



AIMING FOR A CLIMATE NEUTRAL FINLAND

# Cap the Carbon!

The Chemical Industry combats climate change by controlling the amount of greenhouse gases emitted into the atmosphere and by using carbon dioxide in the atmosphere as raw material. At the same time, we foster well-being in Finland by creating tens of thousands of new jobs and producing tens of billions of euros worth of export products.

This vision requires investments which, in turn, require a predictable and stable society. The chemical industry in Finland also needs reasonably priced and emission-free energy, investments in innovation and the scalability of technologies, scientific and mathematical skills and skill-based immigration. Finland must remain a pioneer.

**In order for Finland to be climate neutral in 2035, decisions must be made now.**

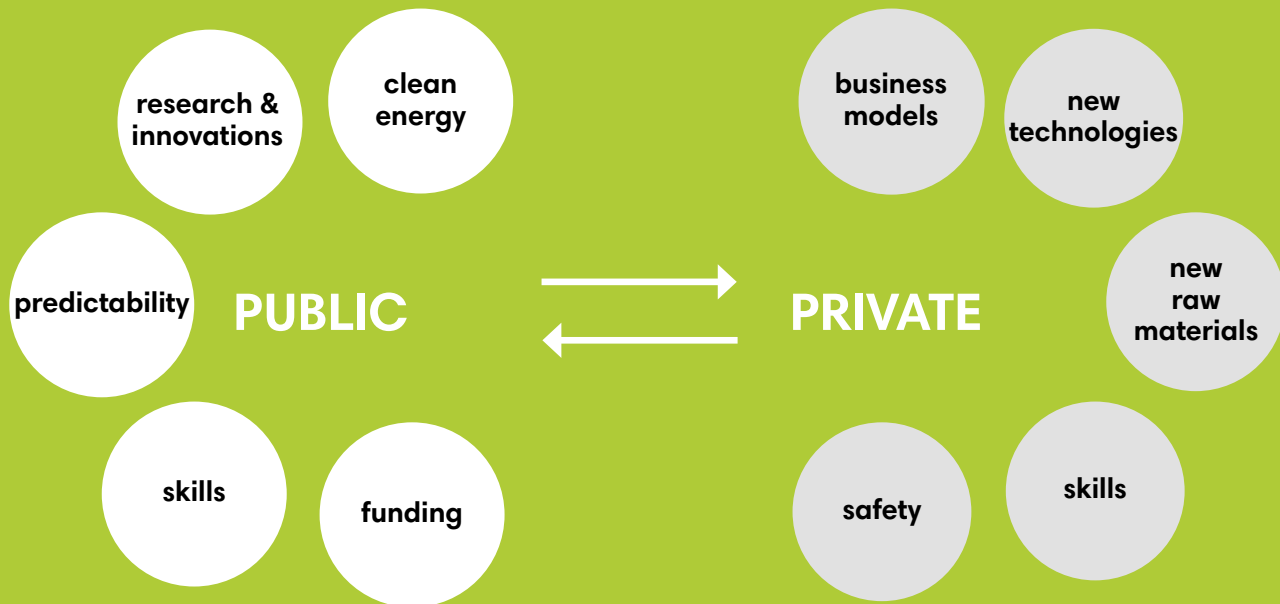
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The Chemical Industry Federation of Finland is a trade association for the chemical industry and its closely related sectors, covering various fields in the basic and production chemical industry.

# A call to collaborate

Sustainable development requires cooperation between the private and public sectors. Industry must be provided an operational environment that remains stable from one government term to another. We need a national industrial strategy aimed at carbon neutrality.



## Glad we started early!

In the early 1990s, the chemical industry in Finland got involved in the international sustainability initiative Responsible Care. We have been focused on sustainability for over for three decades. The results are impressive. Occupational accidents have been reduced by 90 per cent, energy consumption by a quarter and greenhouse gas emissions by one third. The initiative has taught us that sustainable use of natural resources combined with safety, well-being in work communities and transparent communications together are efficient tools for addressing issues and fostering continuous development. It is also important that various companies within an industry learn from each other.

The chemical industry is connected with everything. Chemistry is the industry of industries. Our products find their way everywhere, even in the end products of other industries and all the way to consumers. That

means two things specifically. When we manage to create sustainable practices in the chemical industry, we also lighten the environmental footprint of countless other companies. Secondly, the chemical industry in Finland products exported to other countries also support those countries' climate goals. Finland can play a clearly larger role in solving the climate change.

Fighting climate change requires new processes, and new processes require skills of which we currently do not have enough. We need new engineers, but also mathematical and scientific understanding at all levels of the society, starting with the authorities, decision-makers and media. We need innovations in all areas of our society. Not only technological innovations, but also new kinds of legislation and administrative thinking. It is also clear that we will need skill-based immigration of experts, for whom there is intense international competition.



**Mika Aalto,**  
Director General of The Chemical  
Industry Federation of Finland

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**The chemical industry is connected with everything. Chemistry is the industry of industries.**

# Climate neutral chemical industry in Finland

We have already done a lot to prevent climate change. Still, daily life keeps producing too much greenhouse gas emissions into the atmosphere. Transportation, construction and manufacturing the goods and services that life requires are still not climate neutral.

Help from the chemical industry is needed in order to remedy the situation. In addition to the climate challenge, there is another challenge that chemical industry solutions can affect – putting a stop to the biodiversity loss. Circular economy solutions and wise use of resources can help in preserving biodiversity.

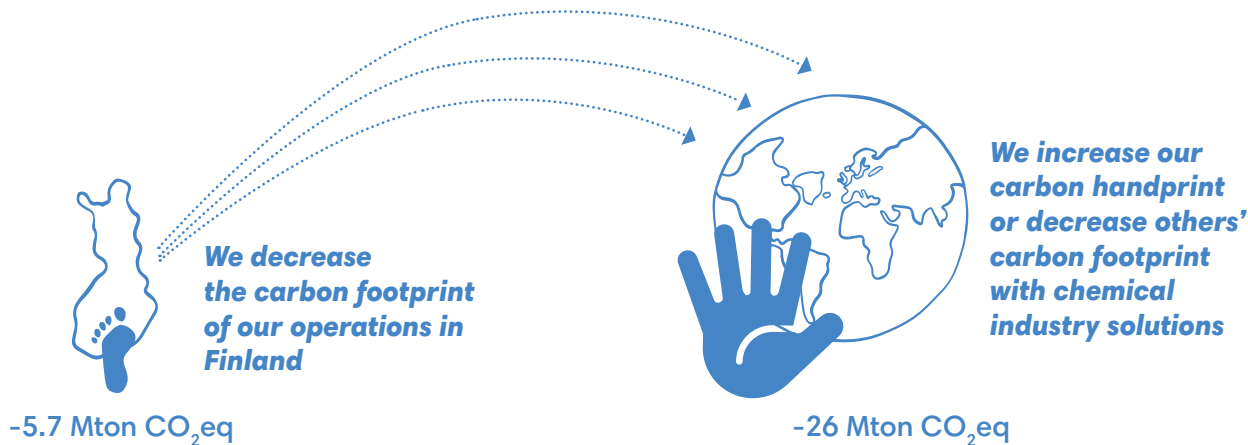
Individual measures that reduce emissions are still necessary, but they alone are not enough. Entire chemical industry value chains must first be made

carbon neutral and then carbon negative. Current technologies allow us to reduce the amount of carbon that ends up in the atmosphere considerably and future technologies will enable us to capture carbon that already has or will end up in the atmosphere.

The carbon footprint is a well-known concept. It refers to the load that an activity puts on the climate. The smaller the carbon footprint, the better. The carbon handprint is a newer concept. It refers to how we can help others decrease their emissions. The larger the carbon handprint, the better.

By engaging in pro-industry policy, the size of the chemical industry's carbon footprint can be decreased and the handprint increased.

## *The export potential of the carbon handprint is EUR 5 billion*



## KIILTO: Our Promise to the Environment is something every Kiiltonian participates in

Kiilto is a Finnish family-owned company that develops, manufactures and markets chemical industry solutions in four different business areas: construction, industrial adhesives and fireproofing, professional hygiene and consumer products. Kiilto's vision reaches to 2080 and for a long time Kiilto's operations have been focused around striving to be the environmental leader in their field of business.

In 2018, Kiilto made a Promise to the Environment. The goal was to create a culture centred on the environment. From the beginning, it was clear that the promises had to be ambitious. The Promise is made up of four parts:

- Green energy: All our company operations will be carbon neutral by 2028.
- Green packaging and logistics: We reduce the use of fossil and virgin packaging material every year.
- Green services: We enable our customers to minimise their environmental footprint.
- Green materials: We use less fossil and virgin raw material and reduce waste every year.

Kiilto has regular steering groups to monitor the progress of these goals. Our Promise to the Environment is part of the daily lives of each Kiiltonian and they participate in coming up with ideas via internal start-up

competitions for which employees can use work time and resources. For example, the idea of recycling industrial plastics, that Kiilto is currently piloting with their customers, came from an employee.

"We feel it is important to engage every Kiiltonian with the goals. All Kiiltonians have participated in environmental training and everyone has personal environmental goals. People have felt inspired by the goals and they want to stick to them," says **Eeva Solja**, Brand and Communications Director at Kiilto.

Kiilto took one of several steps towards carbon neutrality in 2028 by deploying a hybrid system that utilises waste heat and ground heat at their Lempäälä production plant in 2018. Their production plants also utilise solar energy and, for example, in Lempäälä the solar energy plant already produces approximately 15 per cent of the energy consumed by the plant. In 2018–2019 the company managed to reduce their direct carbon dioxide emissions by about 22 per cent.

"Taking care of the environment starts with commitment, attitude and a way of thinking. Only a real desire will enable attitudes to be transformed into processes and an operational culture. For us, every step in the right direction is a cause for joy," says Solja.

“ With pro-industry policy, the size of the chemical industry's carbon footprint can be decreased and the handprint increased.

## Developing skills with a focus on work life

A climate neutral chemical industry in Finland by the year 2045 requires a lot of technical development and changes to existing processes. It is useful to ask who will create that change. What kind of skills do we need and where can they be found? The chemical industry is a global industry and future talents have many attractive and interesting employment opportunities. We must make an effort to get the right experts to come to Finland.

Scientific and mathematical skills are the most important skills in the chemical industry. But we also need business understanding, language and communication skills as well as research and development expertise. We need to understand industrial processes and the

way they will change as well as proactively looking into the future with open eyes. We need engineers and scientists, process managers and researchers. It is important that their degrees contain the right skill set and that people are interested to learn on the job. Work life requires constant self-development.

Scientific and mathematical skills should be considered as basic skills, just like reading. That is why we also need investment in teaching and teacher training. In addition, we must aim to increase the amount of interaction between businesses and educational institutions. Forecasting which skills will be needed in the future should be a joint effort. In addition, our universities need to engage in more international cooperation. The importance of international cooperation cannot be overemphasised. We have the potential to apply for more EU funding for collaboration between universities and businesses.



**Hannele Jakosuo-Jansson,**  
Chair of the Chemical Industry Federation  
of Finland, Committee on Skills and Talent  
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## KEMIRA: Corporate responsibility improves profitability and creates a base for new businesses

Kemira's climate goal is to reduce emissions by 30 per cent by 2030 and become climate neutral by 2045. A plan was drawn up for reaching the goal, detailing the emission sources and solutions for reducing them. Staff commitment to the plan was fostered by conducting conversations with the various functions. That motivated people to participate.

"We set absolute goals aimed at becoming fully emission-free. This is unique in our field as many set goals that are relative to production volume. However, the atmosphere does not care about efficiency, but only about how much emissions end up there. Our customers value clear climate goals. Similarly, investors are looking for constantly more ambitious climate measures," says **Rasmus Valanko**, Head of Corporate Responsibility at Kemira.

"Practical calculations were the basis for the plan. It was great to see that having good data, we were able to draw up a watertight plan for the management, without

leaving any room for interpretation," says Valanko, describing the process.

Kemira's emission solutions include transitioning to renewable energy sources, electrification of processes and improving energy efficiency. When their modeling demonstrated that in most parts of the world purchasing renewable energy was more cost effective, the company immediately started looking for a procurement contract of renewable energy.

"Close cooperation with our procurement department allowed us to sign a procurement contract for wind power within a month of launching our climate goals. Many other projects were also started at the time of setting the goals. We offered our employees the opportunity to come up with ideas of how to do things differently," says Valanko in describing their success.

The goal also helped in achieving a change of attitude. "Corporate responsibility is not seen only as an expense, but rather as something that improves profitability and creates a base for new businesses," says Valanko.

“ The atmosphere does not care about efficiency, but only about how much emissions end up there. ”

## BOREALIS POLYMERS: Using energy saving projects and renewable feedstock to move towards climate neutrality

Borealis Polymers manufactures polyolefin products for everyday plastic solutions. The company's long-term climate work revolves around annual energy saving projects at their production plants. One project involved heat pump solutions designed around distilling columns in order to reduce the amount of steam required by the plants.

Borealis also aims to increase their use of renewable energy. One step closer to the goal is their first wind power procurement contract for their locations in Finland, signed in 2020. Borealis is also speeding up its journey towards climate neutrality by increasing the share of renewable feedstock at their petrochemical plants.

Of all Borealis projects, the Kilpilahti waste heat project is probably the best known. The project explored using waste heat in district heating in the Helsinki metropolitan area in collaboration with Neste and several

energy companies. The project demonstrated that the metropolitan area could reduce its carbon dioxide emissions by up to 2–3 million tonnes annually.

"At first, many thought the project would be impossible to implement. However, preliminary studies demonstrated that utilising waste heat was technically feasible. The project is important even on a national level and we are currently engaged in detailed discussions to determine how it will be continued," says Energy Manager **Jari Salonen**.

Borealis engages in systematic sustainability work and their energy management system is certified. The company's database of energy saving ideas already has many future projects, too.

"As a European company we want to be at the forefront of climate action. Our staff are excited and proud to work in a company that takes climate action and the circular economy seriously. Our customers are also very aware and we get a lot of enquiries about products made out of recycled materials, which is great," says Salonen.

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**The waste heat project demonstrated that metropolitan Helsinki could cut its carbon dioxide emissions by up to 2–3 million tonnes annually.**

## We need emission-free electricity, experts and innovations

The Finnish Government set a goal of being climate neutral by the year 2035, which started cooperation between the private and public sectors to solve the climate challenge. The work utilises 13 roadmaps in which trade and industry highlight their plans for reducing greenhouse gas emissions. The roadmaps define the sector-specific measures that Finland must take, how and where to innovate and invest as well as how to regulate and ensure the correct skills, research and development. The roadmaps include comprehensive measures for decades to come and implementing them will require tens of billions of euros worth of investments. All of this requires a long-term perspective, perseverance and a predictable operating environment.

The chemical industry's roadmap was published in the spring of 2020. According to the roadmap, we will need plenty of emission-free and reasonably priced electricity in order to reduce the emissions of chemical

industry processes. By 2045, the total amount of electricity needed is approximately 29 terawatt-hours and by 2050 it will be 31 terawatt-hours. One terawatt-hour is approximately equivalent to the total annual consumption of all homes in Helsinki.

Secondly, the chemical industry needs experts. The plants and processes that the chemical industry will use in the 2030s are built in the 2020s. The skills needed for this breakthrough require both investing in education and facilitating work-based immigration. The roadmaps also highlight new raw materials – recycled, carbon binding, biologically and synthetically produced raw materials. Some calculations of the required investments are also presented. During the coming decades, at least EUR 1.5–2.5 billion of investments are needed annually when the current level of investments is EUR 1–1.2 billion per year.

Overall chemical industry electricity needs in Finland in 2045

**= 29 TWh**



**1 TWh =  
Helsinki/year**

## Plans are ready, now is the time to act

Deputy Director General **Juhani Tirkkonen** (Ministry of Economic Affairs and Employment of Finland) sees two reasons why the Finnish roadmaps can be successful. “In Finland, the roadmaps were a coordinated effort. That ensured that the 13 individual roadmaps had no overlap or contradictions. This means the energy use of the various roadmaps is aligned to the overall perspective and the same raw material is not used several times over.” The second reason is learning from others. Every roadmap was created separately, but there was a lot of cooperation. “Industrial branches, such as forestry, chemical, technology and energy industry collaborated closely. They all were consulted by AFRY.”

Tirkkonen considers the Finnish roadmaps a considerable success. Many other countries have conducted similar projects, but nowhere else has the effort been as well coordinated as in Finland.

In addition to being an industry initiative, the roadmaps represent expectations set for the public authorities. “In

general, the roadmaps defined certain prerequisites, such as emission-free energy and a stable operating environment,” says Tirkkonen. “There is little talk of actual direct subsidies, but the need for a stable operating environment is highlighted often. Of course, the approximately one billion euros included in the green part of the European Union COVID-19 recovery package is much needed.”

The roadmaps have also served as an input for a VTT Technical Research Centre of Finland background project for creating the basis of knowledge required for Finland’s new climate and energy strategy. The project’s emission reduction scenarios are based on assessing emission reduction potential and investment plans. Later, the Ministry of Economic Affairs and Employment will prepare a new climate and energy strategy for the Government to decide on. However, the message sent by the roadmaps can already be seen in decision-making. Lowering the electricity tax on industry to its lowest level is exactly what the roadmaps proposed.

### FACT

*Carbon dioxide is a greenhouse gas that causes Earth’s temperature to rise when its amount in the atmosphere increases. Human activities produce carbon dioxide, such as when it is created as a combustion product in energy production and in plants and traffic that use fossil fuels. The carbon dioxide content of the atmosphere has increased considerably over the last couple of centuries, making climate neutrality goals necessary. A climate neutral company will only create as much carbon dioxide emissions as it can capture from the atmosphere. That way, the carbon footprint of a product or the overall operations is zero.*



## NESTE: Aiming to create the world's first climate neutral refineries

Neste has transformed from a local oil refiner to a globally leading supplier of renewable and circular solutions. One of their most ambitious goals is climate neutral production by the year 2035. This would mean Neste would have one of the first completely carbon neutral refineries in the entire world.

"Sustainability has been a priority to us for a long time. We also want to be part of the solution in aiming for a climate neutral Finland and Europe. Because we operate refineries, we have been one of the largest sources of emissions and we take our responsibility by actively participating in the development of low-emission and circular solutions," says Vice President of Sustainability **Salla Ahonen**.

The idea of transitioning to climate neutral production was created in staff workshops that accrued over 70 different solutions. One of them is utilising renewable electricity, which Neste has committed to with long-term procurement contracts of new wind power projects.

"As we move to a climate neutral future, we must consider the schedule. What can we do immediately? How about in the future? We cannot afford to wait, but must be able to invest in developing new solutions right now. That is why we invest in innovations," says Ahonen.

Of all Neste employees, approximately 25% work with research, product development and design. A considerable portion of their operations related to innovation concern low-emission raw materials and technologies for processing them.

There are on-going pilot projects at the company's Porvoo and Rotterdam plants that include experimenting with utilising waste heat, using renewable energy for steam production and transitioning to using only renewable electricity. In addition, Neste collaborates extensively with smaller companies.

"The need for low-emission solutions in the world is so great that many different measures are needed. We are not competing with other low-emission solutions, but believe that we can reach the goals by collaborating with others," says Ahonen.



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The need for low-emission solutions in the world is so great that many different measures are needed.

## YARA: Innovations and investments create a basis for combatting the climate crisis

Yara is one of the largest producers of nitrogen fertilisers in the world. In Finland, Yara has managed to reduce the greenhouse gas emissions of fertiliser production by 90 per cent within approximately 10 years. Their next goal is to further reduce by 70 per cent by 2025.

One solution for decreasing the carbon footprint is a catalyst technology developed by Yara, which reduces the nitrous oxide emissions of nitric acid plants by transforming the hazardous laughing gas into harmless hydrogen and oxygen.

“Catalysts are used in all of Yara’s three nitric acid plants in Finland. Our most recent environmental investment is a process boiler worth roughly 7 million euros for our nitric acid plant located in Uusikaupunki. The new boiler allows for a greater catalyst mass and helps in reducing the plant’s laughing gas emissions further,” says Plant Manager **Teija Kankaanpää**.

“We also invest in making use of and capturing process heat. Yara’s plants are already among the most energy effective fertiliser plants in the world, but there are still issues to solve,” says Kankaanpää.

The carbon footprint of fertiliser production is created by the energy used for producing ammonia as well as nitric acid. Yara is involved globally in many collaborative projects that use renewable electricity to produce ammonia with the goal of producing so-called green ammonia free of carbon dioxide emissions.

“Prevention of the climate crisis requires cooperation between various actors. The problem is global and it cannot be solved by any single party,” Kankaanpää reminds.

She also highlights competence and education as important factors in combatting climate change: “We invest in high-quality training of our staff and provide resources for research and development.”



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**Yara’s catalyst technology turns hazardous laughing gas emissions into harmless nitrogen and oxygen.**

# How to cut greenhouse gas emissions

The chemical industry uses a lot of electricity and heat. The reductions in process emissions will require considerably more low-emission energy than is currently available. The electrification of operation is key to achieve this. The electricity must be emission-free, reliable and reasonably priced. New ways of producing heat must be discovered. The temperatures required by chemical industry processes can be created, for

example, with low-emission fuels and heat pumps, meaning electricity. In addition to processes and energy requirements, the greenhouse gas emissions caused by procuring raw materials must also be considered. We can deploy new low-emission raw materials and increase the amount of raw materials recycled back into use. This way, even fossil fuels remain in products instead of being released into the atmosphere.

## FACT

*Right now, there is a lot of talk about the hydrogen economy due to the exceptionally varied ways in which hydrogen can replace fossil fuels. Hydrogen can be produced emission-free using power-to-x (P2X) technologies that use emission-free electricity and water as the raw material for hydrogen. Examples of using hydrogen include fuels for industry and transportation as well as storing renewable energy, such as solar and wind power. By combining hydrogen with the nitrogen or carbon dioxide (CCU) of air allows using it as a raw material for plastic, chemicals and fuels, which is called power-to-chemicals (P2C). The chemical industry is the single largest consumer of hydrogen and is therefore capable of producing, transporting, storing and using it safely.*

# P2X

## 10 of the most interesting technologies for achieving carbon neutrality in industry

1. Electrification of heating and processes and switching fuels
2. Improving and optimising processes
3. New catalysts
4. Power-to-chemicals (P2C)
5. Carbon Capture and Utilization (CCU)
6. Circular economy raw materials and recycling solutions, such as chemical recycling
7. Sustainable bioeconomy raw materials
8. Industrial biotechnology and synthetic biology
9. Digital technologies
10. Resource efficiency, energy and raw materials

These technologies will enable the chemical industry in Finland to more than halve its greenhouse gas emissions by the year 2035 and become carbon neutral by 2045. In order for all of this to succeed, the above technologies must be developed in the 2020s and comprehensively deployed in the 2030s.

## Molecules can solve many problems

The climate change is caused by molecules in the atmosphere that do not belong there. Greenhouse gas emission and waste refer to usable molecules ending up in the wrong place. These are problems chemistry can solve. Climate change can be combatted by directing molecules that have ended up in the wrong place back into the cycle to be used again. Circular economy and chemistry allow us to use molecules efficiently and thus work at solving two great challenges facing the humankind at once: climate change and biodiversity loss.

Today, molecules are not appreciated highly enough. That is why they are spent in great quantities, creating pure waste out of precious molecules. Technology allows us to recycle the molecules to their correct place. We can capture excess carbon dioxide from the atmosphere. Carbon dioxide gives life to the biosphere which produces biomass that we can also utilise sustainably.



**Rasmus Pinomaa,**  
Advisor for the Chemical Industry  
Federation of Finland

The chemical industry is the industry of industries. It uses molecules to produce semi-finished products for industry, raw materials for manufacturers and end-products for consumers. By producing low-emissions products for the world to substitute higher-emission alternatives, Finland can play an even bigger role in solving the climate challenge.

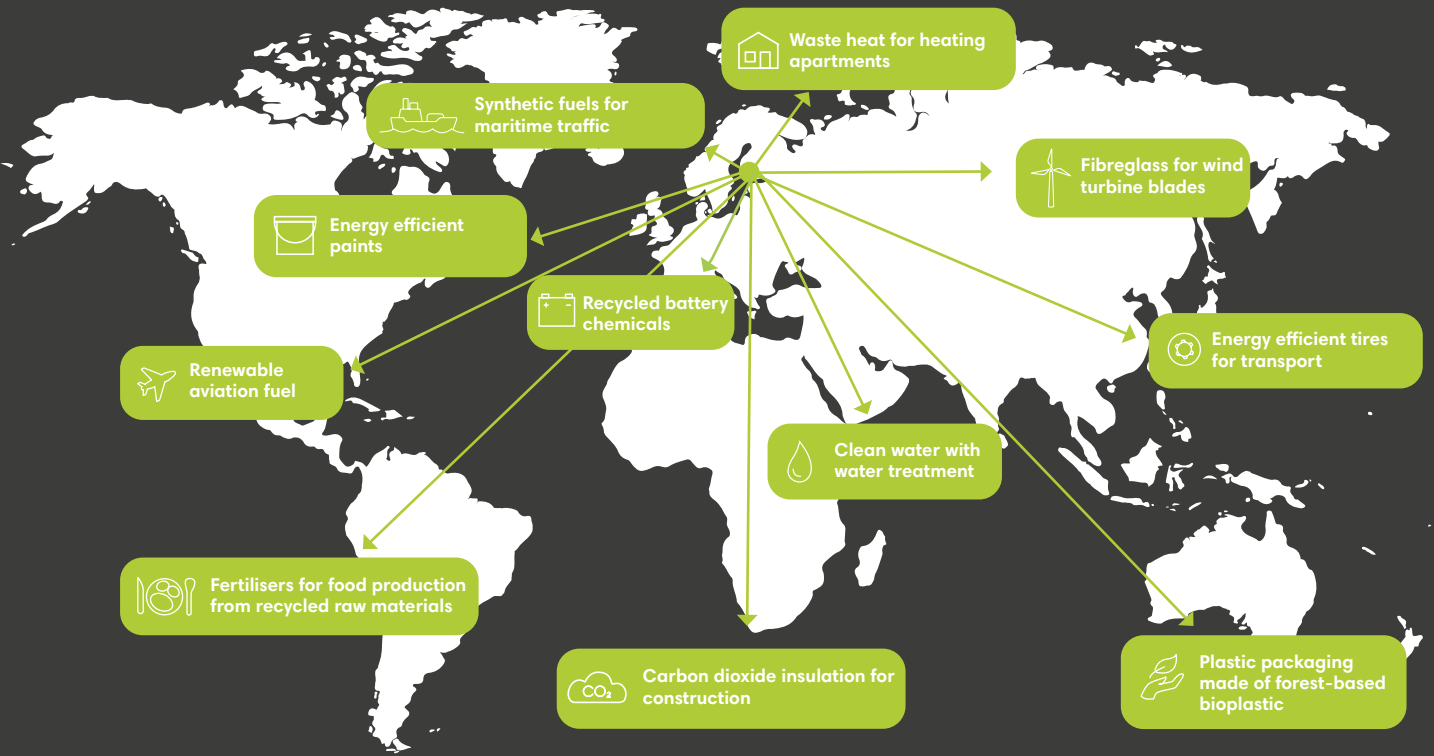
Finland has many benefits in combating climate change. Wind provides renewable energy. Considerable water resources. A strong electricity network. A straightforward civil society. Pulp production that frees up tonnes of bio-based carbon dioxide to utilise. A cold climate to drive demand and cash flow for utilising process waste heat. Top expertise. Of course, there are also challenges. Inadequacy of reasonably priced electricity, inflexible legislation and processing of permits and a habit of looking at issues one government term at a time. It is encouraging and inspiring to notice how even the most difficult problems can be solved with scientific know-how.

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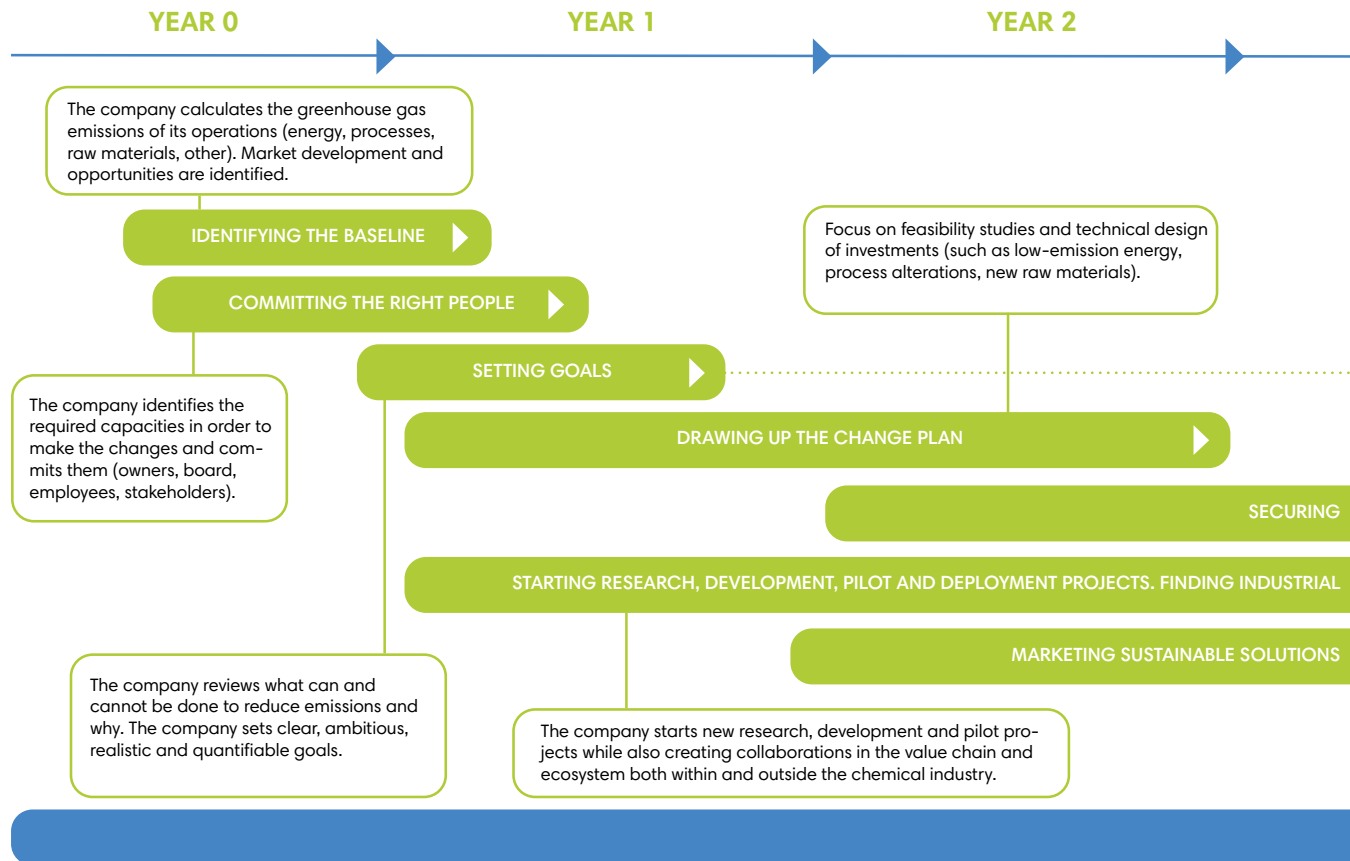
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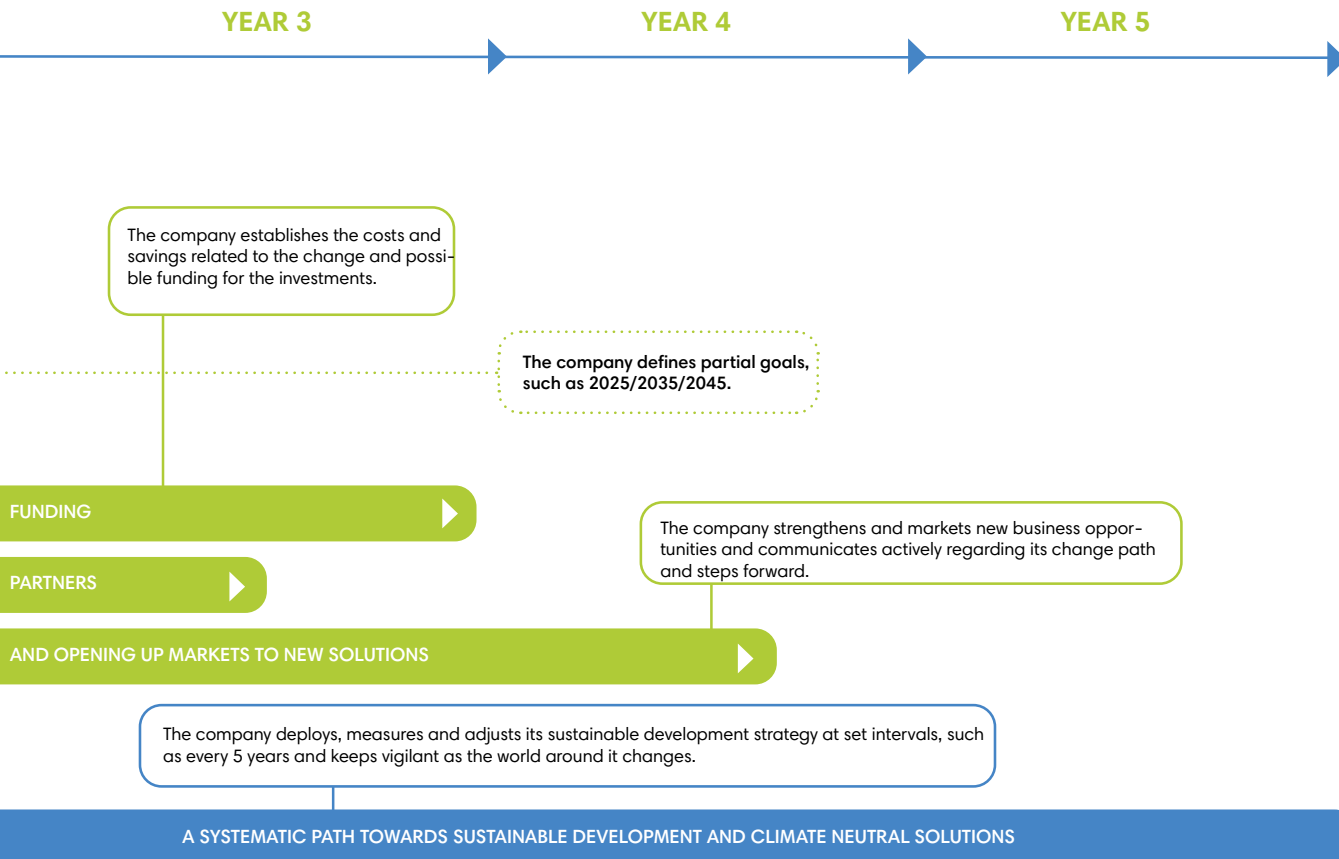
# Chemical industry solutions impact the world



# Path of change towards climate neutrality is the result of consistent work



*A company's road to climate neutrality requires a lot of work. The solutions do not create themselves, but are usually preceded by determined work to identify the company's opportunities for sustainable development and growing the market share of sustainable solutions. Companies' work can be facilitated by decreasing the risks involved and providing incentives. The stability of the operating environment is also important to encourage investments. In 5 years, a company can build a solid base for taking on the challenges of sustainable development. Below is an example of how this could play out:*



## Cooperation for the best results

There is a wide variety of different chemical industry companies in Finland. Products of chemical industry companies can be found almost everywhere, which is why we are often called the industry of industries.

The value chain of the chemical industry is long. Some companies produce large quantities of chemical products using complex processes, which require a lot of energy and large plants. Neste and Kemira are two such companies. Some transform metals and mineral to acquire needed products, such as Yara's fertilisers and Nornickel's battery chemicals. The third group includes companies that utilise chemical reactions to create enzymes, plastic industry materials or industrial gases, such as Borealis Polymers. Companies like Kiilto and Teknos mix chemicals to create products such as medicines, paints and detergents. The fifth group produces commodities by methods such as shaping new products out of rubber or plastic, like Orthex and Molok do.

In order for us to considerably reduce chemical industry greenhouse gas emissions, we must find comprehensive overall solutions. There must be increased cooperation in the interlinked value chains within the chemical industry in addition to considering energy and raw materials purchased from outside the industry. In addition, the products and solutions that the chemical industry produces to its customers must be developed further. Making all of this climate neutral requires changes to the value chains and building ecosystems of companies. For example, the chemical industry can work as a gathering force for recycling and produce considerable added value for the society by combining various parties in the raw material value chain. It is also important to foster cooperation between the public and private sector. In preventing climate change we are all bound together and our actions and choices impact others.

### FACT

*Carbon dioxide is not only a greenhouse gas emission, but also a raw material. One key technology is Carbon Capture and Utilisation (CCU). It allows utilising carbon dioxide in for producing fuels and materials. Carbon negative technologies are an essential part of reducing industrial companies' emissions. In the future, it will not be enough to just reduce our own greenhouse gas emissions. If we want to prevent climate change we must also remove carbon dioxide from the atmosphere.*

# CCU

## ST1: Synthetic fuels are the future of clean transport

The vision of St1 is to be the leading producer and vendor of CO<sub>2</sub> positive energy. In the spirit of this vision, the company researches, develops, produces and invests in order to provide CO<sub>2</sub> positive energy to its customers while creating positive social impact. Transport requires an increasing number of sustainable fuel solutions. However, biofuel production cannot currently be scaled due to a shortage of usable and sustainable raw materials. That is why St1 is conducting research and pilot projects to expand its raw material base because the number of liquid fuel solutions will continue to increase in the future.

Low-carbon transport also requires new solutions. St1 considers synthetic fuels to be a significant part of a sustainable future carbon cycle. Using synthetic fuels requires time, money and long-term regulation in order to get innovation started.

Finland offers a great operational environment for investing in synthetic fuels. We have a considerable wind power potential as well the opportunity to capture

significant amounts of biobased CO<sub>2</sub> emissions from the forestry industry.

“Finland has a sound educational system and plenty of know-how, which creates opportunities for developing new innovations in the chemical and process industries. This is an area in which we have a lot to give even internationally,” says **Timo Huhtisaari**, Director of St1’s Sustainability and Future Business unit.

One of the company’s recent projects is a preliminary study related to a power-to-x pilot plant in Joutseno, conducted in collaboration with LUT University and other partners. Another significant pilot project uses technology and devices of the start-up Q Power to successfully convert carbon dioxide captured from waste-based ethanol production into synthetic methane.

“Synthetic fuels will be critical for climate goals. We must start somewhere and these projects offer a great opportunity for testing developing technologies that will be needed in the future on a large enough scale,” says Huhtisaari.



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Reducing the climate impact of transport requires investing heavily in carbon capture and synthetic fuels manufactured using it as well as innovations related to sustainable raw materials for producing liquid biofuels.

## TEKNOS: Biobased coatings and water-based paints in environmental work

The Finnish paint manufacturer Teknos is making big investments in product development. The company always takes environmental impact into consideration, starting with product development and deploying projects all the way to the end-product. Teknos is also one of the first in the world to develop fireproof paint systems for use in wood construction. The wide adoption of solventless powder paint technology has helped cut down on VOC emissions considerably. Utilising effluents in powder paint production has allowed reducing the amount waste created.

“We want to minimise the impact of chemicals used

with a thin plastic film. Now, Teknos is responsible for developing a coating to use both inside and outside the bottle that is suitable for use with beverages and foods.

The coating for the outside is already completed, but the inside surface has proven more challenging. A beer bottle, for example, must withstand oxygen and the pressure created by carbon dioxide as well as maintaining the taste. A key factor is finding a high-quality raw material that is readily available and cheap enough to replace plastic.

“Only being biobased is not enough for a commercial breakthrough, but the product must be functional and

## “ Open cooperation of industrial actors is key in developing the circular economy.

in paints. We also aim to transition to paints that are either water-based or require less solvents. It is only a question of time that all solvent-based paints will have a water-based option,” says Group Commercial Manager **Tuomas Aspiala**.

In addition, Teknos participates in the development of the first paper bottle in the world that is biobased, recyclable and biodegradable. The paper and carton used in food packaging has traditionally always been coated

attractive in every way. We invest in the technical aspect of the product in addition to it being environmentally friendly,” Aspiala points out.

Cooperation is key in developing the circular economy. Without functional cooperation, a commercial application may never be reached. That is why Teknos highlights open collaboration between industrial actors in the utilisation of recyclable raw materials.

## Safety is a priority

For the chemical industry combatting climate change means new sources of energy, new raw materials, new technology and new work methods. When developing the current production or creating completely new functions, various safety aspects must also be constantly assessed. Climate neutrality does not mean compromising on safety.

Safety means workplaces that are safe for the employees, plants that work without interruption and customers who receive safe products without damaging the environment. The physically and chemically hazardous properties of chemicals requires managing production conditions. That requires professionalism at all stages: in research and development, production design and development as in managing product life cycle.

How about in the future, when changes occur rapidly? We have to create an even more comprehensive overview of the challenges imposed by the changes and recognise the related risks. They must be assessed and managed in time to prepare for the future. The most important thing

is managing changes – regardless of whether they are small or large.

“Overall safety is the number one priority in the chemical industry and that will not change in the future,” says **Anne Helenius-Heir**, Chair of the Chemical Industry Federation of Finland Committee on the Environment and Safety. “I would also like to highlight comprehensive cooperation between various actors. Safe, sustainable solutions are a shared goal and safety must also be part of our shared agenda for reducing emissions.”

Legislation provides a shared framework for operations. However, that is not enough. The proactive safety development of the Responsible Care initiative has produced good results for the Chemical Industry Federation of Finland, making it a pioneer in this regard. For example, occupational accidents have decreased by 90 per cent compared to 1988 and, over the last few years, many Finnish companies have been awarded in European comparisons. Nonetheless, there still remains a lot to do and learn from the world.

“Our actions must be comprehensively sustainable in building a climate neutral future,” Helenius-Heir concludes.



**Anne Helenius-Heir**,  
Chair of the Chemical Industry Federation  
of Finland, Committee on the Environment  
and Safety

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**Safe, sustainable solutions are a shared goal and safety must also be part of our common agenda for reducing emissions.**

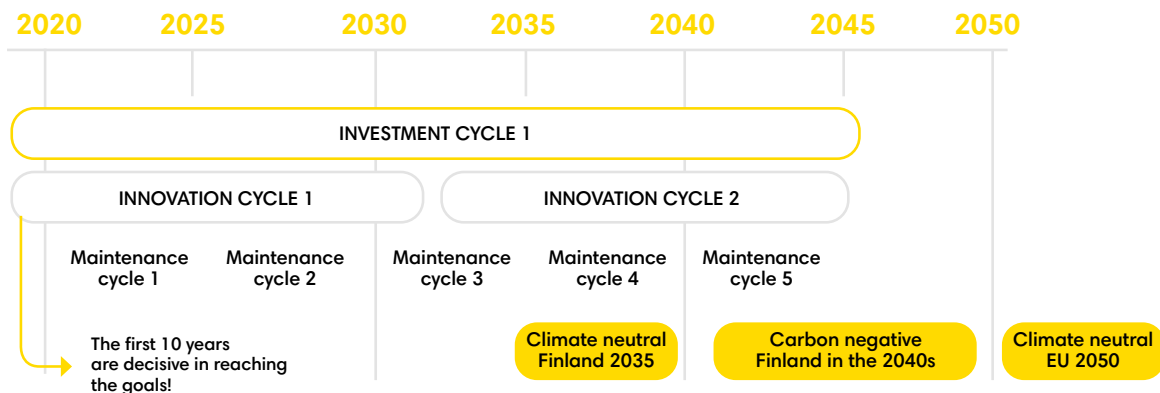
# It is a long road from an idea to a commodity

In order for us to be able to utilise a new insight more comprehensively, it must first be tested. We need pilots for experimenting technologies on a commercial scale. Then, we must create business: commercial solutions and productisation. Markets are not born out of nothing, but building them requires a lot of work. Only then will an insight transform into a general way of operating.

Some of the technologies for preventing climate change are already available but others are only being developed. For example, it is already possible to procure emission-free electricity from the market, as proven by many example in this brochure. Similarly, Yara's case demonstrates that in some fields the development of catalysts has already come quite

far. However, some technologies, such as power-to-chemicals and carbon utilisation, still require large-scale pilots before they are ready for commercial use. It is a long road to transform an innovation into a finished product.

The best thing about carbon neutral chemical industry innovations is that the market for them is global. Catalyst technologies can be replicated to similar processes and carbon capture developed in Finland can utilise carbon dioxide anywhere in the world. There is a global interest in technologies that cut down greenhouse gas emissions. Humankind will spend thousands of billions of euros in order to reduce greenhouse gas emissions. Being a part of that work is of utmost importance – both for the environment and for the national economy.





## MOLOK: A waste recycling insight taking on the challenges of recycling

Molok is a Finnish company whose environmentally friendly waste sorting solutions have spread around the world. The underground deep collection containers they developed offer additional storage space and enable versatile waste sorting.

In addition to a large collection volume, a vertical container makes the waste compact itself. These two factors together allow the trash collection interval to be increased by up to 90 per cent while cutting down on emissions caused by waste transport. The container also keeps the waste cool underground, thus preventing undesirable odours. The waste container itself is environmentally friendly and made using materials with a long life cycle.

Molok has also participated in circular economy development. They have introduced the concept of city block collection, highlighting issues related to waste collection facing areas of single-family homes.

“Many areas of single-family homes still have poor sorting opportunities. Often, the collection points for various waste fractions are spread around and located far away from home. Our survey demonstrated that the proximity of the collection location is one of the factors that has the greatest impact in people’s motivation to sort their waste,” says Molok Oy Director of Products and Marketing, **Samuli Hellemaa**.

The company aims to bring varied, shared collection points that allow recycling all waste fractions required by the new act on waste sorting closer to people.

“Contrary to popular belief, Finland is in fact fairly bad at recycling, and the situation has not improved much over the last few years. Plastic and biowaste pose the greatest challenges to us. We should act well before the European Union intervenes due to a poor level of recycling,” says Hellemaa.



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The proximity of waste collection location is one of the most important factors impacting people’s motivation to sort waste.

A person wearing safety glasses and a checkered shirt is shown in profile, holding a test tube with a yellow liquid in their right hand and a tablet in their left hand. They are standing in a field of green plants, possibly a laboratory or agricultural setting, with a warm sunset or sunrise in the background.

## Summary of thorough research: “We are in a hurry”

*AFRY Vice President Petri Vasara sees the situation clearly. “Finland is combatting climate change as one nation among many. At the same time, we create unique technical know-how. If we can use that to create export products, we can participate in saving the climate and the Finnish welfare state at the same time.”*

Vasara participated in creating all the core parts of the Finnish roadmap. "Finland succeeded in creating a dependable, cohesive plan for the future. The conclusion was that we need an extensive technological development programme that must first be piloted and then expanded to various sectors in 2025–2035. In order to keep this schedule, we need to start making decisions no later than 2022. We have no time to waste."

treatment solutions. Battery chemicals and recycling them. Biobased resins. Utilising waste gypsum. Capturing carbon dioxide from the atmosphere to use as fuel or raw material. Use of biomass as a raw material.

"Any of these technological development paths could be Finland's niche. We are talking about billions of euros, thousands of jobs, secured pensions, saved welfare and, especially, taking care of the climate."

**“ We are talking about billions of euros, thousands of jobs, secured pensions, saved welfare and especially taking care of the climate. ”**

Export is an essential perspective. According to Vasara, the chemical industry in Finland can use its low-emission lead products to reduce greenhouse gas emissions in the world by up to five times the amount that the chemical industry in Finland produces. "That is what it means to have a carbon handprint: incredible emission reductions globally, achieved with Finnish expertise."

During the creation of the roadmap, a technology network was born that identified many technological development paths that suit Finland: Bioplastic and chemically recyclable plastic. Renewable fuels. Water

Vasara highlights some examples: "Chemical recycling of plastic is an interesting and valuable activity. Another example is found in mountains of gypsum. The soil is becoming depleted, fertilisers are needed. Finland has entire mountains of gypsum. We should look very closely into if we could considerably reduce the need for phosphorus in fertilising by using gypsum in the fields. If this solution works it would be good for the climate, waters and the security of supply."

"Finland has a great future ahead, but now is the time to seize it," says Vasara in summary.

## NORNICKEL HARJAVALTA: Responding to an explosion in demand with recycled battery materials

Nornickel Harjavalta is a diverse refiner of nickel metals and chemicals as well as a significant producer of battery chemicals. The Harjavalta nickel plant produces approximately five per cent of the world's clean nickel products. The plant has the smallest carbon footprint in the industry.

Methods Nornickel has used to reduce its carbon footprint by 100,000 tonnes include transitioning to renewable energy and replacing naphtha with liquified natural gas in hydrogen production. Currently, Nornickel is developing solutions for the electrification of transport.

"Finland and Europe aim to significantly increase the number of electric vehicles. The growth is so immense, that without recycling there is no way to meet the demand for metals critical to the electric vehicle industry," says Managing Director **Joni Hautojärvi**.

A new electrical vehicle battery value chain is

being created at the Harjavalta Industrial Park as BASF is building a new battery material plant in the area. Nornickel has signed a preliminary cooperation agreement with Fortum and BASF on battery recycling solutions that would allow materials captured from used batteries to be reused in producing new battery materials.

In the battery recycling cluster, Nornickel refines the materials provided by Fortum into nickel and cobalt required by BASF's battery material plant. Being able to utilise recycled materials in manufacturing electric vehicle batteries will considerably reduce the vehicles' carbon dioxide emissions.

"The location of the recycling plant close to Nornickel Harjavalta further solidifies our position as one the most sustainable nickel refineries in the world," says Hautojärvi.

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Being able to utilise recycled materials in manufacturing electric vehicle batteries will considerably reduce their carbon dioxide emissions.

## From decisions into industry actions

Building a plant is a demanding job. Business case analyses, funding, design, environmental permits and the construction itself take so much time that if we hope that the plant will be operational in 2031, the preparations need to start in 2021. The typical life cycle of a completed plant is 25 years, including several 5-year maintenance cycles and a couple of innovation cycles as the technologies change. This also means that investing in a plant creates very stable jobs for decades to come.

That is why now is the time to make decisions on how Finland will reduce its greenhouse gas emissions during the next 15 years and how we aim to become carbon negative after 2035. Decisions become actions via the above cycles and schedules. Decisions on investing tens of billions of euros require a fairly stable perspective for decades to come.

The only way to succeed in preventing climate change is by cooperation. Society must ensure sufficient supply of clean and reasonably priced energy, offer incentives for research, guarantee stability and continuity beyond individual government terms, import and create the know-how and support investing. Then, the chemical industry can create a business model of sustainable development, make its own investments in research and product development, foster circular economy, start using low-emission raw materials and hire the experts required to make this great industrial revolution happen. Society creates the operational environment, which provides opportunities that companies can then utilise.

### FACT

*Companies' carbon dioxide emissions are reported on three levels. Scope 1 describes the organisation's direct emissions, such as energy production at their location and greenhouse gas emissions of their own manufacturing processes. Scope 2 measures indirect emissions of energy use created by purchased energy, such as that needed for producing electricity and heat. Scope 3 concerns other indirect emissions. These include, for example, emissions of the raw material procurement chain, contractors' effects, waste management, procured transport, logistics and emissions related to employee travel. Climate neutrality in the chemical industry can only be achieved by reducing greenhouse gas emissions on all three levels, meaning mostly production, energy use and raw materials.*

**Scope 1**  
**Scope 2**  
**Scope 3**

# The 10 steps of innovation



## NESTE: Chemical recycling is the missing piece of circular economy

Neste has introduced to the market entirely renewable raw materials for producing polymers and chemicals. Now, the company wants to rise to the global plastic waste challenge. The goal is to process more than one million tonnes of plastic waste every year, starting in 2030.

Neste aims to refine liquefied plastic waste into raw materials for producing new plastic in order for plastic to no longer be manufactured using virgin fossil crude oil. The part of plastic that cannot be recycled would be replaced with plastic based on renewable raw materials.

“A few years ago, sustainability was focused on plastic waste. It is great to be able to offer solutions for two of the great sustainability challenges, meaning climate change and plastic waste,” says Vice President of Sustainability **Salla Ahonen**.

Mechanically recycled plastic is not suitable for all uses due to its quality and purity. In addition, not all plastics can be recycled mechanically. Chemical recycling, which Neste is developing, expands the possibilities for recycling plastic waste.

Chemical recycling allows producing plastic that is of equivalent quality compared with plastic made out of fossil oil. This enables using recycled plastic also in the most demanding purposes, such as food packaging and the medical industry. By offering plastics a new life, Neste is helping reduce the amount of material that ends up in landfill, incineration or the environment.

“The problem remains that people do not recycle their plastic waste correctly. We cannot solve the problem of plastic, but we can create one solution for it. The challenge remains how to get people to sort and recycle their plastic waste correctly,” says Ahonen.

Developing chemical recycling requires close cooperation between various parties. Joint initiatives in all of the plastic value chain are important when aiming for a comprehensive circular economy change in the entire plastic industry. There is great demand for renewable and recycled plastic solutions. Many companies and brands have already publicly committed to starting to use plastic in a more environmentally friendly way.

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Chemical recycling gives plastic a new life.

## ORTHEX: The commodity market has demand for recycled and biobased raw materials

Orthex Group has become one of the leading Nordic commodity producers thanks to its environmentally friendly products. Last year, the company was able to double its use of recycled materials.

“We have utilised recyclable materials in our products since the 1990s. Our goal is climate neutral production by 2030 and increasing the use of recycled and biobased raw materials is an important step in reaching that goal,” says Chief Marketing Officer **Hanna Kukkonen**.

Recyclable materials can come from surprising sources. For example, Orthex has produced buckets out of used fishing nets. Today, all Orthex flower pots are manufactured entirely out of recycled materials.

Nonetheless, there are still challenges in using recycled materials, especially when it comes to food-related products. In such products Orthex utilises biobased raw materials, such as sugar cane, castor oil and wood fibres. Biobased raw materials allow reducing the

carbon footprint of a product by approximately 50–80 per cent.

“The journey has gone well, but it has required a lot of testing. Specifically, procuring transparent and light-coloured recycled plastics is still difficult. I am sure we will discover a solution to this challenge, too, as chemical recycling evolves,” says Kukkonen.

Orthex has also managed to respond to consumer needs in sorting waste. Orthex has received already two different design awards for its SmartStore™ Collect collection container launched in 2020.

“Many traditional storage solutions are not spacious enough for sorting different waste. Smartstore™ provides additional space for recycling while also acting as a seat and being pleasing to the eye. I have never seen any launched product being received so positively. Clearly our product meets a great demand,” says Kukkonen.

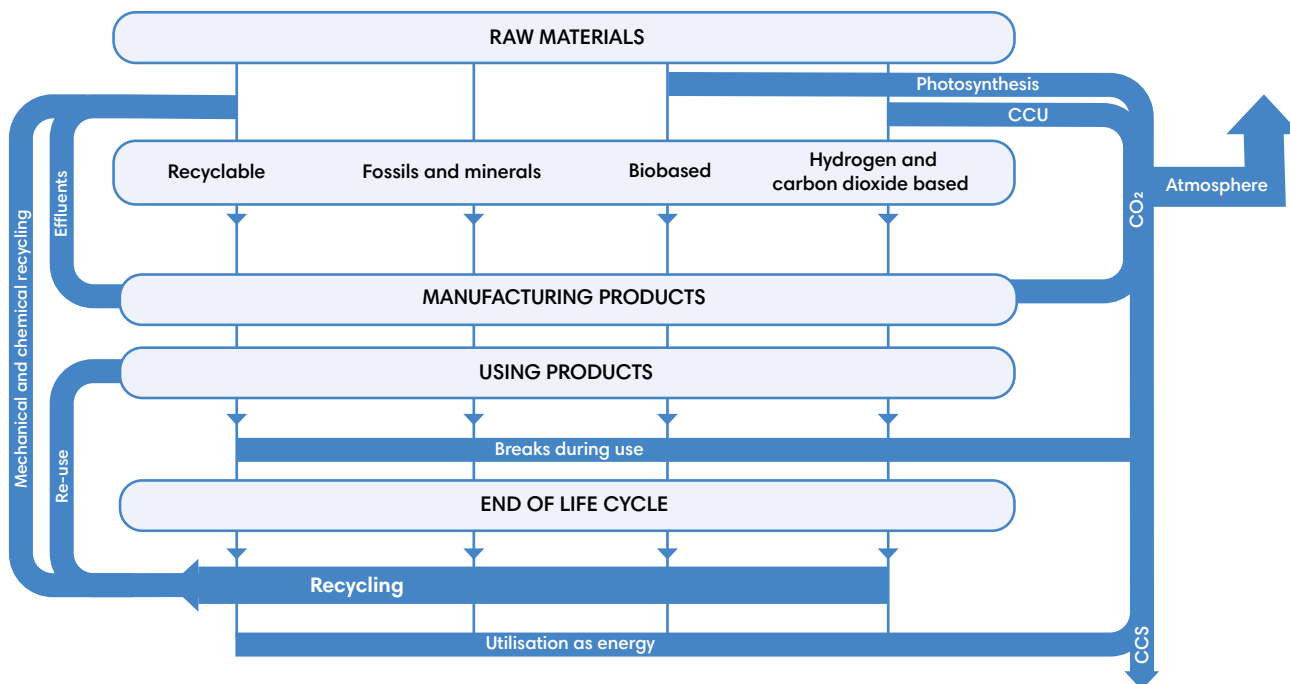
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**Procuring transparent and light-coloured recycled plastics is still difficult. I am sure we will discover a solution to this challenge, too, as chemical recycling evolves.**



## Circular economy is central in preventing climate change

*There is tremendous potential in the material flows of the world. On the one hand, the flows can be made more efficient, using less existing resources. On the other hand, we can also reduce the use of virgin materials as we become more versatile in our ability to create new using the old and utilising material flows. This way, we can get greenhouse gas emissions under control as well as ensuring biodiversity.*



# Cap the Carbon!

The chemical industry in Finland has researched the requirements of climate neutrality. During this research it became apparent that, as we are the industry of industries, we can have a bigger impact on preventing climate change. This requires that we decrease the size of our own carbon footprint while increasing the size of our carbon handprint by exporting low-emission products to the world.

By focusing on key solutions, the chemical industry in Finland can reduce five times as much emissions globally as we ourselves generate. Another conclusion of our research is that investing in low-emission technology and raw materials is valuable work. We can increase our exports by over 40%, meaning EUR 5 billion.

Achieving all of this does require cooperation but, first and foremost, it requires clean energy, skills, innovations and investments. The chemical industry is ready to be more ambitious and take a sustainability leap towards climate neutrality. Cap the Carbon!

# Thank you

**This brochure is a summary of studies conducted for the Climate Neutral Chemistry project in 2018–2021. These comprehensive studies were aimed at increasing the understanding on how the chemical industry in Finland could become climate neutral. Most of the studies are public and they can be found at the website of the Chemical Industry Federation of Finland.**

## **Studies and their results:**

Innovation study: Riscon Oy

Technology roadmap: AFRY Management Consulting

The Sustainable and Circular Business Models for the Chemical Industry handbook: Accenture, Sitra, Business Finland

The Strategic Capabilities study: Aalto University

Cap the Carbon! decision-maker brochure: Kreab Helsinki

## **Steering group for the Climate Neutral Chemistry project:**

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Kemira

Kiilto

Neste

St1

## **Interviews:**

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Hannele Jakosuo-Jansson, Neste

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Petri Vasara, AFRY Management Consulting

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Jenni Rahkonen, Molok

Samuli Hellemaa, Molok

Jari Salminen, Teknos

Tuomas Aspiala, Teknos

Pasi Virtanen, Teknos

Hanna-Kaisa Koskinen, Nornickel

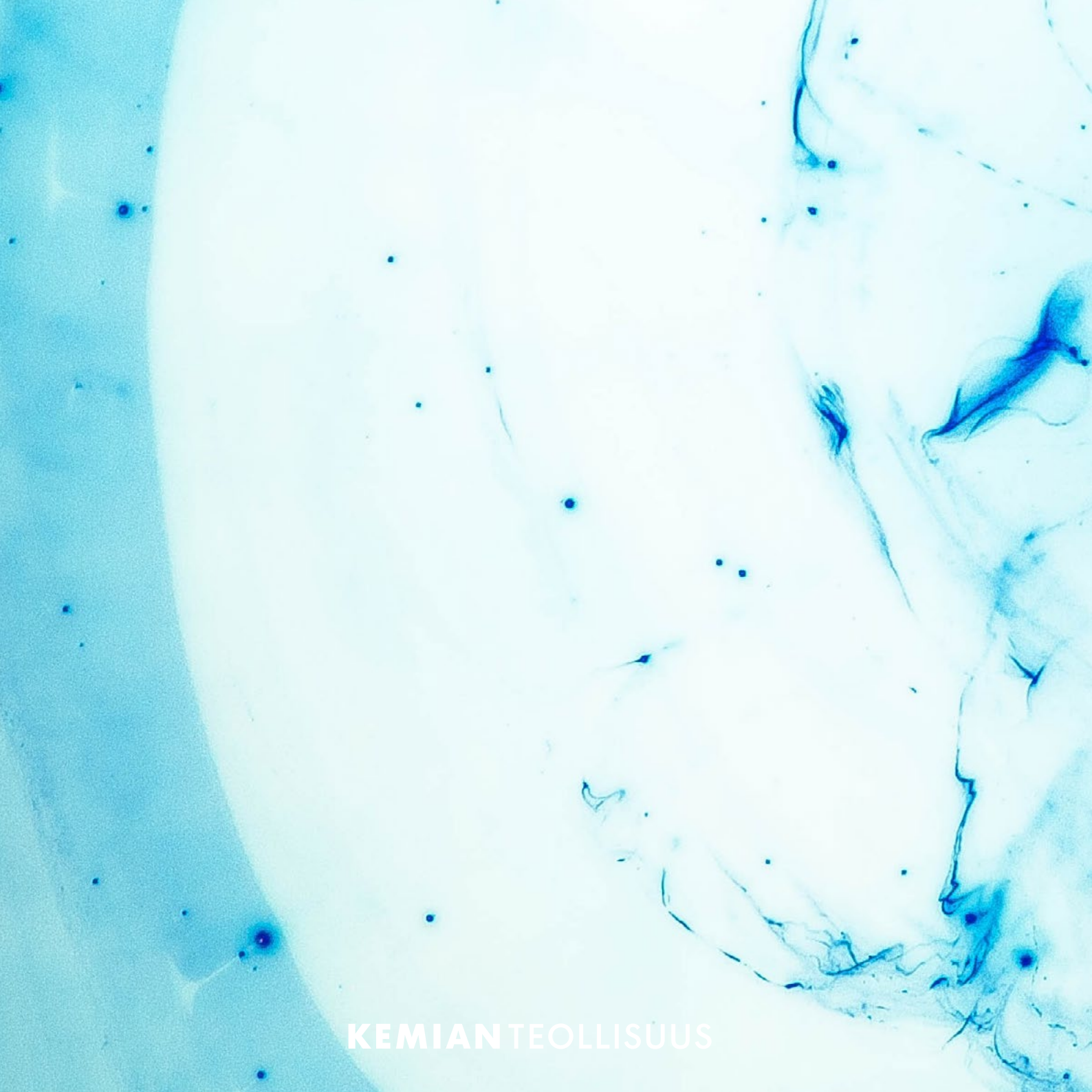
Joni Hautojärvi, Nornickel

**The work for climate neutrality continues in the chemical industry. Follow how the industry is doing at [www.responsiblecare.fi](http://www.responsiblecare.fi)**

This brochure includes a 10-step programme for climate neutral industry targeted at decision-makers. We are glad to discuss it in more detail!

**CLIMATE NEUTRAL  
CHEMISTRY**





KEMIANTEOLLISUUS