

ANNUAL REPORT
IVL SWEDISH ENVIRONMENTAL
RESEARCH INSTITUTE

22

Analysing biodiversity
with environmental DNA

Sediment survey along the
coast of Norrland

PFAS – a challenge for
treatment plants

Learning from nature about
green and sustainable
chemistry

Hydrogen –
climate hype or
climate hope?

Biogas – more
than just energy



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Good results provide new research opportunities

It was fun and exciting to look through IVL's Annual Report for 2022. It shows the breadth of our operations and the environmental benefits we deliver together with our customers. Our excellent financial performance will lead to new research opportunities.

We issued 100 press releases and appeared in 2,140 press clippings this year. If you want to get updated on how IVL appeared in the media this year, you will find a good selection of our press coverage on pages 8-13. Did you know that all organisms leave DNA behind? Biodiversity around the world is threatened, and measures to preserve or recreate ecosystems with a high richness of species are high on the global agenda. We use environmental DNA as an important tool for measuring biodiversity. Read more about this on pages 16-19.

Emissions of environmentally hazardous substances from the Swedish process industry have decreased sharply in line with environmental protection measures. During a few intensive weeks in July, IVL did sediment sampling from the research vessel R/V Sunbeam at a number of large industrial facilities along the coast of Norrland. On pages 22-23 you can read more about the results of the survey. If you want to know how wildlife and the environment are affected by the underwater noise that ships and fairway work create, read the article on pages 24-25.

The work environment is one of our areas of research, so if you want to know how the recycling resulting from the increased electronics consumption affects the work environment, you can read about this on page 30. In many professions, employees come into contact with hazardous chemicals and are at risk of developing allergies and

hand eczema. In a project funded by the insurance company AFA Försäkring, our researchers are developing a method for measuring skin exposure to hazardous substances. You can read about this on page 31.

Swedish wastewater treatment is facing a major challenge due to PFAS. The article on pages 32-33 discusses this. Everyone is talking about hydrogen, so if you want to know what the researchers are saying, read more on pages 40-43. An entire city is moving in Kiruna, which creates both challenges and opportunities. On pages 44-45 you can read about how IVL shows how waste heat from LKAB can heat the new Kiruna.

The energy issue is an important piece of the puzzle when more and more construction and real estate companies want to become climate neutral. On pages 46-49 you read about IVL's projects where we compared the climate impact of different energy system solutions using the Tidstegen tool.

The climate issue is urgent and some of the most important operators in the transition are in the primary industries. However, for these industries to change quickly, the demand for climate-smart products must increase; you can read more about this on pages 50-53. Check out our exciting projects with our customers and what they think about our work on pages 63-71.

Pleasant reading!



THE YEAR IN BRIEF

EMPLOYEES



404

people were employed by the Group

SALES



mSEK 509.5

was the Group's sales

RESULTS



mSEK 35

profit after tax for the year for the Group was

REPORTS



108

reports were published

ARTICLES



75

scientific articles were published

IVL IN THE MEDIA IN 2022



2,140
news stories

54
debate articles

47,941,766 SEK
ad value

119,443,893 SEK
PR value





IVL's strength is that we represent the whole range of environmental issues

IVL stands strong despite a year of global crises such as the war in Ukraine and COVID-19. In a time of economic crisis, political change and uncertainty about the future, it is important to continue to focus on the climate and the environment.

IPCC reports tell us that global climate emissions continue to increase. And the war creates long-term effects with environmental consequences that the whole world must take responsibility for. That is why our fight for a sustainable world must continue. IVL's work has never been more important.

IVL has continued its environmental work during the year and works in close collaboration with the business community to support its transition work. We are still in high demand. IVL's strength is that we stand for the whole range of environmental issues, and that everything we do is based on the latest research.

Debates about carbon dioxide emissions are just not enough. Our strength is that we work with all aspects of environmental issues. We work with water treatment, diversity in nature, new purification technologies, hydrogen – just to name a few. That breadth makes us a strong and important partner. We also stand on a solid academic foundation where everything we say and do is based on research. Today's hindrances to reaching climate goals place high demands on being able to relate to an upside and a downside. Our way of working provides an opportunity to overcome difficulties and make choices that will work in the future.

As a former customer of IVL, I know that our customers see us as a trustworthy company, and they know we take consider the whole range of environmental issues in a credible way. This gives our customers a good and secure basis on which to make various decisions.

We need to increase our presence in the environmental debate and our researchers and specialists need to take up even more space in the media. This would be a good way to describe environmental perspectives from a comprehensive and correct position. The outside world needs our knowledge and expertise to be able to take greater responsibility for the environment. We need to become more visible internationally in order for our work to have even more effect and contribute to a sustainable transition.

When geopolitical conflicts are a fact, Sweden should be at the forefront by exporting smart sustainable solutions. This is an economic opportunity, but also an obvious obligation that we need to accept to achieve a sustainable future. When the world is on edge, the business community takes a leading role in the transition. But it is important to include all aspects of the environment in that work. IVL is a reliable partner in this, with a long history of environmental measurements and work in permit processes, but also with knowledge of how to implement a sustainable transition with all aspects of the environment in mind.

It is important that IVL is a profitable and healthy company and it is extra important that we stand firm when the outside world is wavering. By being profitable, we can continue to keep our focus on the environment and a sustainable world. We reinvest our profits in the company and employee development, which leads to the environmental research of the future.

I would like to express a big thank you to all colleagues at IVL for fantastic efforts in 2022.



MARIE FOSSUM STRANNEGÅRD, CEO

A turbulent world should not scare us away from sustainability

2022 has been marked by adaptation to global crises. The war in Ukraine has meant that IVL has gained new foreign colleagues, but also that we have stopped projects where we collaborated with Russia. Through the great commitment of our employees, we have supported our fellow human beings in Ukraine. We have also worked hard during the year with both the relocation of Hammarby Sjöstadsverk and our new operations in northern Sweden.

It is difficult to assess the long-term effects of the war. The extinction of plants or animals can lead to disruption of ecosystems, the consequences of which are almost impossible to predict. When we have better knowledge of the environmental effects of the war, our employees are prepared to respond and help with the clean-up and environmental work required.

One effect of COVID-19 is that we all had to adapt to working a hybrid mix of working at the office and from home. For new employees, remote work has been more challenging; a sense of belonging is essential to job satisfaction. At IVL, with our positive corporate culture, we try to take care of everyone despite distance. Our dedicated staff associations have contributed by offering a wide variety of activities ranging from swimrun to watercolour courses. That is one of the things that makes me so proud of the company we are and how we behave as colleagues.

No matter how good we have become at working digitally, it can never replace the power of meeting people in person. I am grateful that we can finally meet employees, partners and customers physically again. We gathered all staff for a long-awaited kick-off in Stockholm this spring. Finally we were able to discuss and follow up on our strategy for 2025 when everyone was in the same room. It meant a lot, but above all the more informal meetings were much appreciated by both me and the other employees.

IVL's chairperson, Annika Helker Lundström, chose to leave that position after twelve years. Board member Alf Engqvist, former President and CEO of Göteborg Energi, took over the role of chairman during the spring. With his long-standing

experience in business and the energy industry, Alf is a great support and a valuable resource for IVL.

We continued our investment in northern Sweden last year, where we set up a new office in Skellefteå in 2021. We have continued to grow with new staff and new customers. The growth of Västerbotten and Norrbotten as well as all the transformation and transition work that is going on there makes it important to participate with our research and expertise. We are driving major investments in new technology with renewable energy solutions together with our customers.

The Swedish Maritime Administration's research facility, run by IVL and KTH, began its move to Loudden near Frihamnen in Stockholm last year. In the unique pilot and demonstration plant, new solutions for circular water management and resource extraction are tested and developed. The new premises have been prepared for our operations and we expect to be up and running there during the first half of 2023.

We have exported our expertise in water treatment. IVL works as an environmental consultant in several projects to reduce pollution in the Mithi River, which flows through the multi-million city of Mumbai. Contributing with our knowledge in India is a very positive step. A functioning wastewater treatment plant will contribute to better health and living standards for many people in Mumbai.

Our talented employees continue to do good things for the environment, and they work hard to achieve a sustainable world, regardless of how turbulent the world gets.

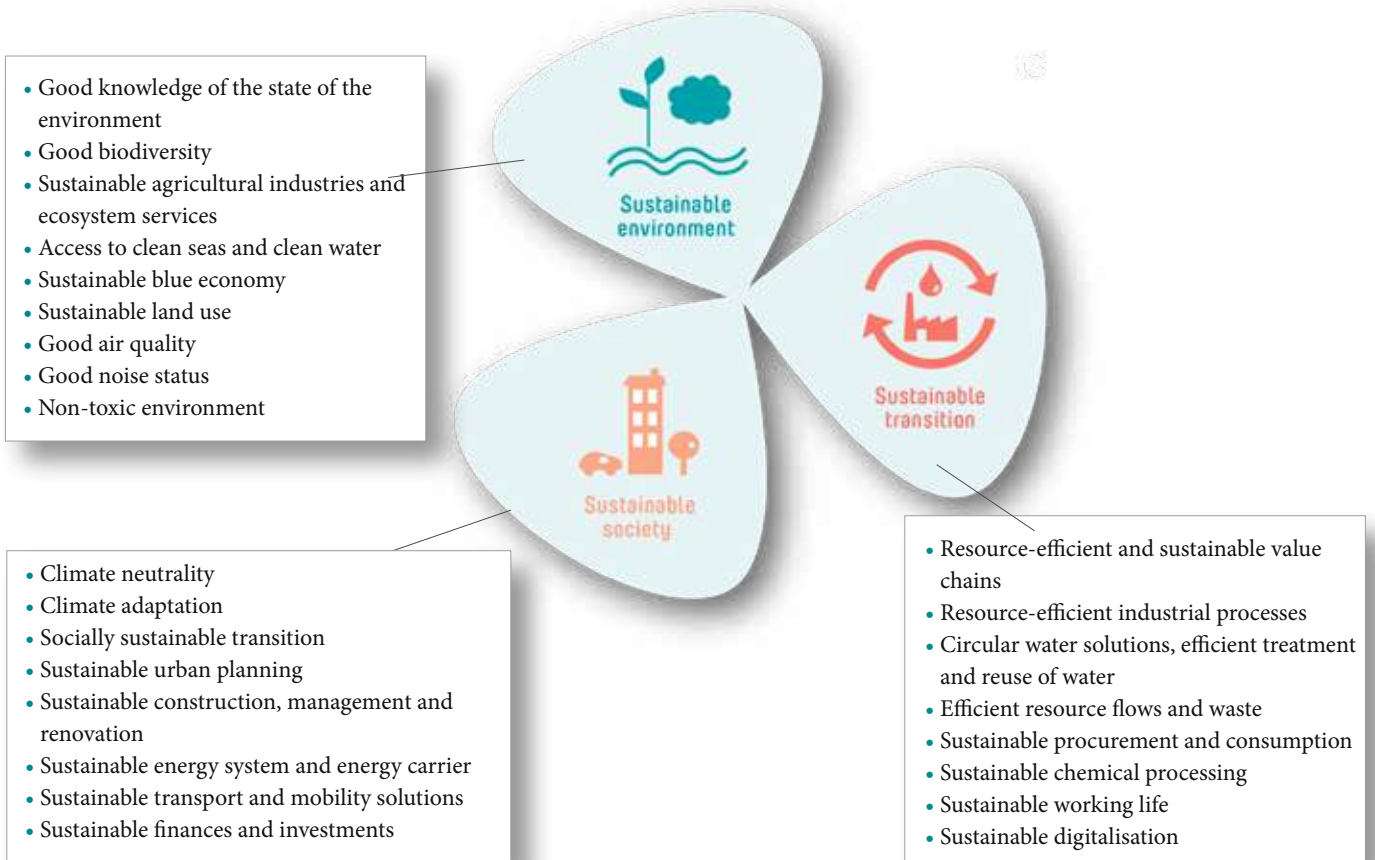
It makes me proud and grateful.

Our purpose is to work with applied research and consultancy projects to promote ecologically, economically and socially sustainable growth in business and society.

OUR THEMATIC AREAS

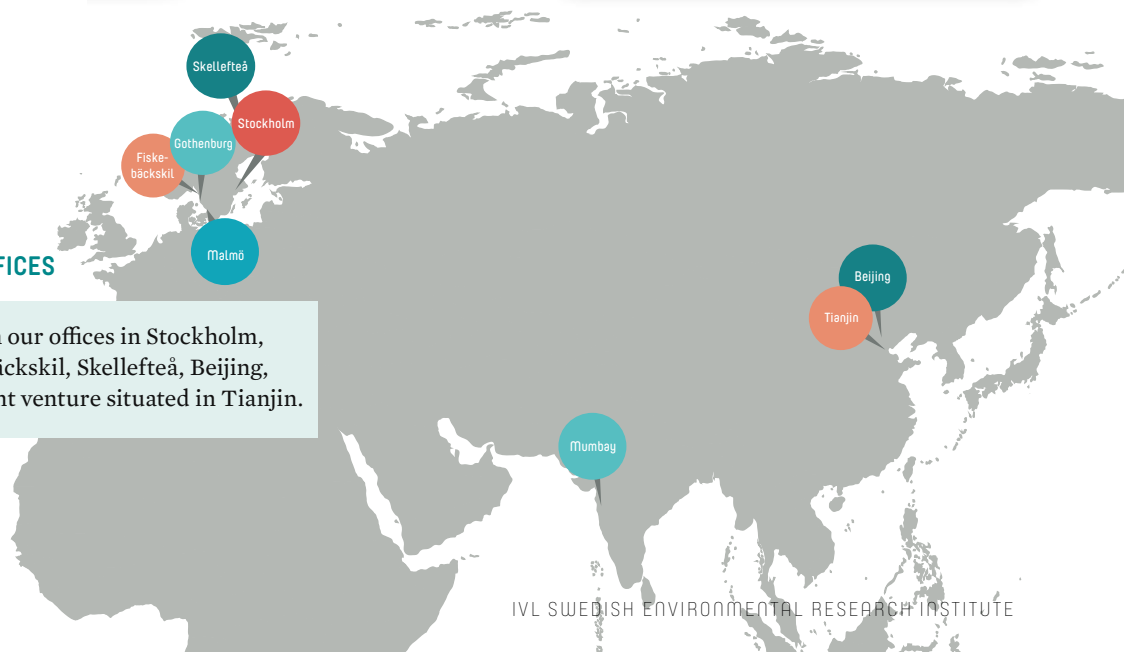
Our three thematic areas will tackle challenges with different perspectives and areas of focus: *Sustainable Environment*, *Sustainable Transition* and *Sustainable Society*. In all the thematic areas, operations are being run and developed with

overarching key concepts such as *utilising the opportunities of digitalisation, change management with a life cycle and system perspective*, as well as *governance to achieve sustainable solutions*.



OUR OFFICES

Just over 400 people work in our offices in Stockholm, Gothenburg, Malmö, Fiskebäckskil, Skellefteå, Beijing, and Mumbai. We also have a joint venture situated in Tianjin.



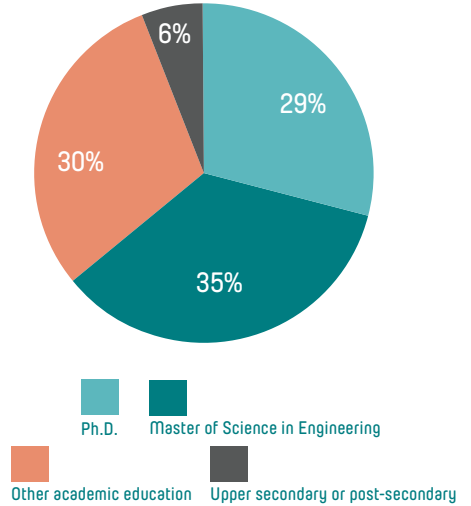
OUR OWNER SIVL

The Swedish Institute of Water and Air Conservation Research Foundation (SIVL), alongside the business sector and government authorities, is establishing a collaboration regarding important issues in respect of the environment and sustainable development.

SIVL is the sole owner of IVL Swedish Environmental Research Institute and funds research and innovation with particular focus on applied issues with an interdisciplinary and system-oriented approach.

OUR EXPERTISE

We possess solid scientific expertise in the form of engineers and environmental scientists, as well as behavioural scientists, economists and sociologists.



OUR VISION IS A SUSTAINABLE SOCIETY.
WE ARE DRIVING THE TRANSITION BY TRANSFORMING:

- SCIENCE INTO REALITY
- ENVIRONMENTAL PROBLEMS INTO OPPORTUNITIES
- LINEAR PROCESSES INTO A CIRCULAR ECONOMY.

OUR CORE VALUES

CREDIBILITY,
FORESIGHT
AND A HOLISTIC
APPROACH

OUR SUBSIDIARIES

EPD INTERNATIONAL
Runs the EPD system, which is a system for verifying and registering environmental product declarations.

EBVD I NORDEN
Facilitate the work of digitising construction processes and contribute to more eco-friendly construction.

BASTA ONLINE
Works for the phasing out of particularly harmful substances from construction products through the "Basta" system.

MÖBELFAKTA
A reference and labelling system for furniture.

IVL ENVIRONMENTAL TECHNOLOGIES (BEIJING) COMPANY LTD
Offers environmental research and consulting services as well as technology transfer services from Swedish environmental technology companies to the Chinese market.

SINO-SWEDISH ENVIRONMENTAL TECHNOLOGY DEVELOPMENT CENTER LTD (SEC)
Through SEC, a large number of Swedish environmental technology companies have been helped into the Chinese market.

IVL INDIA ENVIRONMENTAL R&D PRIVATE LTD
Works with wastewater treatment projects in the Indian market.

News from the year

Every month we publish news about current projects, reports and research results. Set out below is some of the year's news in brief.



Major investment in marine research

Chalmers, University of Gothenburg, IVL, KTH and RISE are joining forces to invest in and operate the Kristineberg Marine Research Station under the name Kristineberg Center for Marine Research and Innovation. The goal is for the Kristineberg Center to become one of Europe's leading marine research and innovation environments.

Many different types of projects are conducted in a number of marine areas at Kristineberg. Some of them include developing new materials and food from the sea. Others concern the impact of climate on marine life and include both underwater robots and digital technology.

Wiser climate decisions early in construction projects

How can the shape of a building affect the climate footprint? At present, it is difficult to determine because there are no established methods and tools for calculating climate impact and comparing different alternatives in the early design stages.

Together with architects, designers and additional research agencies, IVL will develop a tool that will make it easier for the construction industry to evaluate the climate impact of different solutions and integrate this into current working methods early in the construction process. This will increase construction and real estate industry opportunities to make wise climate decisions.

The project is carried out together with the architectural firms FOJAB and Warm in the Winter, and with Rise, Tyréns and Chalmers as special reference partners.

January

February

Guidelines make it easier to build using recycling

Lack of knowledge is one reason why reuse of building materials is still slow. To change that, Avfall Sverige and IVL are launching a set of guidelines aimed at private individuals who want to utilise used building materials or know if windows, doors or other things they have in their homes are suitable for reuse.

The Building Reuse Guidelines cover around 70 products from foundations to roofs and gives tips on how to recognise hazardous materials and how to sort the waste.



New CEO at Basta

Pehr Hård became the new CEO of IVL's subsidiary Basta. He succeeds Sussi Wetterlin, who after seven years as CEO will operate her own company. Pehr Hård is a chemist and has a background both in certification issues for the industry and in digitalisation and sustainability issues. He has previously worked at Sweden Green Building Council and the Nordic Swan Ecolabel.

Basta runs one of the construction industry's largest digital databases with construction products that meet high demands on chemical content. Today, almost 500 Swedish and international manufacturers are connected to the system and the database has over 170 000 construction and civil engineering products that meet Basta's high environmental requirements.



After dieselgate: Nitrogen oxide emissions from light diesel vehicles decrease

As the EU has tightened emission standards for nitrogen oxides from light diesel vehicles in recent years, emissions have also decreased. This is shown by extensive measurements of emissions in real traffic that IVL has carried out. However, diesel cars still emit five times more nitrogen oxides than petrol-powered cars in Sweden. Above all, emissions from older diesel cars cause the nitrogen oxide problem to linger. The oldest Euro 6 diesel cars, with model year between 2015-2017, account for as much as 25 percent of the total nitrogen of the passenger car fleet oxide emissions, and these will be on Swedish roads for many more years.

Nitrogen and the link to carbon sequestration in Nordic forests

In a project for the Nordic Council of Ministers, researchers at IVL, Norwegian NIVA, Finnish SYKE and Danish Aarhus University have calculated nitrogen flow in forest ecosystems in Sweden, Norway, Finland and Denmark. The work is a step on the way to calculating a total national nitrogen budget where all flows of reactive nitrogen across national borders are quantified.

Establishing national nitrogen budgets is a good way of identifying where you have the highest emissions of reactive nitrogen into the environment of a given country. By examining the magnitude and rate of change of nitrogen stocks, it is also possible to forecast future negative effects of nitrogen pollution on the environment and to take action where it is most needed.



IPCC: Climate risks greater than previously estimated

It is very urgent to significantly reduce greenhouse gas emissions while adapting our societies to a warmer, wetter and stormier climate. This is stated by the UN Climate Panel (IPCC) interim report – *Effects, climate adaptation and vulnerability*.

According to the IPCC report, current adaptation rates are not keeping pace with climate change. The main measures are mainly the conservation and restoration of ecosystems, infrastructure measures and agricultural measures.

It is positive that the report focuses strongly on the link between the climate, ecosystems and biodiversity and humans and the communities in which we live, and operate in, according to IVL's climate adaptation experts. The fact that the IPCC highlights the interdependencies between our different systems shows that we cannot work in silos with these issues.



March

How can we strengthen local transition

Much of today's sustainability work in regions and municipalities takes place in silos rather than from a larger holistic perspective. It is also common to overlook conflicting goals. Researchers at IVL and KTH, with support from Formas, have developed a number of tools and methods to strengthen the local transition.

On the website <https://www.ivl.se/projektwebbar/att-fa-omstallning-att-handa.html> (making sustainable transition happen), the project has gathered research-based science on sustainable transition at local and regional level. Among other things, there are scenario-based tools and working methods that can be used in practical terms which also challenge ideas about what is possible, what changes can and should be implemented and what decisions need to be made.

Sustainable clothing of the future

What do the sustainable clothing value chains of the future look like? IVL will find out in a research project that is being started together with the University of Borås and Profu.

The clothing industry is facing major sustainability challenges, both in terms of the environment and social sustainability. The *Sustainable clothing of the future* project covers several aspects of sustainability in the clothing industry. Among other things, consumer behaviour linked to new business models is mapped, new technologies for production, and recycling is being investigated and policy measures evaluated. The impact of e-commerce, home delivery and returns will be given extra attention because it tends to increase transport.



Green fuels can reduce climate emissions from shipping and aviation

Alternative maritime and aviation fuels can play a key role in reducing climate emissions from the transport sector. This is shown in a study in which researchers from IVL and Chalmers University of Technology investigated future fuel choices and which ones can most effectively reduce climate emissions. The analysis shows that it is possible to drastically reduce climate emissions in shipping and aviation by 2050, but it is necessary to accelerate the introduction of alternative fuels.

A combination of fuel choices will be needed, with options differing somewhat for different segments. For coastal shipping with short distances, battery-electric propulsion is efficient. But if those ferries need to go very fast, hydrogen or methanol may be needed. In long-distance shipping or aviation, electric power alone becomes problematic. There are liquid fuels such as biofuels and electrofuels, hydrogen or perhaps ammonia is more interesting. The results have been developed in a project funded by the Swedish Energy Agency and f3 – Swedish Knowledge Centre for Renewable Fuels.



April

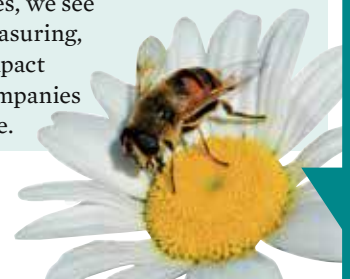
Lifecycle perspective helps retailers steer towards sustainability

In collaboration with Apotek Hjärtat, Perrigo and IDUN Minerals, IVL has been looking at how life cycle assessment can be used in retail to reduce climate impact. The study shows that life cycle analysis (LCA) data has an important role to play, especially if the knowledge comes in early in the processes so that it is used to guide decisions about product development and purchasing. With the help of LCA, companies can get an overall picture of how large the total environmental impact is during a product's life cycle, from raw material extraction through manufacturing processes and use to waste management. It can be used to see where action needs to be taken and how environmental performance can be improved.

Major differences in how companies work with biodiversity

On behalf of the Swedish Environmental Protection Agency, IVL has mapped how businesses work and follow up their work with biodiversity. The results show that there are major differences between companies of different sizes and between companies that have a direct or indirect impact on biodiversity.

Above all, it is companies that have a direct impact on biodiversity, for example through land use such as forestry and agriculture, that have established work on these issues. The survey also shows clear differences between companies of different sizes. In larger companies, we see more resources being used for measuring, reporting and following up the impact on bio-diversity, while smaller companies need more support and knowledge.



New method measures the impact of forestry on biodiversity

Researchers at IVL, together with SLU, have developed a conceptual method that can be used to assess a forest owner's impact on biodiversity based on the forestry work that the owner conducts. The method makes it possible to compare forest owners in different parts of the country and the impact of forestry in relation to different target values.

The method is linked to the overall work that IVL does within the research programme *Mistra Digital Forest* where IVL also develops sustainability indicators for climate impact but also for social and economic aspects

Together, the method and indicators can provide a more comprehensive and integrated assessment of various sustainability aspects for Swedish forestry.

Over one million tons of food is thrown away in Sweden

In Sweden, we throw away over one million tons of food waste every year, which corresponds to 106 kg per person. This is shown by calculations made by IVL, SLU and Statistics Sweden on behalf of the Swedish Environmental Protection Agency. Households account for the largest amounts.

The national target of 40 percent of food waste going to anaerobic digestion has just been reached, but not the target of 50 percent collection for anaerobic digestion or composting. Reaching the target of 75 percent anaerobic digestion by 2023 will require new measures. The figures come from the latest report *Food waste in Sweden* was developed by IVL, SLU and Statistics Sweden through the consortium SMED, Swedish Environmental Emission Data, on behalf of the Swedish Environmental Protection Agency.

May



Alf Engqvist – new chairman of IVL's board

Alf Engqvist became the new chairman of the board for IVL Swedish Environmental Research Institute. He succeeds Annika Helker Lundström, who after twelve years has chosen to step down as chair. Alf Engqvist has many years of experience in the energy industry, including as CEO and group managing director for Göteborg Energi, CEO of Infratek and its subsidiary He has also for many years had several board assignments and was appointed as member of the board for the Gomero Group and 4Public Sverige Handelsbolag.



June

Sweden hosts the UN Stockholm +50 meeting

World leaders gather in June for the Stockholm+50 climate summit. It is then 50 years since the UN's first environmental conference took place, the Stockholm Conference, in 1972.

The conference held in 1972 resulted in the so-called Stockholm Declaration, which contained several principles that are still important for environmental management today. The conference was also important for IVL, which was formed as early as 1966, and the activities that developed in the years afterwards, including in the air quality issues. In several of the environmental issues that were important in the 1970s such as acidification, the ozone layer and mercury, environmental work has been successful. At the same time, we are currently facing major global challenges such as climate change, water scarcity and our ever-growing consumption.

Stockholm +50 is arranged under the name A healthy Planet for All – Our Responsibility, Our Opportunity, which aims to gather the international community behind strengthened cooperation and action in the transition to a more sustainable future.



Major EU investment to accelerate the transition to safe and sustainably designed materials

The EU is investing more than €3.5 million in the IRISS project, which aims to accelerate the transition to safe and sustainably designed materials, products and processes. The consortium is led by IVL to form a global network of experts and trade operators.

Fundamental to the entire initiative is the concept *Safe-and-Sustainable-by-Design (SSbD)*, which involves focusing on providing products early in the supply chain that are part of circular models while avoiding properties that may be harmful to human health or the environment. It integrates circularity, climate neutrality, functionality and safety of materials, products and processes throughout their life cycle. The Innovation and Chemical Industries, IKEM, and SusChem Sweden from Sweden will also participate.

Working together to reduce food waste

About a third of all food produced is thrown away instead of eaten. To counteract this, a voluntary agreement called *Cooperation to Reduce Food Waste* has been drawn up between many operators in the food industry and the state. Interest in participating is steadily increasing, according to the annual report.

An important part of the work is to identify where food waste occurs and what the root cause is.

In this way, the problems can be rectified and the solutions spread to more people. A strong focus is put on standardising data reporting, as measuring food waste is the basis for being able to prioritise measures and see what effect they have.



Sediment survey along the coast of Norrland

During a few intensive weeks in July, IVL did sediment sampling from the research vessel R/V Sunbeam at a number of large industrial facilities along the coast of Norrland. In addition to the smelting plant at Rönnskär, several paper and pulp industries are included.

Emissions of environmentally hazardous substances from the Swedish process industry have decreased sharply in line with environmental protection measures. However, elevated levels of various pollutants originating from historical emissions still occur in bottom sediments outside some plants. The new measurements provide opportunities to follow the development and recovery process over time in the aquatic environment outside major Swedish basic industries.



Great hopes for cost-effective nitrogen removal in Sundsvall

A pilot plant for research on nitrogen removal was commissioned this summer at the Fillan wastewater treatment plant in Sundsvall. The project will find out the most efficient way to remove nitrogen from wastewater in a climate that is cold for much of the year.

Nitrogen contributes to eutrophication in our lakes and seas with algae blooms as a result. The current

project investigates how MBBR technology (Moving Bed Biofilm Reactor, a variant of the biological stage in a treatment plant) can best be designed to provide cost-effective nitrogen removal based on a number of parameters such as temperature, heating, time required, the size of the basins and the different stages of the process.

July

August

New EPD agreement gathers the Nordic region around climate documentation

Developing and using environmental product declarations (so-called EPDs) has so far in many cases been difficult, time-consuming and costly. A new agreement signed between those responsible for the EPD programmes in Sweden, Denmark and Norway creates new opportunities to use environmental data across borders. The agreement means that manufacturing companies that have had an EPD published by one of the three Nordic players can now have it published by the other two players without having to verify it again.

The demand for environmental product declarations has increased rapidly in recent years, especially in the construction industry. The Swedish EPD database now contains over 3,400 registered EPDs. Norway has also seen an explosive increase in EPDs in recent years.



Measures to reduce lead in drinking water – new report from WHO

During World Water Week in Stockholm, the World Health Organization launches a report with measures to reduce lead in drinking water. IVL's water expert Johan Strandberg has been working with WHO to develop concrete advice for national authorities and drinking water producers.

Lead is still present in many water systems around the world, and fixing it is often expensive and takes a long time. In order not to become too great an obstacle, the report proposes a working method that partly makes it possible to prioritise where measures are most needed and partly that these can be carried out in stages. Several countries already have guidelines in place regarding lead in drinking water. WHO's recommendations will be most useful in those countries where guidelines do not exist yet.



Major climate benefit if more construction waste is recycled

At the request of the Swedish Environment Protection Agency, IVL has examined metal content in moss samples from around the country. The results show that levels of lead and copper in moss have diminished in Sweden as a whole since 2015. However, the levels of arsenic, iron, chromium, mercury, nickel, vanadium, zinc, aluminium and cobalt in moss have increased.

The reason for this is not known, and follow-up investigations are required to see if these results persist. The deposition of both metals and nitrogen across Sweden exhibits a clear gradient from the south to the north, which reflects the arrival of emissions from the continent.

This pattern is broken in some locations, however, with elevated metal levels that can be attributed to local and regional sources of emissions. Examples of this include elevated levels of copper and chromium along the Norrland coast, as well as raised levels of iron in the ore fields in Norrbotten County.

Policy instruments are needed to enable a circular economy

Minimum requirements for the share of recycled materials in new products, clear targets for consumption-based emissions and increased circular requirements in public procurement. These are examples of policy measures that need to be introduced in order for the circular economy to become a reality, according to a report that IVL has pro-

duced on assignment for the Circular Sweden business forum.

The report describes both obstacles and possibilities to reduce the generation of waste and residues by investing in longer life-cycle and circular flows, and provides suggestions for important areas for policy to focus on.



Energy expert appointed professor at Lund University

IVL's energy expert Kristina Lygnerud was appointed adjunct professor in the Department of Energy Sciences at Lund University. The position focuses on district heating and cooling and will result in increased exchange between technical and economic district heating research.

Kristina Lygnerud has been active at IVL since 2015, both as an energy expert and business developer. Much of her work has been about new techniques to recover residual heat from cities. She also chairs the board of the international district heating network, Euroheat and Powers.



October

Water research facility moves to Loudden

The Hammarby Sjöstadsverk research facility, which IVL and KTH run together, will soon move to the district of Loudden just east of Frihamnen in Stockholm. A new agreement is signed with Stockholm Vatten och Avfall. The area to which Loudden is being moved has previously been used as a municipal wastewater treatment plant, test and demonstration facility, which provides good conditions for continued operations.

In the unique pilot and demonstration plant Hammarby Sjöstadsverk, new solutions for circular water management and resource extraction are tested and developed. Experts in environmental technology at the facility work all year round with research projects, education and technology development, both in national and international research projects.



Investments in clean water in Mumbai

IVL's work focusing on the global goal *Clean Water and Sanitation*, SDG6, which continues in India. IVL has been engaged as an environmental consultant in several projects concerning water treatment in the megapolis of Mumbai. Mumbai, which has over 24 million inhabitants, is one of many cities in India that has not had a functioning wastewater treatment system. To deal with water issues, the Indian government has initiated several major initiatives. One of the ambitions is to build wastewater treatment plants in all major cities.

In October, IVL's CEO Marie Fossum Strannegård and other representatives from IVL visited Mumbai, including the treatment plant on the Mithi River, which is now ready for use. IVL's office in Mumbai now employs 42 full-time employees and about ten consultants with a focus on the water treatment projects underway in the city.



September

New Kiruna can be heated better with waste heat

The entire city of Kiruna is being moved. This creates challenges – but also opportunities for new and climate-smarter solutions. IVL is leading the Waste Heat in Kiruna project to show how LKAB's waste heat can be used in the municipal district heating network. The ideas are not new – waste heat from LKAB has been included in the district heating network's heat sources in Kiruna since the 90s.

But to achieve greater effect, it is important to be able to use the waste heat throughout the year.

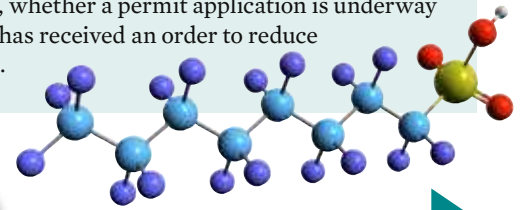
IVL's researchers have used data-based modelling systems to show how seasonal energy storage creates more resource-efficient systems: If the summer's waste heat from LKAB, which is not needed during the warm season, can be stored and used in winter, it helps to heat Kiruna during the coldest months of the year. Energy storage is important to meet supply and demand – and energy system modelling shows that there are great opportunities for this here.



PFAS – how can Swedish treatment plants meet the challenge?

In collaboration with researchers from SLU, Uppsala University and several water and wastewater operators and Swedish Water Development, IVL has produced a knowledge compilation and guidance on PFAS for Swedish wastewater treatment plants.

Perfluorinated substances, PFAS, are very difficult to break down and can therefore accumulate in the environment with a high risk of negative health and environmental effects. Although only a small part of PFAS in the environment is spread via wastewater, there are reasons for wastewater treatment plants to learn more about the PFAS challenge, according to the authors of the report. The report describes how wastewater treatment plants can prioritise their efforts depending on size, associated industries, whether a permit application is underway or whether the plant has received an order to reduce its emissions of PFAS.



November

December

Major environmental benefits from recycling more nitrogen from wastewater

Rising fertilizer prices last year can be a threat to Swedish food production and has led to the Swedish Board of Agriculture now rapidly investigating Sweden's and the EU's ability to produce domestic fertilizer. With new technology, part of the fertilizer need can be covered by recycling nutrients from wastewater, according to a research study from IVL, RISE and Mälardalen University.

By recovering nitrogen from highly concentrated streams at treatment plants, between 10-25 percent of the nitrogen present in wastewater could be returned to agricultural land. In addition to reducing dependence on fossil gas for the production of nitrogen fertilizer, emissions of climate-impacting nitrous oxide from the treatment plants also decrease when nitrogen is recovered, the study shows.

Guidance to reduce climate impact during renovation and reconstruction

Together with Public Housing Sweden and Kommuninvest, IVL has produced guidelines for how property owners and construction contractors can reduce the climate impact of renovation and reconstruction. Eight property owners, together with construction contractors and their consultants, have participated in the pilot project. Their experiences have been compiled and contributed to the creation of the guidelines. The hope is that it will raise knowledge in the industry and that more people will start to demand climate calculations during renovation and rebuilding.



Centre for Circular Building becomes a subsidiary of IVL

The Centre for Circular Construction (CCBuild) becomes a new subsidiary of IVL Swedish Environmental Research Institute. The collaboration started in 2015 as a project within Vinnova's Challenge-driven Innovation programme, and has grown significantly during the years and will now continue to be developed and operated under IVL's guidance.

CCBuild's main task is to support the construction and real estate industries' transition to more circular construction and increased reuse. The cooperation includes network forums,

knowledge sharing and support, and digital services that make it easy to inventory and create overviews of which building materials, furniture and other products that are available for reuse – both within companies and between different organizations and companies through a marketplace. Around a hundred partners are connected to the platform, both small companies and large corporate groups.





SUSTAINABLE ENVIRONMENT





Environmental DNA – an important tool for measuring biodiversity

Biodiversity around the world is threatened, and measures to preserve or recreate ecosystems with a high richness of species are high on the global agenda. But how do you measure biodiversity? Researchers at IVL are developing opportunities within the new research field of environmental DNA.

“Now we’re contaminating the water, Tage!

Mats Töpel laughs and finds a pair of blue plastic gloves in his bag while Tage Vowles tries to catch, with his bare hands, a small salamander in the small frog pond high up in Slottsskogen Forest.

The scene strongly resembles a crime scene. There are plastic gloves, sterile zip bags, filters and various containers. Two very meticulous investigators methodically carry out their investigation. What we are looking for is certainly not the traces of a perpetrator, but something rare and elusive. Both of our Swedish species of newts are protected. The northern crested newt is also included in the EU’s Habitats Directive and thus has a higher level of protection, which means, among other things, that its spawning grounds are protected.

“Actually, you are not allowed to disturb protected species, but for smaller newts there is a special paragraph in the Species Protection Regulations that states that individual specimens may be temporarily captured for study, and we have to say that this is what we are doing,” Vowles said – who, however, does not get a bite this time.

Today’s sampling is also not so much about salamanders per se, but rather involves testing the sampling equipment itself and recording an instructional film.

ENVIRONMENTAL DNA CHEAPER, FASTER AND MORE RELEVANT

“The technology behind environmental DNA is basically based on the same technology that is applied in the analysis of human DNA.

All organisms leave DNA traces behind. For example, when a fish moves through the water, it constantly leaves behind parts by itself like dead skin cells, mucus or faeces. This organic material contains DNA molecules and is called environmental DNA,” Töpel said.

Biologist Mats Töpel began exploring DNA molecules and sequences fifteen years ago and has seen how the technology has become cheaper, faster and increasingly more relevant in the environmental field.

ENVIRONMENTAL DNA CAN BE USED E.G. TO:

- Identify restoration potential for overgrown pastures
- Protect and monitor endangered species
- Prevent the spread of invasive species
- Measure biodiversity change





Tage Vowles, IVL, taking water samples.

"Analysing DNA, and the similar molecule RNA, in environmental samples enables completely new types of investigations. One example is the measurements of COVID-19 in wastewater that were made during the pandemic, or that one can look at so-called genetic variation within species, which is difficult, if not impossible with traditional methods. A great deal is happening in the field now.

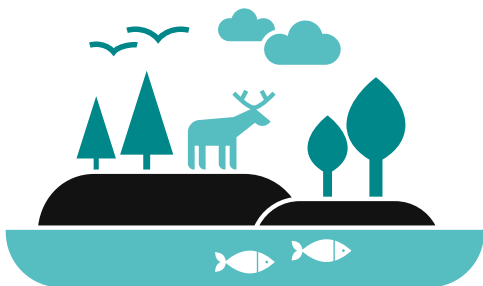
Environmental DNA even reveals what different organisms eat, or which plants a certain type of pollinator visits. Even the hidden biodiversity – microorganisms, unknown species or just genetic variation within a species – can be identified using environmental DNA.

A major advantage compared to typical field inventories is that the actual sampling can be carried out by a layman – with the right instructions – who can then send the sample for analysis and interpretation.

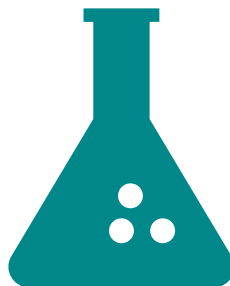
What is of particular interest to many organizations today is the ability to see trends over time, such as how species are affected by different measures. How much higher will the biodiversity be if grazing animals are allowed to walk on overgrown land? How much does it decrease as a result of a certain type of exploitation?

DOES ENVIRONMENTAL DNA MEAN THAT FIELD BIOLOGY HAS PLAYED ITS PART?

"No, not at all, but you can see it as a strong complement. For example, the answers we get through a DNA sample do not say much about how many individuals there are in a certain environment, or what the age distribution looks like in the population. There are therefore investigations that are most easily carried out using traditional inventory methods. But, if we are to be able to tackle the environmental changes we are facing, and manage the effects they have on it biodiversity, we need access



1 Samples from water, air or soil are collected.



2 The samples are prepared in IVL's own laboratory.



3 The data is analyzed and converted into information about biological diversity.



to new, cheap and reproducible methods that include DNA sequencing of environmental samples.

How can you be sure that the results of an environmental DNA analysis are correct? Can't that be misleading?

It is very important to carry out the sampling in the correct order with a relevant number of sampling points. Today we took four samples from this site, and that is more than enough to be able to detect the presence of newts. It is such a small pond. The concentration of DNA is also higher in stagnant water than running water. There is also more DNA in the water in the summer when most species spawn or lay eggs.

And if you want to get a picture of the biodiversity in a forest?

The larger the area, the more samples are needed, but in general you get a pretty good picture already at the first sample. Then there are several different methods – you can search for a particular species or sequence all the DNA in the sample through so-called metagenomics.

While Mats and Tage are filtering their water samples, a moorhen floats past through the reeds. A number of pigeons will repeatedly emerge, hopefully. And the occasional passing dog owner who curiously wonders what's going on. DNA traces are left everywhere by humans, animals and plants.

To minimise the risk of the molecules breaking down on the way to the lab, the sample is preserved in 99 percent alcohol. The samples will then be sent to IVL's lab in Stockholm for DNA sequencing. We already know that there are newts in the pond, but perhaps we will also find traces of other rare species?

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IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Measuring biodiversity linked to different agricultural practices.
- Producing a basis for decisions on action plans and the use of areas.
- Mapping biodiversity in coastal ecosystems.
- Monitoring protected or invasive species in different ecosystems.
- Evaluating the impact of different types of forestry on biodiversity.

GLOBAL OBJECTIVE, SECONDARY GOALS

2.4 SUSTAINABLE FOOD PRODUCTION AND RESILIENT AGRICULTURAL PRACTICES

12.2 SUSTAINABLE MANAGEMENT AND USE OF NATURAL RESOURCES

14.2 PROTECTING AND RESTORING ECOSYSTEMS

15.1 PRESERVE, RESTORE AND ENSURE THE SUSTAINABLE USE OF TERRESTRIAL ECOSYSTEMS AND

15.2 PROMOTING SUSTAINABLE FOREST MANAGEMENT, HALTING DEFORESTATION AND RESTORING DEGRADED FORESTS





How are trees affecting air quality in cities?

The importance of urban trees for air quality was the title of a seminar held in September 2022 by the two research projects, CityAirSim and Purifying the Air with Plants.

WHICH TREE SPECIES ABSORB THE MOST POLLUTANTS?

Jenny Klingberg from the University of Gothenburg presented the results from her Purify the Air with Plants project. The project has been investigating the uptake of so-called PAH pollutants in eleven tree species – both deciduous and coniferous – at different locations in Gothenburg and compared trees of different types in the Botanical Garden's arboretum.

Deciduous trees were measured in June and September in 2018. For the conifers, samples were taken of both annual and three-year-old needles. The conclusion is that conifers contain quite large concentrations of gaseous PAHs – they have a large volume to bind them. The needles also remain in place during the winter and can clear the air even then.

When it comes to particle-bound PAHs, the larch has proven to be good at absorbing them.

"That tree is known to be sensitive to air pollution and should be investigated further," Klingberg said.

A MODEL FOR STUDYING DIFFERENT SCENARIOS

Malin Gustafsson from IVL described how the researchers in CityAirSim have investigated the district of Gårda in Gothenburg. They put houses, streets and vegetation in a digital model of a few blocks and run scenarios with different types of buildings, without vegetation or with different dense tree crowns.

"Trees in the city provide better air quality in some situations, although they can also prevent air circulation on narrow streets. A calculation model that we develop within the

project shows how the leaves or needles absorb pollutants," Gustafsson said.

The calculation model has the working name VERA, which is an abbreviation of Vegetation for Removal of Air Pollution. In it, you can calculate how much pollution sticks to the leaves and what is washed off.

There are several parameters that the model must take into account:

- Deposition, i.e. how much sticks, which in turn depends, for example, on whether the surface is rough or waxy
- The wash-off, which is a combination of the amount of precipitation and time
- Resuspension, which concerns the force required for a particle to detach from the surface of the leaf or needle surface

This is then woven together in a model where you can simulate how air quality is affected by houses and vegetation.

"Since Gårda is located next to the E6 motorway, we can conclude that it would be good to plant trees next to that motorway," Gustafsson said.

INTERACTIVE VISUALIZATION TO LEARN ABOUT AIR QUALITY

Daniel Sjölie from Väst University College described the virtual reality environment over the district of Gårda in Gothenburg that has been developed in CityAirSim to visualise air pollution in urban environments.



Malin Gustafsson from IVL and project manager Håkan Pleijel from the University of Gothenburg are two of the researchers who talked about the importance of urban trees for air quality, partly based on the work done in the CityAirSim project.

There, users can "enter" the environment using VR goggles, then test by placing buildings and trees there to see how the air quality is affected.

Thommy Eriksson from Chalmers spoke about how a total of 200 high school students tested the VR environment. It was partly a question of evaluating how it works, but it was also that part of the educational objective of CityAirSim which is about investigating different ways of sharing knowledge. The participants at the seminar also had the chance to try out the

VR application. One of the end results of the CityAirSim project is to spread the knowledge to urban planners.

CityAirSim is led by the University of Gothenburg in collaboration with IVL and Chalmers. Urban Futures is one of several partners.

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IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Increasing knowledge about how we create sustainable, green and dense urban environments.
- Contributing to increased uptake of air pollutants by plants in urban environments.
- Developing tools for digital visualisation of model results.
- Bringing research results to the public, developing educational materials and tools for sustainable urban planning.

GLOBAL OBJECTIVE, SECONDARY GOALS

- 11.3** INCLUSIVE AND SUSTAINABLE URBANISATION
- 11.6** REDUCING THE ENVIRONMENTAL IMPACT OF CITIES
- 11.A** PROMOTING NATIONAL AND REGIONAL DEVELOPMENT PLANNING
- 13.3** INCREASING KNOWLEDGE AND CAPACITY TO TACKLE CLIMATE CHANGE





Sediment survey along the coast of Norrland

Emissions of environmentally hazardous substances from the Swedish process industry have decreased sharply in line with environmental protection measures. However, elevated levels of various pollutants originating from historical emissions still occur in bottom sediments outside some plants. The question is, how long will it take for the environment to fully recover? In the summer of 2022, IVL conducted new measurements in the Gulf of Bothnia as a basis for forecasting models of future environmental status in the coastal zone.

During a few intensive weeks in July of 2022, IVL did sediment sampling from the research vessel R/V Sunbeam at a number of large industrial facilities along the coast of Norrland. In addition to the smelting plant at Rönnskär, samples were taken outside several paper and pulp industries.

"We know that there are contaminants in the sediments based on earlier surveys. This year's measurements give us opportunities to follow the development and recovery process over time in the aquatic environment outside major Swedish basic industries," said researcher at IVL Magnus Karlsson.

The last time extensive sediment surveys were carried out in Skellefte Bay and the surrounding area was in 2003. The sediments are collected with retrieval in cores up to 80 centimeters long, which are documented and layered at different levels representing different eras of sedimentary material.

At IVL's laboratory in Gothenburg, extensive work is then carried out to analyse the levels of various metals and organic environmental pollutants in the sediment layer sequence.

"We compile and evaluate the data once the chemical analyses are completed. Comparisons with previous surveys give us opportunities to develop forecast models of future environmental conditions and how, for example, pollution levels in fish may develop over time. The results will also be able to form the basis for decision-making in discussions on future action strategies," Karlsson said.

The environmental surveys in the Gulf of Bothnia are part of the work that IVL performs in northern Sweden. IVL has for many years worked with environmental measurements and permit processes, but also in several research and innovation projects with strong links to northern Sweden. In 2023, IVL will continue its investigations outside industries in the north. This time focusing on the health status of fish and the uptake of pollutants.

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Magnus Karlsson, Hannes Waldetoft and Joakim Hällén taking sediment samples on board the research vessel R/V Sunbeam.

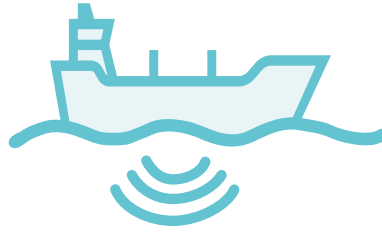
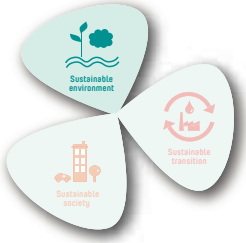
IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Developing control programmes and models for risk assessments of compound concentrations in fish.
- Developing a basis for action strategies.
- Cooperating with local businesses and inform the public about the state of the environment.
- Identifying areas where measures are needed.
- Mapping the spread of pollutants and uptake in organisms.

GLOBAL OBJECTIVE, SECONDARY GOALS

- 3.D** IMPROVING EARLY WARNING SYSTEMS FOR GLOBAL HEALTH THREATS
- 6.6** PROTECTING AND RESTORING WATER-RELATED ECOSYSTEMS
- 6.B** SUPPORT LOCAL INVOLVEMENT IN WATER AND SANITATION MANAGEMENT
- 14.1** REDUCING MARINE POLLUTION
- 14.2** PROTECTING AND RESTORING ECOSYSTEMS





IVL and the Swedish Maritime Administration in collaboration on underwater noise

Underwater noise from shipping and fairway work has a negative impact on wildlife and the environment. IVL and the Swedish Maritime Administration are collaborating on a project to investigate how noise can be managed and regulated at a national level.

Among other things, the project studies how the shape and design of the fairways affect the noise level.

"Shipping is increasing, and with it the underwater noise it causes. There is currently no regulation on how much noise each individual vessel can make," says Torbjörn Johansson, project manager at IVL.

Underwater noise in the oceans is a growing environmental problem. Noise is classified by the UN and the EU as a pollutant and can be equated with e.g. air pollution. But an important difference is that if you reduce emissions of noise, the levels in the environment decrease immediately," Johansson said.

IVL measures noise under water and analyses the effects it has on animals and nature. There are several known ways to reduce noise from ships, e.g. by moving slower or switching to a propeller with a lower acoustic signature. But there is currently no incentive for shipping companies to do so from an environmental perspective.

"Within a few years, new limit values will come from the EU to regulate how much noise is permitted in the oceans. A ceiling will be set for how large parts of different habitats for marine life may be negatively affected by underwater noise," Johansson said.

In the current project, IVL, in collaboration with the Swedish Maritime Administration, will develop proposals on how underwater noise can be managed and controlled at a national level. The project brings together operators affected by underwater noise and develops proposals for how the goal can be achieved with a focus on control, follow-up and implementing various measures.

The vision is that Sweden will be the first country to introduce incentives and measures to reduce underwater noise from shipping lanes. One possibility that will be looked at is to include underwater noise in the new eco-label, Clean Shipping

Index which will reward quieter vessels by having them pay lower port and fairway fees.

An important part of the project is also to study how fairway design affects noise levels. During the autumn of 2022, researchers from IVL have been out measuring noise levels in several fairways, including in Lake Malar. The measuring equipment was placed in different locations to record underwater sound, which is then analysed using signal processing methods.

Carl Andersson at IVL is one of those working on the project.

– "We use the measurements to investigate how ships sound at different manoeuvres and when moving in waters of different depths. Field measurements are necessary because the more general models that are otherwise used today to predict noise do not have sufficiently high accuracy on some kinds of ships. Both we and the Swedish Maritime Administration think that this is an exciting project that we hope will provide new knowledge about how to reduce the noise level underwater with the help of e.g. new incentives," he said.

The project will end in February 2023, but the parties are planning a continuation, where an important theme will be to propose how underwater noise can be introduced in the Clean Shipping Index, and to produce a basis for how it should be done. Another theme will be to develop methods and data collection tools to meet increased environmental requirements that will be set in the upcoming environmental quality standards.

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Carl Andersson and Dag Glebe at IVL collect measuring equipment located outside Västerås in Lake Malar.

IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Helping to reduce emissions of underwater noise from ships and recreational craft.
- Contributing to the development of new technologies for quieter ships and boats.
- Develop new technologies for sustainable production of fish in closed, land-based facilities.
- Create a better understanding of underwater noise in the oceans and how it affects marine life, and help reduce this impact.

GLOBAL OBJECTIVE, SECONDARY GOALS

- 9.1 BUILDING SUSTAINABLE, RESILIENT AND INCLUSIVE INFRASTRUCTURES**
- 9.4 UPGRADING ALL INDUSTRY AND INFRASTRUCTURE FOR INCREASED SUSTAINABILITY**
- 12.1 IMPLEMENT THE TEN-YEAR FRAMEWORK FOR SUSTAINABLE CONSUMPTION AND PRODUCTION PATTERNS**
- 14.1 REDUCING MARINE POLLUTION**





Some of our offerings within Sustainable environment

Water analyses

IVL is an expert on water pollution and acidification problems. With knowledge from long series of measurements dating back to the 1980s, we can analyse the effects and impact of forest management, the impact of air pollution on water systems, industrial emissions into recipient areas and wastewater. The analyses and tests are carried out in our laboratories and are tailored to your needs. Many of our measurement and analysis methods are accredited by Swedac in accordance with SS-EN ISO/IEC 17025:2005. For other methods, we work on the basis of corresponding quality procedures.

WE HELP YOU WITH:

- Mapping of emissions and dispersion of water pollution in forest areas
- Nutrient and acidification status in forest areas
- Analyses of the effects and impact of forest management, the impact of air pollution on water systems, industrial emissions into recipient areas and wastewater
- Determination of inorganic basic chemistry, elemental analyses, low levels of mercury, APH, CPB, FPAS, pharmaceutical residues, pesticides, flame retardants and plasticizers in plastic materials

Air analyses

IVL has extensive experience of both gaseous air pollutants and particulate matter, and offers measurement methods for cost-effective monitoring of air quality. Our extensive measurement activities in relation to the air are truly unique. We offer simple and robust measurement methods for cost-effective monitoring of air quality, both for gaseous air pollutants and particulates such as PM10 and PM2.5.

Many of our measurement and analysis methods are accredited by Swedac in accordance with SS-EN ISO/IEC 17025:2018. For other methods, we work on the basis of corresponding quality procedures.

WE HELP YOU WITH:

- Measurement methods for monitoring ambient air quality, including diffusion samplers
- Determining nitrogen dioxide, ozone, VOC and PAH in the air
- Determining metals in particles
- Analyses of mercury in the air, both in total and in particulate form
- Analytical methods for rare earth elements (REE), such as catalyst metals, from PM10 sampling

Life cycle assessments

A life cycle assessment gives an overall picture of the extent of the environmental impact of a product throughout its value chain. IVL performs life cycle assessments on a range of products and services.

What is the environmental impact of your company's products and services? By ascertaining where in the value chain the environmental impact is greatest, you can identify what measures need to be taken to reduce it.

It is possible to perform life cycle assessments on all types of products – for example on packaging, food, electronics, vehicles, fuels, building materials and construction – but also on services. A life cycle assessment calculates the environmental impact of all emissions and resource usage in the core process, but also the impact of raw material extraction, transport, the usage phase and waste management.

We have been experts regarding life cycle assessments since the early 1990s.

We carry them out on a daily basis in various research and consultancy assignments, as well as in all sectors, including forestry and the process industry, the automotive industry, the materials and construction sector and the manufacturing industry.

WE HELP YOU TO:

- Calculate environmental impact from a life cycle perspective (such as LCA, EPD)
- Conduct sustainability or cost calculations (LCC) from a life cycle perspective
- Review LCA calculations and Environmental Product Declarations (EPD)
- Implement life cycle perspectives in your organisation (Life Cycle Management, LCM)
- Map the climate impact according to the Greenhouse Gas Protocol (GHG)
- Calculate the impact of reuse, recycling, circular economy or industrial symbiosis
- Set requirements from a life cycle perspective for procurements

Analysing biodiversity with environmental DNA (eDNA)

New technologies such as eDNA provide effective analysis of both visible and invisible biodiversity in different types of ecosystems. IVL helps you to perform these analyses.

All organisms carry their genetic code in DNA molecules, and these molecules spread naturally in the environment, e.g. from dead skin cells or sweat. Because these genetic traces are species-specific, they can provide a picture of the biodiversity in a specific environment. These environments can be both natural ecosystems such as forests and waterways, but also artificial systems such as factories or process plants.

Analysis of biodiversity using environmental DNA is often more effective and produces a higher resolution than traditional methods, and also does not affect the species being studied and its ecosystem. Invisible biodiversity, such as microorganisms, unknown species or genetic variations within a species, can also be identified using these methods. By analysing the DNA contained in a sample, you can therefore acquire a better understanding of the diversity in the environment than using a traditional field inventory, when many species can be difficult to find or to ascertain their species.

WE HELP YOU WITH:

- Advice on how eDNA can be used in your business
- Metabarcoding and DNA sequencing
- Analysis of individual species with qPCR
- Metagenome sequencing of e.g. bacteria
- Bioinformatic analysis of DNA data



SUSTAINABLE TRANSITION





Occupational health and safety researchers investigate risks in the repair and reuse of electronics

Our extensive consumption of electronic gadgets is giving rise to a large amount of waste and harmful emissions. Increasing the service life and using things for as long as possible before the electronics are recycled is important – but what does it mean for the work environment? In a project funded by the research council Forte, work environment researchers at IVL will develop a road map to meet the challenges that exist in the repair and reuse of electronics.

We map which operators are on the market and help them identify opportunities for a safe, secure and sustainable work environment. "The goal is to be able to help companies keep and maintain electronics without workers being exposed to harmful chemicals or exposed to other work environment risks," says Anneli Julander, work environment researcher at IVL.

Preventing functioning products from becoming waste is an important measure for a greener and more circular economy. This can be implemented at all levels of society, from daily decisions made by consumers to political control and regulation. Electrical and electronic equipment (EEE) are products that require intensive resources in terms of materials and energy during production, which makes this product category particularly interesting to use and reuse for as long as possible.

"Rapid digitalisation is contributing to more EEE waste. At present, the political pressure and expectations to extract resources from EEE waste outweigh the capacity for it. Chemical and technical solutions enabling a cost-effective and simultaneous complete extraction of e.g. rare metals and precious metals in EEE waste are not yet fully in place," says Klara Midander, work environment researcher at IVL.

In the project, researchers will develop a road map that will make it possible to tackle the occupational health and safety challenges that arise when EEE products are now to be repaired and reused to a much greater extent. An important part will be to measure and quantify exposure to hazardous chemicals when handling and repairing electronics in the workplace. It will also interview market participants and identify how risks are managed at the organizational level and how preventive measures are implemented.

We will highlight the conditions for a sustainable safety culture within the organization in this type of work environment. The goal is to ensure a good and safe working environment for everyone without compromising the opportunities for the green transition that is needed in society," Julander said.

The project on working life and green transition is funded by the Swedish Research Council Forte. It runs until 2024.



Chemicals on our skin – researchers develop new method for measuring exposure

In many professions, employees come into contact with hazardous chemicals and are at risk of developing allergies and hand eczema. In a project funded by the insurance company AFA Försäkring, researchers at IVL will develop a method for measuring skin exposure to hazardous substances.

«By developing a method for measuring skin exposure to several types of chemicals in work environments, we hope to contribute to better assessment of chemical health risks and to fewer people suffer from skin diseases,” says Klara Midander, occupational environment researcher at IVL.

There are currently no limit values for harmful exposure via the skin as well as effective sampling and analysis methods to measure this. This means that knowledge is limited about both what you are exposed to in your professional life and to what extent.



IVL researchers Klara Midander, Anneli Julander and Georgios Giovanoulis.

The method that IVL researchers Klara Midander, Anneli Julander and Georgios Giovanoulis develop in the project will be validated in the laboratory and tested in work environments where skin exposure to chemicals and chemical products occurs, such as in the construction industry, the engineering industry and in health and social care.

The results will contribute to better risk assessment of chemical health risks in workplaces, but also increase understanding of the levels on the skin that cause eczema.

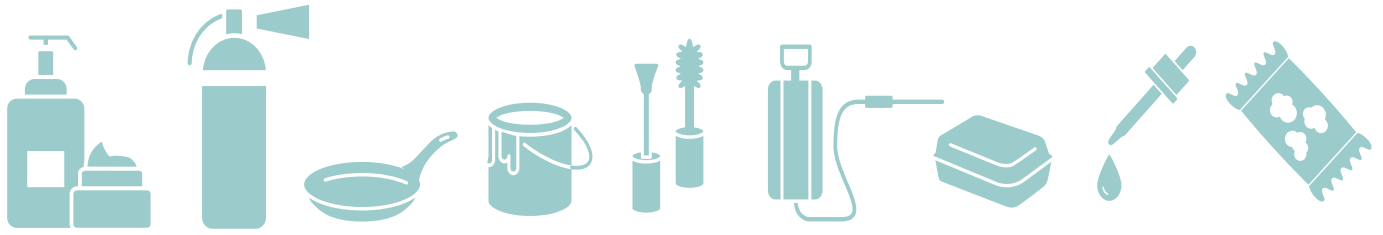
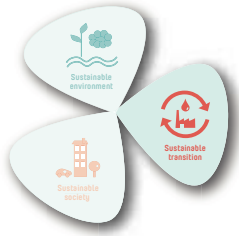
“We see great benefits in being able to measure different types of chemicals on the skin. This is a direct measure that can help us identify harmful exposure to health risks at an early stage. In the long run, such knowledge can also make it possible to understand whether chemicals in the work environment risk spreading to the external environment,” says Klara Midander.

The project is funded by the insurance company AFA Försäkring and runs until December 2023.

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PFAS – how can Swedish treatment plants meet the challenge?

In collaboration with researchers from SLU, Uppsala University and several water and wastewater operators and Swedish Water Development, IVL has produced a knowledge compilation and guidance on PFAS for Swedish wastewater treatment plants.

“Although only a small part of PFAS in the environment spread via wastewater, there are reasons for wastewater treatment plants to learn more about the PFAS challenge, wastewater as a transport route for PFAS, and how wastewater treatment plants can also contribute to reducing PFAS-related problems,” says project manager Christian Baresel at IVL.

Perfluorinated substances, PFAS, are a group of water and dirt repellent chemicals found in a variety of everyday products. Perfluorinated substances, PFAS, are very difficult to break down and can therefore accumulate in the environment with a high risk of negative health and environmental effects.

The report reviews the problem of PFAS with a particular focus on the role and responsibility of wastewater treatment plants. It combines existing knowledge and knowledge gaps, but also provides guidance and recommendations.

Many PFAS have already been banned and action levels have been defined for various PFAS in e.g. surface water, groundwater and drinking water. Stricter regulations in the future will necessitate a gradual separation from the cycle, which may also include an increased focus on wastewater.

“The focus for separation should be on heavily contaminated areas such as fire drill sites and landfill leachate, but measures may also be needed at wastewater treatment plants, if, for example, it is seen that the treatment plant’s contribution is an

important part of the PFAS contamination to the surrounding aquatic environment,” says Andriy Malovanyy at IVL, one of several experts involved in the project.

PRIORITIZE EFFORTS

The project team believes that all of Sweden’s water and wastewater operators need to have knowledge of the PFAS problems in general, and specifically at their wastewater treatment plants. The report describes how wastewater treatment plants can prioritise their efforts depending on size, associated industries, whether a permit application is underway or whether the plant has received an order to reduce its emissions of PFAS. According to the guidelines, knowledge about PFAS load on the treatment plant should be compiled, environmental impacts assessed, sources mapped and upstream work carried out.

Today, there are no treatment and destruction technologies that achieve a far-reaching PFAS reduction from municipal wastewater without large resource consumption and high costs. But several pilot projects indicate that a certain part of PFAS in wastewater can be removed as a synergy effect if the right technology is chosen when a treatment plant is supplemented with advanced treatment to reduce pharmaceutical residues or for recycling of wastewater. In light of upcoming requirements for



Andriy Malovany at IVL Swedish Environmental Research Institute.

advanced treatment for pharmaceutical residues, PFAS treatment can already be taken into account by selecting appropriate technology. This can be seen as a preventive measure and provides flexibility against any future requirements.

"Today's treatment processes at Swedish wastewater treatment plants do not separate PFAS, but at some wastewater treatment plants you still see an effective separation of some PFAS, which is interesting and should be investigated further," says Linda Önnby, PFAS expert in the IVL team that works with the removal of micropollutants from sewage.

IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Increasing the conditions for wastewater treatment plants to reduce the amount of hazardous and persistent chemicals in discharges from sewage
- Contributing to the sustainable development of cities without increased environmental impact where wastewater treatment plants contribute as crucial infrastructure
- Guiding wastewater treatment plants in methods and techniques for increased removal of PFAS from wastewater
- Identifying working methods to increase the treatment and removal of PFAS from wastewater
- Mapping sources and pathways of PFAS, disseminate knowledge and guidelines on methods and thereby reduce the amount of harmful chemicals in the environment

GLOBAL OBJECTIVE, SECONDARY GOALS

6.6 PROTECTING AND RESTORING WATER-RELATED ECOSYSTEMS

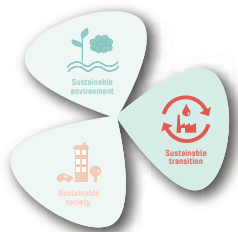
11.3 INCLUSIVE AND SUSTAINABLE URBANISATION

11.6 REDUCING THE ENVIRONMENTAL IMPACT OF CITIES

12.4 RESPONSIBLE MANAGEMENT OF CHEMICALS AND WASTE

14.1 REDUCING MARINE POLLUTION





Green and sustainable chemistry means learning from nature

How can we reduce human and environmental exposure to hazardous substances? This question was at the forefront when the Mistra SafeChem research programme, led by IVL, organized a symposium on green and sustainable chemistry in September 2022.

Green chemistry is a mindset that means that chemical compounds and syntheses should be designed so that they are as eco-friendly as possible. This includes minimising waste and energy consumption, avoiding solvents, using renewable raw materials and preserving as many atoms as possible from the starting material to the finished product. The aim is to develop biodegradable products with low toxicity that can be produced in a safe and resource-efficient way.

These principles are the starting point for Mistra SafeChem's work, which has the vision to promote a safe, sustainable and green chemical industry in Sweden.

THE FATHER OF GREEN CHEMISTRY

Professor Paul Anastas, Yale, helped establish the principles of green chemistry in the 1990s and has therefore been named "The Father of Green Chemistry". He was the keynote speaker at the symposium, which was held at AstraZeneca in Mölndal.

– I am proud to be a chemist. But we need to change how we look at chemistry and its consequences. For example, carbon dioxide is the chemical industry's largest product, a fact which few chemists know. And hundreds of the chemical products we have manufactured accumulate unintentionally in our bodies.

Paul Anastas emphasised the fact that nature is dynamic, not stable, and chemists should learn to work with mixed raw materials and dynamic processes just as nature does.

The work being done by Mistra SafeChem uses this approach became clear when some of the programme's researchers presented their work.

– We learn from nature. We use what already exists and change the structure so that the materials are recyclable," said

Per-Olof Syrén, professor at KTH, who described how they use enzymes to make bioplastics from biomass.

By investigating prehistoric enzymes, which functioned under more extreme conditions, they have been able to develop new enzymes that are better adapted to the high demands of chemical production.

A STEP TOWARDS INCREASED RECYCLING OF TEXTILES

Europeans consume an average of 26 kg of textiles per person per year. 75 percent of it ends up in landfills or is incinerated, thereby releasing methane and carbon dioxide into the atmosphere.

Aji Mathew, professor at Stockholm University, is leading a study in which they produce nanocrystals of cellulose from cotton or mixed textiles.

"Based on this, we can produce ideal building blocks that make it possible to recycle textiles," Aji Mathew explained.

The process will be optimised and become even greener through continued collaboration within Mistra SafeChem.

DIGITAL TOOLS LEARN FOR THEMSELVES

Ian Cotgreave, professor at RISE, talked about the tools for risk and hazard assessment that are being developed by Mistra SafeChem. He emphasised the benefits of digital computational tools – they are both inexpensive and can quickly generate new data that can predict unknown chemical effects.

"Artificial intelligence enables tools to teach themselves about various risks, such as carcinogenicity," Cotgreave said.

Richard Lihammar at IVL is Programme Director for Mistra SafeChem: "I am a chemist, which means I'm a superhero with



Paul Anastas, known as "The Father of Green Chemistry", was the keynote speaker at the symposium on green and sustainable chemistry. Because he was affected by COVID-19, he was allowed to attend remotely from his library in Yale, USA. (Image: Helena Larsson)

superpowers! Chemistry is needed in so many areas. But we have to know as early as the design phase what the effect can be. For example, would we use DDT, PFAS or fossil fuels if they were invented today?

Richard Lihammar emphasised how people in Mistra SafeChem learn from each other and the importance of the entire value chain being among the partners.

"We put experts from different fields in the same room, add a toolbox for green syntheses and assessment tools and see very interesting results.

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ABOUT MISTRA SAFECEM

Participants: There were 14 participants from industry, ranging from manufacturers to users of chemicals. IVL is leading the work. Other research partners are Stockholm University, RISE, KTH, Technical University of Denmark and Chemsec.

Period: The first stage is from 2019 to 2024. Planning is underway for another four years.

Funding: Mistra, the Swedish Foundation for Strategic Environmental Research, provides MSEK 70. The industrial partners are contributing an additional MSEK 30.

Read more: Website: mistrasafechem.se

IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Developing new tools and models to risk assess chemicals as early as the design phase.
- Developing new, more efficient chemical manufacturing processes that reduce material consumption and waste.
- Promote a more sustainable chemical industry and thus reduce exposure to hazardous substances.
- Collaborate with representatives from the entire value chain to improve opportunities to develop safe chemicals with low environmental impact throughout their life cycle.

GLOBAL OBJECTIVE, SECONDARY GOALS

12.4 RESPONSIBLE MANAGEMENT OF CHEMICALS AND WASTE

12.5 SIGNIFICANTLY REDUCE WASTE

3.9 REDUCING ILLNESS AND DEATH FROM HARMFUL CHEMICALS AND POLLUTION

9.4 UPGRADING ALL INDUSTRY AND INFRASTRUCTURE FOR INCREASED SUSTAINABILITY





Some of our offerings within Sustainable transition

Circular economy in a non-toxic environment

Based on scientifically based methods, IVL can offer help and advice on ways to increase circularity by assessing the hazardousness of substances in products and waste that are to be reused or recycled.

The demand for recycled materials is increasing as more companies want to move towards a more circular economy. Today, there is a shortage of recycled materials that meet quality requirements. Obstacles and challenges for achieving a circular economy include not knowing the content of hazardous substances in the material to be recycled and therefore not being able to assess the risk of impact on the environment and human health.

IVL's experts can help your municipality, your company or your organization based on your conditions to get better control of the content of products and waste and give concrete advice and tips on how you can move towards a more circular economy.

WE HELP YOU WITH:

- Mapping hazardous/unwanted substances in products and waste, both based on existing data but also based on analyses in the lab
- Priority for substitution of dangerous substances
- Development of specific measures and guidance on how to achieve increased circularity by assessing the hazardousness of substances present in waste.
- Development of tools to assess the suitability for recovery and reuse of materials and articles that may contain hazardous substances. For example, through LCA-based advice to compare different materials or alternatives.
- Help develop a chemicals strategy by identifying, assessing and prioritising the substances that could be present in products or waste.
- Help identify opportunities to move towards more closed loops and increase traceability of materials. Here, for example, we work to develop circular cycles for industrial plastics and Big Bags.



Climate adaptation and vulnerability analyses

Climate change is already forcing us to adapt society in order to cope with extreme weather events, such as torrential rain, landslides, heatwaves and the risk of fire.

The extent of the impact of climate change will be dependent on the extent of the changes in the climate, but also on society's ability to adapt to these changes.

All local authorities in Sweden need to work on climate adaptation, although some local authorities are more vulnerable than others. Public authorities, companies and the rest of civil society need to act urgently. IVL Swedish Environmental Research Institute provides services that contribute to increased climate adaptation and reduced vulnerability.

WE HELP YOU WITH:

- General climate and vulnerability analyses
- Proposals for and evaluations of adaptation measures
- Analysing how the private sector can be involved in climate adaptation measures
- Studies of the impact of climate adaptation strategies on sustainable development
- Methodological support for public and private operators

Strategic sustainability work and sustainability management

Companies are expected to accept responsibility for their sustainability and environmental impact throughout the entire value chain. To conduct this in an efficient manner, strategic and systematic sustainability and environmental management work is required, permeating all parts of the business. IVL will help you with this.

Strategic and systematic sustainability work can help streamline and optimise resources throughout the value chain. This increases risk awareness and risk mitigation, and encourages new innovations and business models. At the same time, it strengthens the brand and helps to attract and retain skilled employees.

With our help, you can develop and strengthen your sustainability and environmental work both at a strategic level and within operational activities.

WE HELP YOU TO:

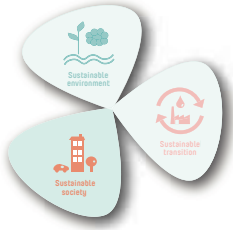
- Identifying sustainability and environmental aspects throughout the value chain
- Develop strategies and objectives for your sustainability work in the short and long term
- Implementing strategies and objectives through
- Following up and communicating sustainability work externally and internally in the company



SUSTAINABLE SOCIETY







Hydrogen – climate hype or climate hope?

Everyone is talking about hydrogen. But what do the researchers say; is hydrogen the answer to climate problems? IVL's hydrogen experts Ali Hedayati, Anders Hjort and Julia Hansson explain where the research stands today and what the future may look like for hydrogen as a fossil-free energy source.

What is the importance of hydrogen in the transformation of our energy systems?

Ali Hedayati: Hydrogen is the backbone of the green transition. Although there is no single solution to the climate crisis, hydrogen plays a crucial role in several of the solutions. Together with CCS and bioenergy, hydrogen technologies are a mainstay in the transformation of the energy and transport sectors. It is not the only solution, but an absolute must in order to achieve the climate goal.

Anders Hjort: Hydrogen and hydrogen-based alternatives, such as various so-called electrofuels, are absolutely an important alternative in the future energy system. But it is still unclear how and where the hydrogen will be used and to what extent, or what it will cost.

Julia Hansson: If we look at the transport sector, which I focus on in my research, there are many factors that affect the role of hydrogen and other hydrogen-based energy carriers. These include the development of fossil-free electricity production, the cost trend for hydrogen-based solutions and their climate and environmental performance, as well as the demand for hydrogen and willingness to pay. The supply of sustainable biofuels and the development of electric alternatives for different modes of transport, as well as the development of CCS, also play a role.

In practice, different policy instruments will also affect the introduction of hydrogen and hydrogen-based fuels.

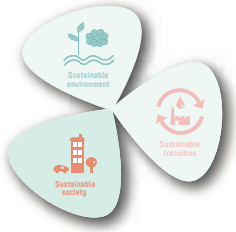
Since both renewable electricity and clean water are needed to produce green hydrogen, there is also a risk of dissatisfaction and criticism if the drinking water supply and electricity supply are affected.

Anders Hjort: The role of hydrogen in the future energy mix may also differ between Sweden and what it looks like globally. I am thinking, in particular, of the fact that industry will need a lot of hydrogen that can be produced nationally, while the transport sector may have its need for electrofuels produced in another country. The International Energy Agency (IEA) mentions e.g. ammonia as a hot candidate for shipping, which does not need to be produced in Sweden. Since both policy and economics determine what the energy mix will look like in the future, my guess is that hydrogen development will look different in different parts of the world.

Ali Hedayati: Since both renewable electricity and clean water are needed to produce green hydrogen, there is a risk of dissatisfaction and criticism if the drinking water supply and electricity supply are affected. Hydrogen is also associated with certain safety risks, which requires careful safety procedures at all stages. Another challenge is how to distribute hydrogen over longer distances. The production facilities can be located far from the end users and the volumes that will need to be transported place high demands on the infrastructure.



Ali Hedayati, IVL.



Julia Hansson, Anders Hjort and Ali Hedayati, some of IVL's hydrogen experts. Photo: Emmy Jonsson, Anna Edlund

What areas need to be explored more and what is needed to get production up and running?

Anders Hjort: We need to know more about hydrogen's potential climate impact before we start up large-scale production of hydrogen, to prevent possible negative effects of hydrogen emissions. We need to examine the availability of clean water and take into account possible water shortages. Another issue is the electricity grid and that a lack of capacity on the grid can put obstacles in the way for hydrogen investments, and that the price of electricity must not be too high.

Julia Hansson: I agree that there are many things left to investigate. Given all the expectations around hydrogen, it is easy to believe that it is mostly about speeding up the introduction itself. But even the companies leading the development say that many issues remain, linked to production, distribution, storage and use as well as to energy system issues and policy, sustainability and business opportunities. In a policy context, hydrogen is often described as an emission-free alternative, but even with renewable electricity, hydrogen is today completely without greenhouse gas emissions from a life cycle perspective. In the long term, of course, emissions can decrease if the whole of society changes, but it is important to analyse the sustainability of hydrogen already now and better understand where hydrogen and other hydrogen-based fuels are most useful. We have recently mapped barriers for hydrogen

introduction in the maritime sector and then assessed above all the high cost be the main obstacle. But the uncertainty that characterises energy issues today and thus the risk of investing in the wrong fuels also appears to be key.

Ali Hedayati: The cost of green hydrogen is absolutely one of the most important barriers. All green energy sources must be economically viable in order to compete with fossil-based sources. As the technology scales up and demand increases, costs will fall, but at this rate it is difficult to determine whether we will meet the global goal for green hydrogen production. To meet the two-degree target, at least 20 percent of total emissions reductions by 2050 must come from the use of clean hydrogen in various sectors (instead of fossil-based resources), equivalent to 660 Mt, according to the IPCC's latest report.

The need and demand are significantly greater than supply and the pace of scale-up is unfortunately slower than expected. Therefore, I believe it is absolutely crucial to have strong political support together with a large-scale demonstration of the production and application of fossil-free hydrogen. Without it, we can hardly expect investors or end users to be willing to invest in hydrogen, even if it is one hundred percent environmentally friendly.



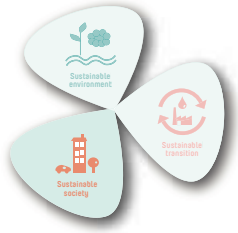
IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Contributing to and analysing the transition of energy and transport systems.
- Disseminate information and make research results on hydrogen available to different operators.
- Collaborate with relevant industry and other decision-makers in the hydrogen field and specifically share and disseminate knowledge with them.
- Collaborate with relevant industry and other decision-makers in the hydrogen field and specifically share and disseminate knowledge with them.
- All of the above contribute to reaching our environmental goals.

GLOBAL OBJECTIVE, SECONDARY GOALS

- 7.1 ACCESS TO MODERN ENERGY FOR ALL**
- 7.2 INCREASING THE SHARE OF RENEWABLE ENERGY**
- 7.A MAKING RESEARCH AND TECHNOLOGY AVAILABLE AND INVESTING IN CLEAN ENERGY**
- 9.1 BUILDING SUSTAINABLE, RESILIENT AND INCLUSIVE INFRASTRUCTURES**
- 9.4 UPGRADING ALL INDUSTRY AND INFRASTRUCTURE FOR INCREASED SUSTAINABILITY**
- 13 TACKLING CLIMATE CHANGE**





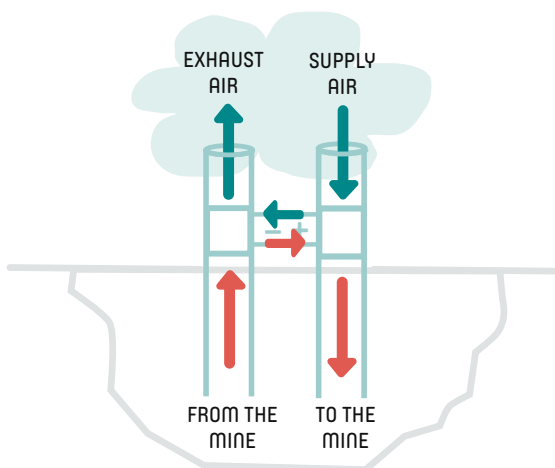
New Kiruna can be heated better with waste heat

The entire city of Kiruna is being moved. This creates challenges – but also opportunities for new and climate-smarter solutions. IVL shows how waste heat from LKAB can heat the new city of Kiruna.

“There is great potential for Kiruna, as well as for a number of other locations with industries that produce waste heat. Energy efficiency is what everyone is asking for and working more with waste heat is an important such step, says Nathalie Fransson, project manager at IVL.

For almost 20 years, it has been clear that the city of Kiruna – literally – was no longer sustainable. In 2004, it was decided that Kiruna city center, about 6000 people, 3000 homes and many businesses, would have to move due to the impact of the mining industry.

This work is currently underway. A new city center is now located about three kilometres to the east of the old one. Moving a city creates challenges – but also opportunities to review old solutions and look for new, smarter ones. Kiruna’s ambition is to become climate neutral by 2025. One measure is to make better use of the waste heat created by the town’s main industry, the mining and minerals company LKAB.



Making better use of the waste heat created by the town’s main industry, LKAB, will help Kiruna achieve climate neutrality.

IVL leads the *Waste heat in Kiruna* project, which started at the end of 2020 with support from the Swedish Energy Agency. The aim is to find ways to make better use of LKAB’s waste heat in the municipal district heating grid.

– We are collaborating on this project with Tekniska Verken in Kiruna, its district heating company Kiruna Kraft and LKAB,” says Nathalie Fransson.

The ideas are not new – waste heat from LKAB has been included in the district heating network’s heat sources in Kiruna since the 90s. But to achieve greater effect, it is important to be able to use the waste heat throughout the year.

IVL’s researchers have used data-based modelling systems to show how seasonal energy storage creates more resource-efficient systems: If the summer’s waste heat from LKAB, which is not needed during the warm season, can be stored and used in winter, it helps to heat Kiruna during the coldest months of the year.

– Fransson says that energy storage is important to meet supply and demand – and energy system modelling shows that there are great opportunities for this here.

One factor that the researchers clearly see affects the size of the energy storage is the price development of biomass. Biomass refers to e.g. residues from forestry, sawmills and agriculture. Examples of heat storage that can be found in a system of boreholes or in rock caverns. But which type of energy storage is best?

– These are questions that we are now proceeding with in further calculations, together with the other partners of the project. Factors that influence this include the need for energy, available power and investment costs,” Fransson said.

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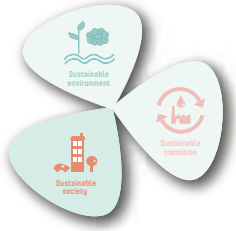
IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Increase the use of existing resource (residual heat).
- Contribute to sustainable urban development in Kiruna and generate a scientific article that disseminates information about smart city development to a broad group of stakeholders.
- Contribute to a more resource-efficient district heating grid.
- Support Kiruna in its efforts to become climate neutral by 2025.

GLOBAL OBJECTIVE, SECONDARY GOALS

- 7.2** INCREASING THE SHARE OF RENEWABLE ENERGY AROUND THE WORLD
- 7.3** DOUBLE THE INCREASE IN ENERGY EFFICIENCY
- 7.A** MAKING RESEARCH AND TECHNOLOGY AVAILABLE AND INVESTING IN CLEAN ENERGY
- 9.4** UPGRADING ALL INDUSTRY AND INFRASTRUCTURE FOR INCREASED SUSTAINABILITY
- 11.6** REDUCING THE ENVIRONMENTAL IMPACT OF CITIES





Biogas is more than energy

Inside the three greenish-brown digesters at the Gryaab wastewater treatment plant in Gothenburg, it is hot, brown and bubbly. Sludge from wastewater and grease from restaurants and commercial kitchens are mixed and left to ferment for a few weeks. Out comes biogas, certified fertilizers and maximised environmental benefits.

In one year, the plant produces 11 million cubic meters of biogas, equivalent to 70GWh. Every week, 500 tons of certified fertilizer are also produced that can replace artificial fertilizers.

"It is a simple technology that combines many environmental benefits, yet we use just under a third of the full potential from waste and residues that exist in Sweden, not to mention globally," says Anders Hjort, biogas expert at IVL.

FROM BY-PRODUCT TO ENERGY CARRIER

Many anaerobic digestion systems at treatment plants were built in Sweden in the 60s and 70s. At that time, biogas was just a by-product of the wastewater treatment itself. It was only in the early 90s that biogas came into use as an energy carrier when biogas began to be upgraded to biomethane," Hjort said.

Since then, interest has gone up and down, but over the past two or three years, the view of biogas has changed and now it is an important addition to the energy mix, also in EU. As recently as last spring, the European Commission decided that an additional 35 billion cubic meters of biomethane should be produced each year within the framework of the REPowerEU initiative.

Most biogas production today takes place in Europe, China and North America, but interest is increasing, not least in times of crisis. Since Russia's invasion of Ukraine and the ban on imports of Russian natural gas, biogas has become even more important.

"The war has definitely redrawn the energy map. Biogas is discussed every time there has been an energy crisis. This time it coincides with both the climate issue and the security situation," Hjort said.

NEW MARKETS FOR LIQUEFIED BIOGAS, LBG

So far, the largest biogas market in Sweden has been bus traffic, but as more and more cities electrify their public transport, biogas needs to go to other markets. Heavy goods vehicles, long-distance buses, certain industrial processes and shipping are some of the hottest candidates.

– It is important that biogas goes to the markets where it is most useful, where it is difficult to replace fossil fuel power with something like electrification," Hjort said.

But to maximise the benefits of biogas, it must often be converted into liquid biogas, so-called LBG. LBG can easily replace or be mixed into liquefied natural gas, LNG, which has become an increasingly common fuel for ships instead of conventional bunker oil, as it reduces emissions of carbon dioxide and sulphur.

Within a couple of years, 15 percent of all bunker fuel consumed in Sweden and the world is expected to be LNG.

– If we can instead offer LBG, it will be a significant contribution to the conversion of shipping," says Karl Jivén, an expert in maritime fuels.

It is entirely possible to produce the quantities of liquid biomethane that shipping needs, but a substantial expansion of the number of biogas plants in Sweden is required, according to Anders Hjort and Karl Jivén.

HIGH ENVIRONMENTAL BENEFIT PER INVESTED KRONA

The main obstacle to a rapid transition is, of course, the economy. LBG is still many times more expensive than oil. Policy instruments and business models that reduce costs are urgently needed.

Over the years, investment support through Klimatklivet has been crucial for the Swedish biogas production. Since 2015, IVL's biogas experts have helped both small and large customers to apply for investment support worth approximately SEK 500 million. Translated into climate benefits, it has, on a low estimate, reduced emissions by half a million tons of carbon dioxide equivalents," Anders Hjort estimates.

– Investments in biogas have a very high environmental benefit per invested krona. And besides, it takes several million years to produce fossil natural gas. Renewable biogas takes only three weeks.



Biogas expert Anders Hjort and Karl Jivén, experts in marine fuels.

IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

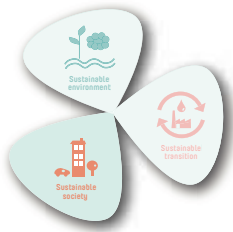
- Aid in the energy transition, e.g. in the form of renewable fuels for shipping and phasing out fossil fuels.
- Produce a basis for decision-makers and policy instruments.

GLOBAL OBJECTIVE, SECONDARY GOALS

7.2 INCREASING THE SHARE OF RENEWABLE ENERGY AROUND THE WORLD

13.2 INTEGRATING CLIMATE CHANGE ACTION INTO POLICY AND PLANNING





Climate-smart energy steps using the Tidstegen Model

The energy issue is an important piece of the puzzle when more and more construction and real estate companies want to become climate neutral. In Råängen in Lund, IVL is collaborating with White Arkitekter and the energy company Kraftringen to compare the climate impact of different energy system solutions using the Tidstegen tool

«Climate assessment of energy use in buildings in operation is complex. The challenge lies e.g. in the fact that what is to be discussed, energy use during the building's lifetime, lies in the future,» explains IVL's energy expert Johan Larsson.

Together with colleagues like Annamaria Sandgren, Anna Nilsson and Desirée Grahn, he is working on developing the right tool (Tidstegen). With years of experience in energy solutions for the real estate industry, Johan Larsson has seen how the climate issue has become increasingly important in the choice of energy solutions.

«There is high pressure from the industry now and the climate issue is high on many people's agenda. We want to help operators choose the right method for the right purpose. With Tidstegen, we can raise our gaze from building level to system level,» Larsson said.

Because, while climate calculations are a highly topical issue for the construction and real estate industry, there is still a lack of established methods for how the calculations are to be carried out. In order to be able to assess how emissions from energy production develop during the lifetime of a building, different scenarios need to be developed. There are already methods for life cycle assessment that answer different questions, but if a method is used in the wrong context or if the analysis is misinterpreted, the result can be solutions that have the reverse effect from a climate and energy system perspective,» Larsson explained.

TIDSTEGEN – BOTH TOOL AND METHOD

“In order to evaluate and compare the climate impact of different energy solutions, it is not enough to start from annual energy needs and emission factors.

– The time aspect and the detailed calculation per hour are very important because the emission factors for production vary depending on the type of energy, demand and outdoor temperature,» Larsson said.

It is also desirable to take into account the climate effects of a change in energy demand on the energy system and not just at the building level, as is the case with the Tidstegen.

– Tidstegen makes it possible to analyse in detail the climate impact of changes in energy use from a so-called impact perspective,» Larsson said.

The tool contains data on which plants produce energy for a certain time depending on the outdoor temperature. Based on this data and data for the building's energy needs, it is possible to calculate the difference in climate impact if a building's energy use changes. The Tidstegen tool can be used both to make energy choices in new production and to make changes in existing types of energy.

DISTRICT HEATING AND SOLAR CELLS IN RÅÄNGEN

In the Råängen project in Lund, Tidstegen is being used to analyse different energy solutions in a residential building



Johan Larsson, IVL, Andreas Eggertsen Teder, White Arkitekter, Annamaria Sandgren IVL and Annika Widmark Sjöstedt, Krafringen.

designed by White architects. The local energy company Krafringen’s district heating grid has contributed with climate data on the local grid.

«The cooperation with all operators has worked very well and everyone has contributed with complementary skills. By starting from both the specific property and the energy system, we came to the conclusion that a combination of district heating and solar cells was the energy solution with the least climate impact,” Larsson said.

Tidstegen is already used in collaboration with several energy companies, property owners and consultants around the country. The hope is that more people will see the usefulness of Tidstegen and that the method and tool can continue to contribute to the industry’s transition to climate neutrality.

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THIS IS TIDSTEGEN

Tidstegen is a method and a tool that IVL has developed to analyse the climate consequences of energy decisions for buildings. Tidstegen uses forward-looking impact assessment that answers the question: How does the planned energy choice affect the total climate impact? What consequences does a particular choice have for both the building and the energy system?

Key starting points for the method are:

- Impact assessment
- Forward-looking
- Hourly data
- Life cycle perspective

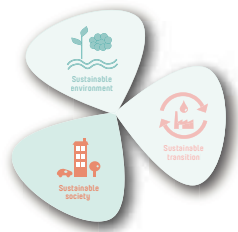
IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Clarifying effects at system level, which leads to inclusive opportunities to influence at the right level.
- Clarifying the climate impact of energy solutions as a basis for both real estate companies and energy companies.
- Clarifying the climate impact at energy system level, which forms the basis for planning for energy companies.
- Contributing with input for decision-makers.
- Clarifying the climate benefits of renewable energy in a particular energy system.

GLOBAL OBJECTIVE, SECONDARY GOALS

- 11.3** INCLUSIVE AND SUSTAINABLE URBANISATION
- 11.6** REDUCING THE ENVIRONMENTAL IMPACT OF CITIES
- 11.A** PROMOTING NATIONAL AND REGIONAL DEVELOPMENT PLANNING
- 13.2** INTEGRATING CLIMATE CHANGE ACTION INTO POLICY AND PLANNING
- 7.2** INCREASING THE SHARE OF RENEWABLE ENERGY AROUND THE WORLD





Climate agreements and climate fees can help transform industry

The climate issue is urgent and some of the most important operators in the transition are in the primary industries. But for the industry to change quickly, demand for climate-smart products must increase and the cost of production must decrease.

«We need to tighten existing policy instruments and create clearer demand for products and materials with low greenhouse gas emissions, all to reduce economic uncertainty and facilitate transition in industry,” says Kersti Karltorp, researcher at IVL.

Some answers to how these uncertainties can be addressed can be found in the Means of Increased Demand for Climate-Efficient Products Report (*Styrmedel för ökad efterfrågan på klimateffektiva produkter*) that Kersti Karltorp and Johan Rootzén, also researchers at IVL, have written together with the environmental consulting firm Anthesis.

“Something that is absolutely key to the industry’s transition is the market price of emission rights within the EU emissions trading system, EU ETS. The prices of emission rights have generally been low, but have increased sharply since 2018 and are also expected to continue to increase. How fast they will increase, however, is uncertain, and variations in prices increase uncertainty.

– A more rapid tightening of the EU ETS emission ceiling would be the easiest thing of all. Everything else is really a bandage on the wounds of dealing with the shortcomings of the trading system,” says Rootzén.

One way to reduce uncertainties may be to introduce so-called Carbon Contracts for Differences (CCfD), an instrument that is still in its infancy but has great potential to lower the threshold for the transition. Another is to introduce a consumption tax on carbon-intensive materials, which would make low-carbon products more attractive on the market, while generating revenue for investments in other areas.

How much hope can we have for CCfD and climate fees?

Johan: Both CCfD and climate fees have potential and deserve further investigation. The European Commission has previously expressed that it would like to see initiatives in individual Member States where this type of instrument is tested. With the Paris Agreement, the Swedish Climate Act and the fact that industry in many places is already making major climate investments, the challenge has become clearer. Now it is a question of creating the right conditions.

Kersti: Of course, some sectors and countries find it more difficult to change than others, but there is another way to talk about this in industry today and about the design of climate policy instruments that include business opportunities and the benefits of climate transition.

Johan: We now see that the steel industry is making strong progress with large corporate alliances that together provide a lot of capital for research and development and with large customers who have expressed a desire to buy fossil-free steel. There are also positive signals in the refinery industry. For example, Preem has set goals to reduce its fossil-based production and switch to only renewable or biofuels-based products. Even the cement industry, which is struggling with its limestone mining permit on Gotland, has announced that the factory in Slite will go from being one of Sweden’s largest emitters to becoming a carbon sink by 2030.



Steel samples. SSAB aims to launch its fossil-free steel in 2026.

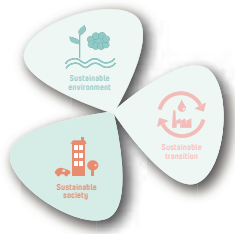
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The steel industry is making strong progress with large corporate alliances that together provide a lot of capital for research and development.

There are also positive signals in the refinery industry.

Even the cement industry has announced that the factory in Slite will go from being one of Sweden's largest emitters to becoming a carbon sink by 2030.

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"The basic problem is that we in Sweden consume as if we had four planets."

Kersti: My view is that it is much easier for industry to invest in climate-smart technology now than it was just five or ten years ago. There are a handful of technologies with great potential that can be scaled up and the willingness is there.

Johan: I agree, but at the same time there are many pieces of the puzzle that must fall into place for a transition to be possible. Several of these pieces are beyond the control of the individual company. It is important not to forget issues such as electricity supply and expertise supply in this context.

Is industry ahead of politics?

John: There is a great willingness to invest today and a lot of private capital. The important thing now is that the policy creates the conditions for investment and finds models for how risks and benefits are to be distributed. The risk of doing too little is greater than the risk of doing too much.

Kersti: Some industries, such as the steel industry, are making major investments to transition now and are pushing for policy and regulatory changes to make this possible. At the same time, many in the industry believe that, for example, permit reviews take too long and that it is difficult to predict how the process will turn out even if the legal requirements are known. But it is of course important to have a robust permit process to avoid that we solve one environmental problem but create another.

Kersti: "The basic problem is that we in Sweden consume as if we had four planets." We need to use less energy and less material. It is a problem in itself that we do not fully realise it. Reduced energy and resource consumption does not have to be at the expense of a good life.

John: But tough climate decisions that affect people's everyday lives and the economy require tough politicians. We may not see such decisions being made in an election year. What many on the research side miss is that policy must actually be politically sustainable.

What is politically sustainable climate policy?

Johan: I think it is important to always remember that the distributional policy effects of climate policy and working smartly and educating people on climate policy and tax options. After all, carbon taxes and emissions trading generate revenues that can be used in part to compensate groups and regions that may be hit harder than others by a policy instrument. It is also important to have respect for and find ways to handle the unrest that sometimes exists before a rapid change. This is especially true in places where the primary industries are a major employer and an important part of the local economy.

Kersti: These issues will only grow in importance. The industry needs clear guidelines, and Swedish authorities are desperately searching for policy proposals that can be used as a basis for the design of a sustainable and effective climate policy. I think now might be a good time to be brave and think in new ways. Sweden must continue to be a progressive voice in the EU.

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Johan Rootzén and Kersti Karltorp, IVL

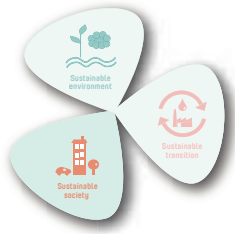
IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Showing possible ways forward for a more sustainable industry and how this is supported by policy.
- Developing a basis for policy instruments for carbon-neutral products.
- Contributing with knowledge about how international policy drives the climate transition and how this affects the nation.
- Contribute with increased knowledge about how climate-impacting emissions from the production of basic materials can be reduced.

GLOBAL OBJECTIVE, SECONDARY GOALS

- 9.4** UPGRADING ALL INDUSTRY AND INFRASTRUCTURE FOR INCREASED SUSTAINABILITY
- 11.B** IMPLEMENTING STRATEGIES FOR INCLUSION, RESOURCE EFFICIENCY AND DISASTER MANAGEMENT
- 13.2** INTEGRATING CLIMATE CHANGE ACTION INTO POLICY AND PLANNING
- 13.3** INCREASING KNOWLEDGE AND CAPACITY TO TACKLE CLIMATE CHANGE





In the PCC report: Only immediate measures in the next few years will enable the climate transition

We have experienced the largest increase in greenhouse gas emissions in human history and if we are to have a chance of limiting global warming to 1.5°C, immediate multisectoral action is needed. However, significant progress is being made in many places and the opportunities to limit climate change and achieve synergies with other sustainability goals are great in both the short and medium term, writes the UN climate panel IPCC, which today releases its third interim report.

One of the largest sources of emissions globally is the construction sector, both through emissions from the production of building materials and the construction phase itself and during the total lifetime of buildings. In 2019, buildings accounted for 21% of global greenhouse gas emissions.

“The pace of action towards 2030 is crucial to fully capture the mitigation potential of buildings,” says Érika Mata, researcher at IVL and IPCC’s lead author of chapter 9 dealing with buildings.

The global building stock – existing and not yet built – can move towards net-zero greenhouse gas emissions by 2050 through efficient design, construction and use, construction with low-carbon materials, by limiting demand for energy and materials, and through renewable energy production. Together, the measures lead to cost reductions, while optimising the mitigation potential achieved and avoiding lock-in effects.

Political measures could capture the full potential if demands were placed on all these elements, i.e. demand, efficiency and production. This may involve a combination of building energy regulations, standards for energy efficiency and market instruments. Well-designed and effectively implemented policy packages, including financing, that combine mitigation and adaptation measures have significant potential for achieving global sustainability goals, including in public health, the labour market and poverty reduction,” says Érika Mata.

INTERSECTORAL INTERACTION

More and more cities are setting net targets for zero greenhouse gas emissions and there are now examples of zero-energy or zero-emission buildings in almost all regions. Many cities also have the power to take climate action because of their mandates over regulations and policies related to land use. Mitigation strategies to reduce greenhouse gas emissions will vary depending on a city’s land use and spatial form and its state of urbanisation.

In established cities, it is about improving or modernising buildings, supporting walking and cycling, and public transport. In fast-growing cities, future emissions can be avoided by co-locating jobs and housing, and by switching to low-emission technologies or avoiding fossil fuels altogether. New cities can plan urban areas based on people’s needs with energy-efficient infrastructure and services. In more informal settlements, there are opportunities to utilise and enable informal practices and institutions in cities related to housing, waste, energy, water and sanitation to reduce resource use and mitigate climate change.

COMING YEARS CRITICAL

«Given the regional and global reach of urban supply chains, a city cannot achieve net-zero greenhouse gas emissions by focusing only on reducing emissions within its administrative boundaries. Similarly, the building sector is closely linked to e.g. the energy sector, land use, resource use and waste management. The transformation of the construction sector therefore



Érika Mata, researcher at IVL

requires strong collaboration among many other sectors,” Mata said.

Ambitious emission reductions require joint decision-making by government ministries and at different levels of authority. It is particularly effective when it is built on the involvement of civil society, various indigenous groups, professional organizations, business and the financial sector.

The coming years will be critical. The decisions made now affect how societies develop; ambitious climate goals also require strong international cooperation. Transnational partnerships play a more important role as technology, knowledge

and experience are shared. For example, collaboration between states leads to increased ambition and climate policy development. Supporting low-emission technological innovation also requires an increased technology impact from policies and investments, such as science education, research and development.

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Érika Mata, erika.mata@ivl.se,

Phone: +46 (0)73-620 04 28

IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Mapping knowledge about renewable energy and climate solutions; identifying cutting-edge competences, research and solutions from operators at local and national level and make these visible internationally.
- Participating in the IPPC AR6 Report on synergies between limiting climate impact, climate adaptation and global sustainability goals, and disseminate the results to researchers and industry.
- Engaging operators from industry and the authorities with the aim of identifying issues and knowledge gaps, increasing knowledge about and interest in climate action and thereby increasing implementation and action.
- Identifying measures, methods, technologies and digital solutions to investigate their potential to be implemented and significantly contribute to achieved climate neutrality.
- Evaluating forest-based building materials as a climate measure.

GLOBAL OBJECTIVE, SECONDARY GOALS

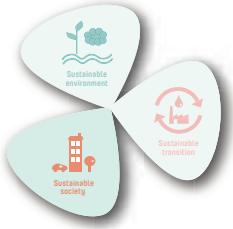
9.4 UPGRADING ALL INDUSTRY AND INFRASTRUCTURE FOR INCREASED SUSTAINABILITY

11.B IMPLEMENTING STRATEGIES FOR INCLUSION, RESOURCE EFFICIENCY AND DISASTER MANAGEMENT

13.2 INTEGRATING CLIMATE CHANGE ACTION INTO POLICY AND PLANNING

13.3 INCREASING KNOWLEDGE AND CAPACITY TO TACKLE CLIMATE CHANGE





Investments in clean water in Mumbai

IVL's work focusing on the global goal Clean Water and Sanitation, SDG6, which continues in India. IVL works as an environmental consultant in several projects to reduce pollution in the Mithi River, which flows through the multi-million city of Mumbai.

«It is very positive that we are on site in India and can contribute with our knowledge in water treatment. Getting a functioning wastewater treatment in place will contribute to better health and living standards for many people in Mumbai and we are happy that we are part of that work,” says Marie Fossum Strannegård, CEO of IVL Swedish Environmental Research Institute.

India, which is one of the world's largest and most populous countries, has major problems with polluted water and water shortages – which is expected to get worse in the future with climate change and urbanisation.

Mumbai, which has over 24 million inhabitants, is one of many cities in India that has not had a functioning wastewater treatment system. To deal with water issues, the Indian government has initiated several major initiatives. One of the ambitions is to build wastewater treatment plants in all major cities. IVL has had an office in Mumbai since 2019 and has been hired as a consultant to support the work with the new treatment plants in the city.

– Overall, IVL's role is to quality assure the design and planning of the facilities from an environmental perspective, provide suggestions for improvements and technical solutions in wastewater technology and ensure that the facilities are built correctly,” says Rupali Deshmukh, business developer for IVL in India.

In October, IVL's CEO Marie Fossum Strannegård and other representatives from IVL visited the various water treatment projects in Mumbai. One of these is the treatment plant on the Mithi River, which is now completed and commissioned.

«We are very pleased to be able to deliver on this assignment. IVL's operations in India have grown rapidly and we have an exciting time ahead of us with the start of two major projects – the wastewater treatment plant in Bandra and Worli, which will start in 2023,” says Rupali Deshmukh.

IVL's office in Mumbai now employs 42 full-time employees and about ten consultants with a focus on the water treatment projects underway in the city.



View of Mumbai's skyline with skyscrapers over the slums of the Bandra suburb, Mumbai.



IVL visiting the treatment plant on the Mithi River in Mumbai, India.



The Mithi River flows into Mahim Bay.

IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Contributing to drastically reducing marine pollution by chemicals and nutrients from wastewater.
- Quality assuring the design and technical solutions for a new wastewater treatment plant.
- Collaboration between Swedish and Indian researchers, consultants and construction contractors.
- Working with the local authorities and municipalities on technical solutions.
- Supporting the development of infrastructure that will benefit the whole of society.
- Contributing to sustainable wastewater treatment solutions and technologies in India.

GLOBAL OBJECTIVE, SECONDARY GOALS

- 14.1** REDUCING MARINE POLLUTION
- 6.3** IMPROVING WATER QUALITY AND WASTEWATER TREATMENT AND INCREASING REUSE
- 6.A** EXTENDING WATER AND SANITATION-RELATED SUPPORT TO DEVELOPING COUNTRIES
- 6.B** SUPPORT LOCAL INVOLVEMENT IN WATER AND SANITATION MANAGEMENT
- 9.1** BUILDING SUSTAINABLE, RESILIENT AND INCLUSIVE INFRASTRUCTURES
- 17.7** PROMOTING SUSTAINABLE TECHNOLOGY IN DEVELOPING COUNTRIES





IVL in China: Working for sustainable agriculture and reducing microplastics

IVL's activities in China have expanded a lot since we began in 1986. Current issues include working for more sustainable food production, for reduced emissions of microplastics from textile production and to help several large companies analyse their environmental impact.

China produces about 2.2 billion tons of agricultural products each year, but still cannot meet the rapid development of consumption and industrialisation. Cultivation and distribution systems are inefficient and unregulated. This leads to food loss and poorer food security as well as a large use of pesticides and fertilizers, which affects BIOLOGICAL diversity.

IVL collaborates with local operators in China in a three-year project that will support sustainable agricultural production. The aim is to reduce food loss and the use of packaging, pesticides and fertilizers.

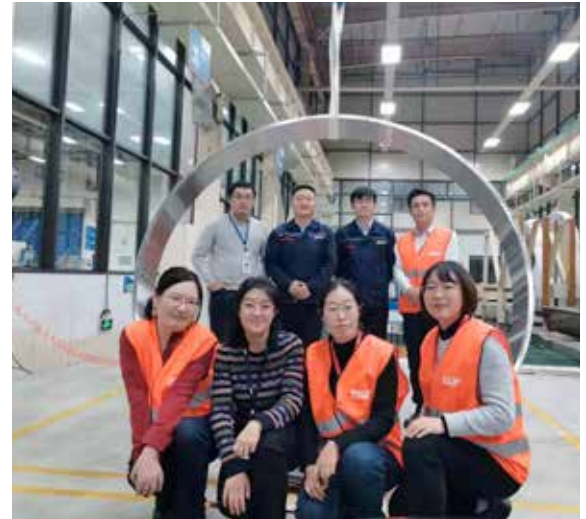
«This project will contribute to increasing resource efficiency in the food chain. It will also provide guidelines for food safety and innovative logistics, thus contributing to circular economy and less pollution and waste,” said Gao Si, Director of IVL's office in China.

One approach is to use experience from Europe to educate retailers and farmers on how to reduce the use of chemicals and create more eco-efficient agricultural production. This includes introducing returnable plastic containers for fruit and vegetables as well as providing information on guidelines and policy proposals.

REDUCE THE TEXTILE INDUSTRY'S EMISSIONS OF MICROPLASTICS

China has the world's largest textile production and accounts for more than two-thirds of global consumption of chemical fibers. According to theoretical calculations, the production of synthetic textiles contributes to a global release of up to half a million tons of microplastics into the oceans every year.

IVL's China office has received support from the Norwegian Retail Environmental Fund to work with the goal of helping to



reduce emissions of microplastics from the textile industry in China. The activities include investigating the quantities of microfibers released in the manufacture of synthetic textiles, how much of it can be separated in treatment plants and testing coagulation and sand filtration in textile industrial treatment plants.

ENVIRONMENTAL PRODUCT DECLARATION FOR WIND TURBINES

Thanks to the cooperation with IVL, the global company Goldwind became the first windpower manufacturer in China to release an Environmental Product Declaration (EPD), which has attracted a lot of attention. Using the EPD system signals the manufacturer's commitment to measure and reduce the environmental impact of its products and services and report them in a transparent manner.

Life cycle data for two of Goldwind's wind turbines shows that the company has adhered to the principles of carbon and energy efficiency in terms of the choice of raw materials, transportation, manufacturing, installation and maintenance.

"These two types of wind turbines have been shown to have a lower climate effect per produced kilowatt hour of electricity than many other wind turbines," says XU Min, senior research expert at IVL.

HELPING SKF ANALYSE ENVIRONMENTAL IMPACT
Since 2021, IVL has a strategic collaboration with SKF in China, including research, to reduce carbon dioxide emissions and find innovative methods in the manufacture of ball bearings.

IVL conducts environmental impact and life cycle analyses that show the environmental impact of the products according to PCR requirements (product and environmental classification rules within the international EPD system). This has enabled a reduction in carbon dioxide emissions for the entire ball bearing manufacturing value chain.

Want to learn more about IVL's operations in China?
Contact Gao Si, si.gao@ivl.se

IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Helping windpower companies measure and reduce their climate impact
- Contributing to more efficient and environmentally friendly packaging logistics
- Replacing single-use packaging with reusable packaging, thereby reducing the use of single-use plastics
- Contributing to increased knowledge about reduced climate impact from energy production.
- Improving international cooperation, e.g. through the sharing of experiences by researchers and businesses.

GLOBAL OBJECTIVE, SECONDARY GOALS

- 7.A** MAKING RESEARCH AND TECHNOLOGY AVAILABLE AND INVESTING IN CLEAN ENERGY
- 8.4** IMPROVING RESOURCE EFFICIENCY IN CONSUMPTION AND PRODUCTION
- 12.3** HALVING FOOD WASTE WORLDWIDE
- 12.5** SIGNIFICANTLY REDUCE WASTE
- 13.3** INCREASING KNOWLEDGE AND CAPACITY TO TACKLE CLIMATE CHANGE
- 17.16** COLLABORATING AND SHARING KNOWLEDGE ON SCIENCE, TECHNOLOGY AND INNOVATION





Some of our offerings within Sustainable society

A tool for sustainable construction – One stop shop

There are growing demands to build sustainably, since the construction sector accounts for nearly 40 percent of global greenhouse gas emissions and for a fifth of emissions in Sweden. The challenges facing the construction sector include making conscious material choices, preparing climate declarations in the case of new construction and renovation work, reusing materials in connection with renovations, etc.

WE OFFER YOU THE FOLLOWING TOOLS:

- Digital environmental information for a circular construction sector (eBVD)
- Sustainability labelling for furniture (Möbelfakta)
- Climate declaration for buildings (BM)
- Complete logbook for construction products (BASTA)
- Product bank and marketplace for reuse of furniture and building resources (CCBuild)

Measures and strategies for increased circularity and resource efficiency

With its wide-ranging skills and experience, IVL can offer you tailored support every step of the way to achieve increased resource efficiency based on your needs and conditions.

To save the climate and reduce the over-exploitation of Earth's resources, we need to develop more circular and resource-efficient solutions. This means that we need to get better at extending the service life of products and using resources more smartly, in everything from manufacturing and design to use and recycling.

Developments are moving rapidly and there are increasing demands from the market and customers for more sustainable solutions. By working actively on the transition to a more circular economy, new business opportunities and greater competitiveness are also being created. IVL will help your local authority, organisation or company, based on your specific conditions, with measures and strategies for increasing circularity and resource efficiency within areas such as plastics, textile and electronics.

WE HELP YOU WITH:

- An assessment of your current situation, suggestions for measures, action plans and providing support and sparring partners for your transition
- Mapping material and waste flows
- Calculating climate impact and assessing the climate and environmental benefits of various measures
- Developing goals, targets and measures to increase resource efficiency and reduce waste quantities
- Developing a strategy and action plan for increased resource efficiency
- Customised training for your staff, customers or partners



Climate goals according to Science Based Targets

Science Based Targets is a method to enable companies to align scientifically based climate goals with the Paris Agreement. The company needs to inventory its emissions throughout its entire value chain, and the target is often linked to investments where economy, feasibility and other effects are carefully investigated.

More and more companies are setting climate goals according to Science Based Targets. This means that they are undertaking to implement the necessary measures to ensure that the rise in temperatures will not exceed 1.5°C. This is an initiative by CDP, UN Global Compact, WRI and WWF. The scientific data is produced by the IPCC and the IEA, among others.

THE STEPS FOR SETTING CLIMATE GOALS

The process starts with the company submitting a letter of intent, in which they commit to developing a climate target within two years. Once the climate target has been submitted, it is reviewed by the organisation behind Science Based Targets on the basis of the requirements that have been stipulated.

The target includes direct emissions (scope 1) and indirect emissions from purchased energy (scope 2). Emissions in the rest of the value chain (scope 3) must be carefully mapped and if those emissions are greater than 40 percent of the total emissions, a climate target must also be developed for them.

IVL works with this issue for companies in different parts of the business sector, such as the real estate industry and the manufacturing industry (automotive, forestry, agriculture and more).

WE HELP YOU TO:

- Develop climate goals according to the Science Based Targets method for various areas.
- Understand the underlying structures within Science Based Targets and how this can be linked e.g. to global indices and the evaluation of the companies' environmental and sustainability work.
- Calculate emissions throughout the value chain: scope 1, scope 2 and the various categories in scope 3.





WHAT SOME OF OUR CUSTOMERS THINK

We work together with many companies, municipalities and the authorities to develop solutions that contribute to an ecologically, economically and socially sustainable society. Here you can read about some of our collaborations and what our customers think of us.



"The result was a so-called cradle-to-gate study together with IVL."

When the technology company Mips started its sustainability work, it was necessary to calculate the climate footprint of the products. This is something that IVL's experts could help with. The results were available a few months later.

The Swedish technology company Mips develops safety systems that are built into sports, motorcycle and safety helmets. It is a kind of low-friction layer that is inserted into helmets and is designed to redirect the dangerous rotational movements that can occur during bumps and falls. Just over a year ago, Mips decided to perform life cycle analyses (LCA) on a few selected products.

– This is a safety company founded in science and technology with the goal of protecting the brain. "Safety is therefore always number one, but sustainability is close behind," says Jakob Wikner, who runs sustainability issues in product development at Mips.

When the work started, there was no sustainability data on raw materials and materials in the company's components. The company needed to have some data to relate to. Jakob Wikner therefore proposed producing life cycle calculations on some of their best-selling products. The result was a project collaboration with IVL Swedish Environmental Research Institute.

«Obtaining comparative data was absolutely necessary for us. To be able to improve the products. It was also about being able to report our climate-related emissions in order to be able to address these and also report them in Mip's public sustainability report. It was at this point that we turned to IVL," Wikner said.

IVL has access to LCA software with several databases with data for emissions from transport, production processes and raw material production - among others. In assignments similar to this, data is collected and the databases are used to calculate the climate impact of goods (expressed in kg CO₂ equivalents). "The amount of data you receive from customers varies from case to case," says Marie Gottfridsson, LCA expert at IVL.

«There are not so many components in a helmet, it is a fairly simple calculation model. There were some uncertainties in the data from Mip's subcontractors, so getting real data was important. The company supplemented its data gradually, so we had a chance to improve the calculation," Gottfridsson said.

The small working group with representatives from IVL and Mips had regular meetings where they updated the information and checked the data from production, e.g. how they corresponded with data from suppliers in other manufacturing countries. It was a process that lasted a few months where data and figures were processed and went back and forth between Mips and IVL.

– We dug deeper into the data and considered the plausibility of some numbers "Can the data be correct? Does the data make sense?"

We did this together. "Data from the Chinese suppliers was a bit special; there was initially not much data to go on from their side," Marie Gottfridsson said.

In this situation, it was important to obtain accurate data on the plastics, fabrics and rubber contained in the components in order to be able to calculate the total emissions. In some cases, the material was unique and then you had to turn to the Chinese manufacturers. Here, the employees of Mip's Chinese subsidiary team helped out.

– We went through IVL's reporting templates and filled in with information as best we could. So the first problem to solve was how to get the rest of the data. The templates were forwarded to the suppliers via our office in China who manage the production chain," Wikner said.



It was good to see that recycled plastic can make such a big difference from a climate point of view. That was good news for us. Now we got it in black and white. Before, it was hard to really know what it looked like.

Jakob Wikner
Product developer at Mips

This review took quite some time as the company had not done anything like this before. Among other things, several translations from Chinese to English were needed. Wikner said that the requirements had to be set very high which made the project impossible. Sometimes you had to choose the information that represented the product or material best, for example when it comes to plastics of different qualities.

«What you have to bear in mind is that there will be relatively rough brushstrokes to get information. You can spend as much time as you like to get accurate data, but in the end you have to put yourself at a level that is good enough and hits reasonably right. For our part, to be able to plan production, it was good enough,” Wikner said.

By new year 2021/22, all the figures were available. IVL counted and compiled the results. It showed that the lion's share of emissions were related to raw materials and energy consumption. The study also showed, for example, that the company can achieve a 35% reduction in the climate footprint of a certain product by switching to industrial recycled plastic. The IVL study is a piece of the puzzle in Mip's growing sustainability work.

Mips is in the process of switching to industrial recycled plastic in the production of products where it is practically possible, work that has been ongoing in parallel with the environmental review. It is actually industrial waste that is reused in new plastic that reduces emissions at the same time. According to Jakob Wikner, the IVL study confirmed how much effect this would have. This would have been impossible without IVL's calculations.

«Now I see what potential there is if we introduce this in all safety systems and products that use the old plastic: But we don't yet know how far we can go. We have verified product by product, you can in some cases get a quality difference in the

plastic, the recycled plastic we have focused on the most, is still surprisingly good.

The IVL study last year is a piece of the puzzle in Mip's growing sustainability work. During the work, IVL acted as expert support. This project included products that account for more than half of Mip's range and the assessment covered only part of the products' environmental impact according to a so-called cradle-to-gate model, but Wikner sees it as a step on the way to further improvements.

«We are very pleased with how this turned out. We are now doing follow-ups and going into more detail, for example by looking at proposals we want to implement and checking with IVL whether they are better or worse from an environmental point of view”, Wikner said.

This can e.g. involve replacing parts in the products, manufacturing a component in a new way, or combining materials in some other way to arrive at an equivalent end product. For example, to create a different colour than before, and colour the plastic instead of applying surface treatment. “This is continuous improvement work. For our part, it is very important to reduce our emissions but also to be able to communicate and be transparent about our sustainability work towards our customers, the major helmet manufacturers, and other stakeholders. Although the interest differs, the trend is that more and more people also demand this,” Wikner said.

Want to know more? Contact:

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"The collaboration with IVL makes Skogsvaktaren a more eco-friendly project."

Wallenstam needed to inventory the climate footprint of its new production. Partly to develop their own climate work, but also because a new law is in the pipeline. IVL Swedish Environmental Research Institute's experts started work and initiated a learning process so that Wallenstam can continue on its own.

Perhaps others could have done the calculations themselves. But we were equally interested in the process afterwards, in the analyses, in being able to take it further. We wanted to know where we can take action most quickly to reduce the carbon footprint. IVL has been a great help in providing us with tools.

Jonathan Rodstedt is a construction expert at Wallenstam, a real estate company that for several years has set its own internal climate goals when it comes to management. But when it comes to the climate footprint of their new production, they needed to build up more knowledge.

"So far, we have not worked as actively to reduce carbon dioxide emissions in our new production as in terms of operation and management. We intend to change that and we wanted to know what is required of us. We saw that IVL's work is close to the research.

They have overall knowledge and have also developed the tools that were relevant to use.

In the background is a legal requirement that comes into force in 2022 and which states that real estate companies and developers must report climate footprints in new projects. Wallenstam wants to prepare for this.

"But we also have internal climate goals that we want to meet. We need knowledge here. How do we map our construction projects all the way down to screw and nut level?"

A first step is to make a so-called baseline measurement that describes what the situation looks like today. It was here IVL's experts came into play, and the project they were to analyse is located in an area called Mölnlycke Fabriker.

The Skogsvaktaren block is two tower blocks in the old factory area of Mölnlycke with historical roots, from which a new district emerges close to greenery and parks. The buildings will have a concrete frame and be built in accordance with Wallenstam's usual technology.

IVL's experts Åsa Thrysin and Frida Görman were brought in and after some initial meetings the work started.

– Wallenstam wants to understand how they can reduce their climate impact. Then they first need to know where they stand today. Where should efforts be made to be effective? "Is it the frame, the roof or somewhere else," Thrysin said.

Together with the industry, IVL has developed a tool that they could use, called the Construction Sector's Environmental Calculation Tool (Byggsektorns Miljöberäkningsverktyg / BM). Everyone has access to the tool, but the fact that it is IVL that is behind it and also maintains the BM tool that contributed to Wallenstam's choice of partner, according to Jonathan Rodstedt.

In the BM tool, information is entered on construction resources, weights and quantities. In the case of transport



“Our shareholders like that we have taken such big steps in our climate work. And we are also well prepared for the new law.”

Jonathan Rodestedt.
Construction expert at Wallenstam

emissions and spills at construction sites, these were based on predetermined scenarios. Everything was then boiled down into a unit of measurement in kilograms of carbon dioxide equivalents (CO₂e) per square meter.

Åsa Thrysin says:

“Wallenstam sent documentation about their materials and quantities for the various building parts that we processed. If there was a lack of information, which there almost always is, we established a dialogue. Then we entered the information into BM which we then reviewed and evaluated if it sounded like a reasonable result.

Whatever seemed reasonable, well, this is where Åsa Thrysin and her colleague took support from the research that exists and on which was entered. They also relied on IVL’s collective experience in the field, in the form of earlier projects.

“The difficult part of the work was to obtain as accurate a basis as possible,” Thrysin said. One exterior wall may differ from the others. It can be an additional frame wall in a garage. All this affects carbon dioxide emissions. Estimates were made when things could not be counted exactly. It all led to several conversations with Wallenstam’s construction expert Jonathan Rodestedt for making a reasonable assumption as possible.

«We had a good dialogue,” he says. IVL has been clear and open and helped us find the data we needed. That dialogue was also a learning experience for us. Among other things, we saw that getting concrete figures is not always as complicated as one might think.

The project started in June and after the summer, Åsa Thrysin and Frida Görman presented a report to a group within Wallenstam, including the company’s sustainability manager. This was the starting point for the company’s own work.

– Perhaps they started this project to prepare for the legal requirement. But once we presented the results, the reaction was: Wow, we can improve here, Thrysin said.

The report and presentation had almost immediate effect. It didn’t take longer than a month before Wallenstam contacted Åsa Thrysin about finding ways to reduce the amount of concrete in the frame and thereby reduce carbon dioxide emissions in the Skogsvaktaren block. Concrete frames are often the most climate-charged factor in building a house.

“They asked us to make a supplementary calculation for how large that saving would be,” Thrysin said. Wallenstam had presented two different options. One option resulted in savings of 9 kilograms of carbon dioxide equivalents per square meter. The second option was even more climate-efficient. There we saved

22 kilograms of carbon dioxide equivalents per square meter.

“We also helped Wallenstam’s sustainability manager to interpret the data and the basis for a review of frames in all Wallenstam’s projects,” Thrysin said.

Wallenstam has offices in Gothenburg, Stockholm and Uppsala. And they build in slightly different ways in each region.

As recently as January, Wallenstam in Stockholm got in touch about doing the same job, but this time in Stockholm.

“For us, the collaboration with IVL led to us being able to make Skogsvaktaren a less climate-impacting project. It has also led to a review of several of Wallenstam’s projects,” Rodestedt said.

Wallenstam is now continuing to implement the results of the collaboration and is developing the action plans where IVL’s calculations are included as a key ingredient.

And in March, ground was broken for the Skogsvaktaren block in the Mölnlycke factory area. With frames that have less impact on the climate.

«Our shareholders like that we have taken such big steps in our climate work. At the end of the day, that’s what our financiers look at.

And we are also well prepared for the new law,” Rodestedt said.



New law on climate declarations

In 2022, a new law on climate declarations for new buildings came into force. The law covers anyone who applies for a building permit after this date. This means that greenhouse gas emissions from the construction phase of the building must be declared as the building’s climate impact. The construction phase includes the extraction of raw materials, the manufacture of construction products, work on the construction site and transport. The basis for a climate declaration is a life cycle analysis (LCA).

Source: Boverket.

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"Anders at IVL succeeded with something we tried many times."



The cooperative OK Värmland wanted to make a major investment in biogas for road vehicles but had difficulty getting started. They hired one of the country's foremost experts on biogas, which they found at IVL Swedish Environmental Research Institute. He helped them with everything from finding suppliers and procuring the filling stations to seeking investment support.

– Anders Hjort at IVL helped us apply for grants through Klimatklivet. We had made many attempts before but never got the deal together. It is obvious that Anders knew what was needed. "We got 100 percent of what we were looking for, which is very unusual," says Stefan Särnehed, CEO of the cooperative OK Värmland economic association.

The cooperative operates OK/Q8 stations throughout Värmland and as part of the fuel market changing, they wanted to expand the supply of biogas. According to Stefan Särnehed, this is an underestimated fossil-free fuel.

"You drive a car on household compost and old sewage sludge. It should be equated with electricity and have the same social support so that ordinary people can make a choice," he says.

"For most people, the electric car is too expensive today, while it is relatively affordable to convert gasoline and diesel-powered vehicles to run on biogas. And the raw material itself, sludge and waste, is so far not in short supply," according to Stefan Särnehed.

"We do not understand why we are not investing in biogas. We

have been trying to get more stations in Värmland for quite a few years. Previously, there was only one in Karlstad, but we wanted a spread," Särnehed said.

IVL has built up its expertise in biogas during the last five or six years. This was done by buying strategically selected companies and recruiting key personnel. One key person is Anders Hjort, an expert with 15 years of experience in biogas and who brought several projects to IVL.

"One of those projects was about me helping a group of farmers in Värmland to apply for funding to establish a biogas plant. Then I also came in contact with OK Värmland. They saw that they could buy locally produced biogas if there were only filling stations," Hjort said.

It costs a lot to build a biogas station. It is about two to four times as expensive as a regular filling station and thus difficult to calculate commercially. For OK Värmland, it has not only been about business benefits, at least not in the short term. OK Värmland is a cooperative and one of their seven guiding principles is



"It's cool to drive around on Swedish fuel, which is 100 percent fossil-free."

Stefan Särnehed,
CEO of the cooperative OK Värmland economic association

about "social consideration".

"If you only look at it commercially, it is far too expensive to invest in biogas, but here it is important to be proactive and to take responsibility," says Stefan Särnehed.

However, it is a competitive advantage to be able to offer a variety of fuels at the filling stations and with the Swedish Environmental Protection Agency's investment support Klimatklivet it would work. Something Anders Hjort made sure to get across. He also helped to set up a functional procurement of the filling stations and acted as client support during construction. And when the biogas stations were ready, Anders Hjort arranged external inspection of the stations.



Anders Hjort,
IVL Swedish Environmental Research Institute, expert with 15 years of experience in biogas.

He says he was involved throughout the journey as a consultant; there were three biogas filling stations in Arvika, Torsby and Säffle.

It wasn't easy. For example, it turned out that one of the existing plots did not work for biogas and therefore they had to build on completely new land. It made the project somewhat more expensive. It was also the case that OK Värmland needed to keep a grip on its wallet when building the stations, so bids were evaluated based on the price of the contract. This led to some delay.

According to OK Värmland's CEO Stefan Särnehed, however, most things have worked like a charm.

"There is really no point where we have not reached the end of the road. Anders is very meticulous and ambitious and has done a good job," he said.

– We try to talk about biogas in every possible way and whenever we get the opportunity. "It's cool to drive around on Swedish fuel, which is 100 percent fossil-free," Särnehed said.■

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"We learned how to work with new ways of thinking and innovation."

Eksta Bostads AB in Kungsbacka pursues issues of sustainability and alternative energy sources. Now, together with IVL, they wanted to investigate the possibility of fourth generation district heating.

Sweden is considered to be at the forefront in utilising residual heat from district heating. But when it comes to utilising heat from sources with lower temperatures, like from old mine shafts, public transport or low-temperature processes in industries, Sweden has not been at the forefront.

This does not prevent one of Europe's foremost experts in the field from being Swedish. Her name is Kristina Lygnerud and she works at IVL Swedish Environmental Research Institute.

«Sweden has settled down after being an early adopter of the first generations of district heating. But now that the step is to be taken from the third generation to the fourth, things are going a little slow. My vision is for cities and residential areas to heat themselves," she says.

Kristina Lygnerud, who divides her time between IVL and Halmstad University College, got in touch with Eksta Bostäder's CEO Christer Kilersjö during a seminar that the governor of Halland held. Kristina Lygnerud was one of the speakers.

The County Governor thought that Halland needed a better energy strategy. "We tried to find concrete projects where we could calculate how the new technology would work," she says.

Christer Kilersjö:

– We have collaborated with IVL several times before and have very good experiences of it. Here we saw a chance to test new technology on a smaller scale.

The project would, through simulation, investigate the possibility of introducing fourth generation district heating in new buildings in the residential area Särö in Kungsbacka. Särö has a history as a holiday resort for affluent Gothenburgers and terraced houses and apartment buildings are now being built there by a private property owner and the tenant-owner association where Eksta is the district heating supplier.

The issue has not been investigated in this way before and it was considered to have such great social interest that the state via the IVL Foundation stepped in and accounted for half the project sum, which made it a co-financing project.

Eksta strives to maximise the proportion of renewable energy in its homes and as part of this, the company has made major investments in solar heating. Solar heating is considered particularly suitable in systems with low-temperature district heating.



“We learned some specific things, but we also learned more generally how to work with development and innovation.”

Christer Kilersjö,
CEO of Eksta Bostäder

«We thought it would be excellent to use solar heat to heat the homes. There is a great potential to exploit fourth-generation solar thermal technology,” Kilersjö said.

In addition to Kristina Lygnerud from IVL, who led and coordinated the project, researchers at Halmstad University also participated. The company BG Dahlman was also involved, they have extensive experience of technical solutions in the district heating system.

For Eksta Bostad, this meant a chance to work closely with qualified researchers.

“We learned some specific things, but we also learned more generally how to work with development and innovation. It opens up an approach to trying new things. That the threshold for trying something new will be lower. This makes us a more attractive employer.

With 4GHD, the need for hot water circulation in the house disappears, which can provide great savings. Hot water circulation is used so that the hot water in the pipes does not cool down too much, it should be kept warm so that those who want hot water in the tap do not have to flush for several minutes. This inevitably entails large energy losses. With 4GHD, heat exchangers are instead installed in each apartment, which means energy savings. These apartment exchangers also completely eliminate the risk of legionella bacteria, which has otherwise been seen as a problem.

The results showed that 4GDH increases energy efficiency in buildings and is cost-effective, especially in properties with 10-15 apartments. In the case of larger properties, the savings will be smaller or will not be achieved at all, as it then costs more to install exchangers in each apartment than to have a common exchanger on the ground floor of the house.

So it does not seem to be the technology that is the biggest obstacle for a housing company to dare to take the step from the third to the fourth generation of district heating. Instead, the stumbling blocks are about laws, agreements between the parties and trust.

Kristina Lygnerud, who is an economist, explains:

«The large district heating companies no longer have full control over the issues. Instead of burning forest waste and other fuel in their own furnaces, new solutions require engaging in relationships with many small heat suppliers. You get a deep customer relationship that lasts a very long time. Kristina Lygnerud says that Eksta turned out to be open to such ideas and was curious to understand this.

Changing something that still works can be a hassle. But by 2050 there will be no fossil sources, biomass will not be enough and the amounts of waste will be less, Kristina Lygnerud emphasises. Then there is not much choice if you want to work with district heating, she says.

A conversion is facilitated by the fact that the developer is also a property owner such as Eksta Bostäder. But the company still ran into trouble because the heat is delivered in the apartment.

“We get further into the apartment on contractual terms. Who do we talk to about air leaks in the house? And how will we be paid for this? That’s where we got into trouble,” says Christer Kilersjö.

This was an exploratory project, not an implementation project. It was not fourth generation district heating at Särö. First, Eksta needs to find contractual answers to the questions that arose.

«We haven’t gotten that far yet. Here we wanted to investigate whether it is possible, and it is. But we have some thoughts on the topic, and we have learned a lot about district heating during the project that we can benefit from,” says Christer Kilersjö. ■



PHOTO: SOFIA SABEL

The co-financed project was led by Kristina Lygnerud at IVL

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EMPLOYEES AND WORKING ENVIRONMENT



Our attractive workplace

SELF-LEADERSHIP AND STRESS MANAGEMENT

At the end of 2021, work began on developing self-guided leadership and stress management. This has been going on throughout 2022 where we offered employees the opportunity to develop their own leadership skills and thus lower their stress through strategies for how to handle different situations at work and in their private life. The digital programme from Bonzun is research-based and structured in eight steps to be done every 1-2 weeks. We also offered coaching opportunities in groups linked to the programme. All managers and the management teams have completed the programme. We have also had lectures on the subject; what is stress and how does it affect us. We believe in the importance of different activities to avoid mental illness and this is an activity that has been done in 2022.

YEAR OF HEALTH

After almost two years of pandemic, IVL chose to invest in a Year of Health for the organization in 2022. We chose this to promote well-being, good health and happiness. The year was divided into four different periods and topics, with an overall focus on health and well-being. The areas we worked with were movement, job satisfaction, recovery and healthy food. Physical activity has been a base and foundation for the entire health year. We have various lectures on e.g. *Walking or interval training* and *Sustainable brains in a stressful world* with inspiration on mindfulness, job satisfaction and testing new blue foods. We also worked with various activities linked to the topic that each employee has been able to perform. We used the Goozo app with activities, and for each activity points were collected with

nice prizes for each completed theme. Under each theme, we have health tips with inspiration. We also chose to increase the wellness allowance that year to SEK 3700 per year.

ASSOCIATIONS AND ACTIVITIES

For us, the commitment of our employees is important and at IVL that commitment is great. We have therefore chosen to sponsor our sports clubs and arts and culture associations with considerable sums every year. This enables various activities that our associations carry out. Our sports association included offers of training – in the form of yoga and circuit training at lunch, jogging and Blodomloppet, for trying out different activities such as summer skiing in Hammarbybacken, bowling, swimrun and mountain biking. A joint ski trip to the Swedish mountains is usually a recurring favourite.

Our cultural associations organize parties, mulled wine tastings and visits to art museums. During the autumn of 2022, twelve beginners learned to paint watercolours on five occasions in Stockholm under the guidance of our colleague and watercolour artist Maria Vigren. The course ended with a vernissage at the Stockholm office.

Bollywood dance was taught in Gothenburg. Most of the activities are based on all our employees' knowledge and interest and the desire to teach and share with their colleagues. These activities are highly appreciated and many choose to participate. There are also groups at the offices that organize afterwork at regular intervals and sometimes with elements of table tennis or board games.





HYBRID WORK

At IVL, the majority of our employees have the opportunity for hybrid work. We want you to work from the office at least 50% of your working hours. This means that you have a great opportunity to work from home the rest of the time.

Many of our employees have appreciated the opportunity to work from home during the pandemic and therefore we continue to offer that opportunity. IVL announced early on that we will be able to work from home even after the pandemic ends.

In Q2 of 2022, our employees started coming back and working from our offices and the return has taken place successively during the year. More and more of our employees appreciate working from our offices with fellowship, networking and having a spontaneous coffee with a colleague.

IVL believes flexibility benefits our employees both in terms of work but also to make the private life fall into place. We also believe that it benefits us as a company to be able to offer flexibility, it makes it easier to recruit and we believe that hybrid work increases productivity.

KICK-OFF

After just over two years of pandemic, it was time for a new kick-off.

In May 2022, IVL gathered its employees in Sweden and India for a kick-off in Stockholm. Unfortunately, our Chinese colleagues could not attend due to covid travel restrictions.

We met for a full day of socialising with activities, presentations, stand-up comedy and with a party in the evening. The event was much appreciated by our employees and the feeling to see everyone again was overwhelming.

CAREER FAIRS

IVL employs many newly graduated engineers every year and also offers degree projects and internships during the study period. We see it as extremely valuable to have colleges and universities as a recruitment base. In 2022, we expanded our work to reach more students. During November 2022, IVL participated at ARKAD at Lund University and at ARMADA at the KTH Royal Institute of Technology. The interest in talking to us and our knowledgeable employees was great and we hope for many potential new employees and to find students for our degree projects.

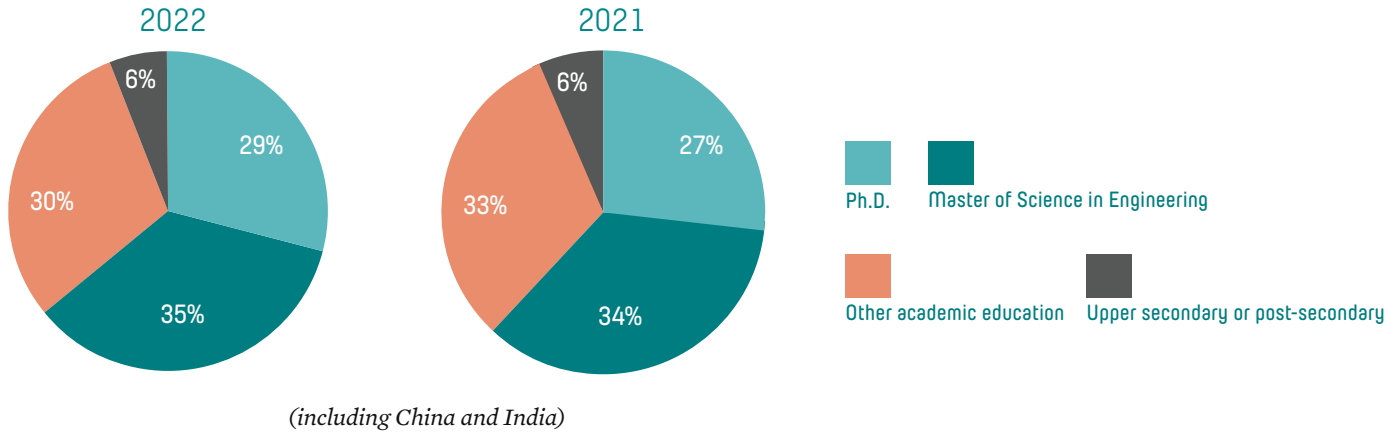
NEW CAREER PAGE

Recruiting is important for IVL as we are constantly growing with the assignments we receive from our customers and clients. In order to be seen and spread our recruitments, IVL has chosen to invest in a new career page and recruitment system. We believe this will help us recruit even more employees with the right skills. Please have a look: career.ivl.se.

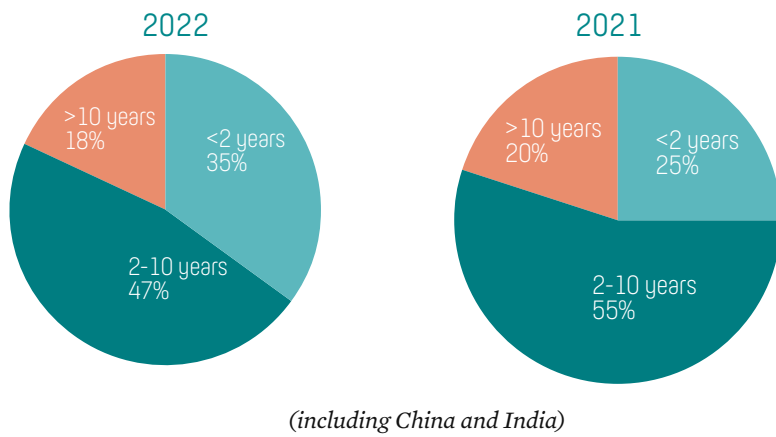
MENTORING PROGRAM

IVL thinks it is important to get a good introduction and support when you are at the beginning of your career. Every year, IVL offers a mentor programme for junior employees who have worked for one year at IVL. Each junior employee is assigned a senior colleague as a mentor who they meet several times during the year to exchange experiences, network and get support as part of their skills development. Our mentors are trained in coaching and mentoring. The interest is great and every year about 15 junior employees participate. We believe that this programme provides a good foundation to stand on in its continued work at IVL.

TRAINING

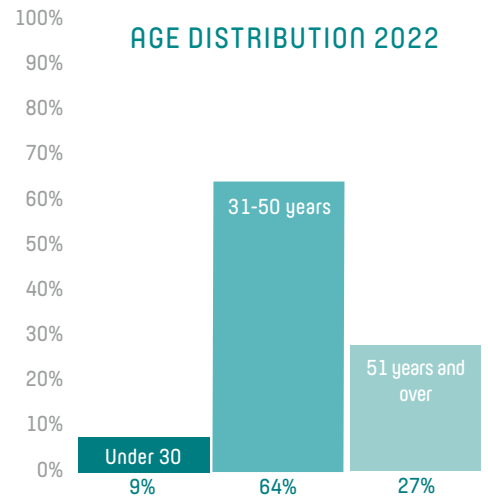


PERIOD OF EMPLOYMENT

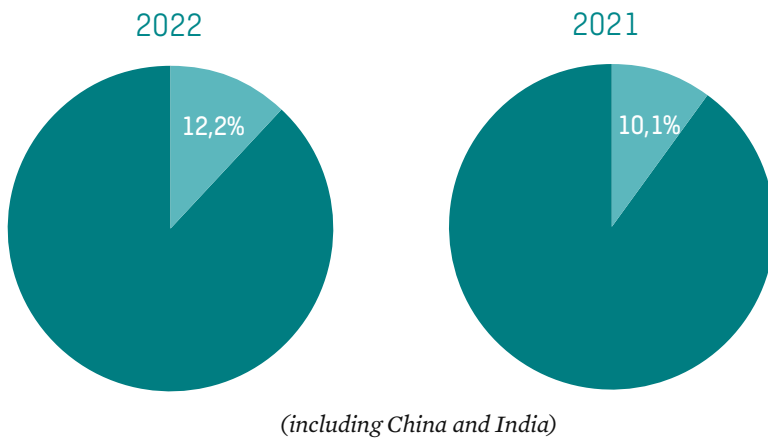


The average length of employment is 6.5 years (excluding fixed-term employment.)

AGE DISTRIBUTION 2022



STAFF TURNOVER



Proportion of employees leaving relative to average employees excluding pensioners and fixed-term contracts: 12.2%



Ethics and integrity

For the IVL Swedish Environmental Research Institute, our independence is fundamental to the entire operation. This independence is guaranteed by our ownership structure, a foundation that was formed jointly by the state and the business sector. IVL was established with the task of supplying independent and credible decision-making data that all parties can rely on.

The Sustainable Development Goals (SDGs) that we primarily work with are SDG 16, Just, Peaceful and Inclusive Societies (secondary goals 16.5 and 16.6). Credibility is one of our most important core values, where our independent position allows us to deliver results that provide sustainability benefits for our customers.

CODE OF CONDUCT

Our employees are our most important resource, and it is important for us to act ethically and responsibly in our work and our relationships.

As a basis for this, IVL has had a code of conduct for many years, based on the UN Global Compact's ten principles and on IVL's values. This applies to all IVL employees and board members, and governs IVL's conduct towards employees, suppliers, business partners and other stakeholders. The introduction of new employees includes a review of what the code of conduct means and how it is applied.

In connection with the code of conduct, IVL has a whistleblower function. This provides employees with a communication channel to raise suspicions of possible violations of the code of conduct, both internally and externally. Through this system,

IVL provides its employees with the opportunity to submit reports, where the right to remain anonymous and not risk repercussions is guaranteed. In 2022, no notifications were received.

RISK ASSESSMENT

IVL's management conducts ongoing assessments of risks related to the company's operations. This includes risks relating to corruption, human rights, working conditions and the environment. Risk assessments are also an integral part of IVL's project process and are carried out in conjunction with tenders and applications. The aim is to pick up on possible risks associated with projects, identify actions and decide whether IVL can carry out the assignment based on our code of conduct and our core principles of credibility and independence.

Credibility is one of our most important core values, where our independent position allows us to deliver results that provide sustainability benefits for our customers.



Environmental impact of our own operations

Environmental considerations permeate everything IVL does, and our own operations should naturally be conducted with the lowest possible environmental impact.

Our work contributes primarily to the following Sustainable Development Goals (SDGs): SDG 2: Zero hunger, SDG 3: Good health and well-being, SDG 7: Affordable and clean energy, SDG 8: Decent work and economic growth, SDG 12: Responsible consumption and production, and SDG 13: Climate action.

We do this through our environmental work primarily in the following areas, based on which environmental aspects are most significant for our business:

- Climate and energy (interim goals 7.2, 13.2 and 13.3)
- Resource efficiency and circularity (secondary goals 2.4, 8.4, 8.7, 12.2, 12.4 and 12.5)
- Sustainable use of chemicals (interim goals 3.9 and 12.4)

IVL's environmental management system, which covers operations in Sweden, is certified according to ISO 14001. The report covers operations in Stockholm, Gothenburg, Malmö and Kristineberg. This includes Hammarby Sjöstadsværk, a unique water treatment research facility that is jointly owned by IVL and the Royal Institute of Technology (KTH).

CLIMATE AND ENERGY

Greenhouse gas emissions from business travel and energy consumption within IVL's operations totalled 186 (76) tonnes CO_{2e}, of which 152 (38) tonnes CO_{2e} comes from business travel and 34 (37) tonnes CO_{2e} from energy consumption. The majority of emissions, 82 (50) percent, come from business travel, of which air travel makes up 73 (31) percent and travel by car 8 (19) per-

cent. Climate intensity, kg CO_{2e}/employee, i.e. emissions per employee amounted to 531 (234) kg CO_{2e}

BUSINESS TRAVEL

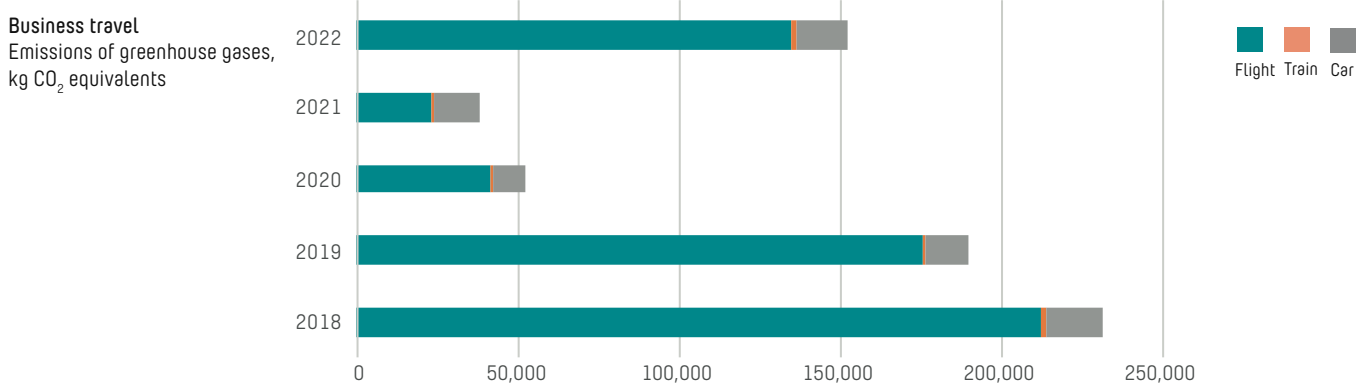
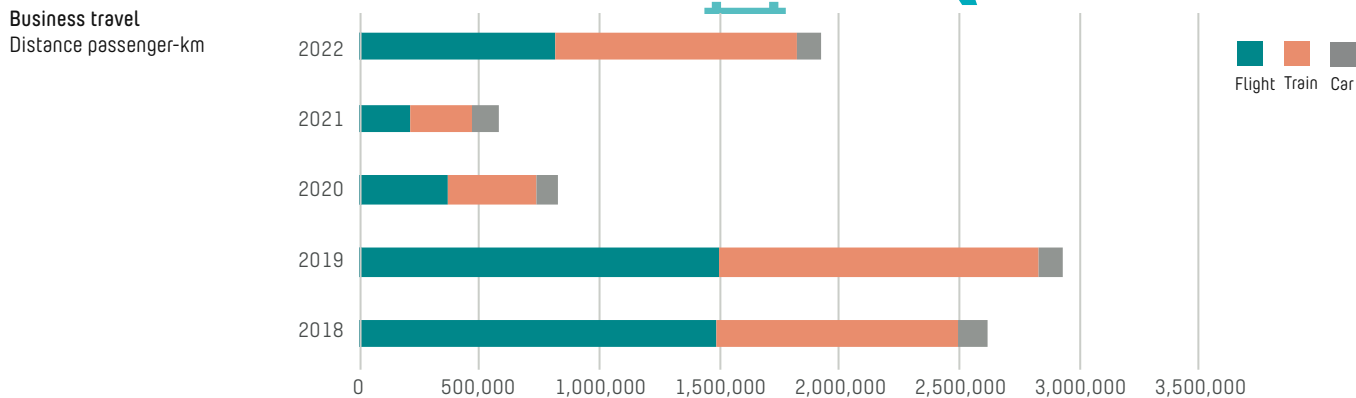
In 2022, business trips have increased compared to last year; this increase is not in line with 2019 before the pandemic. The number of person-kilometers has increased by (68 percent) from the 2021 level and the climate impact (CO_{2e}) has increased by 75 percent from the 2021 level. IVL's goal of reducing emissions from business travel, including by always considering whether travel is necessary and by choosing the train rather than air travel, remains. It is likely that travel will not return to pre-pandemic levels thanks to an increased proportion of digital meetings. However, some travel is essential to run the business and carry out our assignments.

The share of air travel in passenger-kilometers has increased to 42 (37) percent and trains account for 52 (45) percent and car travel has decreased to 6 (18) percent.

ENERGY USE WITHIN OPERATIONS

Total energy consumption for IVL's operations totalled 1,838 (2,072) MWh, of which 48 (50) percent comprised electricity, 41 (43) percent district heating and 8 percent cooling. The decrease is mainly related to temperature variation between the years. The main part of the energy supply is renewable energy. IVL works together with our property managers to jointly identify and execute energy savings and measures for reducing energy consumption. These measures are evaluated and implemented on an ongoing basis.

CLIMATE AND ENERGY - BUSINESS TRAVEL



CLIMATE FUND

Since 2016, IVL has been setting aside funds for a climate fund, which is used to offset carbon dioxide emissions from business travel. Carbon offsetting is conducted by means of credible standards, which ensure genuine and long-term emission reductions as well as contributing to other global goals within Agenda 2030.

As from 2019, IVL decided to allocate additional finances to the fund, corresponding to the external costs for emissions, and that the fund should also include emissions from energy consumption. Furthermore, it was decided that the funds should also be used for climate compensation, in order to facilitate additional measures for reducing emissions from IVL's activities, employees and society at large.

RESOURCE EFFICIENCY AND CIRCULARITY

IVL's operations will be run in a resource-efficient manner, with reuse and recycling being obvious elements. The reuse of IT equipment and mobile phones has increased, and furnishings are also reused as far as possible. Any furnishings and equipment that IVL no longer requires are resold for reuse and continued use. To achieve sustainable purchasing, IVL prioritises purchasing environmentally friendly alternatives when it comes to consumables. Catering at meetings, conferences and other IVL events is vegetarian, organic and seasonal, and fair-trade and locally produced food is selected where available; food waste should also be minimised.

The total amount of waste from IVL's offices, measurement and analysis activities as well as Hammarby Sjöstadswerk

amounted to 41.5 (13.4) tonnes, of which 37.1 (10.9) tonnes were recycled. Hazardous waste from measurement and analysis activities and process activities amounted to 5.6 (3.0) tonnes, of which 1.2 (2.5) tonnes were recycled (R code) and 4.4 (2.4) tonnes were disposed of (D code). The large increase is due to the closure of Hammarby Sjöstadswerk and the decommissioning of all equipment, materials and chemicals, most of which was recycled

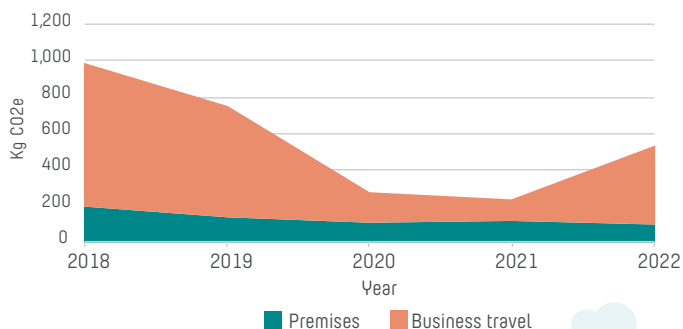
SUSTAINABLE USE OF CHEMICALS

Chemicals are mainly used in IVL's measurement and analysis activities, where the choice of chemicals is largely governed by the analysis methods and the equipment used. When developing analysis methods and purchasing equipment, IVL therefore works systematically to reduce the use of chemicals as far as possible and replace hazardous chemicals with alternatives that have a lower impact on the environment and provide a safer work environment. In 2022, a major instrument investment was made to the analysis operations in Stockholm, which will reduce the consumption of solvents by just over half for the current analyses.

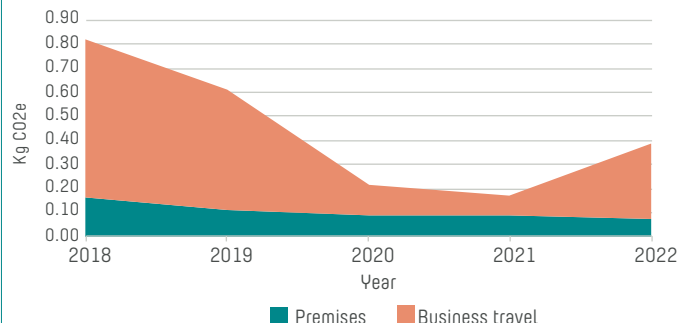
Chemicals are also used for water treatment within the research activities at Hammarby Sjöstadswerk. Here, techniques are developed for reusing and exploiting treated wastewater to help more people have access to cleaner water, at the same time as optimising the use of both chemicals and resources in water treatment.

COMPARISON OF CLIMATE INTENSITY 2019-2022

Climate intensity per employee, kg CO₂e/employee



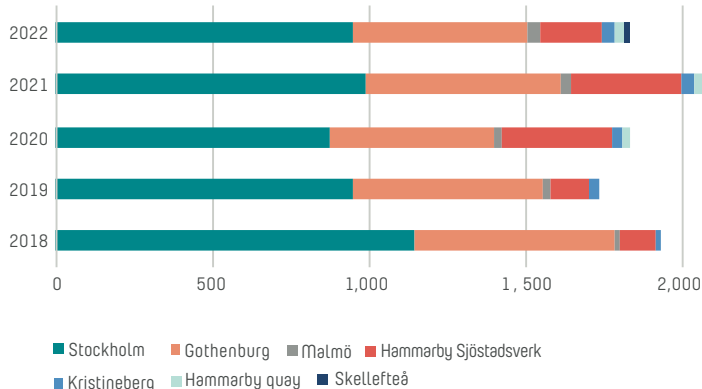
Climate intensity per net turnover, kg CO₂e/TSEK



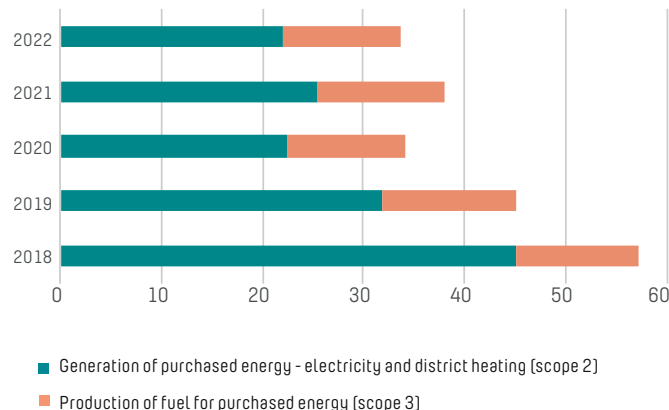
ENERGY AND CLIMATE FACILITIES



Energy consumption per office, MWh

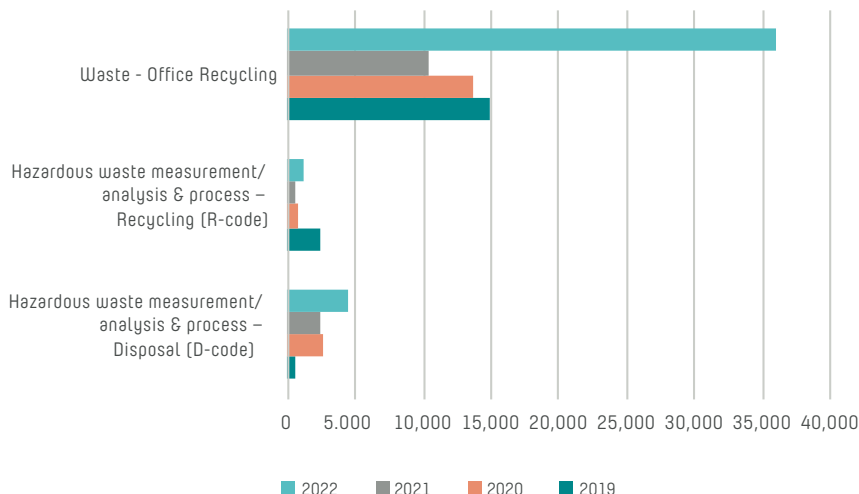


Greenhouse gas emissions from purchased energy, tons CO₂e



RESOURCE EFFICIENCY AND CIRCULARITY – WASTE

Resource efficiency and circularity – waste [kg]



The large increase in waste in 2022 is due to the closure of Hammarby Sjöstadsverk and the decommissioning of all equipment, materials and chemicals, for the most part, was recycled.



Directors' report

The Board of Directors and the CEO of IVL Swedish Environmental Research Institute hereby submit their annual report for operating year 1 January 2022 – 31 December 2022, the company's fortieth fiscal year.

The business in general

The IVL Swedish Environmental Research Institute (IVL) conducts applied research and consultancy assignments across the entire environmental and sustainability area. Our customers are found in all industries, government agencies and organisations. Our operations are based in Sweden and Europe, but our customers are located throughout the world, particularly in China, where IVL has been active for more than 30 years. IVL has offices in Stockholm, Gothenburg, Malmö, Beijing, Mumbai and Fiskebäckskil.

IVL was founded in 1966 and is owned by the Swedish Institute of Water and Air Conservation Research Foundation. The Swedish

government and the Swedish business sector appoint directors to serve on the boards of the company and the foundation.

IVL has operated as a limited company since 1982.

Besides the parent company IVL, the Group consists of the part-owned subsidiaries Bastaonline AB, eBVD i Norden AB, Möbelfakta Sverige AB and the joint venture company Sino-Swedish Environmental Technology Development Center, SEC, in China, as well as the wholly owned subsidiaries EPD International AB, IVL Environmental Technologies (Beijing) Company Ltd and IVL India Environmental R&D Private Limited in Mumbai. IVL's operations are essentially conducted within the parent company.

Overview of Results and Financial Position

EARNINGS AND PROFIT/LOSS STATEMENT 2022

Group

Consolidated net sales for the financial year increased by 6.7 (12.6) percent to SEK 509,558,000 (476,912,000), with earnings after financial items of SEK 43,269,000 (36,280,000).

Profit after tax for the year amounted to TSEK 35 036 (28 159), of which the minority share is TSEK 141 (163). Return on equity was 19.8% (20.2%) and Return on total equity was 11.3% (11.8%).

The Group's total assets increased to SEK 432,663,000 (336,383,000) and equity increased to TSEK 190,344 (157,452). Cash flow was positive by TSEK 67 913 (39 887).

Parent company

IVL's net sales for the financial year increased by 4 (13) percent to SEK 477,015,000 (458,986,000), with earnings after financial items of SEK 28,611,000 (27,297,000). Profit for the year after tax amounted to SEK 14,208,000 (18,988,000).

The balance sheet total amounted to SEK 390,911,000 (319,007,000) and equity to SEK 98,102,000 (86,582,000).

EMPLOYEES

For the number of full-year employed men and women, see the detailed overview and definition in Note 7.

RESPECTIVE SHARE OF RESEARCH AND CONSULTANCY ASSIGNMENTS IN OPERATIONS

During the year, fees and expenses accrued are divided between IVL's research and contract activities by 45.2 % (44.9) and 54.8 % (55.1), respectively. In this context, "research activities" refer to (i) research co-funded by the central government and the business sector via the Swedish Institute of Water and Air Conservation Research Foundation, and (ii) activities funded through subsidies from central government research bodies,

research foundations, the EU and its equivalents. Co-financed activities amount to 10.9 % (11.3) of fees and expenses earned during the year and grant-financed activities to 34.3 % (33.6).

DIVIDEND POLICY

IVL is operated as a limited company and is wholly owned by the Swedish Institute of Water and Air Conservation Research Foundation (SIVL). IVL has operated as a limited company since 1982. The IVL Swedish Environmental Research Institute is non-profit in the sense that no profit is distributed to the owners, rather it is reinvested in the company's R&D operations. The owner foundation, SIVL, is responsible for the funds made available by the state for co-funded environmental research at the IVL Swedish Environmental Research Institute. SIVL is governed by a representative board of directors, where the business community appoints half of the members and the Government appoints the other half. The Chair of the Board is appointed by the Government.

SUBSIDIARIES

BASTAonline AB

BASTAonline AB (corporate ID no. 556719-5697) is 60 percent owned by IVL Swedish Environmental Research Institute and 40 percent by the Swedish Construction Federation. The BASTA system has been in operation since 2005 and BASTAonline AB, which owns and operates the system, was founded in January 2007. The system aims to support the work on substituting undesirable substances in construction products. Manufacturers and suppliers register the products that meet the system's criteria. The products are published in an open database with a public search function and open API. The quality of registrations is reviewed through regular audits of affiliated companies. The

system also provides digital tools for construction projects through a digital logbook service as well as training and webinars. At the start, 55 suppliers were connected to the system – and at the end of 2022, 529 manufacturers and suppliers were connected. The number of articles in the BASTA system was over 180 000 at year-end. The majority of these articles are registered against the rating level BASTA. In 2022, the system has been developed to support digital flows and the logbook service has been developed. BASTAonline also got a new CEO, Pehr Hård, who took office in March of 2022. Net earnings for the financial year were TSEK 7,614 (7,875) with a profit after financial items amounting to TSEK -616 (396). Equity amounts to TSEK 4064 (3586). The company has no staff employed.

Möbelfakta Sverige AB

The company Möbelfakta Sverige AB (corporate ID no. 559252-0810) is 51 percent owned by IVL Swedish Environmental Research Institute and 49 percent by Trä- och Möbelföretagen (TMF). Möbelfakta is a sustainability label for furniture in public procurement. The core operation consists of developing criteria for labelling furniture and processes to verify compliance with requirements at furniture manufacturers. Möbelfakta works actively to harmonise the requirements at a Nordic and a European level. During the financial year, Möbelfakta increased its use as a type 1 eco-label in public procurement in Sweden, Norway and Denmark. Affiliated companies come from Sweden, Norway, Finland, the Baltic countries and Poland.

Net earnings for the financial year were TSEK 3,137 (3,017) with a profit after financial items amounting to TSEK 115 (93). Equity amounts to TSEK 219 (151). The company has no staff employed.

EPD International AB

EPD International AB (corporate ID no. 556975-8286) has been a wholly owned subsidiary of IVL since 1 July 2014. The company has its registered offices in Stockholm, and operations are located at IVL's offices in Stockholm, Gothenburg, Malmö and Beijing, as well as being conducted through international partners. The company operates and manages the International EPD® System, a programme for third-party-verified environmental product declarations (EPDs). An EPD is an optional tool to enable companies to communicate the environmental impact of their goods and services from a life cycle perspective in a comparable and credible manner. The information is used in a number of different industries and applications such as environmental communication between companies, green public procurement and environmental certification of buildings. EPD International communicates globally about the system, maintains and develops the rules and international collaborations, and registers and publishes approved EPDs. The company operates globally and has customers on all continents. In total, EPD International has over 4000 valid EPDs from over 800 companies in over 45 different countries published on www.environdec.com; in 2022, over 1300 new EPDs were registered.

In 2022, the company continued the implementation of its global growth strategy, which was first introduced in late 2020.

Parts of the corporate strategy were updated during the year and decided by the Board in 2022 and now there is an even clearer focus on digitalisation, harmonisation and internationalisation. The aim is to make high-quality EPD services as credible, accessible and affordable as possible. During digitalisation, noticeable progress was made by continuously improving and expanding the automation and digitisation capabilities of the EPD portal. The linking of third-party EPDs tools and software solutions that promote the provision and use of digitised EPDs has once again proven to be the enabler through the large increase in registered and published EPDs in 2022. It has been necessary to prepare the company and its stakeholders for the next phase of gradually scaling up EPD service offerings to handle the expected increase in EPD publications. An increase triggered in selected markets by the ongoing transition from market regulation to market compliance that the company also expects to benefit from in the future. We should also mention the European Commission's slowly concretised plans for a regulated green economy (ESPR/ revised CPR). With a strong global brand and an online presence combined with a physical presence in selected emerging markets and a competitive pricing strategy, the company also made good progress in EPD publications in a global sense. We upgraded our Chinese EPD in 2022. We have introduced the customer service function attached to EPD International's China office and this year North American EPD System joined the network of international partners. One drawback was that the ongoing war in Ukraine forced us to pause all our EPD activities in the Russian market via our license EPD Russia until further notice. Progress in harmonisation is reported in our first year accredited by ANSI/ANAB and the signing of the Nordic MRA between EPD Denmark, EPD Norway and our programme. In this unique multilateral recognition agreement, the three partners commit to harmonise towards a "single PCR" principle. We welcomed the application into our hybrid ISC2022. 600 participants from the conference room at Knauf Insulation in Slovenia under the motto "Access to EPD data to all".

Net earnings for the financial year were TSEK 16515 (10883) with a profit after financial items amounting to TSEK 4 610 (1 968). Equity amounts to TSEK 7037 (4267). The company has no employees.

eBVD i Norden AB

Since 2017, eBVD i Norden AB (corp. ID no. 559093-5390) has been 51 percent owned by IVL Swedish Environmental Research Institute and 49 percent owned by the Swedish Association of Construction Product Industries. The construction sector in Sweden has agreed to voluntarily declare construction products from an environmental point of view according to the digital building product declaration eBVD. eBVD i Norden AB operates a digital system for the digital building product declaration that aims to streamline and reduce the costs of environmental information. At the end of the year 2022/2023, the company had 264 (256) licensed users of the system.

Net earnings for the financial year were TSEK 1,133 (1,245) with a profit after financial items amounting to TSEK 62 (77). Equity amounts to TSEK 429 (393). The company has no employees.

IVL Environmental Technologies (Beijing) Company Ltd

Since 2019, IVL has a wholly-owned subsidiary in China. The subsidiary offers environmental research and consulting services as well as technology transfer services from Swedish environmental technology companies to the Chinese market. Platforms on SDG goals are being built to facilitate sustainable development in various areas. Through years of efforts, the subsidiary has a deep understanding of Chinese and Western mindsets and development concepts, as well as the need to promote sustainable development and thereby promoting good communication and effective cooperation between customers, governments and businesses.

Net earnings for the financial year amounted to TSEK 3437 (2835) with a profit after financial items amounting to TSEK 235 (560). Equity amounted to TSEK 4327 (1736). The company has 6 (6) employees.

Sino-Swedish Environmental Technology Development Center Ltd (SEC)

Together with TAES (Tianjin Academy of Environmental Sciences), IVL has for more than twenty years been the jointly owned company SEC (Sino-Swedish Environmental Technology Development Centre Ltd) based in Tianjin. Through SEC, a large number of Swedish environmental technology companies have been helped into the Chinese market.

Net earnings for the financial year were TSEK 1,984 (12,683) with a profit after financial items amounting to TSEK -203 (16). Equity amounts to TSEK 1680 (1778). The company has 12 (12) employees.

IVL India Environmental R&D Private Ltd

Since 2019, IVL has had a wholly owned subsidiary in India, which mainly works with wastewater treatment projects on the Indian market. Currently, IVL India provides project management support to the city of Mumbai for wastewater treatment projects focusing on reuse of treated wastewater.

Work is underway on a number of smaller projects in wastewater treatment installations where IVL has project management responsibility on behalf of the customer.

Net earnings for the financial year were TSEK 23,175 (1,300) with profit/loss after financial items amounting to TSEK 6,690 (-3,343). Equity amounts to TSEK 3,552 (-971). The company has 41 (27) employees.

Expected future developments

In a turbulent world with war and economic crisis, it is important to keep the focus on sustainability and environmental issues. The transition is a fact and is already being driven by the business community and our customers need our support to include the entire environmental perspective. Our strategic journey for 2025 is a growth strategy. Climate and sustainability issues are business-critical for the commercial sector, and we

are working in close collaboration on the transition work. We have updated our long-term strategy during the year, and we are working to achieve milestones so that we can take on a larger role within research and grow our business. Participation in the organization is a major part of why we have started to deliver on the secondary goal.

Risks and risk management

By the nature of its business, the IVL Group is exposed to financial risks consisting of fluctuations in income and cash flow resulting from changes in exchange and interest rates, as well as credit risks. Overall, however, the financial risks are relatively minor. Nevertheless, currency risks arising from fluctuations in anticipated and contracted payment flows in EU projects total MEUR 3.3 (4.6). A change of 10 öre in the SEK exchange rate will impact income in the amount of MSEK 0.6 (0.6), including the project matching. The company continually assesses the need to hedge the flows of payments, but once more elected not to engage in hedging during 2022. The company's credit risks

consist of outstanding and uninvoiced consultancy assignments. IVL's 30 largest customers, which account for approximately 75% of sales, are all large international companies, the European Commission, Swedish or foreign government institutions and the owner SIVL.

Other information about the business

ASSIGNMENTS

In addition to consultancy projects for industry, municipalities and other organisations, IVL also conducts major projects on behalf of the Swedish Environmental Protection Agency, including responsibility for most of the national monitoring of air and precipitation and, together with other parties in SMED, for the collection and reporting of Sweden's combined emissions regarding air and climate, water, waste and hazardous substances.

EU projects

In 2022, IVL was successful in EU research with 14 granted applications for projects that started in 2022 or will start in early 2023. The research focuses on current issues such as society's climate transition, sustainable and resource-efficient material flows and support for industry's adaptation to the EU's chemicals strategy for sustainability and the development of a sustainable blue economy.

Other current research programmes

In 2022, IVL has been granted research grants from national financiers such as Mistra, Vinnova, Formas and the Swedish Energy Agency. Examples of major research programmes in which IVL participates are Mistra FinBio, which will develop the financial sector's ability to contribute to protecting and enhancing biodiversity. From Formas, four IVL-led projects were granted from the tender From Research to Implementation for a Sustainable Society and one project from the tender Keys to the Circular Economy 2022.

Co-funded research

The Swedish Institute of Water and Air Conservation Research Foundation (SIVL) owns the company and acts as the principal in IVL's co-funded activities. SIVL receives government funding for co-financed research and development at IVL. The co-financing is conditional and requires a corresponding share from the business community; the research has been conducted in 2022 in three thematic areas: *Sustainable Society*, *Sustainable Transition* and *Sustainable Environment*. In 2022, SIVL allocated a total of MSEK 37 (37) for co-financed research through government grants to the Swedish Environmental Protection Agency MSEK 17 (17) and MSEK 20 (20) from Formas. The government funding lays the foundation for a total research budget of MSEK 92 (83) through co-financing of projects with MSEK 23 (22) from industry and MSEK 32 (22) from the EU. In 2022, MSEK 10 (10) was received through Formas for basic funding for the development of skills and research activities, as a complement to the co-funded research.

European networks and collaborations with higher education institutions

IVL's role is to act as a bridge builder and create arenas for collaboration and research with various societal operators. This is one of the reasons why IVL plays an active role in various types of networks and participates in a number of European technology platforms, such as Water Europe (water), DHC+ (district

heating/district cooling), ECTP (construction) and SPIRE. Other examples of international networks: ENERO – European Network of Environmental Research Organisations, and NORMAN – a network of reference laboratories and research organisations involved in the development of methods and tools for the analysis and screening of new, environmentally hazardous chemicals. IVL also runs together with IKEM the national node of the EU platform SusChem with a focus on a sustainable chemical industry.

In Sweden, IVL cooperates e.g. within:

LIGHTHOUSE – Nordic centre for maritime expertise (e.g. Chalmers, the Gothenburg School of Business, Economics and Law, and the Swedish Shipowners' Association),

Kristineberg Marine Research and Innovation Centre. In 2021, a collaboration agreement for the station was signed between GU, IVL, Chalmers, KTH, RISE, the Municipality of Lysekil and Innovatum. For IVL, the agreement means a strengthened commitment to the station's development and increased cooperation with constituent parties to contribute to national and international initiatives linked to the UN Decade of Ocean Research and to the development of a sustainable Blue Economy.

The same organizations formed the Viable Seas Partnership in 2022. For the development of marine research and innovation with a national and international perspective. During 2021, representatives of Viable Seas participated in a number of national and international dialogues on marine research and innovation linked to the UN Decade of Ocean Research and to the development of a sustainable Blue Economy and initiated collaboration on various calls for tenders and initiatives. At the end of 2022, Viable Seas received funding for the establishment and construction of the organization from the Västra Götaland Region.

IVL is also involved in strategic collaboration agreements with KTH and Chalmers regarding the development of collaborative research and increased utilisation of the research. As part of the collaboration, four researchers have been appointed Adjunct Professorships (2 each at KTH and Chalmers). Since 2018, IVL also has a collaboration agreement with the Swedish Forestry Research Institute (Skogforsk) for research on the bioeconomy of the future.

Significant events during the year

- The war has affected the economy to some extent as the restrictions have led to a halt in some projects with Russia.
- The lease for Hammarby Sjöstadswerk has been terminated. The date for moving was set this year. Replacement premises are ready, but negotiation of moving costs has affected costs.

Description of operations and activities

The purpose of IVL's operations is to promote ecologically, economically and socially sustainable growth in business and society through applied research and consultancy projects. The business is organised into three operational units, as well as sections for research, business development and international business, HR, administration and finance, which operate across the organisation. IVL's working methodology is characterised by an interdisciplinary and holistic approach. The company operates broadly in the entire field of sustainability. Therefore, in addition to the traditional environmental expertise, there is also expertise in behavioural science, economics, communication and social sciences.

Operations span all industries and customers are found throughout Swedish society from small businesses to internationally active large companies, industry agencies, government authorities – where the Swedish Environmental Protection Agency is the largest single grantor and contractor – as well as municipalities and organizations.

OWNERSHIP

Since 2004, IVL has been wholly owned by the Swedish Institute of Water and Air Conservation Research Foundation (SIVL), corp. ID no. 802006-2611, with its registered office in Stockholm. The purpose of the foundation is to develop the

long-term prerequisites for environmental research at IVL and, through ownership, to guarantee an independent status for IVL. SIVL is governed by a representative board of directors, for which the chair and six members are appointed by the Swedish government and seven members by the Swedish business community. SIVL is the sole owner of IVL. SIVL proposes members of IVL's board by partly obtaining proposals from business representatives and partly by obtaining proposals from the government.

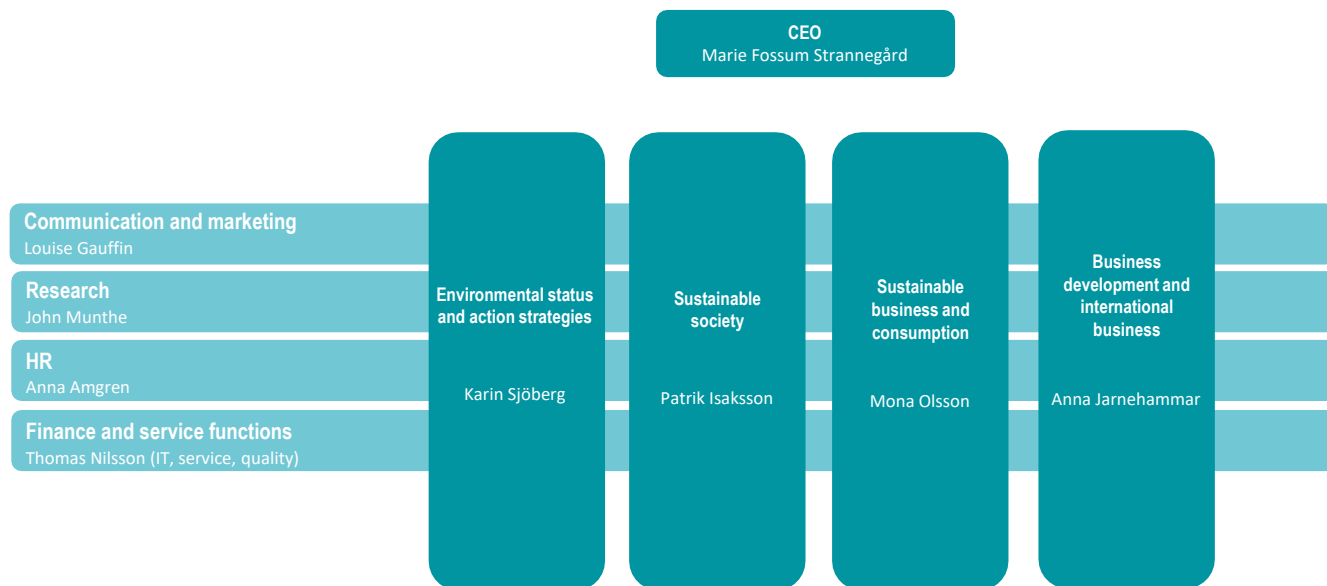
ORGANISATION AND OUR OPERATIONAL UNITS

IVL's operations are organised into three operational units, which in turn are divided into a number of groups with group managers tasked with personnel management and capacity planning. Furthermore, there are units for research, business development and international business, HR, finance and administration; The latter operate across the organization. All units collaborate in a matrix organisation with three thematic areas: *Sustainable Environment*, *Sustainable Transition* and *Sustainable Societies*. Three operational committees with external stakeholders are linked to each focus area. Participants in the operational committees are appointed by IVL's owning foundation SIVL.



All units collaborate in a matrix organisation with three thematic areas: *Sustainable Environment*, *Sustainable Transition* and *Sustainable Society*.

ORGANISATIONAL PLAN



GROUP MANAGEMENT AND MANAGEMENT TEAM
 IVL's executive management consists of the CEO, deputy managing director, administrative manager and head of research. The company's management team also includes three unit managers: HR manager, communications manager, sales manager and a senior advisor. The Director of Quality and Environmental Issues is an adjunct member of the management team.

FOREIGN BRANCHES

IVL's operations in China had 6 employees at the Beijing office at the end of 2022. Its activities are mainly focused on research and assignments, education and knowledge transfer, relationship building with Chinese authorities, companies and organizations, and technology transfer.

BUSINESS INTELLIGENCE

IVL's most important area is how operations contribute to environmental and sustainability benefits for customers and sustainable social development, which is the basis for IVL's vision. In 2022, climate change has remained relevant while biodiversity has received increased attention. The interplay between biodiversity, functioning and stable ecosystems and our ability to address and adapt to climate change has also been highlighted, for example in IPCC reports published in 2022. IVL's external analysis is used as a basis for the development of the strategy plan and plan for operations. In 2022, six megatrends were identified as important for the development of IVL's research: Global population growth, migration, urbanisation;

Climate change and environmental degradation worldwide; Increasing scarcity and competition for natural resources; Accelerating technology development and technological convergence; Changing power structures in the global economy and geopolitical landscape; Diversified values, lifestyles and political governance. The megatrends were used as a basis for identifying through analysis and dialogue which research areas should be managed and developed in the coming years. Results are integrated into IVL's plan for operations for 2023 and includes plans for research initiatives in the areas of Energy (critical raw materials, hydrogen/biogas and industry's climate transition); Ecosystems, green and blue industries (Sustainable ecosystems and biodiversity, Sustainable blue growth and healthy oceans, Sustainable food value chains) and Sustainable industry (Chemical and materials industry; Chemical risks in value chains and occupational health and safety, and Circularity and industrial symbiosis).

GENDER EQUALITY AND DIVERSITY

In order to achieve our vision of a sustainable society, great emphasis is placed on gender equality and diversity issues. 53 (55) percent of the Group's full-year employees are women, and at IVL we focus on expertise when recruiting staff. Over the past year, we have brought in new employees from various nationalities and backgrounds. IVL's board comprises 40 % (40) women and in IVL's management team where 70 % are women. More information about gender equality and diversity work at IVL can be found online: ivl.se.

Sustainable development

A SUSTAINABLE IVL

IVL reports information about the company's sustainability work together with the development and financial results of the business. IVL reports according to GRI's (Global Reporting Initiatives) latest guidelines, entitled GRI Standards, and it reports at CORE level. Through stakeholder dialogues and materiality analyses, IVL has identified the areas that are of material significance to the company.

These are:

- Customer and environmental benefit, i.e. how IVL contributes to improving the environmental performance of customers and a sustainable society
- Work environment, health, and safety
- Gender equality, equal opportunities and diversity
- Skills and management development
- Ethics and integrity
- Climate and energy
- Chemical processing
- Resource efficiency and circularity

A report on the principles and GRI indicators is presented in the Annual Report, under the GRI index section. The Board's tasks include identifying how sustainability issues affect the company's risks and business opportunities. In accordance with Chapter 6, Section 11 of the Swedish Annual Accounts Act, IVL has chosen to prepare a statutory sustainability report as an integrated part of the annual report. The complete sustainability report can be found in the Annual Report 2022, which will be published online: ivl.se.

STRATEGIC OBJECTIVES

IVL's board of directors has adopted the following strategic goals for 2022:

- Market
 - Customer satisfaction
 - Balance between assignments and research
- Economy with
 - Increase in sales
 - Margin
 - New activities from innovation investments
- Attractive workplace
 - Employee satisfaction (eNPS)
 - Staff turnover
- Brand
 - Brand awareness
- Innovation and research
 - Utilisation in relation to the SDG objectives
 - Scientific articles

ENVIRONMENTAL AND QUALITY MANAGEMENT

IVL works on sustainability, environmental and quality issues within the scope of an integrated management system. The system and application within IVL is certified according to ISO regarding environmental and quality management, SS-EN ISO 14001:2015 and SS-EN ISO 9001:2015. These certifications are maintained annually and certified periodically by accredited certification agencies. Most of the operations comprising sampling, field measurements and analyses are accredited and audited regularly by SWEDAC in accordance with SS-EN ISO/IEC 17025:2018. IVL also operates according to the ISO information security standard, ISO 27000.

QUALITY

IVL's work on quality focuses on customer relations, and regular follow-ups are performed to ensure that customers are satisfied with the company's work. The customers represent the business community, local authorities and government agencies. The Customer Satisfaction Index (CSI) on a 10-point scale was 8.4 (8.4) for 2022. The analysis of the results from the interviews is used as a basis for the development of IVL's operations and continuous improvement work. The interviews show that our customers have a positive view of IVL as a professional and important partner and supplier.

THE WORK AND COMPOSITION OF THE BOARD DURING THE YEAR

During the 2022 financial year, the Board held five ordinary meetings, in addition to one statutory meeting. The Board's work primarily includes strategic issues, financial statements and major investments and acquisitions. The Board receives regular reports on the development of the company's operations and finances. Selections of the company's operations are presented at ordinary meetings. The CEO reports to the board at the meetings. The Board appoints a remuneration committee from among its members, which proposes principles for remuneration and other terms of employment for the CEO and other members of the executive management. The committee consists of at least two members who are appointed for a term of two years.

Specification of equity in Group and Parent company

GROUP	Share capital	Other equity, including profit for the year				Total
Opening balance	7,000		150,452			157,452
Minority share equity						(3,008)
Translation difference			-2,144			-2,144
Profit for the year			35,036			35,036
Amount at year-end	7,000		183,344			190,344
Minority equity share						(3,149)

PARENT COMPANY	Share capital	Statutory reserve	Fund for development expenditure	Retained earnings	Profit for the year	Total
Opening balance	7,000	1,400	660	58,534	18,988	86,582
Appropriation of profit according to annual general meeting				18,988	-18,988	0
Dissolution Fund for development costs			-130	130		0
Profit for the year					14,208	14,208
Amount at year-end	7,000	1,400	530	77,654	14,208	100,792

Proposal for the allocation of profit

Available for distribution by the Annual General Meeting (SEK 000):

Retained earnings	77,654
Profit for the year	14,208
Total	91,862

The Board and the CEO propose that the profits [TSEK] be disposed of as follows:

To be carried forward	91,862
Total	91,862

Regarding the company's and the Group's reported results for the financial year and the position in general as of 2022-12-31, please refer to subsequent the Income Statement and Balance Sheet, Cash Flow Statement, the year-end comments and the Notes.



CONSOLIDATED AND PARENT COMPANY ACCOUNTS

Income Statement

TSEK		GROUP		PARENT COMPANY	
		2022	2021	2022	2021
Operating revenues					
Net sales	Note 3	509,558	476,912	477,015	458,986
Change work in progress	Note 4	-34,563	-43,436	-36,678	-53,063
Other operating income		1,269	944	1,269	944
		476,264	434,420	441,606	406,867
Operating expenses					
Project expenses		-53,542	-68,719	-53,542	-55,819
Other external costs	Note 6	-90,174	-63,313	-79,456	-64,203
Staff costs	Note 7	-277,728	-258,195	-269,808	-252,624
Amortisation of intangible and tangible fixed assets	Note 8	-8,955	-9,577	-7,579	-8,895
		-430,399	-400,104	-410,385	-381,541
Operating profit		45,864	34,316	31,221	25,326
Profit from financial items					
Interest income	Note 9	468	2,131	452	35
Interest expenses	Note 9	-164	162	-159	-135
Profit or loss on other securities and receivables which are fixed assets		-2,900		-2,900	2,068
Profit after financial postings		43,269	36,280	28,611	27,297
Appropriations	Note 10	0	0	-9,955	-2,905
Tax on profit for the year	Note 11	-8,233	-8,121	-4,448	-5,404
PROFIT/LOSS FOR THE YEAR		35,036	28,159	14,208	18,988
Minority share of profits for the year		[141]	[163]		

Balance sheets

TSEK		GROUP	
		2022	2021
ASSETS			
FIXED ASSETS			
Intangible fixed assets	Note 12		
Capitalised software development spending		3,975	4,729
Property, plant and equipment	Note 13		
Machinery and equipment		26,441	21,540
Total fixed assets		30,416	26,269
CURRENT ASSETS			
Current receivables			
Accounts receivable		99,330	90,369
Receivables from Group companies		12,471	6,562
Tax assets		5,678	835
Other receivables		8,815	6,755
Earned but unbilled income	Note 5	14,554	8,773
Prepaid expenses	Note 15	10,533	9,151
Total current receivables		151,381	122,445
Short-term investments	Note 20	29,776	32,601
Cash and bank balances	Note 19	221,090	155,068
Total current assets		402,247	310,114
TOTAL ASSETS		432,663	336,383
EQUITY AND LIABILITIES			
Equity			
Share capital	Note 21	7,000	7,000
Other equity including profits for the year		183,344	150,452
Total equity		190,344	157,452
Minority equity share		(3,149)	(3,008)
Provisions	Note 16	19,423	16,421
Non-current liabilities			
Liabilities to credit institutions	Note 18	1,842	691
Current liabilities			
Liabilities to credit institutions	Note 18	1,679	1,479
Ongoing work on behalf of others	Note 4	131,226	95,791
Trade accounts payable		27,118	18,574
Other liabilities		18,861	16,766
Billed but unearned income	Note 5	16,964	8,704
Accrued costs	Note 17	25,205	20,505
Total current liabilities		221,054	161,819
TOTAL EQUITY AND LIABILITIES		432,663	336,383

Balance sheets

TSEK	PARENT COMPANY	
	2022	2021
ASSETS		
FIXED ASSETS		
Intangible fixed assets	Note 12	
Capitalised software development spending		2,725
Property, plant and equipment	Note 13	
Machinery and equipment		22,526
Financial assets		
Shares in group companies	Note 14	3,556
Total fixed assets		28,807
CURRENT ASSETS		
Current receivables		
Accounts receivable		83,513
Receivables from Group companies		20,303
Tax assets		6,222
Other receivables		4,974
Earned but unbilled income	Note 5	14,554
Prepaid expenses	Note 15	10,533
Total current receivables		140,099
Short-term investments	Note 20	29,701
Cash and bank balances	Note 19	192,304
Total current assets		362,104
TOTAL ASSETS		390,911
EQUITY AND LIABILITIES		
Equity		
Restricted equity		
Share capital	Note 21	7,000
Statutory reserve		1,400
Development expenditure fund		530
Total restricted equity		8,930
Non-restricted equity		
Retained earnings		77,654
Profit for the year		14,208
Total non-restricted equity		91,862
Total equity		100,792
Untaxed reserves	Note 10	31,487
Provisions	Note 16	808
Current liabilities		
Work in progress on behalf of third parties	Note 4	178,391
Trade accounts payable		20,784
Other liabilities		16,776
Billed but unearned income	Note 5	16,964
Accrued costs	Note 17	24,910
Total current liabilities		257,829
TOTAL EQUITY AND LIABILITIES		390,911

Cash flow statement

	GROUP		PARENT COMPANY	
	2022	2021	2022	2021
TSEK (Direct method)				
CURRENT OPERATIONS				
Profit after financial postings	43,269	36,280	28,611	27,297
Adjustment for postings excluded from the cash flow	17,522	16,486	13,637	13,402
Tax paid	-13,076	-7,555	-9,815	-4,437
Cash flow from operating activities before changes in working capital	47,715	45,211	32,433	36,262
CASH FLOW FROM CHANGES IN WORKING CAPITAL				
Decrease (+)/Increase (-) in receivables	-16,930	-24,216	-4,103	-28,282
Decrease (-)/Increase (+) in accounts payable	8,544	-852	3,976	-2,467
Increase (+)/Decrease (-) in other liabilities	2,296	-9	433	1,267
Increase (+)/Decrease (-) in advance payments for work in progress	35,435	22,534	30,057	32,221
Cash flow from operating activities	77,060	42,668	62,796	39,001
INVESTMENTS				
Acquisition of intangible assets	-1,250	-378	-	-
Sale/Acquisition of property, plant and equipment	-11,948	387	-10,193	-499
Sale/Acquisition of financial fixed assets	0	46	2,253	47
Change in short-term investments	2,900	-2,104	2,900	-2,104
Cash flow from investment activities	-10,298	-2,049	-9,546	-2,556
FINANCING ACTIVITIES				
Amortisation of loans	1,151	-732	-	-
Cash flow from financing activities	1,151	-732		
Cash flow for the year	67,913	39,887	53,250	36,445
Opening cash and bank balances	155,068	114,725	139,582	102,608
Exchange difference in cash and cash equivalents	- 1,816	456	-528	529
Cash and bank balances at year-end	221,165	155,068	192,304	139,582

Notes

for the financial statements and accounting principles

Note 1

ACCOUNTING PRINCIPLES

COMPLIANCE WITH STANDARDS AND LEGISLATION

The annual report and the consolidated accounts have been prepared in accordance with BFNAR 2012:1 Annual Report and Consolidated Accounts (K3).

Where guidance is not available from the K3 regulation, it has been obtained from the Swedish Annual Accounts Act (1995:1554).

The Parent Company applies the same accounting principles as the Group, other than as indicated below in the section "Parent Company's accounting principles". Divergences between the Parent Company's and the Group's principles arise from limitations in the application of K3 to the Parent Company through the requirements of the Swedish Annual Accounts Act and, in some instances, tax considerations.

BASIS FOR THE PREPARATION OF THE FINANCIAL STATEMENTS OF THE PARENT COMPANY AND THE GROUP

The Parent Company's functional currency is the Swedish krona (SEK), which is also the reporting currency for the Parent Company and the Group. The financial statements are therefore presented in SEK. Assets and liabilities are recognised at historical cost, with the exception of certain financial assets and liabilities that are measured at fair value.

The preparation of financial statements under K3 requires the company management to make judgements, estimates and assumptions that affect application of the accounting principles and the amounts recognised for assets, liabilities, income and expenses. The estimates and assumptions are based on historical experience and a number of other factors that in the prevailing circumstances are judged to be reasonable. The results of these estimates and assumptions are then used to assess the carrying amounts for assets and liabilities that are not otherwise revealed clearly from other sources. The actual outcome may differ from these estimates and judgements. These estimates and judgements are typically made during preparation of the year-end and half-year accounts. As a result of changes at the company or in its business environment, it might become necessary to revise these estimates and judgements.

CHANGES IN ACCOUNTING PRINCIPLES AND DISCLOSURE REQUIREMENTS

In 2022, the Group changed its accounting policy regarding the valuation of financial instruments. Previously, valuation was applied on the basis of fair value. The Group has changed the accounting principle for valuation of financial instruments to K3 Chapter 11 regarding valuation of financial instruments based on acquisition value.

CLASSIFICATION ETC.

Fixed assets and non-current liabilities of the Parent Company and the Group essentially only consist of amounts expected to be recovered or paid after more than 12 months from the balance sheet date. Current assets and current liabilities in the Parent Company and the Group essentially only consist of amounts expected to be recovered or paid within 12 months calculated from the balance sheet date.

PRINCIPLES OF CONSOLIDATION

Subsidiaries are entities over which IVL exercises a controlling influence. A controlling influence consists of a right, directly or indirectly, to control the financial and operational strategies of another company in order to gain economic benefits. In establishing whether a controlling influence exists, account shall be taken of shares with potential voting rights that may be used or converted without delay.

The acquisition method is used to report IVL's acquisitions of subsidiaries. The cost of an acquisition consists of the fair value of assets provided as remuneration, issued equity instruments and liabilities incurred or assumed at the date of transfer. Identifiable acquired assets and assumed liabilities and contingent liabilities in a business combination are initially valued at their fair values on the acquisition date, regardless of the extent of any holding without a controlling interest. The surplus represented by the difference between the cost and fair value of the Group's share of identifiable acquired assets, liabilities and contingent liabilities is recognised as goodwill. If the cost is less than the fair value of the acquired subsidiary's assets, liabilities and contingent liabilities, the difference is recognised directly in the income statement.

Intragroup receivables and liabilities, income and expenses and unrealised gains or losses arising from transactions between Group companies are eliminated in their entirety during preparation of the consolidated accounts.

FOREIGN CURRENCY

Foreign currency transactions are translated to the functional currency at the exchange rate prevailing on the transaction date. Monetary assets and liabilities in foreign currencies are translated to the functional currency at the exchange rate prevailing on the balance sheet date.

Exchange rate differences arising from recalculations are recognised in the income statement. Non-monetary assets and liabilities carried at historical cost are translated at the exchange rate at the date of the transaction. Non-monetary assets and liabilities recognised at fair value are recalculated to the functional currency at the rate prevailing at the time of measurement at fair value, and any exchange rate differ-

ence is then recognised in the same way as for other changes in value for the asset or liability. The functional currency is the currency of the countries in which the companies included in the Group conduct their operations.

The functional and reporting currency of the Parent Company is the Swedish krona (SEK). The reporting currency of the Group is the SEK. Assets and liabilities of foreign operations are translated to SEK at the exchange rate prevailing on the balance sheet date. Income and expenses in foreign operations are translated to SEK at an average rate that is an approximation of the rates at the times of the respective transactions. Any translation differences arising during translation of foreign net investments are recognised in other comprehensive income.

REVENUE

The percentage of completion method is used for all projects where the outcome can be calculated reliably. Assignments carried out on current account, whereby revenue is recognised when the work is performed and normally invoiced to the customer in the following month, generated but unbilled income, are reported as accrued income. Where a fixed price is agreed, the income is reported when the work is essentially completed according to the so-called percentage of completion method. Unbilled ongoing projects are assessed in the balance sheet as the amount of the directly paid expenses plus indirect expenses minus invoiced partial payments.

If it is probable that total contract costs will exceed total contract revenue, the anticipated loss is recognised immediately as an expense in its entirety. Revenue is not recognised if it is likely that the financial benefits will not accrue to the Group. In the event of significant uncertainty regarding payment or associated costs, there is no revenue recognition.

In grant-funded projects in which IVL functions as a contractual partner with the research funding body and allocates project funding to other participants in the projects, such funds are not recognised as income, but accounted for directly under the heading of work in progress on behalf of others. This means that invoicing and costs for expenses are reduced corresponding to the funds received and then paid to other project parties.

OPERATING EXPENSES AND FINANCIAL INCOME AND EXPENSE

Parent Company costs under operating leases are reported in the income statement on a straight-line basis over the term of the lease. Benefits acquired in connection with the signing of an agreement are reported as a part of the total leasing cost in the income statement. Variable charges are expensed in the periods in which they are incurred.

Minimum lease fees under finance leases in the Group are allocated between interest expenses and the amortisation of the outstanding liability. Interest expenses are distributed over the term of the lease such that each accounting period is charged with an amount corresponding to a fixed interest rate for the liability recognised in each period. Variable charges are expensed in the periods in which they are incurred.

Financial income and costs consist of interest income from bank deposits, short-term investments and receivables, and interest expenses to suppliers and other creditors.

RECEIVABLES AND LIABILITIES

Receivables are recognised at the estimated amount of income, i.e. after deduction of uncertain debts assessed individually. Impairment of receivables is recognised in Operating expenses. Other receivables are classified as long-term receivables if the holding period is longer than one year and if they are shorter than other receivables. Cash and cash equivalents consist of cash and immediately available balances with banks and similar institutions.

Loans and other financial liabilities, such as accounts payable, are measured at accumulated acquisition cost. Accounts payable have a short expected maturity and are valued without discounting to a nominal amount. Non-current liabilities have an expected term of more than a year, while current liabilities have a term of less than a year.

PROPERTY, PLANT AND EQUIPMENT

Owned assets

Tangible fixed assets are reported as assets on the balance sheet, if it is probable that future economic benefits will accrue to the company and the acquisition cost for the asset may be calculated reliably. Tangible fixed assets are recognised in the Group at acquisition cost after deduction of accumulated depreciation and any impairment losses. Acquisition cost includes the purchase price and costs directly attributable to putting the asset into place and in a condition that it is fit for use in accordance with the intention of the acquisition.

The carrying amount for a tangible fixed asset is removed from the balance sheet upon scrapping or disposal or when no future economic benefits are expected from the use or the scrapping or disposal of the asset. Any gain or loss arising from disposal or scrapping of an asset is determined as the difference between the selling price and the carrying amount of the asset, less the direct costs of the sale. Any gain or loss arising is recognised as an operating income/expense.

Leased assets

In the consolidated accounts, leases are classified as either finance or operating leases. A finance lease exists when the economic risks and benefits associated with ownership are essentially transferred to the lessee. Where this is not the case, the lease is an operating lease. Assets leased under finance leases are recognised as assets on the consolidated balance sheet. The obligation to pay future lease fees is recognised under non-current and current liabilities. The leased assets are depreciated according to plan, while the lease fees are recognised as interest and the amortisation of the liabilities. Operating leasing means that the lease payment is expensed on a straight-line basis over the term.

INTANGIBLE ASSETS

Goodwill

Goodwill is defined as the difference between the acquisition cost of operating acquisitions and the fair value of assets acquired, liabilities assumed and contingent liabilities.

Goodwill is allocated to cash-generating units and groups of cash-generating units and is tested annually for impairments. Goodwill is thus measured at acquisition cost less any accumulated impairments.

Capitalised software development costs

Other intangible assets acquired by the Group are recognised at acquisition cost, less accumulated amortisation. Subsequent expenditure on capitalised intangible assets is recognised as an asset in the balance sheet only when this results in an increase in future economic benefits associated with the specific asset to which it relates. All other expenses are recognised as a cost when incurred.

OTHER ASSETS

Other assets are measured at cost unless otherwise stated

DEVALUATION OF ASSETS AND TESTING FOR DEVALUATIONS

The reported amounts for the Group's assets are tested for devaluation on every balance sheet date to determine whether there is any indication of devaluation. If any such indication is found, the recoverable amount for the asset is calculated. Any impairment loss is charged to the income statement.

The recoverable amount is the fair value less costs of sale or the value in use, whichever is the higher. In calculating the value in use, future cash flows are discounted by a discount factor that takes into account the risk-free interest rate and the risk associated with the specific asset. The recoverable amount for goodwill and other intangible assets with indefinite useful lives and intangible assets not yet ready for use is calculated annually.

At each reporting date, the company assesses whether any objective evidence exists to indicate impairment of any financial assets or group of assets. Objective evidence includes observable events that have occurred and adversely affect the possibility of recovering the acquisition cost, and a significant or prolonged decline in the fair value of an investment in a financial investment classified as a financial asset available for sale.

EMPLOYEE BENEFITS

Obligations relating to fees for defined-contribution pension plans are recognised as expenses in the income statement as they arise. IVL does not operate any defined-benefit pension plans.

Provisions in connection with terminations of employment are reported only if the company is demonstrably obligated to terminate employment before the normal date, or when compensation is offered as an incentive for voluntary departure. For the company to be obligated to terminate an employment, there must be e.g. a detailed plan setting out, as a minimum, details of the workplace, positions affected and the approximate number of affected employees, as well as compensation amounts for each personnel category or position and the time for implementation of the plan.

PROVISIONS

Provisions are recognised in the balance sheet when the Group has an existing obligation (legal or constructive) arising from an event that has occurred, when it is probable that an outflow of financial resources will

be required in order to discharge such an obligation and when the amount can be estimated reliably.

INCOME TAXES

Income tax is made up of current tax and deferred tax. Income taxes are recognised in the income statement.

Current tax is tax that is to be paid or received for the current year, applying the tax rates that have been decided or decided in practice on the balance date, as well as the adjustment of current tax attributable to earlier periods. Deferred tax is calculated using the balance sheet method, which focuses on temporary differences between the reported amount of an asset or a liability and its taxable amount. The assessment of deferred tax is based on how the reported value of assets or liabilities is expected to be realised or settled.

Deferred tax is based on the tax rates and tax rules enacted or in practice on the balance sheet date.

PARENT COMPANY'S ACCOUNTING PRINCIPLES

The parent company has prepared its annual report in accordance with BFNAR 2012:1 Annual Report and Consolidated Accounts (K3) and in accordance with the Annual Accounts Act (1995:1554).

Differences between the accounting policies of the Group and the Parent Company:

In the Parent Company, participation in subsidiaries and associated companies is recognised using the cost method. Dividends received are recognised as income. In the Parent Company, all leases are accounted for in accordance with the rules on operating leases. Leasing in the consolidated financial statements is reported as tangible fixed assets with short-term and long-term liabilities to credit institutions. In the Parent Company, untaxed reserves are reported, including deferred tax liability. In the consolidated financial statements, however, untaxed reserves are divided into deferred tax liability and equity. In the Group, work in progress is reported at a fixed price according to the main rule, with successive profit settlement. Profit settlement is then calculated on the basis of processing at customer prices, with a certain provision for precautionary reasons. In the parent company, work in progress is reported according to the completion method. Profit recognition takes place when projects are substantially completed, at a completion rate of 95 %.

Note 2

SUMMARY OF FINANCES AND KEY FIGURES

The years 2017-2019 for the Group have not been restated using the new principle for group consolidation.

TSEK	GROUP					PARENT COMPANY				
	2022	2021	2020	2019	2018	2022	2021	2020	2019	2018
SALES AND PROFIT										
Net sales	509,558	476,912	423,588	383,309	352,227	477,015	458,986	405,885	376,037	349,115
Operating profit after depreciation	45,864	34,316	28,544	18,930	2,437	31,221	25,326	15,565	9,983	-6,176
Operating profit after net financial items	43,269	36,280	29,316	20,299	1,763	28,611	27,297	16,341	11,363	-6,840
Profit margin, %	8.5	7.6	6.9	5.3	0.5	6	5.9	4.0	3.0	Øneg
CAPITAL STRUCTURE										
Fixed assets	30,416	26,269	35,918	42,935	46,343	28,807	23,941	32,384	38,177	41,037
Current assets	402,247	310,114	243,446	210,307	183,765	362,104	295,066	229,243	199,839	178,237
Equity	190,344	157,452	128,778	103,605	87,916	100,792	86,582	67,594	57,824	56,795
Untaxed reserves	-	-	-	-	-	31,487	21,531	18,627	15,971	6,571
Current liabilities	221,054	161,819	135,438	136,230	131,749	257,824	210,346	174,849	164,221	155,908
Non-current liabilities	1,842	691	1,423	2,388	2,840	-	-	-	-	-
Provisions	19,423	16,421	14,225	11,019	7,603	808	548	557	-	-
Balance sheet total	432,633	336,383	279,363	253,242	230,108	390,911	319,007	261,627	238,016	219,274
Adjusted equity						125,793	103,678	82,235	70,377	61,920
Equity annual average	173,898	142,865	115,942	95,761	87,424	114,735	92,956	76,306	66,149	64,815
Total capital annual average	384,523	307,874	266,304	241,675	227,867	354,859	290,317	249,822	228,645	217,815
Equity/assets ratio, %	44	46.8	45.9	40.9	38.2	32.2	32.5	31.4	29.6	28.2
Balance sheet liquidity, times	1.82	1.92	1.80	1.54	1.39	1.4	1.4	1.31	1.22	1.1
PROFITABILITY										
Return adjusted equity, %	19.8	20.2	19.9	16.5	1.6	19.8	23.3	16.8	13.4	Øneg
Return on total capital, %	11.3	11.8	11.3	8.7	1.1	8.1	9.4	6.6	5.0	Øneg
OTHER										
Investments fixed assets	12,724	-55	2,824	5,923	15,294	12,466	499	3,677	6,137	14,870
Invoicing/employee, incl. expenses	1,261	1,279	1,228	1,190	1,177	1,367	1,399	1,299	1,221	1,200
Billing rate, %	-	-	-	-	-	66.2	66.7	65.3	65.9	64.1
Full-year employees	404	373	345	322	300	349	328	313	308	291
Wage cost per employee	678	679	696	716	702	761	756	746	742	721

Profit margin

Profit after net financial items, as % of net turnover.

Return on total capital

Profit after net financial items with interest expenses added back as % of the average balance sheet total.

Adjusted equity

Equity plus untaxed reserves, less tax at the standard rate of 20.6%.

Chargeability ratio

Hours charged to customer, as % of the total hours of attendance.

Equity ratio

Adjusted equity, as % of the balance sheet total.

Full-year employees

The number of employees during the year, expressed as full-year positions. The actual number of employees is higher, partly because the organisation has part-time employees and partly because certain employees work only during part of the year.

Return on equity

Profit after net financial items and after tax at a standard 20.6%, as % of average adjusted equity.

Current ratio

Current assets divided by current liabilities.

Note 3

NET SALES

TSEK	GROUP		PARENT COMPANY	
	2022	2021	2022	2021
Net earnings are divided into:				
Billed fees and analyses	443,739	413,407	411,196	395,481
Billed expenses	65,819	63,505	65,819	63,505
Total net sales	509,558	476,912	477,015	458,986

Of the net earnings for the parent company, 20.2% (18.7) refers to invoicing to other companies in the Group, as remuneration for co-financed research, that the company has carried out on a contract basis.

Compensation was also received from Group companies for staffing services and disbursements.

Note 4

CHANGE IN WORK IN PROGRESS/WORK IN PROGRESS ON BEHALF OF OTHERS

TSEK	GROUP		PARENT COMPANY	
	2022	2021	2022	2021
Project costs	865,671	719,821	815,910	667,276
Pre-invoicing	-997,040	-815,612	-989,474	-815,612
Book value	131,368	95,791	173,564	148,334
Change reported in				
Income Statement	34,563	43,436	36,678	53,063
Balance Sheet	-35,435	-22,534	25,230	-32,221
Total change in work in progress for the year	-872	20,902	6,621	20,842

Note 5

INCOME EARNED BUT NOT BILLED/INCOME BILLED BUT NOT EARNED

TSEK	GROUP		PARENT COMPANY	
	2022	2021	2022	2021
Earned but unbilled income				
Project costs	127,806	76,623	127,806	76,623
Pre-invoicing	-113,252	-67,850	-113,252	-67,850
Book value	14,554	8,773	14,554	8,773
Billed but unearned income				
Project costs	50,608	32,898	50,608	32,898
Pre-invoicing	-67,572	-41,602	-67,572	-41,602
Book value	16,964	8,704	16,964	8,704

OTHER EXTERNAL COSTS

Auditor's fees

TSEK	GROUP		PARENT COMPANY	
	2022	2021	2022	2021
R3 Revisionsbyrå KB				
Audit assignment	411	361	290	267
Other services	123	39	123	39
Other auditors				
Audit assignment	18	44	0	8
Total	552	443	413	313

Leasing costs, Group and Parent Company

Leasing fees for operating leases during the year amounted to TSEK 24 735 (25 036). Leasing fees include lease agreements for real estate, computers and certain office equipment. The costs relating to future lease payments on these contracts are payable in the following years:

TSEK	2023	2024	2025	2026	2027
Other lease fees	1,679	1,466	375	-	-
Rental of premises	25,479	23,815	24,410	25,020	25,646
Total	27,158	25,281	24,785	25,020	25,646

Note 7

STAFF COSTS GROUP

	2022		2021	
	Salaries and other remuneration	Social costs (of which pension costs)	Salaries and other remuneration	Social costs (of which pension costs)
TSEK				
Board of Directors and CEO	3,165	1,276 (435)	3,059	1,446 (435)
Other employees	186,404	82,924 (26,250)	169,705	80,401 (28,381)
Total	189,569	84,199 (26,686)	172,764	81,847 (28,816)

AVERAGE NUMBER OF EMPLOYEES* IN THE GROUP DURING THE YEAR:

	2022			2021		
	MEN	WOMEN	TOTAL	MEN	WOMEN	TOTAL
Stockholm	64	80	144	65	75	140
Gothenburg	63	101	164	57	93	150
Fiskebäckskil	1	5	6	2	5	7
Malmö	16	11	27	12	12	24
Beijing	4	10	14	4	9	13
Tianjin	8	4	12	8	4	12
Mumbai	36	1	37	25	2	27
Total	192	212	404	173	200	373

PERSONNEL EXPENSES PARENT COMPANY

	2022		2021	
	Salaries and other remuneration	Social costs (of which pension costs)	Salaries and other remuneration	Social costs (of which pension costs)
TSEK				
Board of Directors and CEO	3,165	1,276 (435)	3,059	1,446 (435)
Other employees	179,040	82,040 (26,250)	165,349	79,518 (28,381)
Total	182,205	83,816 (26,686)	168,408	80,604 (28,816)

SICKNESS RATE PARENT COMPANY

	2022	2021
	3.23%	2.64%

AVERAGE NUMBER OF EMPLOYEES* IN THE PARENT COMPANY DURING THE YEAR:

	2022			2021		
	MEN	WOMEN	TOTAL	MEN	WOMEN	TOTAL
Stockholm	64	80	144	65	75	140
Gothenburg	63	101	164	57	93	150
Fiskebäckskil	1	5	6	2	5	7
Malmö	16	11	27	12	12	24
Beijing	2	6	8	2	5	7
Total	146	203	349	138	190	328

*defined as the number of paid full-time equivalents

NUMBER OF EMPLOYEES ON COMPANY'S MANAGEMENT TEAM

	2022	2021
Men	3	4
Women	6	7

MEMBERS OF THE BOARD

	2022	2021
Men	6	6
Women	4	4

SENIOR MANAGEMENT

Parent company

In accordance with a decision by the AGM, Board of Directors fees totalling SEK 684,000 (654,000), including social security expenses, were reported as costs. Of this amount, the chairperson was paid TSEK 125 (125) excluding national insurance costs.

The period of notice for the CEO of the Parent Company is 12 months and severance pay in an amount corresponding to 6 times the CEO's fixed monthly salary is due if employment is terminated by the company. Pension is expensed according to ITP 2 plan.

Group

The CEO of the joint venture company has an employment contract of 1 year from 2020-07-01. There is no entitlement to any pension other than statutory pension.

Note 8

DEPRECIATION OF TANGIBLE ASSETS AND AMORTISATION OF INTANGIBLE ASSETS

Group and Parent Company

Capitalised expenditure for software development is amortised according to plan annually at a rate of 10 to 33.3 percent of acquisition cost, starting from the date of completion during the year.

Operating goodwill is amortised at 20 percent of the acquisition cost annually. Any devaluation requirement is assessed on the basis of the present value of future surpluses.

Machinery and equipment is depreciated according to plan at an annual rate of 10 to 20 percent of the acquisition cost, starting from the date of acquisition by the Parent Company during the year.

Machinery and equipment is also depreciated according to plan on the basis of the remaining economic life of the asset in accordance with a measurement conducted specifically for an international joint venture.

Note 9

INTEREST INCOMES AND EXPENSES, GROUP AND PARENT COMPANY

The Group reports interest income and return on short-term investments of -2,432 (2,104), and in the parent company TSEK -2,448 (2,104). Interest costs of TSEK 161 (167) were reported for the Group, and TSEK 159 (135) for the parent company, of the interest costs in the parent company, TSEK 78 (58) refer to Group companies.

Note 11

TAX ON PROFIT FOR THE YEAR

ESTIMATE OF EFFECTIVE TAX RATE, SEK 000	GROUP		PARENT COMPANY	
	2022	2021	2022	2021
Profit before tax	43,269	36,280	18,656	24,392
Tax at the applicable rate, 20.6%	8,913	7,474	3,843	5,025
Non-taxable income	0	0	-1	0
Non-deductible expenses	356	266	356	266
Standard income, tax allocation reserves	0	26	13	23
Standard income, funds	25	25	27	25
Tax from previous year(s)	0	-27	0	-27
Foreign tax expense	188	358	210	192
Difference foreign tax	-1,249	0	0	0
Reported effective tax	8,233	8,121	4,448	5,504
Reported effective tax rate	21.91%	22.38%	23.77%	22.56%

Note 13

TANGIBLE FIXED ASSETS

TSEK	GROUP		PARENT COMPANY	
	31.12.2022	31.12.2021	31.12.2022	31.12.2021
Opening acquisition cost	115,471	112,735	112,526	112,027
Purchases for year incl. finance leases	11,947	2,736	10,192	499
Exchange difference	-	-	-	-
This year's disposals	-10,642	-	-10,642	-
Closing accumulated acquisition value	116,776	115,471	112,076	112,526
Opening depreciation	-93,931	-85,825	-93,294	-85,237
Exchange difference	-4	-10	-	-
Retirements for the year	10,642	-	10,642	-
Depreciation for the year	-7,042	-8,096	-6,898	-8,057
Closing accumulated depreciation for equipment	-90,335	-93,931	-89,550	-93,294
Closing residual value according to plan	26,441	21,540	22,526	19,232

Note 10

APPROPRIATIONS AND UNTAXED RESERVES

TSEK	PARENT COMPANY	
	31.12.2022	31.12.2021
Opening balance, untaxed reserves	21,532	18,627
Change in accumulated depreciation according to plan (machinery & equipment)	3,099	-3,662
Change in tax allocation reserve	6,857	6,566
Total appropriations	9,956	2,905
Closing balance, untaxed reserves	31,487	21,532

Note 12

INTANGIBLE FIXED ASSETS

GROUP, SEK 000	DEVELOPMENT EXPENDITURE		GOODWILL	
	31.12.2022	31.12.2021	31.12.2022	31.12.2021
Opening acquisition cost	11,328	12,226	1,118	2,919
Acquisitions for the year	1,250	378	0	0
Disposals	-2,128	-1,276	-952	-1,801
Closing accumulated acquisition value	10,450	11,328	166	1,118
Opening depreciation	-6,599	-6,430	-1,118	-2,886
Disposals	2,127	1,276	952	1,801
Depreciation for the year	-2,004	-1,445	0	-33
Closing accumulated depreciation	-6,476	-6,599	-166	-1,118
Closing residual value according to plan	3,975	4,729	0	0

PARENT COMPANY, SEK 000	DEVELOPMENT EXPENDITURE		GOODWILL	
	31.12.2022	31.12.2021	31.12.2022	31.12.2021
Opening acquisition cost	7,312	8,589	1,118	2,919
Disposals	0	-1,276	-952	-1,801
Closing accumulated acquisition value	7,312	7,312	166	1,118
Opening depreciation	-3,906	-4,377	-1,118	-2,886
Disposals	0	1,276	952	1,801
Depreciation for the year	-681	-806	0	-33
Closing accumulated depreciation	-4,586	-3,906	-166	-1,118
Closing residual value according to plan	2,725	3,406	0	0

Financial leasing

Equipment held under finance leases is included in the Group with a carrying value of TSEK 3,520 (2,170). The headings of current and non-current liabilities in the Group's balance sheet include future payments in connection with lease commitments reported as liabilities. See also Note 18, "Liabilities to credit institutions".

Note 14

GROUP COMPANIES AND OTHER LONG-TERM SECURITIES HOLDINGS

	GROUP		PARENT COMPANY	
	31.12.2022	31.12.2021	31.12.2022	31.12.2021
Opening acquisition value, shares and participations	0	46	1,303	1,350
Acquisitions/sales for the year	0	-46	2,253	-46
Closing accumulated acquisition value	0	0	3,556	1,303

Shares and participations

Company, SEK 000	GROUP			PARENT COMPANY	
	Number	%	Book	Quota value	Book
Basta Online AB	600	60%	-	60	60
EPD International AB	500	100%	-	50	50
Sino-Swedish (Tianjin) Environmental Technology Development Co., Ltd	1	50%	-	581	581
IVL Environmental Technologies (Beijing) Company Ltd	1	100%	-	546	2,799
IVL India Environmental R&D Private Limited	1	100%	-	16	16
eBVD i Norden AB	510	51%	-	25	25
Möbelfakta i Sverige AB	510	51%	-	26	26
Total			0		3,556

Profit/loss for the year, Equity, registered office and corporate registration number are presented in the Board of Directors' Report

Note 18

LIABILITIES TO CREDIT INSTITUTIONS

TSEK	GROUP	
	31.12.2022	31.12.2021
Non-current liabilities		
Opening balance	691	1,423
Change in liabilities to credit institutions	988	-732
Amount at year end	1,679	691
Current liabilities		
Opening balance	1,479	1,718
Change in liabilities to credit institutions	362	-239
Amount at year end	1,841	1,479
All liabilities have maturity dates of less than 5 years		

Note 15

PREPAID EXPENSES

TSEK	GROUP		PARENT COMPANY	
	31.12.2022	31.12.2021	31.12.2022	31.12.2021
Rentals for offices and other premises	6,197	6,072	6,197	6,072
Other prepaid expenses	4,336	3,079	4,335	3,028
Amount at year end	10,532	9,151	10,532	9,100

Note 16

PROVISIONS

TSEK	GROUP		PARENT COMPANY	
	31.12.2022	31.12.2021	31.12.2022	31.12.2021
Deferred tax liabilities	18,754	15,873	-	-
Climate funding	808	548	808	548
Amount at year end	19,562	16,421	808	548

Note 17

ACCRUED COSTS

TSEK	GROUP		PARENT COMPANY	
	31.12.2022	31.12.2021	31.12.2022	31.12.2021
Holiday and overtime liabilities	7,238	7,671	7,238	7,671
Accrued social costs	15,543	9,773	15,543	9,773
Other accrued costs	2,424	3,061	2,129	2,715
Amount at year end	25,205	20,505	24,910	20,159

Note 19

PLEGGED ASSETS AND CONTINGENT LIABILITIES, GROUP AND PARENT COMPANY

TSEK	31.12.2022	31.12.2021
Pledged assets for liabilities to credit institutions		
Blocked bank funds		-
Chattel mortgages	22,800	22,800
Total	22,800	22,800
Contingent liabilities	None	None

Note 20

SHORT-TERM INVESTMENTS, GROUP AND PARENT COMPANY

TSEK	GROUP		PARENT COMPANY	
	31.12.2022	31.12.2021	31.12.2022	31.12.2021
Opening balance	32,601	30,497	32,601	30,497
Change in value	-2,825	2,104	-2,825	2,104
Amount at year end	29,776	32,601	29,776	32,601

Note 22

APPROPRIATION OF PROFIT OR LOSS, PARENT COMPANY

	31.12.2022	31.12.2021
Retained earnings	77,654	58,534
Profit for the year	14,208	18,988
Total	91,862	77,522
Carried forward to next year	91,862	77,522

Note 21

DISCLOSURES ON SHARE CAPITAL, PARENT COMPANY

TSEK	31.12.2022		31.12.2021	
	Number	Quota value per share	Number	Quota value per share
Value/Number at beginning of year	7,000	1,000	7,000	1,000
Value/Number at end of year	7,000	1,000	7,000	1,000

Note 23

SIGNIFICANT EVENTS AFTER THE END OF THE FINANCIAL YEAR

No significant events have occurred after the end of the financial statements.

Stockholm, April 2023

Alf Engqvist,
Chairman of the board

Marie Louise Falkland

Peter Nygårds

Måns Nilsson

Anne Vadasz Nilsson

Henrik Sundstrom

Pär Larshans

Mikael Malmaeus
Employee representative

Linda Styhre
Employee representative

Marie Fossum Strannegård
CEO

Our audit report has been issued in April, 2023

R3 Revisionsbyrå KB

Tomas Nöjd
Authorised Public Accountant

Christina Kallin Sharpe
Authorised Public Accountant

Audit report

To the General Meeting of Shareholders in IVL Svenska Miljöinstitutet AB,
Corporate ID no. 556116-2446

Report on the annual accounts and consolidated accounts

OPINION

We have performed an audit of the annual accounts and consolidated accounts for IVL Svenska Miljöinstitutet AB for the 2022. The company annual accounts and consolidated accounts are included on pages 84-109 in this document.

In our opinion, the annual accounts and consolidated accounts have been prepared in accordance with the Swedish Annual Accounts Act and in all material respects, provide a fair presentation of the financial position of the parent company and the Group as of 31 December 2022, as well as their financial performance and cash flow for the year in accordance with the Swedish Annual Accounts Act. The Management Report is consistent with the other parts of the annual accounts and consolidated accounts.

We therefore recommend to the Annual General Meeting that the parent company and consolidated income statements and balance sheets be adopted.

GROUNDINGS FOR OPINIONS

We have conducted our audit in accordance with the International Standards on Auditing (ISA) and generally accepted auditing standards in Sweden. Our responsibility under these standards is described in more detail in the section on "Auditor's responsibility". We are independent in relation to the parent company and the Group in accordance with good auditing practices in Sweden and have otherwise fulfilled our responsibilities in terms of professionalism and ethical responsibility in accordance with these requirements.

We believe that the accounting evidence we have obtained provides an adequate and appropriate basis for our opinions.

INFORMATION OTHER THAN THE ANNUAL ACCOUNTS AND CONSOLIDATED ACCOUNTS

This document also contains information other than the annual accounts and consolidated accounts, which is available on pages 1-83, 110-124. The Board and the CEO are responsible for this other information.

Our opinion regarding the annual accounts and consolidated accounts does not cover this information and we make no statement confirming this other information.

In connection with our audit of the annual accounts and consolidated accounts, it is our responsibility to read the information identified above and consider if the information to a material extent is inconsistent with the annual accounts and consolidated accounts. In this review, we also take into account the information we collected otherwise during the audit and assess if the information otherwise appears to contain material misstatements.

If we draw the conclusion based on the work done regarding this information that the other information contains a material misstatement, we are obliged to report it. We have nothing to report in this respect.

RESPONSIBILITIES OF THE BOARD OF DIRECTORS AND THE CEO

It is the Board of Directors and the CEO who are responsible for the preparation of the annual accounts and consolidated accounts and for ensuring that they provide a true and fair view according to the Annual Accounts Act. The Board and CEO are also responsible for the internal control that they deem to be necessary to prepare annual accounts and consolidated accounts that do not contain any material misstatement, whether due to error or impropriety.

In preparing the annual accounts and consolidated accounts, the Board and CEO are responsible for the assessment of the company's and the Group's ability to continue the operations. They provide information, when appropriate, concerning conditions that might affect the ability to continue operations and presume continuing operations. However, this going concern assumption is not applied if the Board and CEO intend to liquidate the company, cease operations, or have no realistic alternative than to do either.

Auditor's responsibility

Our objectives are to achieve a reasonable degree of certainty as to whether or not the annual accounts and consolidated

accounts as a whole contain any material misstatements, whether due to error or impropriety, and to provide an audit report that contains our opinions. Reasonable certainty is a high degree of certainty, but it is no guarantee that an audit performed according to ISA and generally accepted auditing standards in Sweden will always discover a material misstatement if such exists. Misstatements can arise due to impropriety or error and are considered to be material if they, individually or together, can reasonably be expected to affect financial decisions that users make based on the annual accounts and consolidated accounts.

As a part of an audit according to ISA, we use professional judgement and adopt a professionally sceptical approach throughout the entire audit. Moreover:

- we identify and assess the risks of material misstatements in the annual accounts and consolidated accounts, whether they are due to impropriety or error, formulate and carry out auditing procedures based in part on these risks and gather audit evidence that is adequate and suitable to form a basis for our opinions. The risk of not discovering a material misstatement due to impropriety is higher than for a material misstatement due to error because improprieties can include acting in collusion, falsifying, intentional omission, incorrect information or disregarding internal controls.
- we obtain an understanding of the part of the company's internal control that is significant to our audit in order to carry out auditing procedures that are suitable considering the circumstances, but to refrain from making a statement on the effectiveness of internal controls.
- we evaluate the suitability of the accounting principles used and the reasonability of the Board's and CEO's estimates in the accounts and associated disclosures.
- we draw a conclusion on the suitability of the Board and CEO using the going concern assumption in preparing the annual accounts and consolidated accounts. We also draw a conclusion, based on the audit evidence collected, as to whether or not there are any material uncertainty factors pertaining to such events or conditions that might lead to significant doubt about the company's and the Group's ability to continue business. If we draw the conclusion that there is a material uncertainty factor, we must in our audit report call attention to the disclosures in the annual accounts and consolidated accounts regarding the material uncertainty factor or, if such disclosures are inadequate, modify the opinion regarding the annual accounts and consolidated accounts. Our conclusions are based on the audit evidence gathered up to the date of the audit report. However, future events or circumstances might mean that the company and Group can no longer continue operations.
- we evaluate the overall presentation, structure and content of the annual accounts and consolidated accounts, including the disclosures, and whether the annual accounts and consolidated accounts portray the underlying transactions and events in a manner that provides a true and fair view.
- we gather adequate and suitable audit evidence regarding the financial information for the units or business activities within

the Group, in order to express an opinion concerning the consolidated accounts. We are responsible for the management, supervision and implementation of the Group audit. We are solely responsible for our opinions.

We must inform the Board of the audit's planned scope and emphasis, as well as its timing. We must also provide information about significant observations during the audit, including any significant deficiencies in the internal control we have identified.

STATEMENT ON OTHER LEGAL AND REGULATORY REQUIREMENTS

Opinion

In addition to our audit of the annual accounts and consolidated accounts, we have also performed an audit of the management of the Board of Directors and the CEO of IVL Svenska Miljöinstitutet AB for 2022 and of the proposed appropriation of the company profit or loss.

We recommend to the Annual General Meeting that the profit be allocated in accordance with the proposal in the management report and that the members of the Board of Directors and the CEO be discharged from personal liability for the financial year.

Grounds for opinions

We have conducted our audit in accordance with generally accepted auditing standards in Sweden. Our responsibilities under those standards are further described in the section "Auditor's responsibilities". We are independent in relation to the parent company and the Group in accordance with good auditing practices in Sweden and have otherwise fulfilled our responsibilities in terms of professionalism and ethical responsibility in accordance with these requirements.

We believe that the accounting evidence we have obtained provides an adequate and appropriate basis for our opinions.

Responsibilities of the Board of Directors and the CEO

The Board of Directors has responsibility for the proposal on the allocation of the company's profit or loss. In the event of a proposed dividend, this includes an assessment of whether the dividend is justifiable considering the requirements set by the company's and Group's nature of operations, scope and risks on the size of the Parent Company's and the Group's equity, consolidation requirements, liquidity and position otherwise.

The Board is responsible for the company's organisation and the management of its affairs. This includes continuously assessing the company's and Group's financial situation and ensuring that the company's organisation is structured so that accounting, asset management and the company's financial affairs otherwise are controlled in a satisfactory manner. The CEO will take care of the operating management according to the Board's guidelines and instructions, and will take the actions necessary for the company's accounting to be performed in accordance with the law and for assets to be managed in a satisfactory manner.

Auditor's responsibility

Our objective regarding the audit of the management, and thereby our statement regarding discharge from liability, is to collect audit evidence in order to be able to assess with a reasonable degree of certainty whether any Board member or the CEO to any material respect:

- has taken any action or been guilty of any negligence that may lead to a liability to pay damages to the company, or
- in any way has acted counter to the Swedish Companies Act, the Annual Accounts Act, or the Articles of Association.

Our objective regarding the audit of the proposed allocation of the company's profit or loss, and thereby our statement regarding this, is to assess with a reasonable degree of certainty whether the proposal is consistent with the Swedish Companies Act.

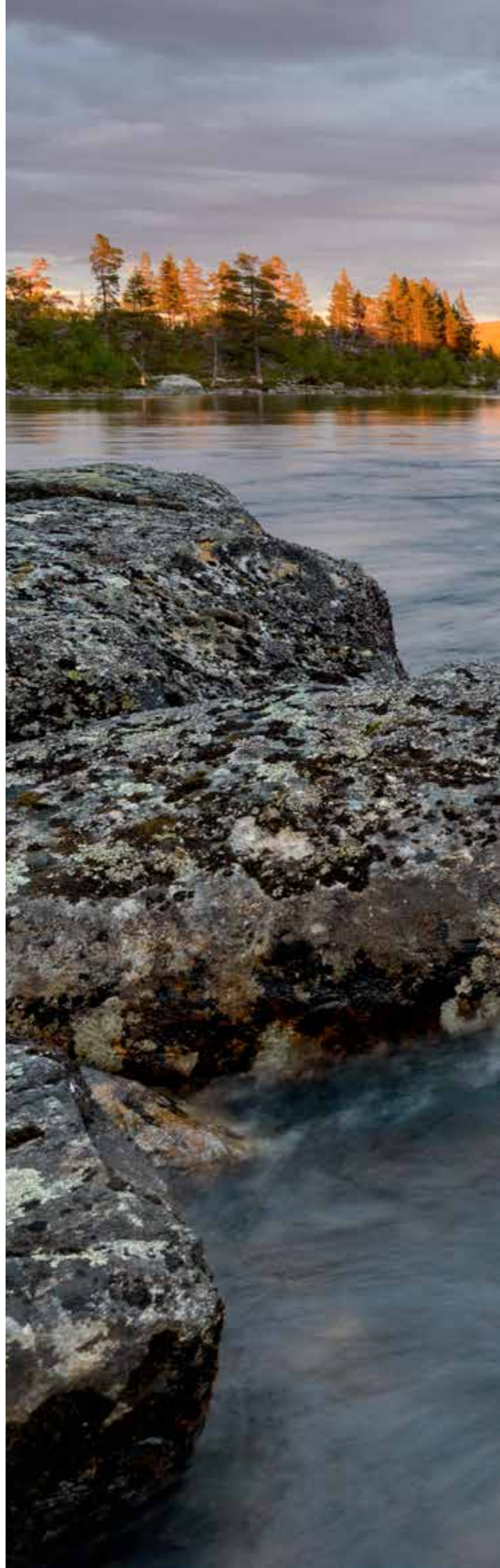
Reasonable certainty is a high degree of certainty, but is no guarantee that an audit performed in accordance with generally accepted auditing standards in Sweden will always discover actions or negligence that can lead to liability to pay damages to the company, or that a proposed allocation of the company's profit or loss is not consistent with the Swedish Companies Act.

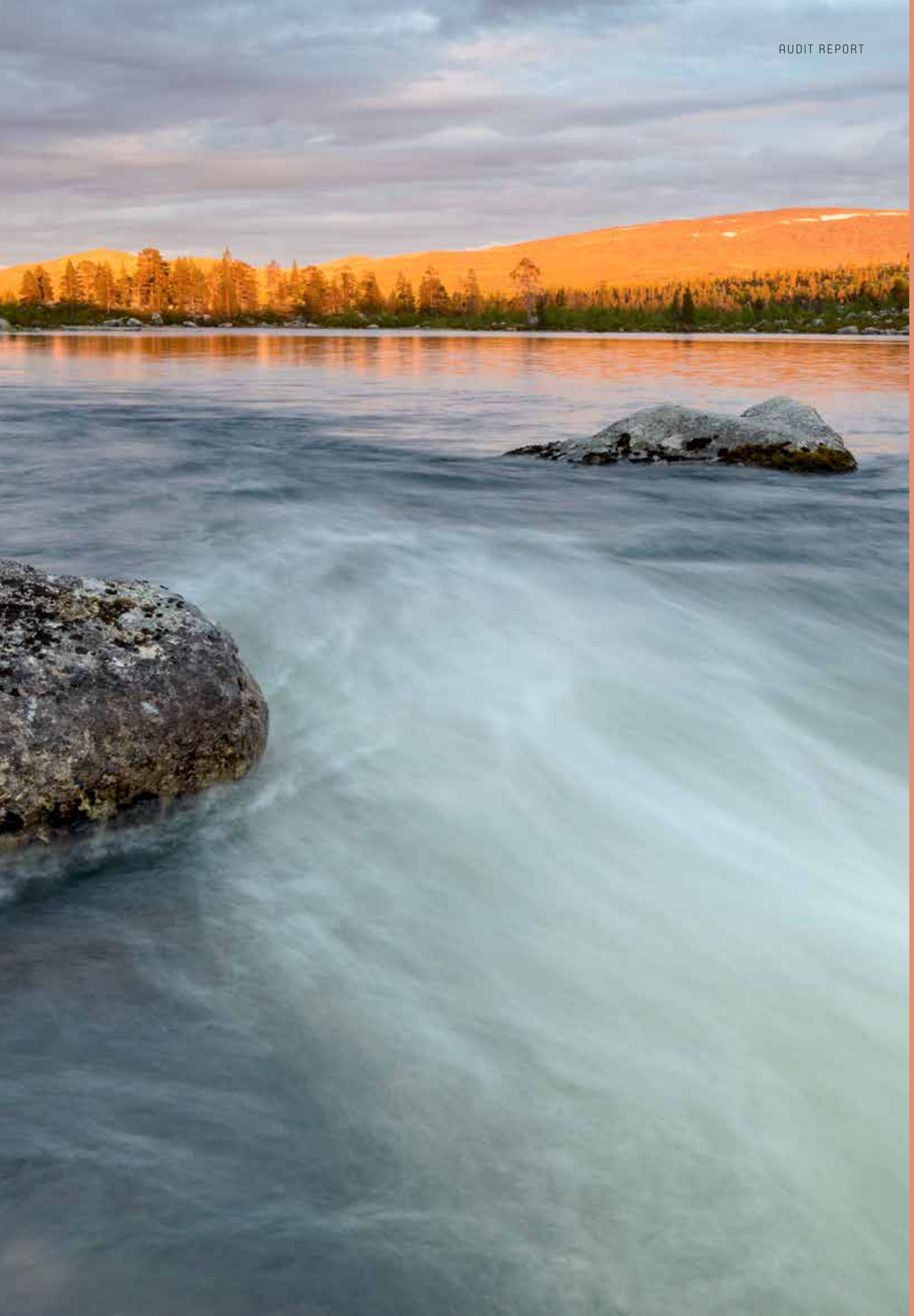
As a part of an audit according to generally accepted auditing standards in Sweden, we use professional judgement and have a professionally sceptical approach in the entire audit. The review of the administration and the proposed appropriation of the company's profit or loss are primarily based on the audit of the accounts. What additional review procedures are done is based on our professional assessment on the basis of risk and materiality. This means that we focus the review on such measures, areas and circumstances that are significant to the business and where deviations or violations would be of particular significance to the company's situation. We go through and test decisions made, the basis for making decisions, actions taken and other circumstances that are relevant to our opinion regarding discharge from liability. As a basis for our opinion on the Board of Directors' proposed allocations of company profit or loss, we have examined whether the proposal is consistent with the Swedish Annual Accounts Act.

Stockholm, April 2023

Tomas Nöjd
Authorised Public Accountant

Christina Kallin Sharpe
Authorised Public Accountant





Sustainability notes

IVL's vision of a sustainable society involves sustainability permeating all parts of our operation, both in relation to our customers and other stakeholders as well as in our internal work. IVL's sustainability work is structured around policies, strategies, management systems and business plans. The work is headed by the IVL management team, which establishes strategy, focus and goals for sustainability work. Development and implementation of the work takes place in the sections. The CEO regularly reports the status of the work to the company's Board of Directors and the foundation's Board of Directors. The Board has overall responsibility for IVL's sustainability strategy and long-term goals, and approves the annual sustainability report.

Focus areas and responsibilities

IVL's sustainability work has been divided into five focus areas, within which various aspects of the work are developed and conducted. The focus areas have been defined on the basis of the essential areas of the operation. They must ensure that sustainability is integrated in all parts of our operation. The structure and the focus areas were defined in 2018, as part of the work of clarifying and strengthening IVL's sustainability work.

A focus area supervisor has been defined for each focus area, and is responsible for the development of each focus area, including objectives, action plans and follow-up, and for coordinating the implementation in the sections. The sections are responsible for the implementation and for development within the framework of each section's area of responsibility.



The five focus areas are:

Improved environmental performance of customers and a sustainable society:

Through assignments and research, IVL will contribute to meeting both the Global Sustainable Development Goals (Agenda 2030) and the Swedish environmental goals. Customer and sustainability benefits are created in assignment projects and research projects together with customers and other partners.

Attractive workplace:

IVL's employees are our most important resource for achieving our vision. For this reason, IVL should be a good and attractive workplace with a healthy working environment. It must also promote gender equality, equal treatment and diversity, with skills and leadership development taking place on a continual basis.

Ethics and integrity:

Ethics and integrity are key components of IVL's reputation as an independent and credible institute. Operations must be conducted in accordance with IVL's code of conduct and values.

IVL also works actively to identify and manage sustainability risks for the business.

Environmental impact

As Sweden's leading environmental institute, it is important for IVL to take responsibility for and minimise both the direct and indirect environmental impact from its own operations. The internal environmental work is conducted primarily within three areas: *Climate and energy*, *Resource efficiency and circularity*, as well as *Sustainable use of chemicals*.

Healthy finances:

In order to conduct and develop our business as well as to be competitive, we require healthy finances. The profits that IVL makes are reinvested in our own research and development. This also includes integrating sustainability aspects into decisions when IVL is providing funding, e.g. when investing in equipment or making a purchase.

Policies

The basis for IVL's sustainability work is described in our code of conduct, based on the UN Global Compact's ten principles and on IVL's values. The code of conduct applies to all IVL employees and board members, and governs IVL's conduct towards employees, customers, suppliers, business partners and other stakeholders.

IVL's policies are reviewed and revised regularly. IVL has eight policies. IVL's sustainability and environmental policy describes the content and focus of sustainability work, and includes gender equality and diversity, work environment, skills development, environmental and quality aspects, as well as requirements for suppliers and partners. IVL also has an overall work environment policy that describes IVL's level of ambition for IVL as a workplace and working conditions within the organization in more detail and includes gender equality and equal treatment. There is also a travel policy describing principles related to environmental, safety and ethical aspects of business travel and corporate entertainment. The following policies also exist: salary policy, information security policy, media policy and a quality policy.

Management system and systematic approach

IVL has an integrated management system that provides a systematic and structured approach to the business and all aspects of sustainability work. The system is certified in accordance with the environmental and quality management standards, ISO 14001 and 9001. Within the framework of the management system, IVL continuously strives for improvement, setting goals and following up according to a defined system of management. The working environment work is conducted according to a working environment plan, which includes division of responsibility, goals, working methods, as well as a plan of action for the areas of organisational and social working environment.

All suppliers and partners are encouraged to follow IVL's code of conduct. The principles in IVL's code of conduct must be applied when evaluating of current and future suppliers.

Development of the sustainability work

Work has continued aimed at clarifying and strengthening IVL's sustainability work. Within the framework of this inter-

nal work, improvement activities are being carried out in prioritised areas. In 2022, improvement activities regarding two focus areas in IVL's sustainability work and regarding stakeholder dialogue have continued:

- Within the focus area "Improved environmental performance of customers and a sustainable society", work to further develop a method for calculating IVL's concrete contribution to the benefit of customers through IVL's work has continued.
- Within the focus area "Environmental impact", the work of clarifying IVL's climate impact within scope 3 and calculating the categories 3.1 Purchased goods and services and 3.4 Transport has been carried out.

The work on stakeholder dialogue continued during the year with an in-depth analysis of our assignments and the customers we had during the year.

In addition to the specific improvement activities that are carried out within the framework of this internal work, continuous improvement work is also conducted in the various focus areas

of IVL's sustainability work within the framework of regular line activities.

DIALOGUE AND COLLABORATION WITH STAKEHOLDERS

The dialogue with stakeholders is an important part of IVL's sustainability work and is a central component in the work to achieve IVL's vision: A sustainable society. For employees, customers, suppliers, the board and owners, a close and ongoing dialogue is conducted during the year through various forums. There are also stakeholders such as funders of research projects, politicians, authorities and, for example, the general public where IVL informs about our activities to contribute to a more sustainable society in general.

In 2021, an in-depth analysis of our external operational committee was carried out, which focused more on IVL's various research areas. In 2022, an in-depth analysis of our assignments and the customers we have had during the year has instead been carried out.

	Ongoing dialogue	Information
Stakeholders	<ul style="list-style-type: none"> Collaborators Customers Suppliers and partners 	<ul style="list-style-type: none"> Board of directors and owners Funders Local community Politicians and authorities The Public Job seekers
Important aspects	<ul style="list-style-type: none"> Improved environmental performance of customers and a sustainable society Work environment, health and safety Equality, non-discrimination and diversity Competence and leadership development Ethics and integrity 	<ul style="list-style-type: none"> IVL shall be a role model for its internal sustainability work Customer value contributes to the customer's sustainability performance Requirements for suppliers
Channels	<ul style="list-style-type: none"> Inforum, intranet Unit meetings and group meetings Chefsforum AMK, Safety representative Employee appraisals Pulse conversations Employee survey 	<ul style="list-style-type: none"> Customer survey including NQI Ongoing customer dialogues Reference and steering groups Events, workshops, web, social media Business councils Meeting with strategic partners

IVL's stakeholders, important aspects and channels.

In-depth dialogue with operational committee

IVL's most important sustainability aspect is the advice we give to our customers. Every year, a customer survey is conducted of a selection of IVL's commissioned projects, where an in-depth interview of how the collaboration works with IVL. This year's customer survey continues to show great confidence in IVL, where all customers consider hiring IVL again and recommend us to others. There is still a demand above all for analysis and impact assessments to understand environmental impact and less of strategies for long-term sustainability, this trend has now been seen for a number of years. We can also see that proposals for measures are being demanded more and more, but still from a low level. If we look a little further ahead, strategy work and proposals for measures to improve environmental performance seem to have a greater impact on what we offer our customers. We can also see that there is a trend of contract customers demanding faster analyses with the right level of ambition and less of deep and future-oriented assignments

MATERIALITY ANALYSIS

The results of the dialogue with IVL's stakeholders in the company's various channels are used as a basis for IVL's materiality analysis and the reporting according to GRI Standards. This governs which areas are highlighted in the sustainability

report, in line with the principle of materiality.

During the evaluation of the materiality analysis, the eight key areas that had previously been identified were still deemed to be relevant. These key areas have been divided into five focus areas, as shown in the table below.

The most important aspect overall for IVL is how the business contributes to environmental and sustainability benefits for the customer and a sustainable development of society, which is the basis of IVL's vision.

Focus area	Key aspect
Improved environmental performance of customers and a sustainable society	Customer and sustainability benefits
Attractive workplace	Work environment, health and safety Equality, non-discrimination and diversity Competence and leadership development
Ethics and integrity	Ethics and integrity
Environmental impact	Climate and energy Sustainable use of chemicals Resource efficiency and circularity
Healthy finances	Customer and sustainability benefits

GRI index – content and page references

IVL Swedish Environmental Research Institute reports information about the company's sustainability work together with the development and financial results of the business in the annual report.

The Sustainability Report, like the Annual Report, refers to the 2022 financial year and covers the parent company unless otherwise stated. The sustainability-related information in the annual report is not audited by a third party. IVL intends to report annually and, for the 2022 financial year, is submitting

its seventh report according to GRI and its sixth report according to GRI Standards, level Core.

IVL's latest sustainability report was published in May 2022. We report all general standard information. For specific standard disclosures, we report what has been defined as material for the business. This GRI index refers to where the information is presented in the annual and sustainability report.

GRI INDICATORS WITH PAGE REFERENCE AND COMMENTS

Information no. Information	Page	Comments and exclusions
GENERAL INFORMATION		
ORGANISATION PROFILE		
102-1 Name of organisation	Cover, 84	Front page of the report
102-2 Activities, brands, products and services	6-7, 15-60, 64-70, 84-86	
102-3 Head office location	6, 84	
102-4 Countries in which the organisation operates	6-7, 84-87	
102-5 Ownership structure and legal form	13, 70-72, 100-101	
102-6 Markets in which the organisation operates	6-7, 84-86, 83	
102-7 Scale of the organisation	6, Note 2	
102-8 Information about employees and other colleagues	6, 74-77, Note 7	
102-9 Supply chain	6-7, 84-86	
102-10 Significant changes regarding the organisation and its supply chain	86	
102-11 Precautionary principle	78, 84-86	
102-12 External initiatives	84-86	
102-13 Membership in organisations and networks	87	
STRATEGY		
102-14 Statement by the CEO	3, 5	
ETHICS AND INTEGRITY		
102-16 The company's core values, principles, standards and norms for conduct	6-7, 78, 90, 110-111, 114-115	
GOVERNANCE		
102-18 Governance and ownership structure for the organisation	84-90, 110-111, 114-115	
STAKEHOLDER DIALOGUE		
102-40 Stakeholder groups	6-7, 30-60, 64-70, 110-11, 116	
102-41 Employees covered by collective bargaining agreements		97% of all employees are covered by collective bargaining agreements. Employees in China do not have collective bargaining agreements.
102-42 Identification and selection of stakeholder groups	6-7, 90, 110-111	
102-43 Methods for dialogue with stakeholders	110-111	
102-44 Key topics and concerns raised in dialogue with stakeholders	110-111, 7	
REPORTING PRACTICE		
102-45 Parts of the organisation included in the report	Note 1.5	
102-46 Definition of report content and demarcations	110-111	
102-47 List of essential areas	110-111	
102-48 Adjustments to previously submitted information		Data regarding energy consumption in premises and emissions of greenhouse gases from purchased energy have been supplemented with Hammarby Sjöstad'sverk and Kristineberg
102-49 Changes in reporting		the Skellefteå office has been added

Information no. Information	Page	Comments and exclusions
102-50 Reporting period	110-111	
102-51 Date of the most recent report	110-111	
102-52 Reporting cycle	98-99	
102-53 Contact information for issues regarding the report	Cover	Back page of the report
102-54 Statements on reporting according to GRI Standards	110-111	
102-55 GRI Index	110-111	
102-56 External review	110-111	

ESSENTIAL AREAS**Social standards**

WORKING ENVIRONMENT, HEALTH AND SAFETY		
103-1	Explanation of significant area and its demarcations	74-77
103-2	Sustainability management and its components	74-77
103-3	Sustainability governance evaluation	74-77
403-1	Management system for working environment, health and safety.	74-76
403-2	Identification of hazards, risk assessment, and investigation of incidents	74-76
403-3	Healthcare in the workplace.	74-76
403-4	Employee participation, counselling and communication regarding the working environment, health and safety at the workplace	74-77
403-5	Training in working environment, health and safety	74-77
403-6	Health-promoting measures	74-77
403-8	Employees covered by a working environment management system	74-77
403-9	Work-related injuries	74-77

EQUALITY AND EQUAL OPPORTUNITIES

103-1	Explanation of significant area and its demarcations	74-77, 79-80, 90
103-2	Sustainability management and its components	74-77, 79-80, 90
103-3	Evaluation of sustainability management	74-77, 79-80, 90
405-1	Diversity in governing bodies and among employees	74-77, Note 7

TRAINING AND EDUCATION

103-1	Explanation of significant area and its demarcations	74-77	
103-2	Sustainability management and its components	74-77	
103-3	Sustainability governance evaluation	74-77	
404-1	Average training time per employee per year	13, 77	Only reported as total per employee

Financial standards**ANTI-CORRUPTION**

103-1	Explanation of significant area and its demarcations	79-80, 90, 110-111	
103-2	Sustainability management and its components	79-80, 90, 110-111	
103-3	Sustainability governance evaluation	79-80, 90, 110-111	
205-2	Communication and training on anti-corruption	78	Part of training in IVL's Code of Conduct

Environmental standards**ENERGY**

103-1	Explanation of significant area and its demarcations	90, 110-111
103-2	Sustainability management and its components	79-80, 90, 110-111
103-3	Sustainability governance evaluation	79-80, 90, 110-111
302-1	Energy use within the organisation	79-81
302-3	Energy intensity	79-81, 90, 110-111

DISCHARGES/EMISSIONS

103-1	Explanation of significant area and its demarcations	79-81, 110-111	
103-2	Sustainability management and its components	79-81, 90, 110-111	
103-3	Sustainability governance evaluation	79-81	
305-1	Direct greenhouse gas emissions (Scope 1)	79-81	Emissions from cars leased by the business are included in the reporting of business travel
305-2	Indirect greenhouse gas emissions from energy consumption (Scope 2)	79-81	
305-3	Other indirect greenhouse gas emissions (Scope 3)	79-81	Includes business travel and production of fuels for purchased energy
305-4	Intensity of greenhouse gas emissions	65-67	

Corporate governance

Corporate governance at the IVL Swedish Environmental Research Institute is based on Swedish legislation and generally accepted practices, with due account taken of the Swedish Code of Corporate Governance. The reason why the Swedish Code of Corporate Governance is not observed in every respect is that it is mainly designed for listed companies and companies with diversified ownership. The Board's tasks include identifying how sustainability issues affect the company's risks and business opportunities.

OWNERSHIP

IVL has been wholly owned by the Swedish Institute of Water and Air Conservation Research Foundation (SIVL) since 2004. At the conversion of the then Institute for Water and Air Conservation Research into a public limited company form in 1982, SIVL's original share capital was allocated in equal part by an agreement between the Swedish government and the Swedish business sector.

SIVL's purpose is to develop the long-term conditions for environmental research and, through ownership, to guarantee IVL an independent status. SIVL is responsible for the funds provided by the Swedish government and the Swedish business sector for environmental and sustainability-related research at IVL.

BOARD

IVL is governed by a representative Board of Directors, of whom the Chair and six members are appointed by the Swedish government and seven members by the Swedish business community. The Chair has the deciding vote.

ANNUAL GENERAL MEETING

The Annual General Meeting (AGM) is generally held at the beginning of May. Members are notified of the AGM by post. The owner, SIVL, is represented at the AGM by the chair of SIVL.

NOMINATION PROCEDURE

SIVL, the sole owner of IVL, proposes members for IVL's Board of Directors, partly by inviting nominations from business sector representatives for four regular members and one deputy member for IVL's Board of Directors, and partly by inviting nominations from the government for the Chair as well as three regular members and one deputy for IVL's Board of Directors.

IVL's Board of Directors must consist of no less than four and no more than eight members, plus no less than one and no more than two deputies. The trade union representatives are also entitled to nominate two members and two deputies.

The members of IVL's board consist of three women and five men and they are presented on pages 116-117.

THE BOARD OF DIRECTORS AND ITS WORK IN 2022

Within the framework of the Swedish Companies Act and the company articles of association, the Board of Directors is responsible for the organisation and administration of the company. Every year, the Board adopts rules of procedure. This document is accompanied by instructions for the work of the CEO, governing the allocation of tasks between the Board of Directors and the CEO. In 2022, according to the rules of procedure, the Board held five ordinary meetings, in addition to the statutory meeting held in May in connection with the annual general meeting and an extraordinary meeting in November. As usual, the ordinary Board meetings took place in connection with the presentation of full-year or interim financial statements, i.e. in March, May, September and December.

All regular board meetings follow an agenda which always includes a report from the CEO, financial reports, strategic issues, as well as a risk and impact analysis. At the board meeting in March, the directors' report and the proposed appropriation of profit were approved, and a refined market analysis was addressed. Items on the agenda for the board meeting in May included the adoption of new rules of procedure for the Board of Directors and instructions for work by the CEO. Special information was also provided regarding the company's risks, an impact analysis and measures or procedures for risk control. At an extended board meeting in September, the company's long-term strategy was discussed. The board meeting in December dealt with, among other things, the company's budget for 2022 as well as goals and strategy documents.

Remuneration Committee

Under the rules of procedure for the Board of Directors of the IVL Swedish Environmental Research Institute, the Board of Directors must appoint a remuneration committee to deal with issues related to terms and conditions of employment and remuneration. The committee proposes salaries, other forms of remuneration, and other terms and conditions of employment for the CEO, which are then presented to the Board of Directors for approval. Similarly, terms and conditions for other members of executive management of the company are proposed by the CEO, and these are then presented to the remuneration committee for approval. The company does not operate any incentive programmes.

Remuneration for the Board of Directors

The 2021 annual general meeting approved fees to the chairperson and members of the board. Remuneration for the chairperson was set at TSEK 125 (125) in fixed remuneration and TSEK 50 (50) in fixed remuneration to ordinary members and TSEK 20 as fixed remuneration to deputies, and in accordance with the decision of the annual general meeting, the total board remuneration including national social costs amounting to TSEK 684 (613). Of this amount, the chairperson was paid TSEK 125 (125) excluding national insurance costs. The employee representatives do not receive a fee.

EXTERNAL AUDIT

The auditors' task, on behalf of the owner, is to conduct an impartial review of the administration by the Board of Directors and the CEO, as well as the company's annual report and accounting records. R3 Revisionsbyrå KB, with Tomas Nöjd and Christina Kallin Sharpe as the head auditors, has been elected auditor for the period until the annual general meeting for 2023.

Tomas Nöjd and Christina Kallin Sharpe are certified public accountants and have led the audit assignment for IVL since 2014.

CORPORATE GOVERNANCE

The CEO is responsible for the day-to-day administration of the company in accordance with the guidelines and other instructions issued by the Board of Directors. The instructions for the work of the CEO were adopted on 14 May 2020 at the statutory board meeting. The company's executive management group consists of the CEO, the Executive Vice President, the Chief Financial Officer and the Director of the Research, Business Development and International Business unit.

The company's management team also includes three heads of sections, the Director of Communications, the Director of Research, the Director of Human Resources as well as the Sales Director, and a senior advisor. The Director of Quality and Environmental Issues is an adjunct member.

- Marie Fossum Strannegård, born 1973, B.Sc. System Analysis 1995, Karlstad University and MBA Strategic Management 2005, Norwegian School of Economics, has been CEO of IVL Swedish Environmental Research Institute since 2020. She had previously held various senior positions within Fortum (2008-2014), Ericsson (2014-2017) and EY (2018-2020), including as a partner. Chairman of the board of PEAK Region and board member for STI – Stockholm Institute of Technology.

- Anna Jarnehammar, born 1965, M.Sc. Mechanical Engineering, 1991, Luleå University of Technology, Executive Vice President and Director of Business Development and International Business. Employed by the company since 2005, first as a head of section and then in 2014 as Director of Business Development and Marketing. Anna Jarnehammar is Chair of the IVL subsidiaries Bastaonline AB and Möbelfakta.

- Thomas Nilsson, born 1969, MBA from Mid Sweden University, is head of administration since 2022.

The heads of sections, the CFO, the Director of Research, Business Development and International Business, the Director of Human Resources as well as the Sales Director all report to the CEO.

The quality and environment manager reports to the CEO regarding functional responsibility ("dotted line").

The management is supported by executive staff functions for financial management, HR, communication, business development and quality and environmental management systems.

INTERNAL CONTROL

Internal control at the company is based on IVL's operational and management system. At the same time, this represents the company's integrated quality and environmental management systems, which are certified in accordance with ISO 9001 and ISO 14001. The management system focuses on IVL's core operations, i.e. "to offer/market and conduct research and consultancy projects in the environmental field", and includes governing documents, procedures and tools for all processes within the company.

The internal control regarding financial reporting comprises the control environment with organisation, decision pathways, authority and responsibilities that have been documented and communicated in governing documents. All governing documents, procedures and tools are available on the company's intranet.

Every year, the Board adopts rules of procedure that govern the division of responsibilities between the Board and CEO as well as the company's financial reporting to the Board. Financial reports are presented to the Board at every meeting. These comprise outcomes, budget and comparison with the preceding year, as well as order backlog, investments and a number of key ratios.

EVALUATION OF THE BOARD AND THE CEO

The Board's work is evaluated annually and this was done in 2016 through a survey conducted by the Board Academy (Styrelseakademien), which was reported at the December meeting.

The Board of Directors continually evaluates the CEO's performance by monitoring progress against objectives. Once a year, in conjunction with the March board meeting, a more formal evaluation is discussed with the CEO.

RISK ANALYSIS AND MANAGEMENT

The management system also includes procedures and a methodology for annual risk analyses of everything from financial risks and conditions, IT security, external factors and customer relations, to loss of skills/expertise and risks associated with image and brand. The risk analyses are accompanied by action plans. The management system is subject to an internal audit twice a year, as well as ongoing checks by independent quality and environmental auditors. This work is also presented to the Board.

Board of Directors



ALF ENQVIST
CHAIR



PETER NYGÅRDS
ORDINARY BOARD MEMBER



MÅNS NILSSON
ORDINARY BOARD MEMBER



ANNE VADASZ NILSSON
ORDINARY BOARD MEMBER



MARIE LOUISE FALKLAND
ORDINARY BOARD MEMBER



PÄR LARSHANS
ORDINARY BOARD MEMBER



HENRIK SUNDSTRÖM
ORDINARY BOARD MEMBER



MIKAEL MALMAEUS
ORDINARY BOARD MEMBER
EMPLOYEE REPRESENTATIVE



LINDA STYHRE
ORDINARY BOARD MEMBER
EMPLOYEE REPRESENTATIVE



JOHAN GISTORP
DEPUTY



SARA GORTON
DEPUTY



ANDERS BJÖRK
DEPUTY
EMPLOYEE REPRESENTATIVE



ANDREAS ENGLUND
DEPUTY
EMPLOYEE REPRESENTATIVE



**MARIE FOSSUM
STRANNEGÅRD**
CEO, CHAIR

CHAIR**ALF ENGQVIST***Board member since 2021*

Former CEO at Göteborg Energi AB

ORDINARY BOARD MEMBER**PETER NYGÅRDS***Board member since 2008*

Chair, Swedish Institute of Water and Air Conservation Research Foundation

MÅNS NILSSON*Member since 2019*

CEO, SEI

ANNE VADASZ NILSSON*Board member since 2021*

Self employed

MARIE LOUISE FALKLAND*Member since 2017*

Senior Technical Manager, Outokumpu

PÄR LARSHANS*Member since 2017*

Head of Sustainability

Ragn-Sells

HENRIK SUNDSTRÖM*Board member since 2020*

Self employed

MIKAEL MALMAEUS

Employee representative

LINDA STYHRE

Employee representative

DEPUTIES**JOHAN GISTORP***Board member since 2020*Head of department,
Swedish Radiation Safety Authority**SARA GORTON***Board member since 2022*

Head of sustainability, Skanska Sweden

ANDERS BJÖRK

Employee representative

ANDREAS ENGLUND

Employee representative

SIGNIFICANT ASSIGNMENTS CARRIED OUT BY IVL BOARD MEMBERS**ALF ENGQVIST**

- *Gomero Group AB, Ordinary board member*
- *Njordr Offshore Wind AB, Ordinary board member*

PETER NYGÅRDS

- *Ecoclimate Group AB, Chair of the Board*
- *Almi Invest GreenTech AB, Chair of the Board*
- *PN Extended Strategies AB, Member of the Board*
- *Compita Sweden AB, Board member*

MÅNS NILSSON

- *Member of the Board at Blekinge Institute of Technology*
- *Board member Sveaskog AB*

MARIE LOUISE FALKLAND

- *Outokumpu Prefab AB, Member of the Board*
- *Outokumpu Press Plate AB, Member of the Board*
- *Dalarna County Administrative Board's advisory council, member*

PÄR LARSHANS

- *Board member SIWI*
- *2 Government appointments*
 - *Collaboration group for business climate transition, Ministry of Enterprise and Innovation*
 - *Advisory Council for the Swedish Chemicals Agency*
- *Member of the Board of Water Europe*

HENRIK SUNDSTRÖM

- *Ånö Hållbarhet & Hantverk AB, CEO*

MIKAEL MALMAEUS

- *Malmaeus Konsult AB, Deputy. Advisor for Global Challenge*

LINDA STYHRE

- *Progressor Development Sweden AB, CEO*

Johan Gistorp

- *KR's Bilplåt Kommanditbolag, Limited partnership*

SARA GORTON

- *Chairman of Stig and Ragna Gorthon Foundation*

ANDREAS ENGLUND

- *Chairman, Ekoingenjörernas Riksförbund*
- *Chairman, Nomination Committee SACO-förbundet Naturvetarna*
- *Teaching at Mid Sweden University via our own consulting firm Imago Catena*

Management team



**MARIE FOSSUM
STRANNEGÅRD**
CEO



ANNA JARNEHAMMAR
Executive Vice President,
Head of Section,
*Business development and
international business*



THOMAS NILSSON
Head of Administration



JOHN MUNTHE
Vice-President, Research



KARIN SJÖBERG
Head of Section,
*Environmental status and
action strategies*



PATRIK ISAKSSON
Head of Section,
Sustainable Society



MONA OLSSON ÖBERG
Head of Section,
*Sustainable Business and
Consumption*



ANNA AMGREN
Director of Human
Resources



LOUISE GAUFFIN
Head of communications



JOAKIM TORÉN
Director of Quality and the
Environment

ADJUNCT



Scientific articles and book chapters

Thematic area: Sustainable environment

- Akselsson, C., Kronnäs, V., Abbasi, U. A., Mattsson, E., Nissanka, S. P., & Ali, A. (2022).** Biological, structural and functional responses of tropical forests to environmental factors. *Biological Conservation*, 276, 11. doi:10.1016/j.biocon.2022.109792
- Ahumada, S., Tagle, M., Vasquez, Y., Donoso, R., Linden, J., Hallgren, F., . . . Oyola, P. (2022).** Calibration of SO₂ and NO₂ Electrochemical Sensors via a Training and Testing Method in an Industrial Coastal Environment. *Sensors*, 22(19), 20. doi:10.3390/s22197281
- Ali, A., Mattsson, E., & Nissanka, S. P. (2022).** Big-sized trees and species-functional diversity pathways mediate divergent impacts of environmental factors on individual biomass variability in Sri Lankan tropical forests. *Journal of Environmental Management*, 315, 10. doi:10.1016/j.jenvman.2022.115177
- Braun, S., Ahrends, B., Alonso, R., Augustin, S., Garcia-Gomez, H., Hunova, I., . . . Thimonier, A. (2022).** Nitrogen deposition in forests: Statistical modeling of total deposition from throughfall loads. *Frontiers in Forests and Global Change*, 5, 9. doi:10.3389/ffgc.2022.1062223
- Cole, S., Hasselstrom, L., Jonsson, K. I., Lindblom, E., & Soderqvist, T. (2022).** Expert guidance for environmental compensation is consistent with public preferences - Evidence from a choice experiment in Sweden. *Land Use Policy*, 118, 14. doi:10.1016/j.landusepol.2022.106127
- Costa-Pierce, B. A., Thorarensen, H. T., & Strand, A. (2022).** Editorial: Ocean/aquatic food systems: Interactions with ecosystems, fisheries, aquaculture, and people. *Frontiers in Sustainable Food Systems*, 6, 3. doi:10.3389/fsufs.2022.1021801
- Dalahmeh, S. S., Thorsen, G., & Jonsson, H. (2022).** Open-air storage with and without composting as post-treatment methods to degrade pharmaceutical residues in anaerobically digested and dewatered sewage sludge. *Science of the Total Environment*, 806, 12. doi:10.1016/j.scitotenv.2021.151271
- De Pauw, K., Sanczuk, P., Meeussen, C., Depauw, L., De Lombaerde, E., Govaert, S., . . . De Frenne, P. (2022).** Forest understorey communities respond strongly to light in interaction with forest structure, but not to microclimate warming. *New Phytologist*, 233(1), 219-235. doi:10.1111/nph.17803
- Gasperini, C., Bollmann, K., Brunet, J., Cousins, S. A. O., Decocq, G., De Pauw, K., . . . De Frenne, P. (2022).** Soil seed bank responses to edge effects in temperate European forests. *Global Ecology and Biogeography*, 31(9), 1877-1893. doi:10.1111/geb.13568
- Hallen, J., Malmaeus, J. M., Johansson, N., & Karlsson, O. M. (2022).** Using a dynamic mass balance model to predict fate and transport of PCBs in a polluted boreal lake in Sweden. *Science of the Total Environment*, 853, 12. doi:10.1016/j.scitotenv.2022.158522
- Hassan, S., Sameer, S. H., Topel, M., & Aronsson, H. (2022).** MSALigMap-A Tool for Mapping Active-Site Amino Acids in PDB Structures onto Known and Novel Unannotated Homologous Sequences with Similar Function. *Life-Basel*, 12(12), 12. doi:10.3390/life12122082
- Jonsson, S., Mastro Monaco, M. N., Wang, F., Bravo, A. G., Cairns, W. R. L., Chetelat, J., . . . Heimburger-Boavida, L. E. (2022).** Arctic methylmercury cycling. *Science of the Total Environment*, 850, 21. doi:10.1016/j.scitotenv.2022.157445

Temaområde: **Hållbar miljö** (forts.)

- Jucker, T., Fischer, F. J., Chave, J., Coomes, D. A., Caspersen, J., Ali, A., ... Zavala, M. A. (2022).** Tallo: A global tree allometry and crown architecture database. *Global Change Biology*, 28(17), 5254-5268. doi:10.1111/gcb.16302
- Karlsson, P. E., Akselsson, C., Hellsten, S., & Karlsson, G. P. (2022).** Twenty years of nitrogen deposition to Norway spruce forests in Sweden. *Science of the Total Environment*, 809, 11. doi:10.1016/j.scitotenv.2021.152192
- Kinney, J. C., Assmann, K. M., Maslowski, W., Bjork, G., Jakobsson, M., Jutterstrom, S., ... Anderson, L. G. (2022).** On the circulation, water mass distribution, and nutrient concentrations of the western Chukchi Sea. *Ocean Science*, 18(1), 29-49. doi:10.5194/os-18-29-2022
- Krause, G., Le Vay, L., Buck, B. H., Costa-Pierce, B. A., Dewhurst, T., Heasman, K. G., ... Strand, A. (2022).** Prospects of Low Trophic Marine Aquaculture Contributing to Food Security in a Net Zero-Carbon World. *Frontiers in Sustainable Food Systems*, 6, 10. doi:10.3389/fsufs.2022.875509
- Kureshi, R. R., Mishra, B. K., Thakker, D., John, R., Walker, A., Simpson, S., ... Wante, A. K. (2022).** Data-Driven Techniques for Low-Cost Sensor Selection and Calibration for the Use Case of Air Quality Monitoring. *Sensors*, 22(3), 23. doi:10.3390/s22031093
- Liagkouridis, I., Awad, R., Schellenberger, S., Plassmann, M. M., Cousins, I. T., & Benskin, J. P. (2022).** Combined Use of Total Fluorine and Oxidative Fingerprinting for Quantitative Determination of Side-Chain Fluorinated Polymers in Textiles. *Environmental Science & Technology Letters*, 9(1), 30-36. doi:10.1021/acs.estlett.1c00822
- Liptzin, D., Boy, J., Campbell, J. L., Clarke, N., Laclau, J. P., Godoy, R., ... McDowell, W. H. (2022).** Spatial and Temporal Patterns in Atmospheric Deposition of Dissolved Organic Carbon. *Global Biogeochemical Cycles*, 36(10), 16. doi:10.1029/2022gb007393
- Liu, W. H., Huang, W. L., Cao, Z. H., Ji, Y., Liu, D. F., Huang, W. W., ... Lei, Z. F. (2022).** Microalgae simultaneously promote antibiotic removal and antibiotic resistance genes/bacteria attenuation in algal-bacterial granular sludge system. *Journal of Hazardous Materials*, 438, 10. doi:10.1016/j.jhazmat.2022.129286
- MacSween, K., Stupple, G., Aas, W., Kyllonen, K., Pfaffhuber, K. A., Skov, H., ... Mastromonaco, M. N. (2022).** Updated trends for atmospheric mercury in the Arctic: 1995-2018. *Science of the Total Environment*, 837, 13. doi:10.1016/j.scitotenv.2022.155802
- Malmmaeus, J. M., & Lindblom, E. (2022).** Quantifying pressures from Swedish industries impacting Sweden's Environmental Quality Objectives. *Impact Assessment and Project Appraisal*, 40(1), 46-59. doi:10.1080/14615517.2021.1984830
- Materic, D., Peacock, M., Dean, J., Futter, M., Maximov, T., Moldan, F., ... Holzinger, R. (2022).** Presence of nanoplastics in rural and remote surface waters. *Environmental Research Letters*, 17(5), 12. doi:10.1088/1748-9326/ac68f7
- Mattsson, E., Erlandsson, M., Karlsson, P. E., & Holmstrom, H. (2022).** A Conceptual Landscape-Level Approach to Assess the Impacts of Forestry on Biodiversity. *Sustainability*, 14(7), 15. doi:10.3390/su14074214
- Mattsson, K., Ekstrand, E., Granberg, M., Hasselov, M., & Magnusson, K. (2022).** Comparison of pre-treatment methods and heavy density liquids to optimise microplastic extraction from natural marine sediments. *Scientific Reports*, 12(1), 9. doi:10.1038/s41598-022-19623-5
- McMillan, H. K., Coxon, G., Sikorska-Senoner, A. E., & Westerberg, I. K. (2022).** Impacts of observational uncertainty on analysis and modelling of hydrological processes: Preface. *Hydrological Processes*, 36(2), 10. doi:10.1002/hyp.14481
- Monclus, L., Loseth, M. E., Persson, M. J. D., Eulaers, I., Kleven, O., Covaci, A., ... Nygard, T. (2022).** Legacy and emerging organohalogenated compounds in feathers of Eurasian eagle-owls (*Bubo bubo*) in Norway: Spatiotemporal variations and associations with dietary proxies (delta C-13 and delta N-15). *Environmental Research*, 204, 9. doi:10.1016/j.envres.2021.112372
- Naaf, T., Feigs, J. T., Huang, S. Y., Brunet, J., Cousins, S. A. O., Decocq, G., ... Kramp, K. (2022).** Context matters: the landscape matrix determines the population genetic structure of temperate forest herbs across Europe. *Landscape Ecology*, 37(5), 1365-1384. doi:10.1007/s10980-021-01376-7
- Peacock, M., Futter, M. N., Jutterstrom, S., Kothawala, D. N., Moldan, F., Stadmark, J., & Evans, C. D. (2022).** Three Decades of Changing Nutrient Stoichiometry from Source to Sea on the Swedish West Coast. *Ecosystems*, 25(8), 1809-1824. doi:10.1007/s10021-022-00798-x
- Pleijel, H., Danielsson, H., & Broberg, M. C. (2022).** Benefits of the Phytotoxic Ozone Dose (POD) index in dose-response functions for wheat yield loss. *Atmospheric Environment*, 268, 7. doi:10.1016/j.atmosenv.2021.118797
- Plue, J., Kimberley, A., Bullock, J. M., Hellemans, B., Hooftman, D. A. P., Krickl, P., ... Honnay, O. (2022).** Green infrastructure can promote plant functional connectivity in a grassland species around fragmented semi-natural grasslands in NW-Europe. *Ecography*, 2022(10), 14. doi:10.1111/ecog.06290
- Putz, K. W., Namazkar, S., Plassmann, M., & Benskin, J. P. (2022).** Are cosmetics a significant source of PFAS in Europe? product inventories, chemical characterization and emission estimates. *Environmental Science-Processes & Impacts*, 24(10), 1697-1707. doi:10.1039/d2em00123c
- Regnell, O., Tesson, S. V. M., Oskolkov, N., & Nerentorp, M. (2022).** Mercury-Selenium Accumulation Patterns in Muscle Tissue of Two Freshwater Fish Species, Eurasian Perch (*Perca fluviatilis*) and Vendace (*Coregonus albula*). *Water Air and Soil Pollution*, 233(7), 13. doi:10.1007/s11270-022-05709-3
- Schellenberger, S., Liagkouridis, I., Awad, R., Khan, S., Plassmann, M., Peters, G., ... Cousins, I. T. (2022).** An Outdoor Aging Study to Investigate the Release of Per-And Polyfluoroalkyl Substances (PFAS) from Functional Textiles. *Environmental Science & Technology*, 56(6), 3471-3479. doi:10.1021/acs.est.1c06812
- Selin, E., Wann, M., Svensson, K., Gravenfors, E., Giovanoulis, G., Oskarsson, A., & Lundqvist, J. (2022).** Hazardous chemicals in non-polar extracts from paper and cardboard food packaging: an effect-based evaluation. *Environmental Sciences Europe*, 34(1), 14. doi:10.1186/s12302-022-00666-4
- Sinha, R., Thomas, J. B. E., Strand, A., Soderqvist, T., Stadmark, J., Franzen, F., ... Hasselstrom, L. (2022).** Quantifying nutrient recovery by element flow analysis: Harvest and use of seven marine biomasses to close N and P loops. *Resources Conservation and Recycling*, 178, 11. doi:10.1016/j.resconrec.2021.106031
- Soderqvist, T., Nathaniel, H., Franzen, D., Franzen, F., Hasselstrom, L., Grondahl, F., ... Thomas, J. B. (2022).** Cost-benefit analysis of beach-cast harvest: Closing land-marine nutrient loops in the Baltic Sea region. *Ambio*, 51(5), 1302-1313. doi:10.1007/s13280-021-01641-8
- Sokhi, R. S., Moussiopoulos, N., Baklanov, A., Bartzis, J., Coll, I., Finardi, S., ... Kukkonen, J. (2022).** Advances in air quality research - current and emerging challenges. *Atmospheric Chemistry and Physics*, 22(7), 4615-4703. doi:10.5194/acp-22-4615-2022
- Vijayan, A., Osterlund, H., Magnusson, K., Marsalek, J., & Viklander, M. (2022).** Microplastics (MPs) in urban roadside snowbanks: Quantities, size fractions and dynamics of release. *Science of the Total Environment*, 851, 14. doi:10.1016/j.scitotenv.2022.158306
- Westerberg, I. K., Sikorska-Senoner, A. E., Viviroli, D., Vis, M., & Seibert, J. (2022).** Hydrological model calibration with uncertain discharge data. *Hydrological Sciences Journal*, 67(16), 2441-2456. doi:10.1080/02626667.2020.1735638

Theme area: Sustainable transition

- Akhtar, N., Bokhari, S. A., Martin, M. A., Saqib, Z., Khan, M. I., Mahmud, A., . . . Amir, S. (2022).** Uncovering Barriers for Industrial Symbiosis: Assessing Prospects for Eco-Industrialization through Small and Medium-Sized Enterprises in Developing Regions. *Sustainability*, 14(11), 21. doi:10.3390/su14116898
- Baresel, C., Yang, J. J., Bornold, N., Tjus, K., Kanders, L., & Westling, K. (2022).** Direct GHG emissions from a pilot scale MBR-process treating municipal wastewater. *Advances in Climate Change Research*, 13(1), 138-145. doi:10.1016/j.accr.2021.09.006
- Brunskog, J., Glebe, D., Garza-Agudelo, D., & Nilsson, E. (2022).** Absorption and scattering by perforated facings with periodic narrow slits. *Journal of the Acoustical Society of America*, 151(3), 1847-1859. doi:10.1121/10.0009826
- Cascone, C., Murphy, K. R., Markensten, H., Kern, J. S., Schleich, C., Keucken, A., & Kohler, S. J. (2022).** AbspectroscOPY, a Python toolbox for absorbance-based sensor data in water quality monitoring. *Environmental Science-Water Research & Technology*, 8(4), 836-848. doi:10.1039/d1ew00416f
- Kathare, M., Julander, A., Erfani, B., & Schenk, L. (2022).** An Overview of Cleaning Agents' Health Hazards and Occupational Injuries and Diseases Attributed to Them in Sweden. *Annals of Work Exposures and Health*, 66(6), 741-753. doi:10.1093/annweh/wxac006
- Martinsson, J., Runefors, M., Frantzich, H., Glebe, D., McNamee, M., & Mogren, O. (2022).** A Novel Method for Smart Fire Detection Using Acoustic Measurements and Machine Learning: Proof of Concept. *Fire Technology*, 58(6), 3385-3403. doi:10.1007/s10694-022-01307-1
- Strandberg, B., Osterman, C., Akdeva, H. K., Moldanova, J., & Langer, S. (2022).** The Use of Polyurethane Foam (PUF) Passive Air Samplers in Exposure Studies to PAHs in Swedish Seafarers. *Polycyclic Aromatic Compounds*, 42(2), 448-459. doi:10.1080/10406638.2020.1739084
- Yu, I. K. M., Rechberger, H., Gutberlet, J., Istrate, I. R., Parizeau, K., McQuillian, H., & de Barcellos, M. D. (2022).** Closing the waste gap. *One Earth*, 5(11), 1181-1184. Retrieved from <Go to ISI>://WOS:000906387900002
- Bauer, F., Nielsen, T. D., Nilsson, L. J., Palm, E., Ericsson, K., Frane, A., & Cullen, J. (2022).** Plastics and climate change-Breaking carbon lock-ins through three mitigation pathways. *One Earth*, 5(4), 361-376. doi:10.1016/j.oneear.2022.03.007
- Palm, E., Hasselbalch, J., Holmberg, K., & Nielsen, T. D. (2022).** Narrating plastics governance: policy narratives in the European plastics strategy. *Environmental Politics*, 31(3), 365-385. doi:10.1080/09644016.2021.1915020

Thematic area: Sustainable society

- Camarasa, C., Mata, E., Navarro, J. P. J., Reyna, J., Bezerra, P., Angelkorte, G. B., . . . Yaramenka, K. (2022).** A global comparison of building decarbonization scenarios by 2050 towards 1.5-2 degrees C targets. *Nature Communications*, 13(1), 11. doi:10.1038/s41467-022-29890-5
- Creutzig, F., Niamir, L., Bai, X. M., Callaghan, M., Cullen, J., Diaz-Jose, J., . . . Urge-Vorsatz, D. (2022).** Demand-side solutions to climate change mitigation consistent with high levels of well-being. *Nature Climate Change*, 12(1), 36-+. doi:10.1038/s41558-021-01219-y
- Elginöz, N., Owusu-Agyeman, I., Goran, F., Hirschier, R., Rydberg, T., & Cetecioglu, Z. (2022).** Application and adaptation of a scale-up framework for life cycle assessment to resource recovery from waste systems. *Journal of Cleaner Production*, 355, 12. doi:10.1016/j.jclepro.2022.131720
- Elginöz, N., Papadaskalopoulou, C., & Harris, S. (2022).** Using life cycle assessment at an early stage of design and development of zero discharge brine treatment and recovery. *Water Resources and Industry*, 28, 12. doi:10.1016/j.wri.2022.100184
- Ellingsen, L. A. W., Thorne, R. J., Wind, J., Figenbaum, E., Romare, M., & Nordelof, A. (2022).** Life cycle assessment of battery electric buses. *Transportation Research Part D-Transport and Environment*, 112, 13. doi:10.1016/j.trd.2022.103498
- Fagerstrom, A., Abdelaziz, O., Poulidikou, S., Lewren, A., Hultheberg, C., Wallberg, O., & Rydberg, T. (2022).** Economic and Environmental Potential of Large-Scale Renewable Synthetic Jet Fuel Production through Integration into a Biomass CHP Plant in Sweden. *Energies*, 15(3), 17. doi:10.3390/en15031114
- Friberg, R., & Sanctuary, M. (2022).** Matched trade at the firm level and the micro origins of international business-cycle comovement. *International Journal of Finance & Economics*, 27(3), 2997-3009. doi:10.1002/ijfe.2309
- Hagbert, P., Perjo, L., & Nyblom, A. (2022).** Taking the lead or following norms? Examining intersections of power in sustainability transitions in Swedish housing associations. *Environmental Sociology*, 8(2), 187-198. doi:10.1080/23251042.2021.1997386
- Hao, L. J., Yin, H., Wang, J. F., Tian, M., Wang, X. H., Ge, Y. S., . . . Sjodin, K. (2022).** Research on Analysis Method of Remote Sensing Results of NO Emission from Diesel Vehicles. *Atmosphere*, 13(7), 16. doi:10.3390/atmos13071100
- Hao, L. J., Zhao, Z. H., Yin, H., Wang, J. F., Li, L. J., Lu, W. H., . . . Sjodin, A. (2022).** Study of durability of diesel vehicle emissions performance based on real driving emission measurement. *Chemosphere*, 297, 7. doi:10.1016/j.chemosphere.2022.134171
- Harris, S., Kanders, L., Vassallo, F., Cipollina, A., Ebrahimi, S., & Xevgenos, D. (2022).** Challenges in preparing for Environmental Technology Verification in a demonstration project: A case study of three innovative water treatment technologies. *Water Resources and Industry*, 28, 12. doi:10.1016/j.wri.2022.100176
- Harris, S., & Reigeluth, S. (2022).** Editorial-Circular economy solutions for industrial brines. *Water Resources and Industry*, 28, 4. doi:10.1016/j.wri.2022.100192
- Kanchiralla, F. M., Brynolf, S., Malmgren, E., Hansson, J., & Grahn, M. (2022).** Life-Cycle Assessment and Costing of Fuels and Propulsion Systems in Future Fossil-Free Shipping. *Environmental Science & Technology*, 56(17), 12517-12531. doi:10.1021/acs.est.2c03016
- Lygnerud, K., Klugman, S., Fransson, N., & Nilsson, J. (2022).** Risk assessment of industrial excess heat collaborations e Empirical data from new and ongoing installations. *Energy*, 255, 9. doi:10.1016/j.energy.2022.124452
- Lygnerud, K., & Langer, S. (2022).** Urban Sustainability: Recovering and Utilizing Urban Excess Heat. *Energies*, 15(24), 11. doi:10.3390/en15249466
- Martin, M., Weidner, T., & Gullstrom, C. (2022).** Estimating the Potential of Building Integration and Regional Synergies to Improve the Environmental Performance of Urban Vertical Farming. *Frontiers in Sustainable Food Systems*, 6, 18. doi:10.3389/fsufs.2022.849304
- Mata, E., Kihila, J. M., Wanemark, J., Cheng, S. H., Harris, S., Sandkvist, F., . . . Yaramenka, K. (2022).** Non-technological and behavioral options for decarbonizing buildings - A review of global topics, trends, gaps, and potentials. *Sustainable Production and Consumption*, 29, 529-545. doi:10.1016/j.spc.2021.10.013
- Moldanova, J., Hassellöf, I. M., Matthias, V., Fridell, E., Jalkanen, J. P., Ytreberg, E., . . . Eriksson, K. M. (2022).** Framework for the environmental impact assessment of operational shipping. *Ambio*, 51(3), 754-769. doi:10.1007/s13280-021-01597-9





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