling capacity – both chemical and mechanical.
- Invest in research and development for advanced chemical recycling.
- Invest in ways to receive larger volumes of renewable bio-based and circular raw materials.
- Cooperate and share information along the value chain to facilitate the introduction of fossil-free raw materials and intermediate products.
- Take an active role in identifying and developing what is needed to create competitive bio-based and circular value chains.
- Commit to taking part in efforts to improve and accelerate permit processes in cooperation with other stakeholders.
- Undertake awareness raising on the benefits of carbon for value chains and the need for fossil-free raw materials for society's ability to transform.
- At regular intervals identify which direct emissions and waste emissions the industry is giving rise to.

Specific commitments of the chemical industry to reach their specific goal

- At regular intervals identify which emissions the industry is giving to.
- Undertake awareness raising on the benefits of carbon for value chains and the need for fossil-free raw materials for society's ability to transform.
- Cooperate and share information along the value chain to facilitate the introduction of fossil-free raw materials and intermediate products.

Specific commitments of the pharmaceutical industry reach their specific goal

- At regular intervals identify which emissions the pharmaceuticals are giving rise to on the user side.
- Undertake awareness raising on the medical benefits of pharmaceuticals as well as their impact on the environment and climate, and the need for fossil-free raw materials and products for society's ability to transform.

Specific commitments of the plastic industry reach their specific goals

- Ensure that the products the Swedish plastic industry puts on the market are designed for recycling to increase recycling to maintain it a high level.
- Through smart design and development of products, the Swedish plastic industry will support its customers in using plastic as efficiently as possible.
- Commit to making necessary investments in recycling capacity to ensure the highest possible degree of recycling.
- Commit to increasing the inclusion of recycled plastic in products.

Chemical transition

The companies in the chemical, pharmaceutical and plastic industries in Sweden have agreed on the following common goal for achieving a chemical transition. The commitments and proposed actions are not listed in any particular order.

The Swedish chemical, plastic and pharmaceutical industries will be leaders in the development and use of sustainable chemistry, contributing to increased chemical safety and circularity in all parts of the value chain.

We urge the Government and/or the Riksdag to take the following action:

- Strengthen the development of research, innovation and implementation of safe and sustainable chemicals in Sweden by doing the following:
 - Create a national initiative (called "Kemi-kliv")

that can support the chemical industry by facilitating investment in upscaling, testing and demonstration environments, etc.

- Work with industry actors to create an innovation hub for sustainable chemistry in Sweden.
- Actively participate with industry actors in the development and implementation of the EU Safe and Sustainable by Design (SSbD) framework.
- Invest in and contribute to research initiatives to increase development and adoption of alternative and more accurate risk assessment methods and put these on the same footing as animal testing in regulatory contexts.
- Invest and provide support for the production of tools to assess chemicals in a sustainable and lifecycle perspective.
- Coordinate public procurement in regions and municipalities to increase the use of safe and sustainable chemicals.
- Foster increased competitiveness by taking the following action:
 - Appoint a national chemical coordinator under the Ministry of Business, Industry and Innovation with responsibility for coordinating strategic research projects, development and regulation, as well as enforcement.
 - Task relevant government agencies with providing the necessary conditions for innovation and use of safe and sustainable chemicals, with the aim of promoting development and competitiveness in the chemical, plastic and pharmaceutical industries.
 - Strengthen national enforcement and collaborate in international enforcement to promote innovation and development of alternatives in the Swedish market.

Industry commitments to accelerate the chemical transition

- In cooperation with stakeholders, launch an initiative in 2025 to develop common KPIs (key performance indicators) to measure and monitor development and substitution, leading to safer chemical use and circularity.

- Implement a structured process to map the substances being used and produced, based on health, environment and sustainability perspectives in all parts of the value chain.
- Prioritise development of alternatives to and substitution of chemicals, where there is a risk of undesired effects, when they are present in products used by many consumers and/or they are used in the production of many products due to their properties and functions.
- Develop and use chemicals that facilitate circular solutions and contribute to society's climate transition.
- Contribute proactively to the development of Swedish chemical policies and scientific risk-based EU legislation that can lead to safe chemical use, competitiveness and substitution if needed.

Supply of talent

The companies in the chemical, pharmaceutical and plastic industries in Sweden have agreed on the following common goal for supply of talent. The commitments and proposed actions are not listed in any particular order.

The member companies have the right talent and expertise to implement the transition and reach the Roadmap's climate transition goals

Proposed actions for the Government:

- Task universities with collaborating with the private sector to develop education programmes and courses that meet the needs of the green transition and the radical technology shifts now taking place.
- Continue to expand vocational colleges to ensure that more programmes and courses are matched with industry needs. Provide vocational colleges with more resources for marketing.
- Implement measures that improve study and career guidance.
- Improve the ability to attract and recruit top international talent by strengthening the link between academic and industrial research.
- Provide incentives to increase mobility between the private sector and academia.

Industry commitments to reach the talent supply goal:

- Provide more internships and summer work placements for students at various levels.
- Accept more students working on thesis projects at IKEM's member companies.
- Get more involved in education programmes by participating in various forums at technical colleges, vocational colleges and in university programmes and courses.
- Increase local engagement to inspire children to become more interested in science subjects through activities at science centres, science days and similar forums aimed at younger children.



A vision for climate-neutral competitiveness by 2045

SWEDEN – THE WORLD'S FIRST CLIMATE NEUTRAL WELFARE SOCIETY

Let's take a journey through time. We're going to travel two decades into the future. The year is 2045 and Sweden is no longer generating net emissions of carbon dioxide. The climate neutrality goal set at the beginning of the 2020s has finally been reached. We were the first of all the welfare societies in the world to achieve this.

The climate transition initiated a complete transformation of several fundamental systems upon which modern society is based, most notably the supply of raw materials, waste management and the production and distribution of energy. A key factor in reaching the goal of a circular and biogenic raw material supply was that companies, municipalities and regions saw opportunities for local symbiosis. By working more closely together and recognising the value of each other's value chains, resources such as residual heat, water and carbon atoms are now being used far more effectively than in the past. The transition to a circular economy has resulted in increased competitiveness and new job opportunities in Sweden.

Sweden's journey towards climate neutrality has involved making tough political decisions at the national and European levels, considerable public and private sector investments and, not least, perseverance. But the right choices were made and, half way into the new century, we are now stronger as a country than ever. We view carbon differently now as a material. Carbon has become a valuable resource and carbon atoms are no longer being incinerated as waste. A demand for carbon has been created. In crucial ways, Sweden in 2045 is a significantly more prosperous, robust and competitive country than in the past.

THE KEY TO THE FUTURE AGAIN

Two decades from now when people are asked what made the climate transition possible, they will probably point to the crucial role that businesses played. The private sector has been a driving force in reaching the goals adopted by policymakers. For several important industries and sectors the transition involved sweeping changes to both production processes and business models. Since the chemicals produced by companies in the innovation and chemical industries are and remain indispensable key components in most industrial value chains, chemistry has once again shown the way to the future.

This is reminiscent of the first industrial revolution almost two hundred years ago. In the same way as chemicals made the emergence of industry possible in the 1800s, in the decades leading up to 2045 chemicals have been crucial in the development of new, energy-efficient processes, in the realisation of new technology and in industries' efforts to prolong the life of their products. The fact that global demand for chemicals in 2045 is almost double what it was 20 years earlier is a clear illustration of this.

THE INNOVATION AND CHEMICAL INDUSTRIES' UNIQUE CONTRIBUTION TO CLIMATE NEUTRALITY

A factor that distinguishes companies in the chemical, pharmaceutical and plastic industries is that they are strong innovators. The development of new chemicals and applications has driven the development of society throughout history. For example, the discovery of penicillin at the end of the 1920s made it possible to cure many previously serious diseases and improve people's lives. Another example is Bakelite, which was invented at the beginning of the 20th century. It was the first

“In 2045, as we look back, it is clear that chemical industry and technological breakthroughs that companies made were entirely crucial for Sweden's journey towards climate neutrality”

plastic to be manufactured on an industrial scale and it was the obvious choice of the emerging electronics industry thanks to its good electrical insulation properties and low price. Phasing out chlorine gas in the paper bleaching process and replacing it with hydrogen peroxide and chlorine dioxide is another example of successful chemistry that put Sweden and Scandinavia on the map.

In 2045, as we look back, it is clear that the chemical industry and the technological breakthroughs that companies made were entirely crucial for Sweden's journey towards climate neutrality.

- **What was considered waste has become new raw material**

A significant proportion of harmful emissions have historically come from the combustion of carbon-based fuel. As late as in the 2020s Sweden was importing household waste from other countries, which was then incinerated to generate heat and energy. Two decades later this type of activity is a distant memory. In 2045 Sweden has essentially stopped burning waste. Waste is quite simply regarded as far too valuable a raw material to be incinerated. Municipalities and private waste operators alike

have adopted a new course in their waste management and are now recycling waste to create the most important raw material streams of the future.

In 2045 the carbon cycle is now closed. Due to the expansion of both mechanical and chemical recycling over the past few decades, carbon atoms are now being used as inputs in the production of everything that humans need, including vaccines, clothes and clean drinking water. Materials that bind carbon atoms over their lifetime are considered a resource, providing new raw materials for industry once they have served their initial purpose. This technology is mitigating further emissions of greenhouse gases (GHG) while also reducing the need for virgin fossil raw materials, thus saving the earth's resources.

- **Carbon dioxide – from problem to valuable resource**

In 2045 carbon dioxide is captured and incorporated and used as an input material in the production of new products. Carbon dioxide is, for example, used as a raw material in the production of methanol which in turn is used for new materials such as plastic. By turning carbon dioxide into chemicals and materials, various industries are also supplied with valuable inputs such as polymers and plastics.

In the space of two decades Sweden has fully integrated new, physical infrastructure for carbon distribution. A cross-border pipeline system links Sweden with its neighbouring countries. Through these pipelines carbon dioxide is delivered at competitive prices, especially to the chemical industry.

- **Securing a supply of carbon has required large volumes of biogenic raw materials**

As production increases with growing prosperity, a supply of new carbon atoms is also needed – even though there is a fully functional carbon cycle – to meet the needs of the chemical, pharmaceutical and plastic industries. In 2045 biogenic carbon raw materials have become the most important source of fossil-free carbon atoms for industry, while at the same time biological diversity is being protected.

For Sweden this development has meant that it has been possible to make use of the country's plentiful forest raw materials, such as shavings and chips, as well as agricultural residuals generated within the country. The increased value of forest raw materials has enabled investments vital for society to be made, such as the expansion of the infrastructure for biomethane distribution.

- **The chemical transition has secured a supply of safe and reliable products**

Chemicals have helped to make our communities more prosperous, safer and more resilient, and there is broad understanding of the role chemicals play in modern society.

Companies in the innovation and chemical industries have a commercial and intrinsic motivation to make their production processes more efficient, minimise raw material use and improve the properties of their products. The decision that was taken at the beginning of the 2020s to accelerate the chemical transition has been a crucial factor in mitigating the risk of chemicals harming the environment. The Government and the private sector have worked together to build world-leading research collaboration to develop and commercialise new chemistry. This has become an export success for Sweden.

The EU's REACH Regulation (Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals) gave the EU an early lead in efforts to promote safe substances and increase the use of alternatives. It has served as a global role model and resulted in more globally harmonised regulation. Global harmonisation has also resulted in enforcement of the market, which had long been lacking.

STRONG INNOVATION AND CHEMICAL INDUSTRIES ARE SIGNIFICANT FOR THE SWEDISH ECONOMY

New, innovative technologies have been crucial in Sweden's journey towards climate neutrality. In 2045 the companies in the innovation and chemical industries operating in Sweden, are considered to be the very best

in the world in sustainability and innovative chemistry. The chemical clusters around the country are the most coveted research and innovation environments in the EU. Outstanding research and top-class manufacturing of advanced biopharmaceuticals that are more effective and have fewer side effects than conventional medicines have improved Sweden's attractiveness. In 2045 Sweden is an attractive place with a favourable climate for investment in new and exciting projects. It is therefore also a highly attractive destination for international researchers who want to be at the forefront of research and development.

“Boasting one of the highest levels of value added and constantly growing exports of high-quality products, companies in these industries are providing jobs, contributing to growth and strengthening Sweden’s international reputation”

Just as at the beginning of the 2020s, the innovation and chemical industries are absolutely crucial for Swedish prosperity. Boasting one of the highest levels of value added and constantly growing exports of high-quality products, companies in these industries are providing jobs, contributing to growth and strengthening Sweden's international reputation. The predictions of how many new jobs this development might create have been exceeded time and time again.

The increased significance of chemistry has also made it necessary to include chemicals in emergency preparedness plans. The sustained strong position of the industry in Sweden is allowing us to build up stocks of chemicals that are critical for society as well as chemical-based products. Having a supply of everything from pharmaceuticals and hygiene products to the input chemicals vital to industrial supply chains is crucial to ensure that basic services in society continue to function, even in the event of an emergency or war. In this context the closer cooperation that exists within the EU is vital for ensuring that European industries have access to the chemicals they need for their production.

Sweden's leading position is clearly evident in 2045. The strong development of these industries was, however, never a given. Unlike the mining and forestry industries, whose raw materials are found literally in or growing from the ground, the innovation and chemical industries' continued existence in Sweden depends on the conditions provided for the companies operating in these industries. Sweden's implementation of forward-looking reforms created the right conditions for major investments, which in turn enabled Sweden to become the world's first climate-neutral, circular and competitive welfare society at the same time as it increased chemical security.

CLIMATE NEUTRALITY REQUIRES VIGOROUS EFFORT

Our vision is aimed at a future that is two decades away. That may seem like a long time, but taking into account political terms of office or industrial investment cycles, it is actually just around the corner. There are also multiple challenges to overcome. Realising the vision will require foresight and radical reforms, close cooperation between private and public sector actors, and unleashing the drive and innovative power of business and industry.

The climate transition and increased circularity offer good financial opportunities for a country like Sweden. Sweden's industrial companies are already world leaders in innovation and in their focus on the climate and environment. With the right conditions in place they will be able to drive the future transition towards sustainable production globally.

Companies in the innovation and chemical industries

have the desire, drive and ability to help Sweden reach the 2045 climate neutrality goal. In this Roadmap the goals are described for the industries' journey and identifies the decisions that policymakers need to take so that opportunities can be realised.



The innovation and chemical industries – an introduction

PEOPLE'S LIVES DEPEND ON CHEMISTRY

Possessing knowledge and understanding of chemical properties is essential for the basic functions of modern society. These properties also provide essential aspects of people's everyday lives. Without chemicals it would not be possible, for example, to remove waterborne diseases from our drinking water or maintain high standards of hygiene in healthcare. Chemicals are also used in the home in green and effective cleaning products, as well as in food preparation and to increase

the shelf life of our food. We could draw up a long list of the roles that chemicals and their properties play in our everyday lives.

Chemistry is also crucial for Swedish industry. Almost all the goods we produce – a full 96 percent – are in some way dependent on chemistry. This includes the medicines that relieve pain and cure deadly diseases. Today, people in the EU are living almost 30 years longer than they did a century ago. The ability to use chemicals

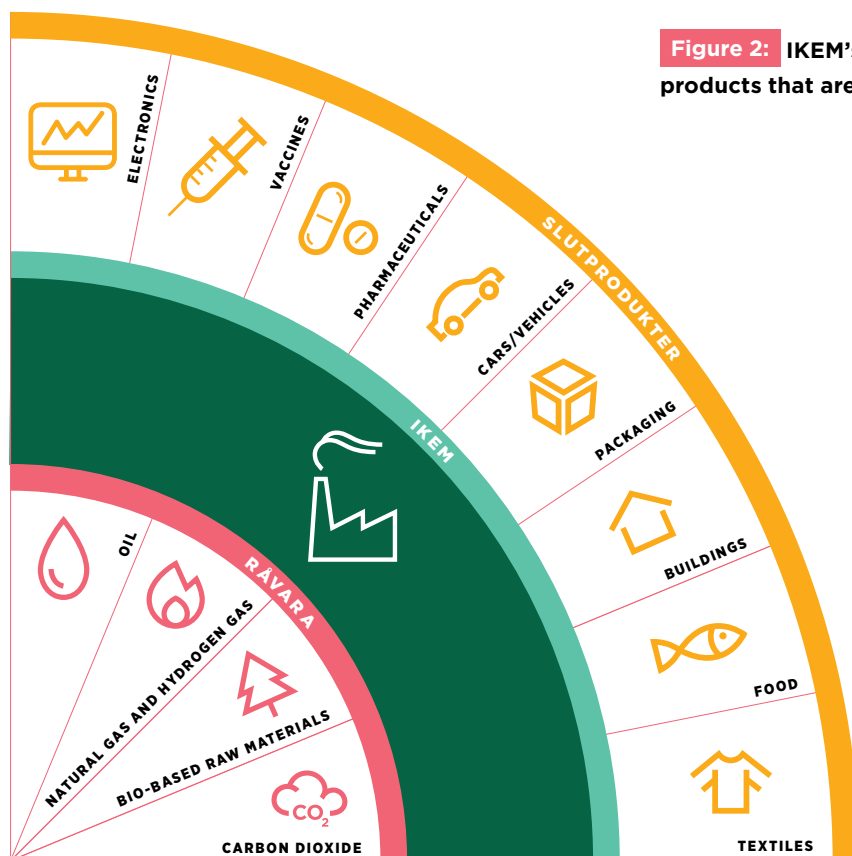


Figure 2: IKEM's members turn raw materials into products that are vital for society

has improved people's living conditions and enabled many to live longer, healthier and more productive lives. Chemicals have also enabled us to maintain a standard of living that our ancestors could only dream about. Chemistry is absolutely crucial in all other types of industrial production as well and therefore also essential for Sweden's economic and social welfare.

People's knowledge and curiosity about chemistry goes way back in history. Groundbreaking discoveries have laid the foundation for today's modern chemical industries. But we still have a lot to learn about chemistry and what it can do. Research in the fields of chemistry, toxicology, materials science and environmental science is constantly advancing and challenging us to re-examine old truths and seek new solutions to both small and large societal problems.

CHEMISTRY IS ESSENTIAL FOR JOBS AND SUSTAINABLE GROWTH

The innovation and chemical industries consist of companies active in Sweden in various fields, such as chemicals, plastics and pharmaceuticals. The common denominator is chemistry. These companies develop and produce everything from basic and speciality chemicals, products made from plastic and rubber to advanced pharmaceuticals.

The companies are and have long been crucial for Sweden's economy and competitiveness, contributing in multiple ways. First and foremost, these companies are vital for Sweden's exports. Around 85 percent of what they produce is sold to other countries. In 2022 IKEM member companies accounted for 24 percent of Sweden's goods exports and 20 percent of value added.

The chemical industries are also a vital driver of jobs. 10 percent of all those employed in Swedish industry work within the pharmaceutical, chemical, rubber, plastic, refinery and cement industries – around 70,000 people. But this is not the whole story. Many of the companies – especially those conducting research – are high tech and thus generate jobs in other industries as well. Every job at these companies generates an additional two or three jobs in other sectors.

NO CLIMATE TRANSITION WITHOUT CHEMISTRY

The importance of chemistry for modern society is matched by its importance for the climate transition being implemented in Sweden and around the world. Chemical products and materials are part of all value chains, which means that the inputs produced by companies in the innovation and chemical industries are indispensable for all industrial activity (Figure 2).

“Chemicals are essential for our ability to develop all the technologies required to produce fossil-free electricity”

Chemicals are essential for our ability to develop all the technologies required to produce fossil-free electricity, but they are also indispensable components in the high voltage cables needed to transport fossil-free electricity with minimal energy losses.

Industries that want to reduce their emissions and create circular flows also depend on chemistry. Industrial gases are necessary as raw materials but also in process optimisation. Examples of important gas raw materials for the chemical industries include hydrogen gas and methane, but carbon dioxide is also expected to play an increasingly important role as a raw material in the climate transition.

The automotive industry is an example of an industry that needs chemicals to manufacture batteries. Chemicals are also needed to produce sustainable, safe and recyclable materials for cars and lorries. We need chemicals in order to replace petrol and diesel with fuel made from renewable and recycled materials.

Chemicals remain a vital part of the modern forest industry. They are used, for example, to improve tree growth,

combat pests and diseases and to increase carbon uptake in the soil.

AN INDUSTRY OF THE FUTURE WITH GROWING TALENT NEEDS

Companies in the innovation and chemical industries have employees ranging from operation technicians and chemists to environmental engineers and business economists. Companies operating in Sweden employ people from all around the world. Since many of the companies are competing in the global arena, securing the right talent and expertise is crucial in order to attract and retain investments from abroad.

“The green transition, innovative advances and technology shifts are changing professional roles and adding new ones”

levels of education. One major challenge is the declining interest among students in Sweden in enrolling in STEM (science, technology, engineering and mathematics) programmes. More and more students in years four to six have a negative opinion of natural sciences subjects, and knowledge levels as measured by PISA (Programme for International Student Assessment) are falling. The result is that natural sciences and technology programmes have empty spaces or that students are dropping out of programmes relevant to the innovation and chemical industries.

The main skills in demand are those gained at the post-secondary level, i.e. in higher vocational and university education. Having employees with a post-graduate education is also vital to attract future investments to Sweden in competition with other countries.



The chemical industry in Sweden and throughout Europe is facing significant challenges. The green transition, innovative advances and technology shifts are changing professional roles and adding new ones. Over the next three years companies in the process and pharmaceutical industries will need to recruit more than 20,000 employees. Meanwhile Sweden has an ageing population and is facing a major wave of retirements. Companies are finding it increasingly hard to find the right personnel. More than three-quarters of companies in the chemical industry are experiencing recruitment difficulties. As other industries are also in need of science and technology expertise – both at the specialist and basic levels – this competition in the job market is only going to increase.

If chemical industry companies are to remain competitive and also reach the 2045 climate neutrality and chemical transition goals, they will need talent with various



Chemistry's role in various value chains – current examples

This chapter describes some of the work of IKEM's member companies do to improve human conditions and contribute to the green transition.

CHEMISTRY FOR CLEANER MEDICINES

Pharmaceutical manufacturing involves some of the most complex production processes that exist. One crucial step is purifying the active ingredient. Nouryon in Sweden develops and manufactures a substance called Kromasil® that is used to purify pharmaceuticals – an important element in modern pharmaceutical manufacturing.

- “You’ve probably heard of Ozempic, the diet drug based on GLP-1 (glucagon-like peptide-1) receptor agonists. It’s actually a diabetes drug and is one example of what Kromasil® can do. Our technology purifies medicines in a cost-effective way, which is a major benefit for both health and the environment,” says Joakim Carlén, Marketing Director at Nouryon.

“Over the past few decades, society and customers have created a demand for sustainable products.”

Kromasil® is used to purify active ingredients in pharmaceuticals, thus reducing side effects and improving quality. A substance enters one end of a solid steel pipe filled with Kromasil®. Everything is then subjected to

enormous pressure. The Kromasil® particles capture and hold onto various molecules for various lengths of time, depending on what they look like. The various substances in the mixture emerge at the other end of the pipe, one at a time in sequence.

This achieves 99.9 percent purity, which meets the high standards of the pharmaceutical industry. Insulin for diabetes is another example of a drug that is purified using Kromasil®. Other purification methods exist but Kromasil® offers unique benefits:

- “We can load double the amount of active ingredients onto our particles compared with other methods, which halves the amount of solvent needed. This enables cost savings and offers significant environmental benefits as the solvents are often chemical-based.”

Nouryon is currently working on developing new products to meet the growing needs of the biotech and pharmaceutical industries.

- “Kromasil® is one example of how innovation and sustainability go hand in hand in the chemical and pharmaceutical industries. The need for purification is growing as the molecular complexity of pharmaceuticals increases and they can no longer be purified using simpler methods. By working closely with our partners, we can help provide cleaner medicines, improve process efficiency and safeguard the environment.”

INNOVATION AND SUBSTITUTION THAT CREATE VALUE

Innovation and substitution are both fully integrated aspects in chemical industry business concepts. If companies fail to constantly develop their product portfolios



Photo: Nouryon

to meet customer needs and expectations as regards functionality, safety, sustainability and economy, they will quickly become less competitive. Over the past few decades, society and BASF customers have created a demand for sustainable products. BASF are committed to understanding these evolving expectations and using these opportunities to develop further and minimise risks. BASF has developed TripleS, a tool for working strategically and with a long-term perspective to steer the product portfolio towards environmental, social and financial sustainability.

- “TripleS stands for Sustainable Solution Steering and it is helping us at BASF and our customers to identify and prioritise the substances we need to find substitutions for. It is important to be able to use chemicals while ensuring compliance to current and potential future regulation for our customers,” says Mark Meier, CEO of BASF Nordic/Baltic.

After analysing the positive and negative effects of all 45,000 chemicals in the product portfolio throughout their lifecycle, they can be divided into five categories: Pioneer, Contributor, Standard, Monitored and Challenged. The products that are placed in the Pioneer category exceed the market’s sustainability assessment stan-

dards. In the Challenged category we find, for example, products that include substances of very high concern (SVHC) or where there are clear indications of regulation in the near future. In 2022 BASF updated this method to further steer their product portfolio towards substances linked to our transformation process, in areas such as climate change and energy, resource efficiency and circular economy. Through this update BASF have integrated TripleS assessment even more deeply into evaluations of our R&D processes, including taking into account the requirements set out within the framework of the European Commission’s Safe and Sustainable by Design.

- “Almost half of our products fall into the two categories with the highest ranking. Less than 2 percent are in the lowest ranked category. However, by reviewing our product portfolio systematically in this way, we are ensuring that our resources are focused on the substances where finding alternatives can make the biggest difference – both for us and for our customers,” says Meier.

Knowledge about chemical substances is constantly increasing through research, and a revision of the REACH Regulation is anticipated. Together this will lead to changes in the categorisation of substances

Figure 3 BASF’s method to increase sustainability – Triple S



“In order to produce climate-neutral vehicles it is necessary to eliminate emissions from raw material extraction, material manufacturing, product manufacturing and recycling”

according to the TripleS method. This is precisely why a tool is needed that ensures that the right substances are being prioritised when there are so many rules and regulations to follow.

In this Roadmap the industry commits to work in a more structured and transparent way on substitution, and if TripleS can serve as a source of inspiration to others, that is a very good thing.

GREEN CHEMICALS THE KEY TO CLIMATE-NEUTRAL ELECTRIC VEHICLES

Polestar's ambition is to produce the world's first climate-neutral vehicle. Chemical company Sekab is helping to make this vision a reality.

Although the electric vehicle market is growing, the transport sector is still expected to account for a large share of emissions in the future. Swedish electric vehicle manufacturer Polestar wants to demonstrate that reducing emissions from production lines is also possible. In partnership with leading industry actors, including chemical company Sekab, the Polestar O project aims to identify and eliminate emissions generated in material manufacturing.

- “We are in the process of mapping the production processes for different materials in the vehicle in order to identify the chemicals being used today. We

will then ask ourselves how these can be produced without greenhouse gas emissions, for example by finding bio-based and recycled alternatives. If we don't find an alternative, the material has to be substituted or removed. This is a major task, but we are making progress and moving in the right direction,” says Mathilda Johansson, Research and Development Engineer at Sekab, who is working on the project.

In order to produce climate-neutral vehicles it is necessary to eliminate emissions from raw material extraction, material manufacturing, product manufacturing and recycling. Chemicals are a crucial component in the electric vehicle battery itself but are also vital for building sustainable and safe vehicles. Sekab, which produces bio-based chemicals in Örnsköldsvik, is hoping to be able to replace fossil chemicals with ethanol-based alternatives.

- “Chemicals are essential in many vehicle components, and are used both directly and indirectly in materials and their manufacturing processes. To achieve a climate-neutral vehicle, all fossil chemicals need to be phased out and replaced with emission-free ones. Bio-based and circular chemicals are therefore essential for a sustainable society in the future.”

The Polestar O project has attracted a lot of attention both in Sweden and internationally since its launch in 2021. Johansson is convinced that other industries are watching this project with considerable interest and that several of them will take a similar path in the future.

- “Cars are a very good example of a complex consumer product composed of a huge variety of materials. The solutions being developed within Polestar O will likely be able to be implemented in the manufacture of many other products as well.”

CHEMICALS VITAL FOR FOSSIL-FREE ELECTRICITY

To achieve climate neutrality, we need to produce power from sources such as wind and solar. Without chemicals these renewable energy sources would not be a realistic option.

Although wind power is nothing new, it was not until modern times that it began to make up a substantial proportion of society's energy mix. The rapid expansion



on of wind power over the past few decades has been made possible by, for example, new sustainable and lightweight composites.

- “The design of wind turbines and rotor blades is extremely complex. Specialist chemicals are crucial in ensuring that the materials used, such as carbon fibre composites, are sufficiently light and possess the right properties,” says Staffan Asplund, Vice President Product Stewardship & Regulatory Affairs at chemical company Nouryon in Gothenburg.

High-performance materials are also needed for the cables that distribute electricity to homes and businesses. Cables that are laid underground or on the seabed need casings that provide both perfect insulation and protection against outside elements. Meeting these needs requires advanced chemical processes and specially developed chemicals. Polyethylene cables are, for example, produced by Borealis, a chemical company in Stenungsund that sources its chemicals from Nouryon, among others.

Once the tall wind turbines are in place, the maintenance process needs to be as easy as possible. The

lubricant used for wind turbines needs to tolerate large temperature fluctuations and, most importantly, it must not degrade.

- “This requires synthetic lubricants specially designed for the purpose.”

Chemicals are also vital for solar energy. Semiconductors in solar cells obviously contain chemicals, but so do the panels themselves. To function properly they need to be able to handle heat, cold and precipitation, while also allowing sufficient light transmission. They should preferably also be self-cleaning. Modern chemicals and methods now make it possible to produce these types of materials.

Chemicals can also reduce the amount of energy needed, for example by changing the properties of paint.

- “In Sweden we talk a lot about the energy we use for heating, but in many parts of the world energy is instead used for cooling. By adding smart chemicals to roof paint the painted surface can reflect more sunlight and thus reduce the heating effect and the amount of cooling needed inside a building.”



How companies are working towards climate and chemical transitions – a status report

THE CLIMATE IMPACT OF THE INNOVATION AND CHEMICAL INDUSTRIES

The chemical industry producing chemicals and chemical products, basic pharmaceutical products and medicines, as well as products made from rubber and plastic account for 8 percent of industry's and 3 percent of Sweden's total direct greenhouse gas emissions. These are known as Scope 1 emissions (Figure 4).

Thanks to Sweden's favourable electricity mix, Scope 2 emissions are very limited. Many companies also have contracts for the supply of a large share of renewable electricity, further limiting Scope 2 emissions.

Scope 3 emissions and climate impact from raw material chains, transport and end-use are very high in relation to both Scope 1 and 2. Sweden's chemical industry is part of the global raw material and end-product market, in which there is currently a low degree of circularity and carbon recycling.

HEAVY DEPENDENCE ON FOSSIL RAW MATERIALS AND ENERGY

Companies in the innovation and chemical industries are heavily dependent on fossil raw materials. There are historical explanations for this but it is also a matter of access to alternatives. Breaking this fossil dependence will be possible but it will require substantial changes.

Many chemical products, such as plastics and pharmaceuticals, are currently produced using fossil raw materials such as oil and natural gas. These fossil oils and gases are the source of the raw materials used to synthesise various chemicals and products. Fossil raw materials are also used in the manufacture of solvents

Scope 1 – Direct emissions

These are direct emissions from sources owned or controlled by a company. These could be emissions from processes or from the company's on-site energy use, such as natural gas and fuel, and refrigerants. Scope 1 also includes emissions from the company's vehicle fleet, such as company cars and lorries.

Scope 2 – Indirect emissions

These are indirect GHG emissions from purchased or procured energy, such as electricity, steam, heating or cooling, which is produced outside the plant and consumed by a company. One example is electricity purchased from a power company.

Scope 3 – Other indirect emissions

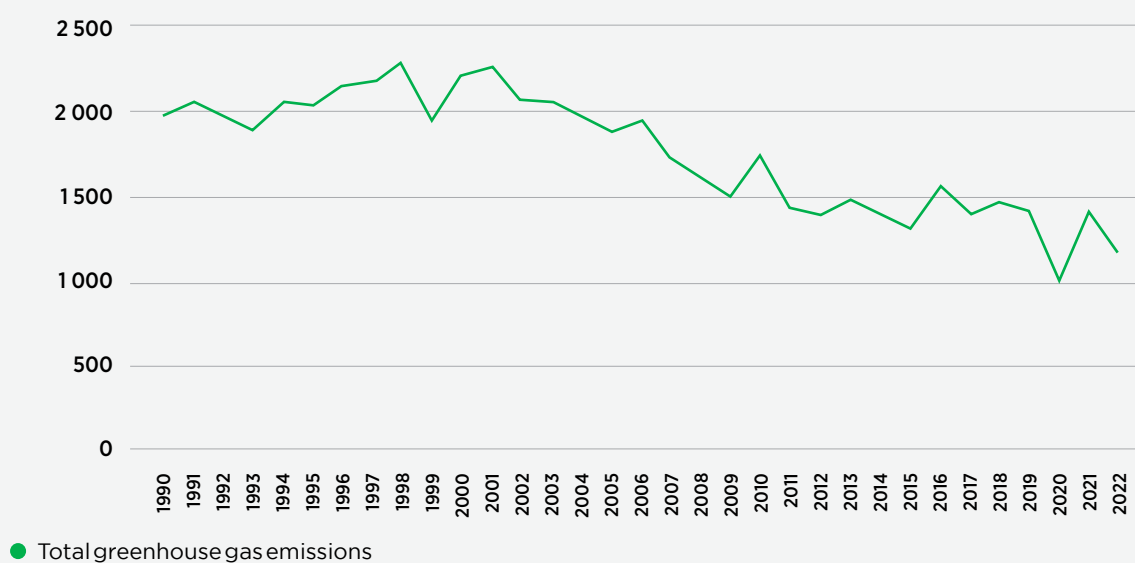
These are indirect GHG emissions that the company does not own or control. These could be both upstream and downstream emissions. Examples of upstream emissions are those arising from purchased goods and services or staff travel to and from the workplace. Downstream emissions could come from processing or use of sold goods, or waste management relating to sold goods.

as well as other chemicals used in actual chemical processes, for example in the pharmaceutical industry.

Fossil dependence is linked to energy requirements as well. Industries require large amounts of energy for the



Figure 4 The total direct greenhouse gas emissions of the chemical, plastic and pharmaceutical industries in Sweden



processes they use to turn raw materials into finished products. Fossil fuels are often used as the primary energy source for these processes, either through direct combustion or as raw material to produce electricity or heat. Fossil fuels are also used in the transportation and distribution of chemicals and products within the chemical industry.

THE COMPANIES' ONGOING EMISSIONS REDUCTION INITIATIVES

Despite the extent of the challenge, companies in the Swedish chemical, plastic and pharmaceutical industries have for many years been working in various ways to reduce the climate impact of their operations and processes, in particular by focusing on energy efficiency and resource use.

Many companies are investing in energy efficiency improvements and transitioning to fossil-free energy sources to reduce the amount of fossil fuels they use. This mainly involves investing in ways to optimise existing production processes and in electricity production to replace the fossil fuels used to operate the plants.

Sweden has a large supply of forest-based and agricultural raw materials. There are already companies in Sweden that use or are converting to using bio-based raw materials to decrease the amount of fossil raw materials they need and to reduce their carbon emissions. They are doing this while also continuing to take biodiversity into consideration.

Several companies are also developing technologies for both chemical and mechanical recycling to enable used materials and chemicals to be recycled and converted into new products to replace fossil raw materials. Within the plastic industry, for example, more and more plastic waste is being used to produce new plastic components through mechanical recycling.

The Swedish innovation and chemical industries are world renowned for being at the forefront of research and development. The same is true of their climate initiatives. Companies are investing in innovative R&D to find new, sustainable solutions and materials to replace fossil raw materials and chemicals. This includes developing and producing new bio-based materials and identifying new applications for recycled materials.

“The Swedish innovation and chemical industries are world renowned for being at the forefront of research and development.”

CHEMICAL USE REQUIRES MANAGEMENT OF CONFLICTING OBJECTIVES

One of the most comprehensive and effective chemical regulations in the world today is the EU REACH Regulation. It requires industry actors to produce data on the chemicals they manufacture or import in order to manage them safely. The substances that cannot be managed safely may be regulated or banned under the REACH Regulation. REACH is designed to ensure harmonisation of risk assessment and management of the substances throughout the EU. This is crucial if we as a society are to benefit from chemicals without allowing them to cause harm to health and the environment. Chemicals are sometimes associated with inherent conflicting objectives – the same chemical could be essential but also highly dangerous. One example is tensides. These are used in detergents to dissolve fat and dirt, but they can also be irritants and can cause skin damage if used incorrectly. If the risk of skin irritation is reduced then this also reduces the cleaning effect of the tensides. Conflicting objectives of this type and others need to be managed to enable us to produce all of the advanced and everyday materials that we take for granted in modern society and that are needed for the climate transition ahead of us. It is therefore not advisable to set goals for fully phasing out substances based on individual hazardous properties.

DEVELOPMENT AND INNOVATION FOR SAFE AND SUSTAINABLE CHEMISTRY

Chemicals are used because they fill a function. A chemical transition involves a process of substitution where-

by we constantly evaluate the chemicals we manufacture or use, and continually replace them with alternatives that are safer, more economical or more sustainable, without significantly compromising on effectiveness.

The REACH Regulation is a fundamental aspect of society's efforts to ensure safer chemical management and, as a whole, serves as an important driver to create incentives for innovation. But it is not the only driver. To make development and implementation of safe and sustainable chemistry a reality – and for the REACH Regulation to reach its full potential – multiple incentives need to work together.

Substituting chemicals based on various driving forces in society has always been an integrated aspect of companies' innovation strategies and is essential for their long-term competitiveness. In some cases, regulation has been the main driver of substitution; in other cases functionality or customer expectations have driven the process. Changing chemical use is nothing new, in other words. It has been an ongoing process in which various policy tools have been created to control the speed at which chemicals can be substituted throughout a value chain. For the chemical industry in Sweden chemical transition means the pace of the process whereby chemicals are evaluated and replaced by other, safer and more sustainable chemicals.



Companies' ongoing climate efforts

CARBON DIOXIDE IS BECOMING A VALUABLE RESOURCE

Chemicals of various types are crucial resources in modern society, but are also vital for the climate transition. The way in which basic chemicals are produced is therefore significant. Without fossil-free chemistry, there would be no fossil-free materials and products. Perstorp, a company located in Stenungsund in west Sweden, has plans for an advanced factory to produce sustainable methane. The initiative is called Project Air. The goal of the project is to reduce total carbon emissions by 500,000 tonnes a year.

- “This is equivalent to the emissions of all of Sweden's domestic flights,” says Cecilia Svensson, Executive Vice President Sustainable Transformation at Perstorp.

Methanol is a cornerstone of the modern chemical industry. Perstorp currently uses 200,000 tonnes of fossil methanol a year at its various production locations around Europe. A number of technologies are now being combined to replace all of this with green, sustainable methanol. The sources are renewable hydrogen gas, bio-gas and residual flows from production – and perhaps most strikingly, captured carbon dioxide.

- “This is what we call green chemistry. By substituting fossil production methods and chemicals with green methods and products, we can completely change our climate footprint. Through Project Air we can turn carbon dioxide into a resource. Instead of emitting carbon dioxide into the air, we are capturing it and using it as a raw material for chemical production.”

This shift towards viewing carbon dioxide as a resource is increasingly gaining a foothold in the chemical industry. We talk about the carbon cycle – how carbon circulates in new cycles and is used in ways that do not harm the climate and the environment.

- “We and our industry colleagues have a clear vision for the future. It's a future where carbon dioxide is a valuable resource that we want to take advantage of; where we buy and sell carbon dioxide and transport it through pipelines between production locations and factories. I think this is the key: changing our view of carbon dioxide and recognising its value – how we can utilise something we previously considered to be waste. We humans seem to be good at making a mess, but we are also really good at cleaning up after ourselves.”

SMALL PLASTIC STREAMS ADD UP

AstraZeneca is running several parallel initiatives to reduce its climate and environmental impact, and to promote sustainability throughout the pharmaceutical value chain. This involves establishing circular flows, optimising production processes and partnering with other actors.

- “Health and sustainability go hand in hand. It's about looking at all existing processes and always challenging. For example, by just saving surplus plastic from the ampoules we produce, we are able to recycle more than 1,000 tonnes of plastic every year in a high-quality residual flow,” says Marika Du Rietz, Regional Sustainability Lead at AstraZeneca.

Du Rietz describes how plastic recycling methods are constantly being improved. Plastic that was previously categorised as waste is now sold as high-quality raw material to a local producer of plastic bags, which in turn are reintegrated into AstraZeneca's production in a circular flow.

AstraZeneca has also launched a pilot project together with Apoteket AB, Tamro and Remondis – the first of its kind – to recycle parts of inhalers. The plastic holders from used inhalers are collected from patients and sent to a recycling plant where they are cleaned, ground down and reused to make new plastic products for other industries.



- “Around a third of all the plastic holders are handed in to Apoteket AB and successfully recycled. In Sweden we are good at handing in medicines, and this has been a success factor for our pilot project,” says Du Rietz.

In addition to plastic recycling, AstraZeneca is also recycling and reusing solvents as part of the company's green chemistry programme. This includes product design and how manufacturing processes are set up to minimise waste and environmental impact.

There is also a major emphasis on energy efficiency and the transition to renewable energy sources. AstraZeneca in Sweden has reduced its carbon emissions from its own operations by 98 percent since 2015.

- “We have plenty of initiatives in the pipeline to strengthen our sustainability efforts. With the ampoule example, we are now taking the next step to close the plastic cycle and use the surplus to make new ampoules. Nothing goes to waste!”

NOW WE CAN RECYCLE ALL HOUSEHOLD PLASTIC PACKAGING

At Site Zero, the new sorting and recycling plant of Swedish Plastic Recycling in Motala, the ground has been laid to recycle all plastic packaging from Swedish households.

Site Zero can sort 200,000 tonnes of plastic per year. On a 5 kilometre conveyor belt 1,000 items of packaging are sorted every second. Up to 95 percent of the plastic packaging entering the facility can be sorted and separated for recycling.

- “The plastic comes to us and goes through a fully automated process. First it is separated into soft and hard plastic, after which it is sorted into 12 different fractions using advanced infrared technology. This allows us to recycle the plastic while retaining its quality”, says Linnea Granström, Climate and Environmental Strategist at Swedish Plastic Recycling.

The plant was designed to meet future demand. Today only about half of all plastic packaging that Swedish Plastic Recycling's customers put onto the market is separated at source, i.e. by households. Increasing the amount collected for recycling is crucial going forward.

The municipalities have recently taken over responsibility for this and are also going to expand kerbside collection from all households between now and 2027. Granström welcomes this:

- “It will increase the amount of waste collected by making it easier to sort and separate waste at source. Today we also accept plastic packaging from our Nordic neighbours in order to utilise our full capacity, but the goal is to be able to recycle all plastic packaging from Swedish households. This requires improved collection rates and better design for recycling. We are working closely on this with municipalities and producers through training and guidance.”

Site Zero has enabled Sweden to take an important step towards making plastic part of the circular economy. Collecting and sorting all types of plastics and then recycling them separately is essential in creating functional circular flows and reducing the use of primary plastics.

- “We consider ourselves a facilitator in the process of reusing recycled plastic in packaging and products of an equivalent quality”, concludes Granström.



Basic premise for the goals and commitments in the roadmap

By 2045 Sweden will no longer be generating net emissions of carbon dioxide. This is a significant challenge for a society whose prosperity is built on the use of oil and gas – nevertheless it is an important commitment and a goal that is possible to achieve. The roadmaps presented up to now within the framework of the Fossil Free Sweden initiative show that Swedish companies have the knowledge and willingness to reduce their process-related climate impact and to provide the products and technical solutions that the climate transition requires.

This journey – which in two decades needs to culminate in a climate-neutral Sweden – begins with the innovation and chemical industries. Just as chemistry was essential for the industrial revolution in the mid-1800s and for the prosperity it brought, chemistry today remains a necessary part of most industrial value chains where transition is either being planned or implemented. Without chemicals, few of the commitments made in the 22 roadmaps presented so far within the framework of Fossil Free Sweden can be met. We therefore also need a goal to increase the use of safe and sustainable chemicals throughout value chains – a chemical transition goal.

This Roadmap for the chemical-, plastic- and pharmaceutical industry has two overarching objectives: to reduce the climate footprint of companies and to accelerate the chemical transition. To realise these objectives, businesses and policymakers will be forced to invest significant resources. Reaching these objectives is also dependent on a number of fundamental conditions being in place.

- The industries' transition in respect of the climate and chemical transitions needs to take place **on market terms**. The introduction of new technical and digital solutions requires the right regulatory and commercial climate. By the same logic, pro-

duct manufacturing requires demand and a willingness among customers to pay for sustainability and performance. An essential aspect of reducing emissions of carbon dioxide and other greenhouse gases is the existence of a competition-neutral emissions trading system within the internal market of the EU. Policy instruments and fiscal incentives need to be designed so that they do not disadvantage any specific sector; for example, the same conditions for the supply of raw materials and fuel should apply to all actors in the market.

- Business investment requires **legal certainty**. For companies to be willing to make investments, ground rules that are in place for the long term as well as level playing fields are crucial. Environmental impact assessments of activities regulated by the Swedish Environmental Code need to have predictable processes and be efficient and fast to carry out. The REACH Regulation plays a crucial role in the harmonisation of chemical legislation within the EU. REACH must also remain the principal chemical legislation, and the regulation of chemicals according to it must have a scientific and risk-based approach. The goals described below rely on such an approach and legal certainty in order to be reached.
- The chemical, plastic and pharmaceutical industries operate in a global market characterised by significant competition for development and production facilities. Effective vital societal functions and critical **infrastructure**, such as for waste and sewage systems, gas grids, transport of goods and people, and production and distribution of electricity, are essential in order to attract new investments to Sweden. Industries need fossil-free baseload electricity at a competitive price and the ability to connect to the power grid within reasonable timeframes in all parts of the country.

- In order for the chemical, plastic and pharmaceutical industries to take advantage of the opportunities offered by technical developments and digitalisation, they need a supply of ***talent***. Swedish universities must therefore offer programmes that provide the right knowledge and skills, and businesses need to be given the right conditions to recruit top international talent.



The Roadmap's climate neutrality goals

The Roadmap of the chemical, plastic and pharmaceutical industries contains goals for reaching climate neutrality by 2045. These industries in Sweden have agreed on three common goals. Each individual industry – chemical, pharmaceutical and plastic – has also agreed on specific goals. For clarification, these goals are not for each individual actor but for the industry/sector collectively. For each goal there is a description of what is expected of policymakers and of industries' own commitments. The commitments and proposed actions are not listed in any particular order. All actors need to be proactive and turn their goals into concrete actions based on what they are able to influence and the opportunities that arise.

THE CHEMISTRY, PLASTIC AND PHARMACEUTICAL INDUSTRIES' COMMON GOALS

2035: 40 percent of the raw material we use is recycled⁶ or bio-based

2045: 80 percent of the raw material we use is recycled⁷ or bio-based

This goal includes Scope 3.

After 2045 efforts to replace the remaining fossil raw material will continue depending on the new technologies and new materials resulting from innovation. The goal is for all carbon atoms to only be bound in materials until they can be circulated again and thus not cause any GHG emissions into the atmosphere. Transformer oil is an example of a chemical product where it is currently difficult to replace the fossil raw material.

To enable the chemical, plastic and pharmaceutical industries to reach these goals, the following conditions are necessary:

- The Government and the EU secure a sufficient supply of sustainable raw materials, such as re-

“The Government needs to actively encourage industry's use of sustainable bio-based raw materials from agriculture and forestry, and prices need to be competitive.”

cycled materials, recycled carbon dioxide and bio-based raw materials at a world market price. For example, the Government must encourage the production of biogas for industrial use to meet industrial demand at a competitive price.

- The entire waste system needs to be reformed to reduce the use of fossil raw materials. The waste management system needs to first regard used materials and products as raw materials before they become waste. All waste management actors must therefore work to facilitate circularity. Reusing as well as mechanical and chemical recycling of materials are to be encouraged before energy extraction or disposal in landfills. The Government therefore needs to steer the municipalities towards using their waste monopoly to bring about the development of recycling plants, to the same extent as they did for waste incineration.
- The Government needs to actively encourage industry's use of sustainable bio-based raw materials

⁶ Recycled raw material means waste that is converted into new raw material through a recycling process. We do not distinguish between industrial waste and consumer waste. Industrial residuals that have never become waste are, however, not counted as recycled waste.

⁷ Ibid.



from agriculture and forestry, and prices need to be competitive.

- The Government and the Riksdag need to advocate and ensure that the EU does not limit the use of bio-based raw materials.
- The Government needs to actively promote technology development and innovation in recycled and alternative raw materials – in both research and upscaling.
- The Government ensures that infrastructure is in place for the fossil-free transition, such as gas pipes (for biomethane, hydrogen gas and carbon dioxide), ports and railways.
- The Government creates incentives to increase demand for recycled and bio-based raw materials, for example through quota obligations at the EU level and in public procurement.
- To promote demand for materials and products with no climate footprint, the Government needs to develop and offer reliable and comparable calculation methods. It is important to be able to show the difference between the emissions from virgin fossil, bio-based or recycled raw materials/products over their entire lifecycle, based on comparable lifecycle assessments and third-party certification.

We also urge commercial actors and brand owners need to also set ambitious internal goals for the use of recycled and bio-based materials to further increase demand.

2038: Net zero greenhouse gas emissions

This goal includes Scope 1 and 2.

To enable the industry to reach the goal, we urge the Government and Riksdag to do the following by 2030:

- Secure access to fossil-free, baseload electricity at competitive prices, and ensure and secure connection to the power grid within reasonable timeframes in all parts of Sweden.
- Adopt new laws and provisions for faster and more predictable permit processes. The Government also needs to task county administrative boards with providing support to companies in the permitting process and to develop their business promoting measures.

- Ensure that there are facilities for storing carbon dioxide for Swedish industry at a similar price to other EU countries, and ensure that Swedish industries operating in the global market are not disadvantaged.
- Ensure that there is infrastructure in place for the fossil-free transition, such as gas pipelines (for biomethane, hydrogen gas and carbon dioxide), ports (incl. for shipment of CO₂ to be stored) and railways.
- Ensure that there is infrastructure in place for the transportation of carbon dioxide through a pipeline in Sweden that also connects Sweden to other relevant countries. The Government must ensure that industries with process emissions of carbon dioxide from the use of raw materials with fossil content can connect to this pipeline.
- Guarantee that the adopted EU-ETS (European Emissions Trading System) regulations remain aligned with Fit for 55 and thus ensure that long-term and predictable conditions are in place for investments in the transition.

2030: Only fossil-free electricity is used for the industry's own operations

This goal is within Scope 2.

To enable the industry to reach the goal, the following is necessary:

- The Government needs to secure a supply of fossil-free baseload electricity at competitive prices and enable connection to the power grid in all parts of the country within a reasonable timeframe.

THE THREE INDUSTRIES' COMMON COMMITMENTS

- Increase the share and use of renewable and circular raw materials.
- Increase and expand electrification of industry processes.
- Develop and invest in technology for carbon capture such as CCU (carbon capture and utilisation) and CCS (carbon capture and storage).
- Invest in expanding recycling capacity – both chemical and mechanical.

- Invest in research and development for advanced chemical recycling.
- Invest in ways to receive larger volumes of renewable bio-based and circular raw materials. The industries are committed to cooperation and information-sharing throughout the value chain to facilitate the introduction of fossil-free raw materials and intermediate products.
- Take an active role in identifying and developing what is needed to create competitive bio-based and circular value chains.
- Commit to taking part in efforts to improve and accelerate permit processes in cooperation with other actors.
- Undertake to spread knowledge on the benefits of carbon for value chains and the need for fossil-free raw materials for society's ability to transform.
- At regular intervals identify which direct and waste emissions the industry is giving rise to.
- Awareness raising on the benefits of carbon for value chains, and the need for circular and bio-based raw materials for society's ability to transform.
- Cooperate and share information along the value chain to facilitate the introduction of fossil-free raw materials and intermediate products.
- Take an active role in identifying and developing what is needed to create competitive circular and bio-based value chains.
- Participate in efforts to improve and accelerate permit processes in cooperation with other actors.

THE PHARMACEUTICAL SPECIFIC INDUSTRY'S GOAL

By 2030 the industry will have determined which are the largest emission sources in pharmaceutical lifecycles and will have identified appropriate steps to reduce them.

The goal includes supplies delivered to pharmaceutical companies as well as pharmaceutical use in outpatient care, inpatient care and in clinical trials.

To enable the industry to reach the goal, the following conditions are necessary:

- By 2027 the Government/EU offers an European standardised and comparable method for measuring and reporting product emissions.
- The Government ensures that guidelines are developed, and that support is provided no later than 2029 to avoid double counting of emissions as far as possible.
- The regions and pharmacies must be active participants in efforts to identify and establish emissions on the user side, and identify appropriate actions to reduce these emissions.
- The Government initiates public procurement reforms. Public procurement of pharmaceuticals should be structured to promote those with low impact according to the standards produced, ensuring that patient benefits are safeguarded.

THE CHEMICAL SPECIFIC INDUSTRY'S GOAL

2030: Identify which GHG emissions that products can give rise to by 2030

This goal includes Scope 3.

To enable the industry to reach the goal, the following conditions are necessary:

- By 2027 the Government/EU offers an European standardised and comparable method for measuring and reporting product emissions.
- The Government ensures that guidelines are developed, and that support is provided no later than 2029 to avoid double counting of emissions as far as possible.

THE CHEMICAL INDUSTRY'S COMMITMENTS

To achieve the specific goal of the chemical industry, this industry is prepared to make the following commitments:

- At regular intervals identify which emissions the industry is giving rise to.

THE PHARMACEUTICAL INDUSTRY'S COMMITMENTS

To achieve the specific goal of the pharmaceutical industry, this industry is prepared to make the following commitments:

- At regular intervals identify which emissions the pharmaceuticals are giving rise to on the user side.
- Awareness raising on the medical benefits of pharmaceuticals as well as their impact on the environment and climate, and the need for fossil-free raw materials and products for society's ability to transform.

THE PLASTIC SPECIFIC INDUSTRY'S GOALS

2030: Double the amount of Swedish plastic waste enters a material recycling process⁸ compared to today's levels

2040: 80 percent of Swedish plastic waste is to enter a material recycling process⁹

The base year for these goals is 2022.

To reach these goals the following conditions need to be in place:

- The entire waste system needs to be reformed to reduce the use of fossil raw materials. The waste management system needs to first regard used materials and products as raw materials before they become waste. All waste management actors must therefore work to facilitate circularity. Reusing as well as mechanical and chemical recycling of materials are to be encouraged before energy extraction or disposal in landfills. The Government therefore needs to steer the municipalities towards using their waste monopoly to bring about the development of recycling plants, to the same extent as they did for waste incineration.
- Incineration of plastic waste should only take place when all other methods using the best available technology are no longer possible.
- The Government actively promotes technology development, innovation, upscaling and new ventures within plastic recycling and the use of recycled and alternative raw materials – both for research and upscaling.

- The Government ensures that long-term ground rules are in place for the recycling industry to strengthen the investment appetite. Rapid changes in limits and amended definitions can quickly alter the conditions in the recycling industry.
- The Government clearly defines consumer responsibility to ensure that waste is sorted on the consumer side.

THE PLASTIC INDUSTRY'S COMMITMENTS

To achieve these goals of the plastic industry, this industry is prepared to make the following commitments:

- The products that the Swedish plastic industry puts on the market will be designed for recycling to increase and maintain a high recycling rate.
- Through smart product design and development, the Swedish plastic industry will help its customers to use plastics as efficiently as possible. Examples of this could be to optimise product life and facilitate reuse and repair.
- Make the necessary investments in recycling capacity to maximise recycling.
- Increase the recovery of recycled plastic from products.

AREAS FOR REFORM

The chemical, plastic and pharmaceutical industries' goal of achieving climate neutrality by 2038 requires investments and reforms. Initiatives in the following three areas should therefore be prioritised.

1. New carbon sources
2. Climate-neutral energy
3. Residual heat

New carbon sources

Carbon, in the form of carbon dioxide from fossil fuel combustion, is contributing to the greenhouse effect. At the same time, carbon atoms are essential for almost all chemical production – from plastics, pharmaceuticals

⁸ Material recycling: According to Chapter 15, Section 6 of the Swedish Environmental Code, material recycling means processing waste to produce new substances or items that are not be used as fuel or filler materials.

⁹ Ibid.

and textiles to the chemical products needed in other industrial production. To meet the rapidly growing demand (See Figure 5), the carbon cycle needs to be closed and carbon atoms reused.

Bio-based raw materials

Bio-based raw materials are essential for the innovation and chemical industries' ability to develop alternatives to fossil oil and to reduce their emissions. The innovation and chemical industries are dependent on carbon atoms as raw material, and biogenic carbon atoms are therefore a valuable alternative to fossil-based carbon atoms. Examples of bio-based raw materials that these industries can use include biogas, ethanol, tall oil and sawdust. Several basic chemicals are already being produced using bio-based raw materials. In certain cases, however, new technologies and therefore also new investments are needed to take advantage of the bio-based raw materials. In Sweden, for example, Industrins Biogaskommission (biogas commission representing various industries) is focusing on industry access to biogas as a raw material and has identified a demand amounting to 6 TWh by 2030 for this purpose. Industry's total biogas requirement by 2030 will be

around 10 TWh, which is equivalent to half of Sweden's estimated requirement.

Sweden, with its large supplies of forest-based and agricultural raw materials, is in an excellent position to increase the use of bio-based raw material, while maintaining high standards in terms of protecting nature and biodiversity. It is fully possible to bind biogenic carbon atoms in products, not just in trees. If the carbon atoms in the products can then be reused and circulated, they will become part of a carbon sink that is sustained over time.

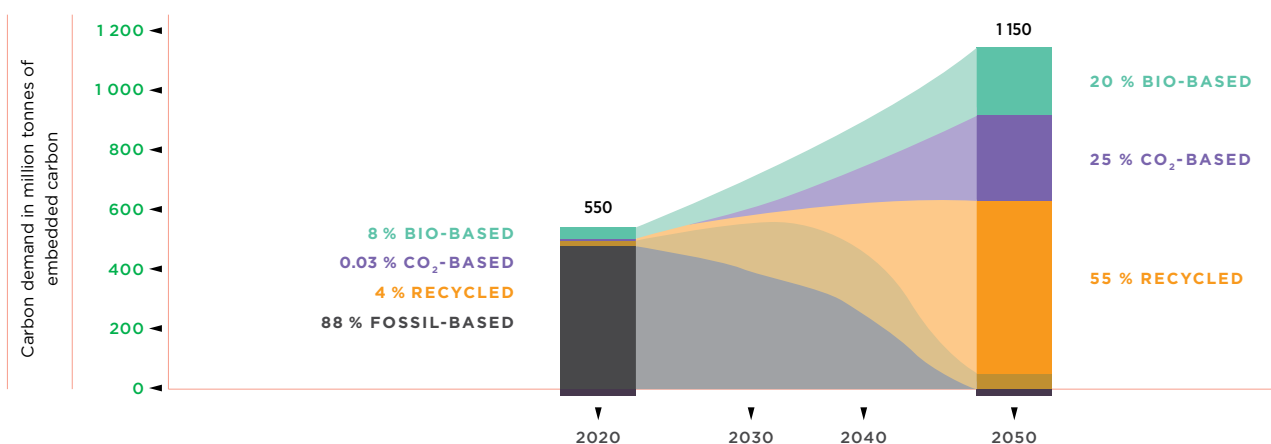
Uses for carbon dioxide

The chemical, plastic and pharmaceutical industries' unique contribution to Sweden's climate neutrality goal is the potential for their companies to use captured carbon. Carbon capture and usage (CCU) is a collective term for a number of processes where the carbon from captured carbon dioxide is put to use. By incorporating carbon dioxide in new products, we reduce the need for new fossil raw material, at the same time as we avoid direct emissions to the atmosphere. Carbon dioxide can be used as a raw material to create molecules that

Figure 5 Switching from new fossil carbon atoms to sustainable carbon involves substantial changes for many sectors in society

Source: www.renewable-carbon.eu/graphics

Carbon embedded in Chemicals and Derived Materials



can become new materials and chemicals. For example, methanol molecules can be created from captured carbon dioxide. Methanol molecules then become building blocks for further processing.

Carbon capture and storage

For many types of operations, capture and storage, as well as actual emissions reductions, will be an important aspect in efforts to achieve net zero emissions. Carbon capture and storage (CCS) is a way of collecting carbon dioxide and storing it permanently in the ground. Although CCS is a relatively new technology, projects have been implemented and initiatives are being developed in many parts of the world.

Putting today's "waste" to use

Demand for carbon atoms is expected to double over the next 25 years. To meet this demand, the carbon atoms need to remain in society's cycles rather than being incinerated and released into the atmosphere as carbon dioxide, as is the case today.

This can be done through both chemical and mechani-

cal recycling of plastic (Figure 6). In chemical recycling, the plastics are broken down to their original molecules which can then be used in the manufacture of brand new plastic raw materials or chemicals of the highest quality. In mechanical recycling, which is a more energy-efficient process, plastics are sorted, cleaned and melted down without the chemical structure of the material being affected, but with some impact on the quality of the recycled material. The benefit of chemical recycling is that it produces brand new plastic of the highest quality that can also be used for sensitive products such as food packaging, toys and medical technology products.

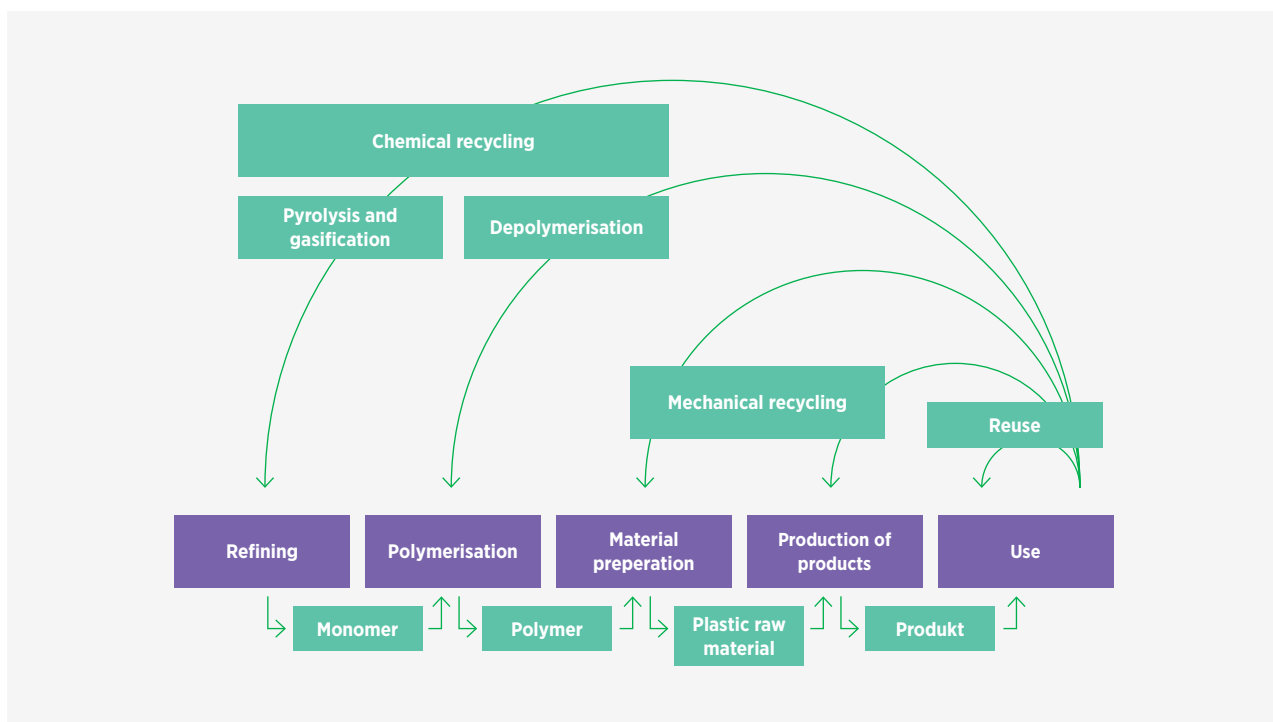
Climate-neutral energy

Biogas

Today natural gas or propane are normally used as inputs or for heating in industry. Alternatives will be needed to reduce the use of fossil raw materials and emissions from these gases. Natural gas and biogas consist of the same molecules but with different origins.

Biogas is a fossil-free alternative to natural gas. It plays an important role in Sweden's resilience and prepared-

Figure 6 How to close the plastic cycle instead of incinerating plastics.



ness since we are able to produce the gas ourselves with the right incentives in place. To ensure a supply of clean and upgraded biogas for industry at a competitive price, total biogas production in the EU needs to be increased and focused on industrial use. In its RePowerEU plan, the European Commission has set a goal for the EU to produce 35 billion cubic metres of biogas per year by 2030.

Electrification

Electrification is critical as a replacement for fossil fuels and in mitigating GHG emissions. Electrification is also critically important for alternative methods of producing certain chemical products and chemicals. Hydrogen gas, for example, is currently produced mainly from natural gas in a steam reformer, but it can instead be produced through electrolysis using no fossil raw materials at all. This process does, however, require a large amount of electricity.

Hydrogen gas is a versatile and indispensable raw material and is used in several critical processes, including ammonia production, hydrogenation of oils and fats, metallurgy, chemical synthesis and even as fuel for fuel cells.

Several of the innovative technologies that the innovation and chemical industries are developing, and that will be vital if Swedish industry is to achieve climate neutrality, require this type of fossil-free hydrogen gas.

Residual heat

There is still considerable potential to increase heat recovery, despite the fact that Sweden is a world-leader in energy efficiency and in using residual energy from industry. Residual heat can, for example, be used to produce compressed air, for greenhouse cultivation or in water purification. Industrial residual heat can also be used in local district heating systems, reducing the need to burn bio-based raw materials. The most recent calculation was carried out 15 years ago and showed that around half of the residual heat that existed in 2009 was used in local district heating systems. The extent of its potential today is unknown.

Industrial manufacturing processes in the innovation and chemical industries are highly energy-intensive. At this time more than 1.5 TWh of residual heat is delivered from IKEM's members to district heating systems around

Sweden, although the majority of the members could deliver even more. This potential is probably greatest in locations where there are well-established chemical clusters.



The Roadmap's goal for an accelerated chemical transition

While the climate transition goal involves an expressed objective of reducing the level of carbon dioxide in the atmosphere, there is no similar direct connection between the chemical transition and specific substances. As discussed in earlier chapters of this Roadmap, the chemical transition is therefore primarily a process whereby the industry's own goals and commitments will help to accelerate development and ensure safe and sustainable chemistry. This acceleration is in turn important for our ability to realise the ambitions in the REACH Regulation as well as the Riksdag's national objectives.

What do we in the chemical industry mean by chemical transition?

A chemical transition is a continuous process where chemical substances are constantly being evaluated based on their inherent properties, safe management, economy, functionality and sustainability.

The purpose is to improve one or more of the above parameters gradually and continually, without any significant negative impact on any of the others. The objective is to make it possible to use chemicals and chemistry to benefit humanity, while at the same time continually reduce negative impacts on health and the environment. Accelerating the chemical transition is about the pace of the process whereby chemicals are evaluated and replaced by other, safer and more sustainable ones.

THE CHEMICAL, PLASTIC AND PHARMACEUTICAL INDUSTRIES' COMMON GOAL FOR AN ACCELERATED CHEMICAL TRANSITION

The companies in the chemical, pharmaceutical and plastic industries in Sweden have agreed on the following common goal.

The Swedish chemical, plastic and pharmaceutical industries will be leaders in the development and use of sustainable chemistry, contributing to increased chemical safety and circularity in all parts of the value chain.

To enable the industry to reach the goal, the following conditions are necessary:

- The Government supports the development of research and innovation, and the implementation of safe and sustainable chemicals in Sweden by taking the following action:
 - Create a national initiative for the chemical industry to facilitate investment in upscaling, testing and demonstration environments, etc.
 - Work with the industry to create an innovation hub for sustainable chemistry in Sweden.
 - Participate in industry efforts to develop and implement the EU Safe and Sustainable by Design (SSbD) framework to strengthen innovation and promote the development of chemistry in Sweden.
 - Invest in and contribute to research initiatives to increase development and adoption of alternative and more accurate risk assessment methods (in silico, AI, in vitro, etc.), and put these on the same footing as animal testing in regulatory contexts.
 - Invest in and provide support to produce tools to assess chemicals in a lifecycle perspective.

- Coordinate public procurement in regions and municipalities to increase the use of safe and sustainable chemicals.
- The Government is working to foster increased competitiveness by taking the following action:
 - Appoint a national chemical coordinator under the Ministry of Business, Industry and Innovation with responsibility for coordinating strategic research initiatives, development and regulation, as well as oversight.
 - Task relevant government agencies with providing the necessary conditions for innovation and the use of safe and sustainable chemicals, with the aim of promoting development and competitiveness within the chemical, plastic and pharmaceutical industries.
 - Strengthen national enforcement and collaborate in international enforcement aimed at promoting innovation and development of alternatives in the Swedish market.
- Launch an initiative in 2025 to develop KPIs for an accelerated chemical transition to measure and monitor development and substitution, leading to safer chemical use and circularity. The industry intends to develop KPIs in an open dialogue with other stakeholders in society, such as government agencies, NGOs, academia and policymakers, and to communicate this in a transparent way.
- Implement a structured process to map the substances being used and produced, based on health, environment and sustainability perspectives, with the aim of increasing the use of safe chemicals in all parts of the value chain.
- Prioritise development of alternatives to and substitution of chemicals with undesired effects that could end up in products in widespread use by many consumers.
- Develop and use chemicals that facilitate circular solutions and contribute to society's climate transition.
- Contribute proactively to the development of Swedish chemical policies and scientific risk-based EU legislation that can lead to safe chemical use, competitiveness and substitution if needed.

Fact box: SSbD – EU Safe and Sustainable by Design framework

Safe and Sustainable by Design (SSbD) is a framework initiated under the EU's chemical strategy which aims to support innovation and the design of chemicals and products with an emphasis on safety and sustainability. By using SSbD principles in the design process, the objective is to create products and services that are good and beneficial for people and the environment throughout their life-cycle. This means using materials in a sustainable way, reducing waste and emissions, and including safer chemicals right from the start. The idea is for this to contribute to a better and more competitive economy within the EU.

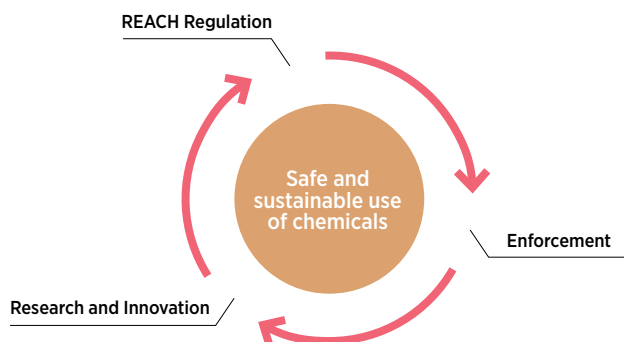
AREAS FOR REFORM

The following three areas form a common foundation to achieve the Riksdag's goal of a toxic-free environment, and the industry's goal of an accelerated chemical transition. Prioritisation and coordination in these three areas is essential. For this reason, it is proposed that a chemical coordinator under the Ministry of Business, Industry and Innovation be tasked with coordinating strategic R&I initiatives, development of policy instruments, fiscal incentives, and compliance and enforcement, as well as reforms that support companies' need for top talent. Reform of this type could result in stronger protections for health and the environment as well as improved competitiveness in the chemical, plastic and pharmaceutical industries.

THE CHEMICAL, PLASTIC AND PHARMACEUTICAL INDUSTRIES' COMMON COMMITMENTS

To achieve the chemical transition goals the chemical, plastic and pharmaceutical industries are prepared to make the following commitments:

1. Strengthen and foster innovation to develop safe and sustainable chemicals
2. Regulations that promote and lead to development and innovation to increase substitution
3. Strengthen enforcement and encourage compliance to ensure commercial competitiveness and exclude irresponsible and non-compliant actors



Strengthen and foster innovation to develop safe and sustainable chemicals

Research and innovation are critical in the process of finding alternative chemicals, which is also the basis of the EU's chemical strategy. In a country like Sweden, investments in research and innovation can strengthen competitiveness and attract new investments, while also making it possible to reach the goal of protecting health and the environment.

Sweden currently lacks support and incentives to promote the development of new chemistry within the framework of its chemical policies. This is a problem that is impeding innovation and thereby also substitution, which consequently makes it more difficult to implement REACH. For Sweden to take on the leadership role in the development of safe and sustainable chemicals, it is important to work in a strategic and forward-looking way, focusing on providing excellent conditions for research and innovation. One key area that needs to be prioritised to speed up the development of new chemistry is the technology for early risk assessment and risk screening. With the help of AI and machine learning, we have the potential to identify patterns and connections that can be hard to find using conventional methods. This could help to save time when developing new chemicals or new applications for various substances. Through automation of the testing process, researchers can assess more quickly how chemicals are interacting with biological systems and the environment.

Regulations that promote and lead to development and innovation to increase substitution

Strict regulation can improve the protection of health and the environment but may also impede innovation and implementation of new chemistry, and thereby be counterproductive.

Effective regulation must be based on scientific facts and risk assessments, and not solely on the hazardous properties of a substance. The risks associated with various types of chemicals ultimately depend on how and in which context they are handled. There are significant differences in risk levels depending on whether chemicals are handled and used in a closed industrial process or by consumers. Chemotherapy drug manufacturing is a good example. The substance that is successfully used to treat cancer and prolong the life of a person could be deadly in a different context.

Regulation of chemicals must always be based on how and in which context they are used.

Developing and launching new chemicals on the market and in value chains is a time-consuming process. To support the process, the creation of regulations and restrictions needs to keep pace with the development and implementation of safe and sustainable alternatives. This will increase the pace of substitution, decrease the risk of undesired substitutions and ultimately improve the protection of health and the environment.

Strengthen enforcement and encourage compliance to ensure commercial competitiveness and exclude irresponsible and non-compliant actors

No regulation is stronger than its weakest link. Enforcement is therefore crucial to ensure that companies can be competitive and that the rules are applied in the manner intended by the legislator. Increased e-commerce and the EU's broad and sweeping restrictions placed on large groups of chemical are imposing entirely new demands on enforcement authorities and inter-agency cooperation. It is not sufficient for individual agencies to work in isolation; enforcement needs to be planned in parallel with measures to ensure compliance and take place through cooperation between national authorities and at the EU level. Strong and effective enforcement is also an important factor in identifying irresponsible or criminal actors and enabling companies that act responsibly to do the right thing.

The Roadmap's talent supply goal

The possibility to grow as an industry while also achieving the climate and chemical transitions depends on the Innovation and Chemical Industries having access to the right skills and talents. For a long time, IKEM and its member companies have been engaging and cooperating closely, with the education sector at all levels – from primary schools, regional vocational training and science centers to specialized research schools. However, the challenges are still immense and therefore, both the industry and the government need to invest even more in talent supply.

The chemical, pharmaceutical and plastic industries in Sweden have agreed on a common goal – achieve climate neutrality by 2045 and a chemical transition.

The member companies have the right talent and expertise to implement the transition and reach the Roadmap's climate transition goals

Below is a description of what is expected of policymakers and the industries' own commitments in order to reach the goal. The commitments and proposed actions are not listed in any particular order.

The Government needs to do the following:

- Task universities with producing education programmes and courses in cooperation with the private sector so that they meet the needs of the green transition and the radical technology shifts now taking place. This includes programmes for new students as well as people already in the workforce.
- Continue to expand vocational colleges to ensure that more programmes and courses are matched with industry needs. Vocational colleges also need to be provided with more resources to market their programmes.
- Implement measures that support study and career guidance so that more students can get information

about the career opportunities that exist in the innovation and chemical industries.

- Facilitate attracting and recruiting top international talent by strengthening the link between academic and industrial research.
- Provide incentives to increase mobility between the private sector and academia, for example by providing funding for more industrial researchers.
- Increase the funds/grants for natural science educations – from primary school to university.
- Invest in professionals on how to verify their training/knowledge expertise and give advice on how to acquire further education.

THE CHEMICAL, PLASTIC AND PHARMACEUTICAL INDUSTRIES' COMMON COMMITMENTS

- Provide more internships and summer work placements for students at different levels.
- Accept more students working on thesis projects at IKEM member companies.
- Get more involved in education programmes by participating in various forums at technical colleges, vocational colleges and in university programmes and courses.
- Increase local engagement to inspire children to become more interested in science subjects through activities at science centres, science days and similar forums aimed at younger children.

