

ANNUAL REPORT
IVL SWEDISH ENVIRONMENTAL
RESEARCH INSTITUTE

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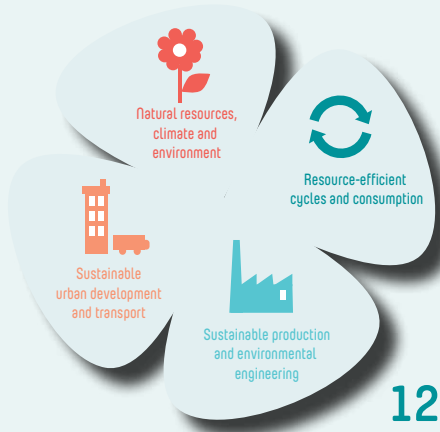
We monitor
road traffic emissions

Big gains with
digital waste management

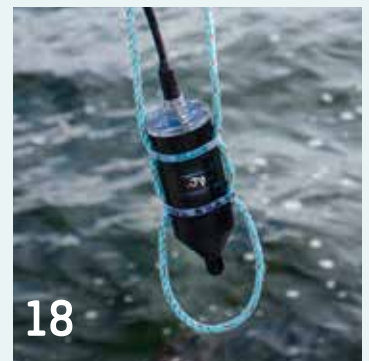
The smart city
heating itself

Sweden can become fossil-free
without prosperity collapsing

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Our work for a sustainable society

With a broad environmental profile and specialist expertise, we are continuing our long-term work using measures and solutions that contribute to the global goals and Agenda 2030. On the spread on pages 8-9, our Head of Research and Head of Business Development will disentangle the concepts between our advanced research, our targeted assignments and what we offer our customers. In this year's Annual Report, you can also read about some of our exciting projects. The breadth of our work requires a high level of coordination, which is why we are working according to four thematic areas.

Within the thematic area **Natural resources, climate and environment**, you can read about our project in Kristineberg on sustainable blue economy, including examples of food technology, biofuels, boat bottom paint and tourism. Our investment in the marine field, with our employees based at the Kristineberg Marine Research and Innovation Centre, is now beginning to produce results. We also describe our work on underwater noise, which disturbs marine life and may be affecting fish stocks and entire ecosystems. Did you know that mussels, which can't even hear, are stressed by noise? This is one of the exciting results to have emerged from our study. Later in our Annual Report you can read more about shipping and how, by installing scrubbers, it is possible to clean ship exhaust fumes to meet new sulphur requirements that are entering into force in 2020.

Within the thematic area **Resource-efficient cycles and consumption**, you can read about digital waste management and the opportunities this represents for the sector – a sector that is facing extensive digitalisation. We can testify to the fact that electrification of transport is high on the agenda, and be sure to read about IVL's intensive research efforts resulting from the boom in electric cars.

A sustainable Swedish chemical industry is a significant area of focus for IVL, and within the thematic area **Sustainable production and environmental technology**, we are working with several projects. These include SusChem, a Swedish platform for a sustainable chemical industry that aims to increase collaboration between industry and research.

As part of the work of contributing to a fossil-free transport sector in the Nordic region, the Nordic research project **Shift** is now summarising four years of studies regarding transforming the transport sector in a project within our thematic area **Sustainable urban development and transport**. You can also read about how smart cities can heat themselves, as well as the great opportunities that exist in terms of all the energy we are wasting at present. You can also join us as we pay a visit to Green Solberga, a collaboration with Stockholmshem and their tenants. Together with small businesses, the tenants have had the opportunity to cooperate on everything from fish farming and cultivating herbs in a basement to exchange projects aimed at achieving a greener and more sustainable district.

In this year's Annual Report, we describe the project that was "dieselgate on rails" in the early stages, as well as how our monitoring of emissions from traffic is continuing to improve the air in our cities. Thanks to our dedicated and skilled employees, 2019 was another successful year in our development.

Happy reading!



TORD SVEDBERG, CEO

IMPORTANT EVENTS IN 2019

In 2019, IVL launched a collaboration with IKEM and the Swedish chemical industry to establish **SusChem Sweden**, a Swedish node for the European technology platform SusChem. SusChem works to inspire the European chemical industry to help solve the major challenges in society.

In 2019, the **Mistra SafeChem** programme, led by IVL, was granted approval. This programme aims to promote the expansion and implementation of a safe, sustainable and green chemical industry. The programme combines innovative research into new manufacturing processes, new tools for risk screening and risk assessment, life cycle analysis as well as material handling with industrial ambitions.

In 2019, the Vinnova initiative **Climate-leading process industry** was launched with the West Swedish Chemical and Material Cluster, in which IVL is contributing with e.g. the mapping of renewable raw material resources in Västra Götaland.

A number of projects funded by Vinnova and the EU's research programmes are focused on digitalisation to support safe water management and supply. In these projects, IVL develops and applies combinations of digital tools such as sensors and models in the EU project **Water Harmony**. Via open data in digital twins for water treatment plants, innovative new products are being developed for sustainable water treatment in the Vinnova project **Open Waters Digital Twin**.

IVL's operations in China have been built up with funding in the form of grants, the EU's research budget, funding from Swedish companies in China and from Swedish financing organisations such as the Swedish Agency for Economic and Regional Growth, the Swedish Energy Agency, Vinnova and Formas. IVL has managed to obtain funding from the Chinese Ministry of Science and Technology, including to extend the R&D collaboration between China and the EU within Next Gen.

For many years, IVL has conducted project activities in **India**, mostly financed by Sweden, Swedish companies and the EU. In one project funded by the EU's aid budget, IVL has advised Mumbai and Delhi on how to solve their water and waste problems. As a result, IVL has established an office in Mumbai.

IVL's experts emerge as the foremost in their field

The IVL Swedish Environmental Research Institute has had a strong 2019. The business is continuing to grow and CEO Tord Svedberg, along with IVL's employees, has done an excellent job during the year.

Our long-term work for the climate and the environment is now producing results in society, particularly in the business sector, where we are working more and more actively to achieve our climate goals. In the transition to carbon dioxide neutrality that the whole of Sweden is now facing, IVL is a particularly secure and knowledgeable partner, providing support and assistance in the climate work. Thanks to our long-term commitment and sound knowledge, we are able to influence companies' sustainability benefits.

Through our ongoing business intelligence, we determine the areas we are going to work with in order to approach IVL's vision of a sustainable society, but also more tangibly to obtain a better knowledge of the areas where we need to develop our offerings and establish future operations – both within research and consultancy.

FOCUS ON DIGITALISATION

During the year, IVL has focused heavily on digitalisation, which has become a central component in many companies' environmental and sustainability work.

Digitalisation is making advances everywhere and is becoming an increasingly important area for our customers, which is why we are working strategically in this area. Here, opportunities are opening up for our customers to use new technology to develop and streamline their operations with sustainable solutions. IVL is involved in a larger number of digitalisation projects, both within research and in our consultancy assignments, which will contribute to us achieving our climate goals and which can also strengthen the competitiveness of the companies.

IVL's visibility in the media has become particularly evident. One of IVL's employee can be seen or heard on the radio, TV or in newspapers just about every week. This might relate to transport, plastics, the phasing out of coal-fired power, waste, sustainable urban planning – or

some other area covered by IVL's wide range of activities.

This visibility stems from IVL's high degree of relevance. The issues IVL has been working on for many years have now emerged as highly topical and crucial from a social perspective, and IVL is now occupying more space in the debate. IVL's experts are emerging as the foremost in their respective fields.

Our visibility is also a result of strategically targeted communication work. This is in line with IVL's overall strategy and social remit. We aim to deliver benefits through our substantial expertise in the fields of sustainability and the environment.

IVL's strategy remains unchanged: by means of our great expertise across the entire environmental field and our proximity to our customers, we will deliver benefits, both directly to our customers and strategically to achieve the vision of a sustainable society. Based on our independence, our credibility and our holistic approach, we will be an obvious choice for a long-term, sustainable collaboration between the business sector, academia and society. This interaction between the state and the business community is one of the cornerstones of IVL's activities. It is important for it to be nurtured and developed.

NEW DEVELOPMENT WITH NEW CEO

After twelve successful years as CEO, Tord Svedberg announced his retirement during the year. Tord has lifted the business and developed IVL into a successful company, which has grown into one of the foremost players in the field of sustainability and the environment.

IVL is now both strong and well equipped to cope with future challenges. Marie Fossum Strannegård will take up the position as the new CEO during the spring, and will be taking IVL into the next phase of our development. The Board is happy and excited, and considers that Marie's business experience and expertise in the fields of digitalisation, sustainability and communication will be a valuable asset for IVL's continued development.

Twelve years in the service of the environment and the climate – now I'm handing over the baton

It is now twelve years since I climbed the stairs and stepped in as CEO of the IVL Swedish Environmental Research Institute. It was a company I had already come across as a customer and on whose board I had sat, so even though the assignment was new, I was very familiar with our challenges and opportunities.

At that time, in 2008, there were around 160 people working on climate issues here: experts, researchers and specialists. Twelve years later, that number has now grown to 322. These have been exciting years characterised by development, filled with challenges and major advances. We have enjoyed strong growth, and we have succeeded in both developing the business and winning more and more space in the media.

SALES HAVE MORE THAN DOUBLED

In monetary terms, our operation has more than doubled in size. Sales have increased by 135 percent, from MSEK 163 in 2007 to MSEK 383 in 2019. We have enjoyed positive profitability over this time, and it is very gratifying to know that we have achieved a profit margin of 5.3 percent in 2019, which we are investing to strengthen our position and to be able to invest in new areas.

We have continually regenerated ourselves in line with developments in the field of sustainability and the environment, and adapted our business in accordance with the changing need for our services. At all times, we have kept our sights firmly set on our vision: a sustainable society.

In order to develop specific areas and push through developments within environmental and climate activities, we have established subsidiaries, such as BASTA and EPD International. These are still small, although net sales have increased significantly and now amount to just over MSEK 7.

Our mission is for research and other results to be applied by both the business sector and public authorities, with the goal of achieving increased sustainability benefits. We will be turning science into reality, as we like to say. In order to disseminate this knowledge, we need strategically targeted communication

work, an area that we have invested in and that has borne fruit. We have developed meeting places where business and the state can meet, for the benefit of a sustainable society. Our visibility in the media has increased significantly, from 752 press clippings in 2012 when we first started recording this parameter, to 3,385 in 2019.

We have changed our logo and profile, strengthened our brand and expanded. IVL's logo can now be found in many places around the world. It can be seen at our offices in Stockholm, Gothenburg, Malmö, Fiskebäckskil, Beijing and Mumbai.

In recent years, we have embarked on a digital journey that is set to continue. This applies in particular to our offerings and services, where digital tools are becoming increasingly important in the sustainability work. This also applies to our own operations, where we have elevated our premises in Stockholm and Gothenburg and developed workplaces that make it easier for employees to communicate and collaborate.

IVL's research is an integral part of the company's operations and a prerequisite for being able to conduct a consultancy assignment with cutting-edge expertise, and has contributed greatly to us being able to establish ourselves as a credible institute. The breakdown between consultancy and research remains at around 50/50.

CREATIVE ATMOSPHERE

This journey of success has been possible thanks to our skilled and incredibly dedicated employees. For a knowledge company like IVL, it is absolutely vital to be an attractive employer that is able to retain talented employees and attract new ones. Now, as I hand over the CEO baton in 2020, I will miss the creative and informal atmosphere that exists within IVL. I am convinced that IVL has the expertise and the position in society, including internationally, to enable it to meet future challenges for the benefit of our customers and for society at large. I am leaving confident in the knowledge that IVL will continue to contribute to the development of a sustainable society.

Who we are

The IVL Swedish Environmental Research Institute is an independent research institute in the field of sustainability and the environment. We work with applied research and consultancy assignments, which contribute to meeting both the global sustainability goals and the environmental goals adopted by the Swedish government.

OUR EXPERTISE

In addition to scientific expertise in respect of the environment, we also include behavioural scientists, economists and sociologists among our employees. We possess both broad-based and specialist expertise – almost a third of our employees have doctorates.

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

The owner foundation 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. The foundation's Board of Directors appoints members to the Board of the Directors of the limited liability company IVL. The state and the business community are also represented on the company's Board of Directors with an equal number of members.

OUR SUBSIDIARIES

In addition to the parent company IVL, the Group also consists of the following subsidiaries:

- Bastaonline AB
- EPD International AB
- IVL Environmental Technologies (Beijing) Company Ltd and the joint venture company SEC in China
- The pilot and test facility Hammarby Sjöstadsverk, which IVL owns along with KTH



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

What we do

We conduct advanced research and carry out targeted assignments for companies and organisations that require expert assistance in the environmental field.

We build up our expertise through research and by analysing the outside world. The results we produce are leading to new methods and in-depth knowledge. This is how we safeguard quality and relevance in our assignments.



Whom we serve

IVL is driving through the transition to a sustainable society through applied research and development, in close cooperation with the business community and the public sector. Our commissions are based on science, and our research is characterised by an interdisciplinary and systematic approach.

We identify development needs and knowledge gaps through an ongoing dialogue with decision-makers from the business community, public authorities, local authorities and other relevant stakeholders, in order to meet current and future sustainability challenges.

CUSTOMERS

IVL's customers can be found in both the private and public sectors, and span a large number of industries and value chains. Actors in the public sector include the state, public authorities and local authorities. IVL's interdisciplinary expertise and independent position are in great demand, both within consultancy assignments in order to meet specific needs in relation to strategic and operational environmental and sustainability work, as well as in research projects to resolve common challenges.

OWNERSHIP

The Swedish Institute of Water and Air Conservation Research Foundation (SIVL) is the sole owner of IVL and will, alongside the business sector and government agencies, establish a collaboration regarding important issues in the fields of the environment and sustainable development. The foundation funds research and innovation with particular focus on applied issues with an interdisciplinary and system-oriented approach.

ACADEMY

IVL collaborates with national and international universities and research institutes, in order to contribute both to the development of new knowledge and to the application of the latest academic findings in industry and the public sector.

PROFESSIONAL AND TRADE ASSOCIATIONS

As an independent player, IVL is an important meeting place for cross-industry issues, as well as an arena for meetings between industry and authorities. We collaborate closely with professional and trade associations in many projects.

Anyone who engages us as consultants gets all our research in the bargain

The IVL Swedish Environmental Research Institute not only conducts advanced research, but also performs targeted consultancy assignments for companies that require expert assistance in relation to the environment. In this regard, Anna Jarnehammar, Head of Business Development, and John Munthe, Vice-President, Research, discuss a lesser-known, but still important part of IVL.

“We carry out equal amounts of research and consultancy work. Half of IVL’s operations are made up of external assignments for companies, government authorities or other organisations. But some of our customers are unaware of this fact, that our consultancy assignments are just as important as our research – and that we are just as good when it comes to carrying out assignments,” says Anna Jarnehammar, Head of Section for *Research, Business Development and International Affairs* at IVL.

“These consultancy assignments can be either small or large in scope. An example of this is when the grocery chain Lidl required assistance to carry out more accurate calculations of their flagship store’s climate debt. It is difficult when the energy comes from so many different sources over the course of a day. For this assignment, IVL’s experts developed a method to measure climate debt on an hour-by-hour basis. Or when LKAB is required by the authorities to perform flow measurements and analyse the quality of the water in streams and lakes in association with mining – then it is IVL, with 50 years of experience in hydrological studies, that has the expertise to deal with this.”

What are the benefits of being an institute working with both research and consultancy projects?

John Munthe, Vice-President, Research:

“In a perfect world, the two elements complement each other. We build up our expertise through research, produce methods, new knowledge and other results, and thereby safeguard the quality and relevance of our assignments. Correspondingly, we can see that the consultancy assignments play a role by identifying the areas where more research is needed. The assignments are often carried out closer to the end user, and this is frequently accompanied by dialogue about future knowledge requirements.”

Anna Jarnehammar:

“When you engage IVL as a consultant, you always get our research in the bargain. We have loads of databases. We keep a close eye on Sweden’s climate emissions. We’ve been conducting life cycle assessments for years. We can put things into context, distinguish the big from the small, to ensure that the focus is placed on the right measures.”

What will the culture be like at IVL when consultants and researchers are brought together under the same roof?

John:

“I think there will be a positive symbiosis. You often find that the same people carry out both aspects, although not always. Regardless of this, we always share our knowledge and contacts. And it’s not just the case that the researchers are contributing to the consultants’ knowledge – it’s just as common for sharing to take place in the other direction. People who work with consultancy assignments are good at defining problems and knowledge requirements. When this interaction is working optimally, I feel that this elevates our projects. Nor is it the case that we draw a distinction internally, either financially or career-wise. We are just as happy about large research assignments as about large consultancy assignments.”

As a customer, however, you don’t always want complex research results, but rather something that is specifically adapted to your own business, don’t you?

John:

“Yes, and the research differs from the consultancy assignments in such instances. If a company approaches IVL with a problem they want a specific answer to, then we adapt the assignment to the customer’s needs. Listening to the customer is a basic prerequisite for being able to sell assignments – what do they want and can we help them with this? It requires knowledge, experience and flexibility. And working to solve problems is right at the heart of IVL.”

What do you consider to be the main reasons for customers choosing to engage IVL?

Anna:

“We can see from our annual customer surveys that one of the most important reasons is our unique expertise, where in certain cases there are simply no alternatives in the market. We employ more than 300 environmental specialists covering virtually all areas – science, politics, engineering, behavioural research – yet all with the focus on sustainability and the environment. This is accompanied by the fact that we have a good reputation and that a result from us is credible. In fact, 100% of the respondents were happy to engage IVL again. That’s been the situation for the last three years.

Another thing that our customers appreciate is that they are



John Munthe, Vice-President, Research, and Anna Jarnehammar, Head of Section for Research, Business Development and International Affairs at IVL

invited to take part in the implementation process. They feel that they are increasing their skills, and have a completely different view of how the results can be applied. One difficulty when engaging a consultant often relates to taking the results and implementing them in your company at the end of the assignment.”

John:

“When you are facing a new challenge or a difficult problem in respect of how to manage your environmental and sustainability work, IVL is a good partner. We may not suggest the easiest way forward, but we can tackle the problem from a holistic perspective and bring together skills from several different areas.”

Anna:

“I would like to mention our independence at this point, which contributes to our credibility. Coupled with the fact that we are always at the forefront, as we work with both research and assignments. This means that we can work here and now, yet at the same time bring knowledge to individual assignments regarding future requirements and developments in the field. We can see around the corner.”

John:

“In addition, we shouldn’t forget that we have a number of subsidiaries. These include one in China, which is an important operation with a local office in Beijing and local employees who are familiar with the Chinese bureaucracy and its systems. We have this subsidiary because there is an enormous amount to do in respect of the climate and the environment in China. We cooperate with universities and institutes there, although we also help Swedish companies that have operations in China.”

IVL is independent, you say. Could this mean that IVL might deliver results that the customer had not envisioned?

John:

“That can happen. We try to be responsive to our customers, yet we conduct independent investigations and do not produce any adjusted results.”

A customer might occasionally receive assistance in relation to funding through co-funded projects. How does this work?

Anna:

“If you have a problem that relates to more than one company, perhaps an entire sector, then we have the potential to develop co-funded projects, where the state can provide half the funding through IVL’s ownership foundation. We frequently take the initiative for this, and it is not uncommon for this to take place with customers that we have built up a good relationship with. In this case, the issue should be a little broader and should not just concern the individual company, and the results must be public in the form of a report or similar.”

What do you gain by being involved in a collaboration with IVL, if others can read the report for free afterwards?

John:

“In our co-funded research, we design the projects in dialogue with the business partner or partners and execute the projects in close cooperation with them. This naturally provides greater insight and a better transfer of knowledge.”

Anna:

“Exactly. You build up the skills in your own organisation. As a company, you can obtain entirely new insights that allow you to improve your own business model and identify new business opportunities by participating with a broader base of companies. The actual learning journey is often just as important as the destination.”

What will the future be like, and what business models might see the light of day?

Anna:

“We have a bright outlook, and believe that IVL’s expertise and offering will be even more relevant in future. For example, we have doubled our sales in ten years and are continuing to witness strong growth. The transition to a more sustainable society means that the solutions that are being developed now will become part of the core business of companies more rapidly. We can see potential in more circular business models, such as reuse in the construction sector and additional services in the energy and manufacturing sectors. I also hope that we can develop more licensing services, such as helping companies more continuously.”



IVL contributes to achieving the Global Sustainable Development Goals



Carin Ström

Agenda 2030 and the UN's 17 Global Sustainable Development Goals (SDGs) were adopted in 2015. The goals cover and integrate all three dimensions of sustainable development: *economic*, *social* and *environmental*. This has increased the collective understanding of the need to solve the climate crisis, reduce inequalities and eliminate extreme poverty by 2030 – without exceeding the planet's ecological limits.

There are only ten years left until 2030 and the climate threat is imminent. Achieving the UN's goals requires new and additional measures, as well as a systematic approach when dealing with current and future challenges.

The world around us is constantly changing. Sustainable development requires us all to act together. IVL works with actors from all sectors of society in order to identify and realise solutions and opportunities that will lead to a sustainable society.

Here at IVL, we are convinced: That meeting the SDGs will create a better world for everyone. We work with applied research and consultancy assignments, which contribute to meeting both the global sustainability goals and the Swedish environmental goals adopted by the government.

The 17 goals within Agenda 2030 are divided into 169 interim goals. IVL's work is intended to contribute directly to more than 40 of these. On the following pages, you can read about several examples of the way we work.

The global goals are interconnected and comprehensive. In several cases, this means that measures aimed at achieving one goal will also contribute to or counteract other goals. IVL's work is characterised by a holistic approach and a lifecycle perspective, and our ambition is to identify synergies and conflicting aims as well as to propose measures and solutions that will contribute to Agenda 2030 as a whole.

Carin Ström,
research coordinator,
IVL Swedish Environmental Research Institute

How IVL contributes to the global goals

<p>ZERO HUNGER</p>  <p>IVL contributes to:</p> <ul style="list-style-type: none"> - sustainable food production systems where ecosystems are maintained, which strengthen the capacity to adapt to climate change and progressively improve land and soil quality. <p>Relevant interim goal: 2.4</p>	<p>GOOD HEALTH AND WELL-BEING</p>  <p>IVL contributes to:</p> <ul style="list-style-type: none"> - reducing instances of death and disease caused by harmful chemicals, pollution and contamination of air, water and soil. - strengthening early warning, risk reduction and management capabilities in relation to national and global health risks. <p>Relevant interim goals: 3.9, 3.d</p>	<p>CLEAN WATER AND SANITATION</p>  <p>IVL contributes to:</p> <ul style="list-style-type: none"> - achieving universal and fair access to safe drinking water and sanitation by developing and introducing technologies for water collection, desalination, water efficiency, wastewater treatment, recycling and reuse. <p>Relevant interim goals: 6.1-6, 6.a, 6.b</p>
<p>AFFORDABLE AND CLEAN ENERGY</p>  <p>IVL contributes to:</p> <ul style="list-style-type: none"> - ensuring universal access to a significantly increased share of renewable energy in the global energy mix, and to affordable, reliable and modern energy services. - accelerating the pace when it comes to improving energy efficiency and strengthening international collaboration in respect of research and technology for clean and renewable energy. <p>Relevant interim goals: 7.1-3, 7.a, 7.b</p>	<p>DECENT WORKING CONDITIONS AND ECONOMIC GROWTH</p>  <p>IVL contributes to:</p> <ul style="list-style-type: none"> - improving resource efficiency in production and consumption, breaking the link between environmental destruction and growth. - promoting a safe working environment. <p>Relevant interim goals: 8.4, 8.8</p>	<p>INDUSTRY, INNOVATION AND INFRASTRUCTURE</p>  <p>IVL contributes to:</p> <ul style="list-style-type: none"> - revitalising infrastructure and industry to make them sustainable, with more efficient use of resources as well as environmentally friendly technologies and industrial processes. - supporting domestic technological development, research and innovation in developing countries. <p>Relevant interim goals: 9.2, 9.4, 9.5, 9.b</p>
<p>SUSTAINABLE CITIES AND COMMUNITIES</p>  <p>IVL contributes to:</p> <ul style="list-style-type: none"> - reducing the negative environmental impact of cities by working on air quality and the management of municipal and other waste. - affordable, accessible and sustainable transport systems for all, as well as inclusive and sustainable urbanisation. - cities and communities implementing integrated plans for inclusion, resource efficiency, climate change mitigation and adaptation, as well as resilience to disasters. <p>Relevant interim goals: 11.1-3, 11.5-8</p>	<p>RESPONSIBLE CONSUMPTION AND PRODUCTION</p>  <p>IVL contributes to:</p> <ul style="list-style-type: none"> - environmentally friendly handling of chemicals throughout their life cycle, as well as significantly reducing emissions and discharges into the air, water and soil in order to minimise negative consequences for health and the environment. - reducing waste through preventive measures, reuse and recycling. - encouraging companies to implement sustainable practices and integrate sustainability information in their reporting cycle. - identifying and eliminating inefficient fossil fuel subsidies that encourage wasteful consumption. <p>Relevant interim goals: 12.1-8, 12.a, 12.c</p>	<p>CLIMATE ACTION</p>  <p>IVL contributes to:</p> <ul style="list-style-type: none"> - strengthening resilience and adaptability to climate-related hazards and natural disasters. - integrating climate action in policies, strategies and planning at a national level. - improving education, awareness and human and institutional capacity in respect of early warnings, climate adaptation as well as mitigation of climate change and its consequences. <p>Relevant interim goals: 13.1-3</p>
<p>LIFE BELOW WATER</p>  <p>IVL contributes to:</p> <ul style="list-style-type: none"> - preventing and reducing marine pollution, particularly from land-based activities, including marine debris and the input of nutrients. - protecting marine and coastal ecosystems in order to achieve healthy and productive seas. - strengthening the conservation and sustainable use of the seas and their resources. <p>Relevant interim goals: 14.1-2, 14.a-c</p>	<p>LIFE ON LAND</p>  <p>IVL contributes to:</p> <ul style="list-style-type: none"> - the conservation, restoration and sustainable use of ecosystems on land and in freshwater as well as their ecosystem services, particularly forests, wetlands, mountains and arid areas. - cultivating forests sustainably, stopping deforestation, restoring depleted forests, reducing the destruction of natural habitats and halting the loss of biodiversity. - integrating the values of ecosystems and biodiversity in national and local planning and development, as well as in accounting strategies. <p>Relevant interim goals: 15.1-3, 15.5, 15.8-9</p>	<p>PARTNERSHIPS FOR THE GOALS</p>  <p>IVL contributes to:</p> <ul style="list-style-type: none"> - the development, transfer and dissemination of environmentally friendly technologies to developing countries. - strengthening the Global Partnership for Sustainable Development and complementing it with a new partnership that exchanges knowledge, expertise, technology and financial resources in order to contribute to the attainment of the SDGs, particularly in developing countries. <p>Relevant interim goals: 17.7, 17.16</p>

Four thematic areas creating a broad environmental profile

The IVL Swedish Environmental Research Institute has Sweden's broadest environmental profile. The work is organised in four thematic areas in order to meet our customers' needs regarding everything from taking samples in the forest and of soil to developing digital tools.

The breadth of IVL's activities requires a high degree of coordination. That's why there are four thematic areas, which complement and coordinate the activities of the internal sections. They help to promote interdisciplinary projects and increase internal expertise, in particular through coordinated monitoring of the outside world.

The texts shown alongside present IVL's thematic areas in greater detail.

The thematic areas are the basis for IVL's four operational councils. Here, members from the business sector and government agencies meet employees from IVL to discuss knowledge gaps and research requirements.

Another important meeting place is IVL's annual stakeholder day, where the operational councils meet selected individuals from society and business to discuss upcoming projects and present new research results.

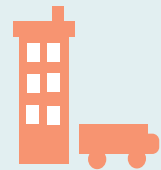
THE ROLE OF THE FOUNDATION

The Swedish Institute of Water and Air Conservation Research Foundation (SIVL) is the sole owner of the IVL Swedish Environmental Research Institute.

The operational councils contribute to the development of annual business plans, which provide a foundation for the decisions of SIVL's Board of Directors regarding the direction of IVL. This includes ensuring that the state research funds received from the Ministry of the Environment are used effectively for research that is co-funded by the business sector.



Natural resources,
climate and
environment



Sustainable urban
development
and transport

SUSTAINABLE URBAN DEVELOPMENT AND TRANSPORT

This thematic area spans the entire breadth of the civil engineering sector. By means of a systematic perspective, it takes a comprehensive approach to urban planning, land use, infrastructure development and the existing built environment. Air pollution, transport and mobility are also included, as well as how society both affects and is affected by climate change.

Stina Stenquist, an IVL employee in the Urban development group, is secretary of

the thematic area's operational council.

Here's what she says about 2019:

"During the year, we have focused on making IVL even better when it comes to building on the research needs of the participating organisations. Operating in the form of workshops, we have jointly developed ideas for new joint projects. The project ideas are now being reviewed by IVL and will hopefully result in new joint applications."



Stina Stenquist, Secretary of the thematic area's operational council

NATURAL RESOURCES, CLIMATE AND ENVIRONMENT

This thematic area includes strategies, policies and impact assessments regarding ecosystems and climate issues. It focuses on the way we use natural resources and ecosystem services, such as the Swedish forest, as well as the resulting environmental and climate impact. It also includes issues relating to environmental risks, water management and ecological compensation, as well as the environmental, social and financial aspects of various activities.

Daniel Edlund, an IVL employee in the

Urban Land Use group, is the new secretary of the thematic area's operational council. Here's what he says about the work in 2020: "I'm looking forward to gaining a greater insight into IVL's operations and to being able to take part in interesting discussions and new approaches based on the views of industry and the authorities regarding current issues. One hope is that we in the operational council will identify a new area where IVL can play a bigger role and make a difference in the long term. This feels extremely exciting and inspirational."



Daniel Edlund, Secretary of the thematic area's operational council

RESOURCE-EFFICIENT CYCLES AND CONSUMPTION

This thematic area focuses on the development of a circular economy by means of methods that support the endeavour to achieve more resource-efficient products and services. By strengthening decision-makers' knowledge about a lifecycle approach and sustainable value chains, new business models are being developed with a view to more sustainable consumption and use. The work is also looking at sustainable waste management, as well as chemicals and risk assessment.

Tova Andersson, an IVL employee in the Sustainable consumption and resource flows group, is secretary of the thematic area's operational council. Here's what she says about 2019:

"The public debate and awareness have been raised by an incredible amount in respect of many of the issues we work with: sustainability, lifecycle analyses, what is climate smart, how to use plastics, what chemicals are present in the products we use and how we consume goods in general. I think that's great."



Tova Andersson, Secretary of the thematic area's operational council

SUSTAINABLE PRODUCTION AND ENVIRONMENTAL TECHNOLOGY

Within this area, the aim is to contribute to the development of operations that satisfy stringent environmental and working environment requirements, combined with increased quality, efficiency and profitability. The thematic area works with process optimisation, sustainable energy systems, innovations in environmental technology and the development of circular water systems.

Joel Wanemark, an IVL employee in the Process modelling and digitalisation group, is secretary of the thematic area's operational council. Here he talks about some highlights of 2019:

"The most interesting event was the operational council's study visit to Södra Cell's pulp mill in Mönsterås. This gave us a real insight into the environmental work carried out at the plant, as well as many interesting discussions about the future of forestry. IVL's stakeholder day in May was also a fun experience, with representatives from a wide range of sectors and backgrounds discussing the cross-border topic of digitalisation with a focus on sustainability, in order to identify future research requirements."



Joel Wanemark, Secretary of the thematic area's operational council



Resource-efficient
cycles
and consumption



Sustainable
production
and environmental
engineering

The world has woken up – now we need action

Being involved in and working on the climate issue has been both painful and fantastic during 2019. Climate change is progressing more rapidly than we had feared, yet at the same time the world has begun to wake up.



Annamaria Sandgren

In Europe, coal-fired power has declined significantly and the EU has presented the European Green Deal. In Australia, which has experienced large bushfires in parallel with coal making up a significant proportion of the country's exports, the judiciary halted the development of a new coal mine due to global warming. In Sweden, procedures were tightened up with the Government, according to the Climate Act, now able to have the final word in licensing processes.

The business sector views freedom from fossil fuels as an important competitive advantage. Various sectors, including carbon-intensive ones, have drawn up roadmaps through the Fossil-Free Sweden initiative. Some of these admittedly rely on large volumes of biofuels, where biodiversity and global access are issues that need to be addressed. Others rely on the storage of large volumes of carbon dioxide, which will probably be part of the solution in the long term, although the technology is not yet sufficiently developed. There are challenges, in other words, but the roadmaps are a good start.

And then we have Greta Thunberg's school strike. As someone who is active at a research institute, I would like to stress that the things Greta is saying can be found in UN reports that are backed by all the world's climate scientists. The fact that the world has woken up is good news, of course, and this needs to be converted into action.

IVL will continue to deliver solutions and scientifically established grounds for decision-making. We will remain independent, and will clearly state the advantages and disadvantages of various approaches. We will also be clear about the fact that, although new technology can take us a long way, society also has to promote a sustainable lifestyle. A good example of this is road traffic, where increased traffic volumes mean that emissions have not fallen quickly enough, despite technical advances. The transition also has to be fair, and sustainable alternatives are required. There is a greater need for cars in the country than in the city.

We can see that more people want support as regards sustainable finance, and I am personally pleased that the government is going to be reviewing our pension funds. This is partly because they are a power-broker in the financial world, and partly because it feels safer if my pension funds are not invested in financially risky fossil-based activities.

We are aware that we need to remain well below two degrees of global warming. This will require a considerable effort from the whole of society. We don't need to deliberate over whether the transition relates to the concrete industry or air travel, or whether it applies to Sweden or other countries. It's both. And it's now. Among the general public, the climate issue is sometimes portrayed as hopeless. But for those of us who have been involved for a while, it's clear that we are at a stage where a great deal is happening on many levels. 2019 was the year when the climate issue reached out. Now we have to make sure that 2020 is the year when it is noticed.

Annamaria Sandgren,
*expert in climate and sustainable social systems,
IVL Swedish Environmental Research Institute*

TOPICS WHERE IVL IS CURRENTLY INVOLVED IN THE CLIMATE CHALLENGE:

- Adaptation to a changing climate
- Capturing and storing carbon dioxide
- Behaviour and consumption
- Circularity and dematerialisation
- Effects on ecosystems and water cycle
- Effective climate leadership
- Energy and resource-efficient buildings
- Finances, risks and business models
- Fossil-free industry
- Energy systems of the future
- Roadmaps, strategies and climate goals
- Sustainable urban development
- Sustainable procurement
- Climate statements and roadmaps
- Climate goals according to the Science Based Targets (SBT) method
- Climate-neutral building materials and building processes
- Climate-smart food
- Carbon storage and land use
- Mobility and the transport systems of the future
- New economic models
- Policies and instruments
- The climate impact of products (EPD, LCA)
- Statistics and public reporting



Tomas Gustafsson, Tina Skårman, Karin Kindbom, Helena Danielsson, Åke Sjödin, Ingrid Mawdsley and Karin Kindbom are some of the individuals at IVL who produce Sweden's official statistics for greenhouse gases emissions. Tobias Helbig, Martin Jerksjö, Gunilla Pihl Karlsson and Katarina Yaramenka are missing from the picture.

IVL keeping track of Sweden's climate emissions

The IVL Swedish Environmental Institute plays an important role in the international climate work – by annually producing data about Sweden's greenhouse gas emissions which is then reported to the UNFCCC. The work takes place within the Swedish Environmental Emissions Data consortium, and is one of the many assignments that IVL carries out on behalf of public authorities and the business sector.

IVL was one of the initiators behind establishment of Swedish Environmental Emissions Data (SMED), as the Swedish Environmental Protection Agency needed help in improving its data collection and international reporting of emissions.

The work at SMED began in 2001 and is carried out alongside the Swedish Meteorological and Hydrological Institute (SMHI), Statistics Sweden (SCB) and the Swedish University of Agricultural Sciences (SLU). The aim is to gather and compile Sweden's emissions statistics in respect of the climate, but also in respect of air and water pollution, waste and hazardous substances.

IVL COORDINATES THE WORK RELATING TO AIR AND THE CLIMATE

The four parties involved in SMED are responsible for various sectors within climate reporting. IVL, which is the coordinator for the field of air and the climate, gathers data about emissions to the air from industrial processes, product use and various aspects of waste.

"This assignment is extremely stimulating, as the data is used in climate negotiations within the UN and the EU as well as for national monitoring," says Tina Skårman, IVL's project manager for climate reporting.

IVL gathers data from a number of different sources, including from public authorities and trade associations, as well as from companies' environmental reports. The data is compiled in accordance with international guidelines and is reviewed within SMED, as well as by the Swedish Environmental

Protection Agency and experts in other countries. Tomas Gustafsson and Karin Kindbom from IVL are experts who participate in reviews of other countries' reporting.

"All countries have to produce the data in a comparable manner. In terms of credibility, it is extremely important to have comparable data in the international climate work," says Tina Skårman.

SMED reports emissions data to the Swedish Environmental Protection Agency, which in turn supplies the information to the UN via the Ministry of the Environment. In addition to this, SMED provides expert support, for example during climate negotiations, and develops climate scenarios that set out how emissions may change in the future.

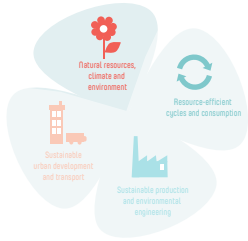
EMISSIONS DATA SINCE 1990

Thanks to SMED's work, detailed data regarding Sweden's annual emissions has been available since 1990. Around forty people within SMED are involved in total, of whom some ten are IVL employees.

"It is incredibly rewarding to be a part of such a large team and to collaborate with the other organisations within SMED and with the Swedish Environmental Protection Agency," says Tina Skårman.

► **If you would like to know more about our work with emissions data, please contact:**

Tina Skårman, tina.skarman@ivl.se, tel. +46 10-788 67 70



Sustainable blue economy growing here

During 2019, a total of 23 projects were launched at IVL in relation to Sustainable Development Goal 14: Life below water. The assignments in the marine sectors account for an ever larger proportion of IVL's activities, and there will now be even more at the research station in Kristineberg.

“It’s no longer just marine biologists working with marine issues. Projects are under way here in relation to food technology, biofuels, paints for boat bottoms and tourism. Researchers are working side-by-side with start-ups and large companies, and institutes such as IVL and RISE are joining forces and complementing one another.”

This is according to IVL’s Martin Sjöberg, Director of the Kristineberg Marine Research and Innovation Centre, which is based at Kristineberg Research Station near Lysekil.

Established in 1877, this is the world’s second-oldest marine research station (the first was founded in Naples in 1872). It attracts researchers and students from all over the world, largely thanks to the unique range of species in Gullmar Fjord. The access to both deep and shallow water with varying salt concentrations, due to the substantial variation in the depth of the fjord, makes it possible to set up experiments that would otherwise be difficult to perform. Water pipes run throughout the main building, carrying surface water and water from depth to various labs and experimental halls.

NATIONAL ARENA FOR MARINE RESEARCH

Since 2018, Kristineberg Marine Research and Innovation Centre has been a national arena for marine research and innovation, made up of the IVL Swedish Environmental Research Institute, the University of Gothenburg, Chalmers, RISE, KTH and Lysekil local authority. It has no fixed legal form, but rather represents a partnership. The operation is based in Kristineberg, but at the same time is more than just a physical location.

“First and foremost, the aim is to open up the station itself for collaboration with companies and entrepreneurs, and to make available the resources and research skills that can be found here. That’s the first thing. The second is for the centre to bring together and develop the national marine innovation system by being an incubator and a node for sustainable blue growth,” says Martin Sjöberg.

The work aimed at realising this particular ambition is now under way, as part of an intensive collaboration with public authorities, research funders, coastal municipalities and individual actors. And not least through the SMART Ocean (Sustainable Marine Aquaculture and Renewable Technology) innovation initiative, which is bringing together actors from the

western Swedish business community, academia, innovation and the public sector, with Kristineberg as the hub. Our hope is that we will soon receive long-term funding for the entire operation of the centre.

Around 30 researchers work at the station, including seven from IVL.

“Everyone has coffee and lunch in the canteen together. We write applications and articles together. Kristineberg has always been a meeting place. We receive visitors here pretty much constantly. It’s a completely natural place to exchange ideas,” says Martin Sjöberg.

MASSES OF OYSTERS

People coming here may also encounter rose anemones, pipefish, sea urchins and starfish. The intake hall houses dozens of aquariums and tanks containing animals and plants from Gullmar Fjord. IVL’s researchers can often be found here, sorting through masses of oysters and mussels from ongoing research projects.

On one jetty by the neighbouring quay, the state research institute RISE is conducting corrosion studies on various submerged materials. Kjell-Åke Andersson demonstrates a corrosion chamber that simulates real conditions, although in an accelerated form. The assignments are received e.g. from the shipping industry, energy companies and companies applying for patent protection.

“Our customers can come here and take part in the work themselves. This makes the collaboration more fun and more successful, and it is really appreciated.”

In one ten-metre-long aquarium, GU researcher Eduardo Infante is simulating changing ocean currents and temperatures resulting from climate change. He does not see any boundaries between the various actors – quite the contrary.

“We have a global agenda, so it doesn’t matter which institute or company you are from. Together we have a huge network, and we can develop projects using experts from all over the world. This makes Kristineberg an extremely dynamic environment. It’s always exciting to be here.”

► **Are you interested in our work on a sustainable blue economy?**
Contact Martin Sjöberg, martin.sjoberg@ivl.se, +46 10-788 69 37



IVL's Martin Sjöberg is the Director of the Kristineberg Marine Research and Innovation Centre (below), which is based at Kristineberg Research Station near Lysekil. IVL has been running experimental lobster farms there since 2019.

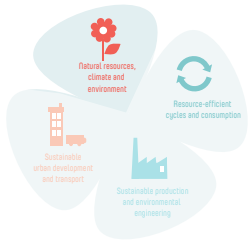


IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Increasing the financial benefits of sustainable management of marine resources (14.7)
- Extending scientific knowledge, research and technology that contributes to healthier oceans (14.A)
- Collaborating and sharing knowledge about science, technology and innovation (17.6)
- Encouraging more effective partnerships (17.17)

We do this by developing marine research capacity and creating broad collaborations for research and innovation through an open marine collaborative arena.





IVL putting its ear to the surface of the water

Long-term noise from traffic causes us to become ill and stressed. But what about traffic noise below the surface? Underwater noise is attracting more and more attention, but our limited knowledge in this field is preventing effective measures and instruments.

“It’s very noisy in the sea. Sound travels much further in water than in the air. We might perhaps hear a motorway from a distance of five kilometres, for example. The underwater noise from a busy sea lane can be heard from a distance of a hundred kilometres,” says Torbjörn Johansson, researcher and project manager at the IVL Swedish Environmental Research Institute.

The Swedish coasts are heavily trafficked. The Baltic Sea is one of the world’s busiest bodies of waters, with some 40,000 ships passing through Öresund every year. Shipping is important and energy-efficient, but more shipping means more underwater noise. Noise which disturbs marine life and may affect fish stocks and entire ecosystems.

NOISE STRESSES WILDLIFE

Studies have shown how even mussels, which can’t even hear, are stressed by sound. Porpoises avoid ships at distances of more than a kilometre, even though most of a ship’s noise is at frequencies that porpoises cannot hear. Other studies have demonstrated avoidance reactions, reduced foraging and increased stress among fish, marine mammals and invertebrates that have been exposed to underwater noise of the same type as vessel noise.

“As humans, we have no real relationship with underwater noise. We only experience it when we are diving or snorkelling. Sounds that do not bother us can be extremely disruptive to various species of animals. They can hear different sounds with different frequencies than we can, which means they detects sounds that we don’t even hear,” says Torbjörn Johansson.

With the long-term aim of exploring how noise affects various invertebrate organisms, he and Anna-Sara Krång conducted a pilot study in the autumn of 2019 using sound recordings in Gullmar Fjord, before and after the start of lobster fishing. The idea was to get an idea of the noise levels from recreational traffic.

“Sweden has more recreational boats per capita than most other countries. Recreational traffic is high during the summer months, especially in coastal areas such as shallow bays, which constitute nurseries for the smallest creatures,” says Anna-Sara Krång.

Unlike noise in the air, there are no restrictions regarding underwater noise. This is partly a result of a lack of measurement data, particularly in respect of noise from recreational boats.

MOST NOISE FROM THE PROPELLER

“We would need to ascertain the noise levels in shallow areas, what levels are acceptable and what levels have a negative impact on ecosystems. However, the noise levels in the water can vary greatly depending on water depth, currents and the nature of the seabed,” says Anna-Sara Krång.

This is a complicated research area. And it’s not always that easy to know what is causing the noise.

“There was one sound that recurred every day and disappeared at night. Small snapping sounds, a little like someone snapping their fingers, only weaker. At first we thought there was something wrong with the equipment. Our guess is that it might be the sound of wrasse crushing small shells, but the only thing we actually know is that the sound is coming from some animal. This illustrates just how little we know about the sounds beneath the surface,” says Torbjörn Johansson.

One thing we know for sure is that the largest source of noise occurs during propeller cavitation – the bursting of the air bubbles that arise due to a propeller’s movement through the water. The best thing to do to reduce underwater noise is probably to sail in such a way that there is no cavitation from the propeller – more slowly, in other words.

SIMULTANEOUS MEASUREMENTS IN THE SHIPNOISE PROJECT

With funding from the Swedish Transport Administration, IVL will now delve into this issue. The two-year Shipnoise project will develop a measuring station that can be positioned adjacent to shipping lanes and automatically record noise in both the air and the water from passing vessels. Rise, VTI and Furetank Rederi are also involved in the project.

Sound above the surface of the water does not affect the underwater acoustic image. For example, noise from fans does



not pass into the water, unless the fan is causing vibrations in the hull and on into the water. Through simultaneous measurements of noise above and below the water, researchers will be better able to understand the differences between the two. It will also ensure that measures intended to dampen the noise at one end do not cause it to increase at the other.

“Above all, Shipnoise will highlight the knowledge gap between noise in the air and noise in the water – we know much more about noise in the air and how it affects the environment. This may in fact be our most important educational point,” says Torbjörn Johansson.

► **If you would like to know more about our work on underwater noise, please contact:**

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 Anna-Sara Krång, anna-sara.krang@ivl.se, tel. +46 10-788 69 12

IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Upgrading infrastructure and adapting it to make it sustainable with more efficient use of resources, as well as more clean and environmentally friendly technologies and processes (9.4)
- Preventing and reducing pollution (noise) in the sea (14.1)
- Protecting coastal ecosystems to avoid significant consequences, with the aim of achieving a healthier sea (14.2)

We do this by measuring and analysing the consequences of underwater noise in the sea and in lakes, and by submitting proposals for measures aimed at reducing the impact of noise pollution in the oceans.



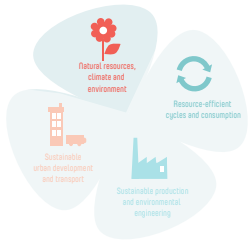
Anna-Sara Krång

researcher in marine ecology, ecotoxicology and marine aquaculture at IVL's office in Fiskebäckskil

I am currently working on several different research projects regarding the marine environment, ranging from microplastics and underwater noise to sustainable aquaculture. A number of years ago, we investigated how various sports facilities, playgrounds and equestrian centres using plastic and rubber materials can be sources of microplastics. It was fun to be involved in increasing knowledge about these issues. This will hopefully lead to measures aimed at reducing the spread of microplastics to the environment.

I am inspired by all those who get involved and work in various ways to make the world a better place. If I had to name a historical role model, it would have to be Marie Curie. Today, Greta Thunberg inspires the ordinary man and woman on the street to make a difference. I am driven by a curiosity to discover and learn new things. The most enjoyable thing of all is to collaborate with skilled and friendly colleagues and partners in projects that feel relevant.

My top environmental tips are to eat more greens and less meat, but certainly mussels and oysters. Avoid plastic when you can and recycle the plastic you do use. Replace the two-stroke engine in your boat with a more environmentally friendly alternative, and cut your speed in coastal areas to reduce fuel consumption, emissions and noise.



Emission control shifting pollutants from air to water

From 2020, new requirements are in force that compel all international shipping to reduce their emissions of sulphur dioxide to the air. However, rather than opting for more expensive low-sulphur fuels, many shipping companies are instead expected to install scrubbers that clean the exhaust gases with seawater, which is then discharged, contaminated, back into the sea. This scrubber water has a toxic impact on zooplankton, according to research from the IVL Swedish Environmental Research Institute.

“The new sulphur regulations are important for reducing the impact of shipping on air quality, but they do not give any consideration to the impact on the marine environment. If the ships continue to run on dirty fuel oil, the pollution ends up in the water instead, where it can have severe consequences for the marine ecosystem,” says Hulda Winnes, project manager and researcher at the IVL Swedish Environmental Research Institute.

The EU-funded research project “Scrubbers – Closing the loop”, which ended in the summer of 2019, has analysed the environmental effects of open and closed scrubber systems for cleaning exhaust gases from ships. The open scrubber system uses large amounts of seawater to clean the exhaust gases, and this water is subsequently discharged again. The closed system recirculates the water in the system and releases smaller volumes of water following treatment in a treatment plant.

NEGATIVE EFFECT ON ZOOPLANKTON

In ecotoxicological tests, a number of marine organisms were exposed to scrubber water in various concentrations. The tests demonstrated adverse effects on vital functions in several organisms. The highest level of sensitivity was identified in copepods – a group of zooplankton that are of central importance in the food chain. Even low concentrations of both untreated water from open scrubber systems and treated scrubber water from closed systems caused negative effects in the organisms.

Untreated scrubber water from the open system contains e.g. heavy metals, aromatic hydrocarbons and soot particles.

The treated water from the closed scrubber is less contaminated and the residual products that are separated out are taken back to land. In a comparison, the discharges from open scrubbers pose a greater risk to the marine environment than discharges from closed systems.

INCREASED RISK IN SHIPPING LANES

Individual ship journeys do not have that much of an impact on the marine environment, but in busy shipping lanes, ports and estuaries, the environmental risks increase.

“Several of these contaminants break down fairly quickly, but at the same time are extremely toxic. When the marine environment is continuously exposed to scrubber water from new vessels, the acute impact tends to be long-lasting. I can see a considerable risk of biodiversity decreasing as a result of the scrubber technology,” says Kerstin Magnusson, marine ecotoxicologist at IVL and one of the authors of the report.

Since the end of the project, the issue of the scrubber technology’s environmental impact has been high up on the agenda,” says Hulda Winnes.

“It can be found in the daily press, is discussed in industry forums as well as at meetings with the International Maritime Organization. This is thanks to many different actors around the world, not just IVL, but it feels good to have been involved in drawing attention to the issue, and to have also made an important contribution to the subsequent discussion.”



"It feels good that we at IVL were involved in drawing attention to the issue," says Hulda Winnes, IVL, who has studied the environmental consequences of scrubber technology in shipping.



Hulda Winnes

PhD in shipping and marine technology at IVL's office in Gothenburg

I started my PhD at the Department of Marine Technology at Chalmers in 2001, as the department's first PhD student in the environmental field. It was perfect for me. I am an environmental scientist and I have always been interested in shipping. In Gothenburg, shipping is always close at hand and visible, and, like me, many people have family connections to shipping.

I joined IVL in 2010. Here, I have had the opportunity to participate in and lead many exciting projects. It's great when you get the opportunity to highlight an environmental issue from various points of view. It is challenging to both analyse and describe complex relationships in a comprehensible manner. That's why our project on scrubber cleaning in ships was very interesting to work on. There was also considerable interest in our findings.

I am inspired by meeting people who are fun and interested in the world around them. I feel that this is something you do when you work at IVL.

Generally speaking, I think it feels good to be aware of the consequences of what you are doing. This can relate to the food and clothes you buy, to travel or just about anything, in fact. Not because you should feel ashamed, but so that you can choose the least bad option to the best of your ability. So my top environmental tip is quite simply to keep up-to-date regarding the environment.

IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Reducing the effects of harmful chemicals and pollutants as well as contamination of the air, water and soil (3.9)
- Upgrading infrastructure and adapting it to make it sustainable with more efficient use of resources and more clean and environmentally friendly technologies and processes (9.4)
- Preventing and reducing pollution in the sea (14.1)

We do this by analysing the environmental effects of the selected technology for cleaning emissions and discharges.



Kerstin Magnusson

ecotoxicologist at IVL's office at Kristineberg's marine research station in Fiskebäckskil

I work with research and assignments related to environmentally hazardous substances and their impact on the environment, above all on the marine environment. The thing that interests me most at present is examining the effects of discharges from shipping on the marine environment. We are launching a major new EU project in which we will be continuing this work. If the new project reinforces the evidence regarding the harmful effects of scrubber water, my hope is that it will have implications for environmental policy and contribute to a tightening up of the requirements regarding which marine fuels will be allowed.

Our work on scrubber water has also attracted the attention of several banks, which has resulted in me getting to present our results to financial investors who are unsure about whether scrubber equipment has any future. Their concerns obviously relate to the financial side of the matter, but I also find that many of them have a genuine interest in the marine environment.

After many years as a university researcher, I wanted to work with more applied projects where there is greater potential for the results to be used directly in environmental improvement measures.

I get my inspiration from environmentally aware young people, as they offer considerable hope for the future.

Do you have any environmental tips you would like to share?

Spend a lot of time out in nature and take it all in, for real! If more people did this, I am convinced it would be much easier to steer social development in a more sustainable direction.

► **If you would like to know more about IVL's work with shipping and the marine environment, please contact:**

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Kerstin Magnusson, kerstin.magnusson@ivl.se, tel. +46 10-788 69 07



Sweden can become fossil-free without prosperity collapsing

Sweden has a unique opportunity to become the world's first carbon dioxide-neutral country by 2045. The government has set this as an objective in the climate policy framework, but many have regarded it as an unrealistic dream, at least until very recently.

Here at IVL, we consider it to be feasible. We can see this in the research that is taking place every day at the Institute, and we can see it through the Mistra Carbon Exit research programme – a programme that is being hosted by IVL and that I am leading.

The goal is within reach, but we have to dare to change the structure of society. A climate transition will result in completely new ways of getting about, building houses and roads and producing materials and electricity.

On the positive side, almost all the technology we need is either here or on the way, although it may need to be scaled up. And even though it is expensive for some of the actors, the cost will not be as high if it is spread across the whole of society. We have demonstrated this in the programme.

The downside is that we have been aware of much of this for years without a great deal being done about it. There are many large and small barriers to overcome. For example, building in a climate-neutral fashion is not profitable. It's still cheaper to continue releasing emissions. But it's not just about costs. Habits and attitudes can sometimes be more important. It may seem daunting to elect not to have your own car and to switch to car pooling or public transport. But our research shows that once you've tried carpooling, it's much easier to carry on doing it.

However, shouldn't we expect everything to be much more expensive if we are to live carbon-neutral lives?

No, that doesn't have to be the case. For an individual industry producing steel or cement, for example, switching over may entail considerable costs. Such a transition has to be performed sensibly so that industry does not choose to leave the country.

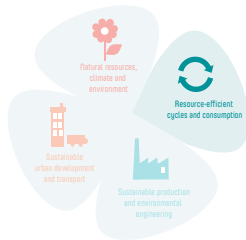
However, if the cost is distributed across the entire value chain instead, it will only be marginally more expensive for the end consumer. Our researchers have demonstrated that building a dwelling using climate-neutral concrete would only be around half a percent more expensive. For an apartment in a big city, this is no more than a step in the bidding process.

The research within Mistra Carbon Exit is now entering its harvest phase, and there are plenty of interesting results to bring home. We have completed the technical development pathways that describe how Sweden can achieve net zero emissions. These form the basis for analysing which instruments and business models can be used to drive the transformation. There are also results from attitude surveys that are important. When we connect technology to behaviours and instruments, we have produced something genuinely new.

We have also opted to view the transition from a value chain perspective, which is also new. In our opinion, measures should be put in place in those parts of the value chain that have the maximum impact at consumer level. This might be early in the value chain, so that you develop new materials. Or in the final stage, by pricing carbon dioxide in such a way that the consumer opts for a climate-friendly alternative, or so that large buyers such as the Swedish Transport Administration stipulate climate neutrality as a requirement.

But how will the climate transition affect other environmental factors? It will undoubtedly put a spotlight on society and the environment. Some things will get better – for example, we expect air quality in cities to improve. But it may also have a negative impact on natural environments. For example, we will have to route pipelines through sensitive areas. This may be unavoidable, yet we have to be aware that this is happening and how it is taking place.

Lars Zetterberg,
*programme director Mistra Carbon Exit,
IVL Swedish Environmental Research Institute*



Big gains with digital waste management

Using new smart technology, Swedish waste management has considerable potential to develop more efficient and more sustainable solutions. To provide guidance and inspiration, the IVL Swedish Environmental Research Institute and the Swedish Waste Management and Recycling Association have produced four publications showing a number of good examples.

“In the waste sector, there is considerable potential for digitalisation to contribute to greater societal benefits. There is money to be earned and environmental gains to be achieved here,” says Eva Stättin, project manager and digitalisation expert at IVL.

Compared to other Swedish sectors, waste management is lagging behind in terms of digitalisation. Interviews with local authorities and waste organisations show that this partly due to the new technology being difficult to grasp. In addition, it can be difficult to know what benefits digitalisation may entail, and both knowledge and leadership are required in order to succeed.

“There is a considerable demand for support and guidance in the sector, especially in respect of how digitalisation can be used to support logistics and data collection. Digitisation is an extremely important area for the waste industry. Properly used, smart solutions of this type can streamline waste management and lead to better preventive measures and increased reuse,” says Jessica Christiansen, Head of Development at the Swedish Waste Management and Recycling Association.

“Since digitalisation can be challenging, it is good to have tangible examples that demonstrate the value that can be achieved as a result of digitalisation initiatives. Experiences from our own sector are in particular demand, which is why, in the report, we have highlighted good examples both from the Association’s members and from initiatives in our neighbouring countries,” says Eva Stättin.

“DIGITAL INNOVATION NECESSARY”

For a number of years, measurements have been carried out to determine the digital maturity of various industries and sectors. In the waste sector, the company AMCS conducts a “Digital Transformation Barometer” every year to get an idea of how the digital transformation is progressing in the sector on a global scale. In the most recent barometer, 80% of the respondents (representing both municipal organisations and private actors) state that they view digital innovation as essential for their activities. With the support of digitalisation, it is possible to achieve goals such as increased productivity, more efficient logistics, improved customer service, greater competitiveness and, not least, reduced environmental impact.

THE FOURTH INDUSTRIAL REVOLUTION

Another study describing how far the waste sector has come on its digital journey is the International Solid Waste Association (ISWA), which has also conducted a global investigation into how the “Fourth Industrial Revolution” (which largely relates to digitalisation) is affecting the waste sector. This demonstrates a high level of awareness that the sector needs to change. At the same time, there are few who dare to state with any precision what impact digitalisation will have on their operations. The ISWA’s study also concludes that the organisations that stick to traditional models and technologies to run their operations are unlikely to still be on the market in 15 years’ time.

The respondents in the ISWA’s study predict that the effects within waste management will be greatest within new materials and connected advanced sensors (IoT).

► **If you would like to know more about IVL’s work with digitalisation, please contact:**

Eva Stättin, eva.stattin@ivl.se, tel. 010-788 67 10



The four publications on digital waste management can be found at www.ivl.se

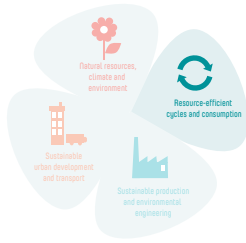


IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Improving global resource efficiency and striving to break the link between economic growth and environmental destruction (8.4)
- Reducing the negative environmental impact of cities with regard to municipal waste (11.6)
- Contributing to the sustainable use of natural resources (12.2)
- Reducing the amount of waste by means of measures to prevent, reduce, reuse and recycle waste (12.5)

We do this by developing smart new technologies for more efficient waste management





Electrification of transport generating more environmental research

The electric car market is accelerating. In ten years' time, four million electric cars are expected to be driving around in the Nordic countries alone. At IVL, intensive work is now underway to satisfy the research needs resulting from the electric car boom.

“We are experiencing a global shift towards electrification of large parts of both the transport sector and industry. This represents a change of system and entails questions and problems that we need to resolve very soon,” says Lisbeth Dahllöf, researcher at the IVL Swedish Environmental Research Institute.

Mining metals, recycling spent batteries and energy consumption for the manufacture of battery cells – there are a number of challenges, covering environmental, social and economic sustainability. The enormous demand for batteries is putting pressure on the industry as well as bringing sustainability into sharp focus, particularly as regards raw materials.

Most scientists and experts agree that the shift from fossil-powered to electric is fundamentally a positive change for the climate, the local environment and human health in cities. However, this does not mean that you can sweep actual environmental consequences and emissions under the carpet, believes to Lisbeth Dahllöf, who carried out a study of the literature alongside her colleague Mia Roman two years ago regarding greenhouse gas emissions from the production of electric car batteries. This report gave rise to both surprise and anger, and was used as a weapon in the debate on electric cars versus fossil cars, almost solely to the benefit of fossil cars.

LOWER EMISSIONS FROM BATTERY MANUFACTURING

“Some electric car enthusiasts felt that we destroyed the electric car. But I think it can cope with this. We can see that the discussion has become more level-headed now, and the interest in electric cars is greater than ever,” says Lisbeth Dahllöf.

In November 2019, together with her colleague Erik Emilsson, she submitted an updated report to the Swedish Energy Agency showing that emissions from the manufacture of electric car batteries have fallen.

According to the new report, the manufacture of lithium-ion batteries emits an average of between 61-106 kg of carbon dioxide equivalents per kilowatt-hour of battery capacity produced. If data that is less transparent is included in the calculations, the upper value is 146 kg of carbon dioxide equivalents per kilowatt-hour produced. In the 2017 report, the average was 135-

185 kg of carbon dioxide equivalents per kilowatt-hour of battery capacity, excluding the recycling stage.

This reduction in emissions is mainly due to the fact that the battery factories have grown in size and are operating at full production capacity, making them more efficient per unit produced. The calculations also include the possibility of using electricity that is more or less fossil-free in several of the production stages. At present, many battery factories are powered by fossil electricity. In order to get below 60 kg of carbon dioxide equivalents, emissions from the mining and processing of the raw materials also have to be reduced and the share of recycled materials has to increase.

“The issue of metals is difficult. We are talking about finite resources here, and the mining operations themselves often represent a major social and environmental burden. We need better traceability in order to ensure sustainable production throughout the entire chain,” says Erik Emilsson.

IMPORTANT TO RECYCLE THE METALS

Recycling the metals from spent batteries is important in order to reduce the need for virgin raw materials.

The recycling of cobalt, nickel and copper is now relatively efficient, provided the batteries end up in the right place in the recycling system. Lithium, on the other hand, is not recycled on a large scale, due to its low raw material price, high recycling costs and low volumes of batteries received.

“China has come further in terms of the market for recycled materials, as they have much larger volumes,” says Lisbeth Dahllöf.

Last year, on behalf of the Nordic Council of Ministers, IVL investigated what happens to the spent batteries and what amounts can be expected in the future. A large wave of spent batteries will start to be seen in 2030, the study shows.

“At that point, it is important for us to have a well-functioning recycling operation in place to deal with all the battery chemicals. This is not the case at present. I hope that effective recycling will be completely natural by then,” says Lisbeth Dahllöf.



Major focus on electrification and metals

In 2019, an internal process was initiated aimed at bringing together IVL's expertise in the field of electromobility as well as establishing new projects across borders. Today, IVL employees work through several different groups in projects related to electrification and the sustainable use of metals.

TRACEMET - TRACEABILITY FOR SUSTAINABLE METALS AND MINERALS

TraceMet will create a system that provides better traceability for metals. The project was launched at the initiative of the trade association Svemin and is being led by IVL. Several strategic partners from the mining sector are linked to the project, including LKAB and Boliden, as well as key players such as Volvo Group, Scania, Elektrokoppar, ABB and SSAB. With the aid of mass balance accounting and a blockchain database, you will be able to see, throughout the entire metal value chain, both the carbon footprint of the metal and how much recycled material it contains. In this way, TraceMet will demonstrate how an internationally accepted system for certification and traceability can be designed to support more sustainable metal production.

ACCESS TO METALS TO ACHIEVE THE SWEDISH CLIMATE GOALS

On behalf of the Royal Swedish Academy of Engineering Sciences, IVL has mapped the conditions for the increased use of metals that are critical in order for Sweden to achieve climate neutrality by 2045. Using scenarios and investigations of risks in countries that have assets, the report shows which metals are likely to remain critical.

RESPONSIBLE PROCUREMENT OF COBALT IN ELECTRIC BUSES

Cobalt is a much sought-after metal that is used in rechargeable batteries. It is also a "conflict mineral", with more than half of the world's production coming from Congo-Kinshasa, where child labour is commonplace. On behalf of Skånetrafiken, IVL has charted the problems associated with cobalt mining, investigated Skånetrafiken's supply chain of cobalt in electric bus batteries, as well as developed recommendations for how Skånetrafiken can minimise the risk of contributing to child labour and slavery and at the same time promote basic human rights and tolerable working conditions.

ZERO-EMISSION VEHICLES IN CITIES

Cities and local authorities can play a major role by providing good facilities for charging both electric and gas vehicles. On behalf of the Swedish Energy Agency, IVL is investigating various options for speeding up the transition to more zero-emission vehicles and zones. This work will result in recommendations and proposals for how Nordic cities can continue to work on this issue. For example, IVL is looking at strategies for electric charging at apartment buildings, the provision of land for refuelling stations for buses, as well as power requirements for rapid charging.

MAXYCLE - A NOVEL CIRCULAR ECONOMY FOR SUSTAINABLE RE-BASED MAGNETS

Magnets are used in larger quantities in electric cars and electric hybrids than in cars with internal combustion engines. Several rare earth elements are found in these magnets, which currently come almost exclusively from China. The EU project MaXycle aims to study the potential for using recycled magnetic materials in the production process. The project combines the development of the new recycling technology and an environmental analysis that is carried out by IVL.

► *If you would like to know more about IVL's work with electrification, please contact:*

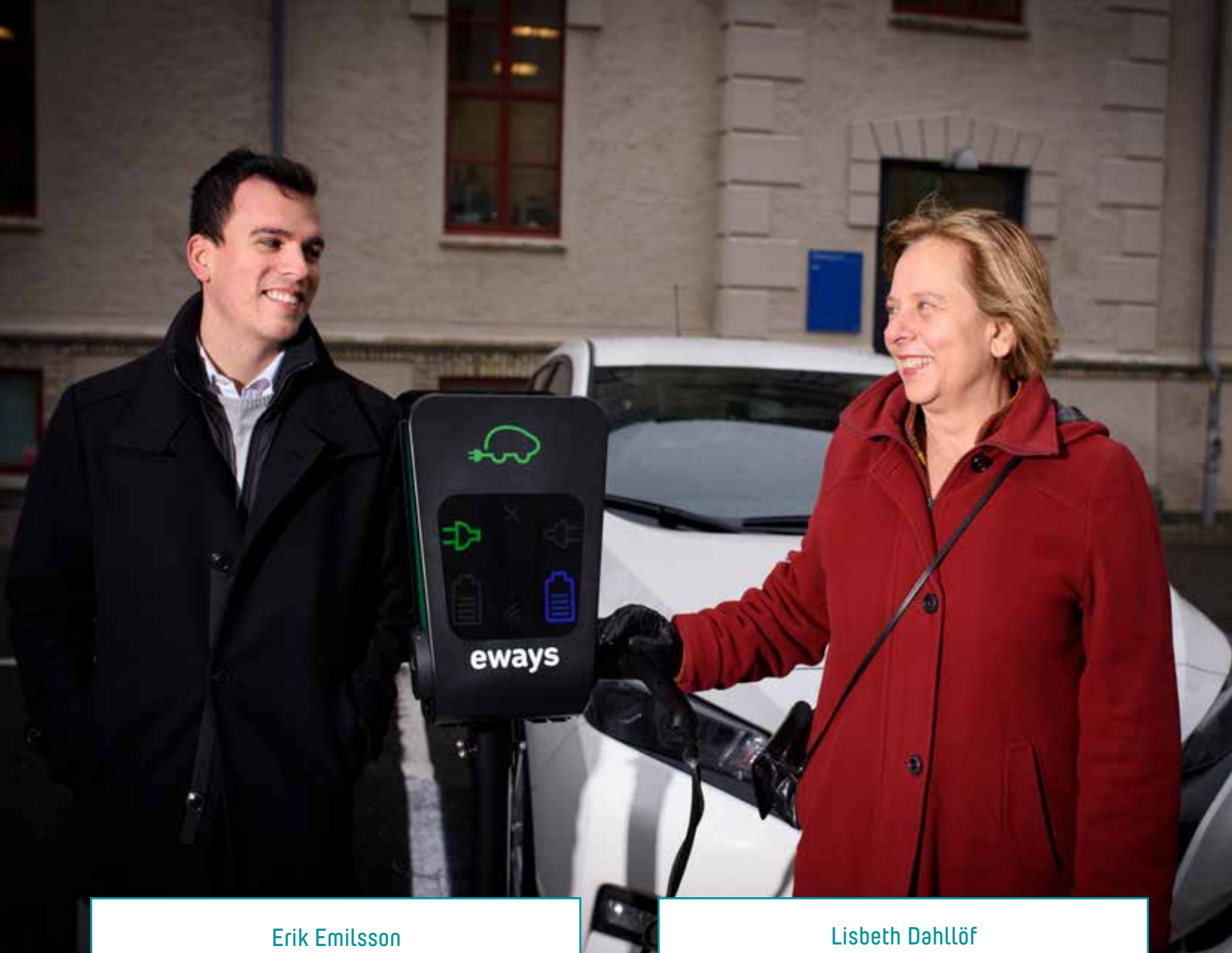
Lisbeth Dahllöf, lisbeth.dahllof@ivl.se, tel. +46 10-788 68 53
Erik Emilsson, erik.emilsson@ivl.se, tel. +46 10-788 67 29

IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Improving global resource efficiency and striving to break the link between economic growth and environmental destruction (8.4)
- Contributing to reliable, sustainable and resilient infra-structure of high-quality (9.1)
- Upgrading infrastructure and adapting it to make it sustainable, with more efficient use of resources and more clean and environmentally friendly technologies and processes (9.4)
- Reducing the negative environmental impact of cities with regard to municipal waste (11.6)
- Contributing to the sustainable use of natural resources (12.2)
- Reducing the amount of waste by means of measures to prevent, reduce, reuse and recycle (12.5)
- Increasing public awareness of sustainable lifestyles (12.8)
- Improving awareness and increasing human and institutional capacity in terms of mitigating climate change (13.3)

We do this by providing a nuanced picture of an electrified transport sector.





Erik Emilsson

M.Sc. in Chemistry and Physics
at IVL's office in Gothenburg

I have only been at IVL for a little over a year, and for me IVL represents the perfect blend of technology, environmental benefits and societal benefits. I work primarily with resource flows and waste. My dream project at IVL is one where we work effectively with industry to develop a solution that benefits the company financially and has a positive impact on the environment. One where the company is inspired to continue thinking about the impact their products have throughout their lifecycle.

I am inspired by Bill Gates, who is using his money to really make a difference in the world. He is also an excellent problem-solver at heart. I find it enjoyable to delve into the way we use the earth's material resources in modern technologies, such as electric cars and solar cells.

My top environmental tip: Don't be seduced by the consumerism created by phenomena such as Black Friday. Instead, just buy things you really need and that will last a long time. When you make purchases as a consumer, you are, to a large extent, voting for what you want the market to look like in future.

Lisbeth Dahllöf

M.Sc. in Chemistry,
Licentiate Degree in Life Cycle Analysis
at IVL's office in Gothenburg

My role is to develop the field of resource management with the emphasis on vehicles, although I also work with other areas such as life cycle analysis. I like it when theory is interwoven with practice, collaborating with many others and making a real difference. My dream project would be to be involved in planning a new city district or village that would provide the conditions to live completely sustainably.

In an organisation like IVL, no two days are the same and you are always learning something new. I have considerable opportunities to influence what I am working with. I am inspired by my colleagues within and outside of IVL. I am very much looking forward to the TraceMet project that we have just launched. There will be a lot of new things to learn, the project is highly topical and everyone is really interested.

Do you have any environmental tips you would like to share?

Try to avoid getting stuck in a rut in everyday life – identify small improvements all the time. There are many simple ways to reduce your environmental impact, and you can often improve your health into the bargain, for example where this entails you having to move more. Raise the issue of the environment in a positive way with your friends and family as well, so that it becomes something that is taken seriously.

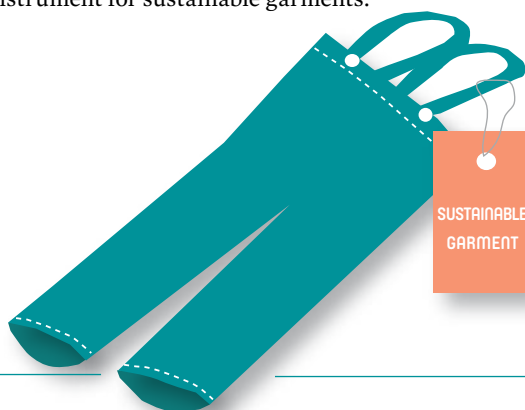
Record number of environmental product declarations

An increasing number of companies want to present the environmental and climate impact of their products. This is particularly evident at IVL's subsidiary EPD International, for example. In 2019, a record number of environmental product declarations – 303 – were registered in the international EPD system.

The international EPD system is an information system that describes the environmental impact of products and services from a life cycle perspective. The idea behind the system is to provide quality-assured and comparable information about the environmental performance of goods and services in environmental product declarations (EPDs).

The rapid rise in the number of EPDs registered in recent years shows that there is an increasing need for information describing the environmental impact of products. The product category that grew most last year comprised construction products, although environmental product declarations were also registered for many other goods and services, such as food, furniture and paper products. The world's first environmentally declared garments were also launched in 2019, when the company Fristads, working in collaboration with RISE, developed an EPD for some of its work clothes. The development of the

“Green Collection” has resulted in RISE IVF, alongside Fristads and the IVL Swedish Environmental Research Institute, developing the regulations and an EPD standard at garment level. This allows all companies to use the system as a common measuring instrument for sustainable garments.



Basta adopts a holistic approach to endocrine disruptors in construction products

IVL's subsidiary Basta is working to phase out particularly hazardous substances in construction products. Now that the EU has agreed on a definition for endocrine disruptors, Basta is adopting a holistic approach to the issue and is working alongside IVL to develop a guide for assessing endocrine disruptors in construction products.

“Endocrine disruptors are a widely debated group, and the mechanisms behind how they affect us are complex. The fact that the EU has now agreed on criteria for endocrine disruptors represents a major advance. It will provide support for the entire sector, enabling us to focus on removing those substances that are worst from an environmental and health perspective,” says Sussi Wetterlin, CEO of Basta.

Basta's database is one of the largest in the sector, containing more than 50,000 construction products. The inclusion of the EU's definition of endocrine disruptors as a criterion in the system means that endocrine disruptors will be treated in the same strict way as e.g. carcinogens or substances that affect human reproduction. Greater responsibility will also be placed on those who manufacture and market these substances, chemical products and goods.



“The sorting facility will be the missing link between the collection of textiles and high-quality recycling,” says Maria Elander, project manager at IVL.

Unique plant for textile sorting being built in Malmö

The world’s first automated textile sorting plant on an industrial scale is going to be built in Malmö. This became clear during the year, when the IVL Swedish Environmental Research Institute and its partners were given the green light for the SIPTex project – Swedish Innovation Platform for Textile Sorting.

The project, which is receiving MSEK 22 in funding through Vinnova’s “Challenge-driven innovation” initiative, aims to increase material recycling of textiles and will contribute to achieving the sustainability goals in Agenda 2030.

“The textile sector is one of the sectors producing the highest environmental impact on a global scale. Automated sorting of textiles is one of the keys to creating efficient textile flows and a circular cycle,” says Maria Elander, project manager at IVL.

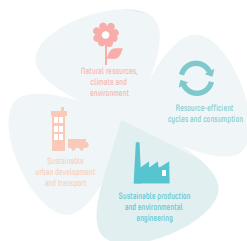
The plant will be operated by southern Skåne’s waste company Sysav, which is also investing in the project. Operations are planned to start in summer 2020. Several major Swedish textile, fashion and furniture companies, local authorities, charities, research institutes and public authorities are also taking part in the project: a total of 21 parties, led by the IVL

Swedish Environmental Research Institute.

There is considerable potential for increasing textile recycling in Sweden.

At present, we only recycle around five percent of the almost 140,000 tonnes of new textiles that are sold on the Swedish market every year. The goal is to progressively increase the sorting capacity of the new plant to 16,000 tonnes per year.

“The idea is to create a sorting solution that is tailored to the needs of textile recyclers and textile companies, and that will become the link that is currently missing between textile collection and high-quality recycling. In order to create a circular cycle, we need active cooperation between producers, sorters and material recyclers,” says Maria Elander.



Suschem Sweden will pave the way for a sustainable chemical industry

May saw the launch of SusChem Sweden – a Swedish platform for a sustainable chemical industry. The aim is to increase collaboration between industry and research on important issues, as well as to contribute to the development of sustainable chemicals, products and technical solutions. The IVL Swedish Environmental Research Institute and Innovation and Chemical Industries in Sweden (IKEM) are behind the initiative.

“Our aim with SusChem Sweden is to strengthen the competitiveness of the Swedish chemical industry by increasing cooperation and speeding up the development of products, materials, technology and chemicals that contribute to a more sustainable society,” says Sara Anderson, project manager at IVL.

SusChem Sweden is part of the European platform SusChem, which has been in existence for ten years. The platform has played an important role in developing and coordinating multinational European collaborations between research and industry. Over the years, the European platform has also inspired the European Commission to invest more than SEK 10 billion in important research and innovation projects. The aim now is to

also achieve this in Sweden.

“The timing for SusChem Sweden is perfect. Swedish chemical companies are increasingly viewing sustainability as an opportunity to identify new products and services. The Swedish Government is investing in a substitution centre that will encourage the development of sustainable chemical products and production processes,” says Nils Hannerz, Head of Research and Innovation at IKEM.

► **For more information, please contact:**

Sara Anderson, sara.anderson@ivl.se, tel. +46 10-788 67 21



On 15 May, we saw the launch of SusChem Sweden – a Swedish research platform for a sustainable chemical industry. Ibrahim Baylan, Minister for Business, Industry and Innovation, was present to cut the ribbon, together with IVL's CEO Tord Svedberg (left) and Magnus Huss, Director General at IKEM.

IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Reducing the effects of harmful chemicals and pollutants as well as contamination of the air, water and soil (3.9)
- Upgrading infrastructure and adapting it to make it sustainable with more efficient use of resources and more clean and environmentally friendly technologies and processes (9.4)
- Contributing to the sustainable use of natural resources (12.2)
- Collaborating and sharing knowledge regarding science, technology and innovation (17.6)

We do this by means of the platform contributing to increased cooperation between industry and research, which speeds up the development of sustainable chemicals, products and technological solutions.







IVL and Jämtkraft developing the fossil-free aviation fuel of the future

In one research project, working alongside Jämtkraft, Chalmers and Lund University, IVL will be investigating whether it is possible to start large-scale production of fossil-free aviation fuel. Carbon dioxide will be collected from the chimney of the combined heat and power plant in Lugnvik, near Östersund, and will be mixed with hydrogen to produce the aviation fuel. The hydrogen that is required for the process will be produced from renewable electricity.

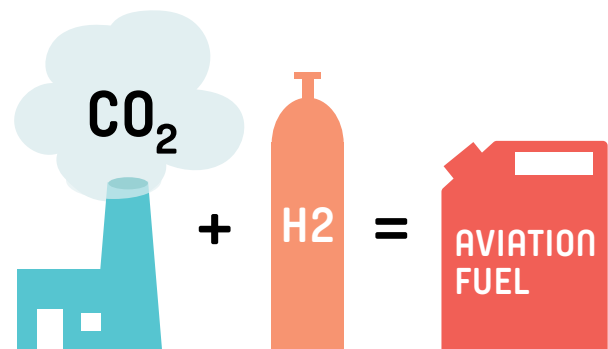
“Having the opportunity to lead a project at the cutting edge of research, in cooperation with the business sector and academia, and with such a clear application that is relevant to the whole of society in such a topical area, is very inspiring. We have managed to put together a highly skilled project team, and it will be great to work together to help bring large-scale Swedish production of fossil-free aviation fuel closer to fruition,” says Anton Fagerström, project manager and researcher at the IVL Swedish Environmental Research Institute.

There are already a number of facilities that are using aspects of the technology. The aim of this project is to go one step further and obtain sustainable aviation fuel as an end product. The amount of carbon dioxide collected from the combined heat and power plant determines how much aviation fuel can be produced. When fully developed, it is estimated that the existing amount would be sufficient to produce aviation fuel equivalent to roughly five percent of the aviation fuel filled up annually in Sweden.

“If we succeed in capturing carbon dioxide and producing fossil-free aviation fuel, we will hopefully have helped to find one of the answers for making the transition to a sustainable future. This is a strong incentive for me personally, and it feels

particularly good to be a part of this project,” says Ulf Lindqvist, Head of Heat Production at Jämtkraft.

The project, which has been supported by the Swedish Energy Agency, is being led by IVL. Chalmers and Lund University will be contributing with their expertise in the development of the new technology. Fly Green Fund, Nordic Initiative for Sustainable Aviation, A Flygbränslehantering and The Power Region through Östersund local authority are also involved in the project.



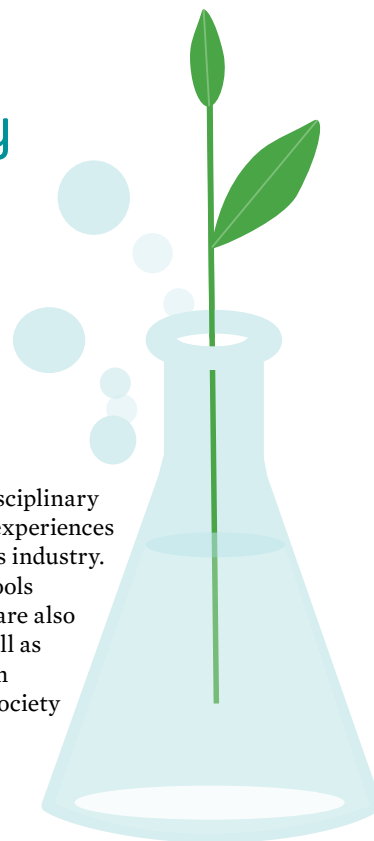
Large research grant to develop green chemistry

Alongside industry, the funder Mistra is investing MSEK 100 in the SafeChem research programme, which aims to create a sustainable chemical industry and reduce exposure to hazardous substances. IVL is leading the programme, which also comprises researchers from Stockholm University, Rise, KTH, DTU in Denmark and wide-ranging involvement from industry.

“This is a large and significant investment, and a first step towards the creation of a research and innovation platform for green chemistry in Sweden and internationally,” says John Munthe, IVL’s Vice-President, Research.

Key aspects of the programme include developing new processes for the industry and developing a toolbox of models and methods for performing risk assessments on new chemicals. A series of case studies will be conducted, where specific synthesis, recovery and substitution processes will be studied and evaluated.

The programme is interdisciplinary and will benefit from the experiences of e.g. the pharmaceuticals industry. Holistic approaches and tools for lifecycle management are also important elements, as well as conveying knowledge from research to business and society in general.



Full-scale facility for purification of pharmaceutical residues inaugurated in Simrishamn

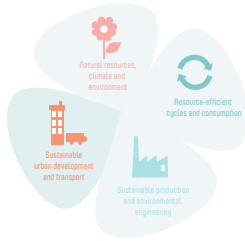
In May, the full-scale plant for the purification of pharmaceutical residues was inaugurated at Stengården’s wastewater treatment plant in Simrishamn. On the site, IVL’s water experts, working in collaboration with Simrishamn local authority, have tested a completely new and innovative purification system.

“Removing pharmaceutical residues from the water entails considerable benefits for the environment. It can also contribute to significant environmental benefits around the world,” says Staffan Filipsson at IVL.

The development project, which was launched at the end of 2014, is the third stage of Vinnova’s “Challenge-driven innovation” programme. In previous studies, IVL has worked alongside partners to test a number of techniques for the purification of pharmaceutical residues, the recovery of water and



the production of energy, phosphorus and other nutrients. In the final stage, the project has been scaled up and most of the outgoing water from Simrishamn’s treatment plant is purified by means an innovative system employing several different purification techniques – disc filtration, ozone treatment, followed by a sand filter or activated carbon. The goal has been to achieve wastewater that is so clean that it can be reused.



Shift transforming the Nordic transport sector

Greatly increased electrification, stronger policies for freight transport, new business models for climate-smart transport innovations and combined mobility services and electric roads. The Nordic research project “Shift” is now summarising four years of studies and showing the way forward for a fossil-free transport sector in the Nordic region.

“It is perfectly possible to significantly reduce emissions from the transport sector in the Nordic region, but this is urgent and we need strong action immediately. The largest reductions in emissions can be achieved through the technical conversion of vehicles and fuels, as can clearly be seen from our models,” says Julia Hansson, project manager for Shift at the IVL Swedish Environmental Research Institute.

Shift – Sustainable Horizons in Future Transport – encompasses one of the greatest challenges of our time: the transformation of the fossil-powered transport sector. This challenge is particularly great, since society as a whole is reliant on a fossil-based infrastructure, with technical, political and social aspects that all need to change fundamentally. For this reason, the project has brought together researchers who are approaching the issue from various perspectives, including via comprehensive modelling work on energy systems, business models, gender perspectives and policy evaluation.

Shift is a Nordic project including partners from Denmark and Norway. What makes the Nordic region suitable to lead the transformation of the transport sector?

“The Nordic countries jointly possess both technical expertise and experience of many different policy instruments aimed at reducing emissions. We also have a good supply of renewable raw materials. In recent times, the Nordic governments have also agreed that they want to take the lead in the field of climate change. We are regarded as pioneers, testing a range of solutions such as biofuels, electric roads and combined mobility services. In our opinion, integrated perspectives are important for finding the best solutions. It is now a matter of ensuring that these solutions are disseminated and implemented to a greater extent in all the Nordic countries.

Which measures are most important in the short and long term?

“Action is required in a number of areas, but it is particularly important to continue to support the introduction of efficient vehicles and fuels that produce low greenhouse gas emissions, especially for freight transport by road, sea and air. Such transport also requires measures to reduce demand and lead to changes to mode of transport. The important thing is for us to continue to apply pressure from all sides and to pick up the pace. Just because the issue has finally been included on the

agenda, this doesn’t mean that we have reached our goal. In the Nordic region, the conversion of both long-distance and short-distance freight traffic needs to be supported more.

Shift is one of three flagship projects being funded by Nordic Energy Research, a body under the Nordic Council of Ministers. Along with the other flagship projects, Negative CO2 and Flex4Res, Shift has developed a scenario that illustrates how the Nordic region can become carbon dioxide-negative by 2040.

“It can be done, if we want to. The Nordic countries are uniquely placed to meet the zero emissions target. If we fail to maintain our leading position in the global transformation, we cannot expect other countries to take the lead either,” says Julia Hansson.

► ***If you would like to know more about IVL’s work with sustainable transport, please contact:***

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IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

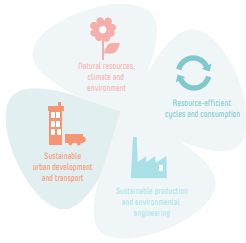
- Increasing the share of renewable energy (7.2)
- Contributing to reliable, sustainable and resilient infrastructure of high-quality (9.1)
- Increasing access to sustainable transport systems (11.2)
- Taking immediate action to combat climate change and its consequences (13)
- Integrating climate action in policies, strategies and planning (13.2)
- Improving awareness and increasing human and institutional capacity in terms of mitigating climate change (13.3)

We are achieving this by means of energy system modelling, reviewing business models, gender perspectives and policy evaluation, as well as by developing scenarios and action proposals for a climate-neutral Nordic region by 2040.





"The Nordic countries are uniquely placed to meet the zero emissions target," says Julia Hansson at IVL, project manager for Shift.



The smart city heating itself

Every year, huge amounts of energy are wasted in the form of heat from e.g. metro systems and wastewater, which could be employed in residential buildings and offices. Across the EU, as much as 340 terawatt-hours could be recovered each year – 10 percent of the total energy demand for heating and hot water. IVL is running a number of large-scale EU projects, which are developing new knowledge and innovative solutions to take advantage of these untapped heat flows.

“At present, we allow much of the available residual heat to go up in smoke, literally. This is not resource-efficient. In the same way as we make biogas from food waste and circulate materials, we can use this energy more than once,” says Kristina Lygnerud, energy expert and project manager at the IVL Swedish Environmental Research Institute.

According to international statistics, Sweden is the best in the world at recovering residual heat in district heating systems, yet despite this we still only manage to recover a small percentage. Around nine percent of the heat in district heating systems comes from industrial processes. Most of the residual heat is not used at all. Kristina Lygnerud wants to change this situation.

“There are several reasons why residual heat is not recovered. At times it is the technology that puts a spanner in the works and fails to allow cost-effective investment, while on other occasions it is the companies that do not want to be dependent on another party. But we also know that there are some successful collaborations where residual heat has been recovered for decades, and so successfully that they cannot use all the heat. So it can be done, if we want to.

UTILISING THE HEAT PEOPLE CREATE

Her vision of the city of the future is a city that heats itself. A system that can utilise the heat that the people in a city generate, simply by being in the city.

Where the heat from ventilation systems, from refrigeration processes in grocery stores and data centres, from municipal infrastructure such as wastewater and public transport, as well as from nearby industrial activities, is channelled back into the city’s heating and hot water infrastructure.

In order to be at the cutting edge, IVL has concentrated in recent years on recruiting a number of experts who are skilled in respect of the new district heating technology. This is commonly referred to as fourth-generation district heating, and allows both increased recovery from residual heat sources as

well as increased use of renewable energy sources. IVL is currently leading several large-scale EU projects in this field.

One of the latest initiatives is the EU’s Rewardheat project. This focuses on the recovery of surplus heat at low temperatures (below 50°C), as opposed to industrial waste heat, which is usually at higher temperatures. This might be heat from e.g. watercourses, old mine shafts or low-temperature processes in industries, which will subsequently be incorporated into existing district heating systems. New system solutions will be tested at eight demonstration sites across Europe: Denmark, Croatia, Germany, France, Italy, the Netherlands and near Helsingborg in Sweden.

WASTEWATER AND DATA CENTRES

The project is continuing to build on another EU project led by IVL – Reuseheat – which will demonstrate four different scalable systems for the reuse of untapped heat flows in urban environments, incorporating them into existing district heating systems. This is being carried out through four separate demonstration projects in France, Spain and Germany. In Nice, France, heat from wastewater will be recovered to heat offices and hotels, while in Berlin in Germany, heat will be drawn from the metro system. In Brunswick, Germany, the energy from a server hall will be used to heat homes in a nearby neighbourhood of low-energy residential buildings, while in Spain, heat from refrigeration systems will be used to phase out older, fossil heat.

There is considerable potential, and research within Reuseheat has shown that as much as 340 terawatt-hours could be recovered from data centres, metro systems, service facilities and sewage treatment plants every year in the EU. This is equivalent to ten percent of the EU’s total energy requirement in terms of heating and hot water. This energy saving also entails major climate gains. During the year, Reuseheat’s demonstration project in Germany received the “Global District Energy Climate Award” for its solution for recovering waste heat from



In smart cities, the heat from municipal infrastructure such as wastewater and public transport, as well as from nearby industrial activities, is channelled back into the city's heating and hot water infrastructure.

the data centre – a solution that saves approximately 1,284 MWh of primary energy, equivalent to 304 tonnes of carbon dioxide, each year.

“Data centres are a low-hanging fruit that are the focus of much discussion. And there appears to be even greater potential regarding heat from wastewater,” says Kristina Lygnerud.

Identifying a viable economic model is an important element in being able to transform the district heating sector. It is also one of IVL’s main tasks in several EU projects.

“We place a great deal of focus on understanding which economic factors can influence investments in this form of heat recovery, what risks exist in relation to multiple heating systems and how the national energy systems will be affected. Without this knowledge, nobody will want to invest in solutions of this type. We are also looking at the level of acceptance of new system solutions, and what is needed to design sustainable business models for them,” says Kristina Lygnerud.

IVL is also working to chart the knowledge that already exists in relation to low-temperature district heating globally, and is part of a group that will be developing a handbook regarding the implementation of the new technology.

ENERGY CITIZENS CONTRIBUTE

So if Kristina Lygnerud were to look into the future a little, how soon does she believe the new technology will be in place? Are the solutions closer than we think?

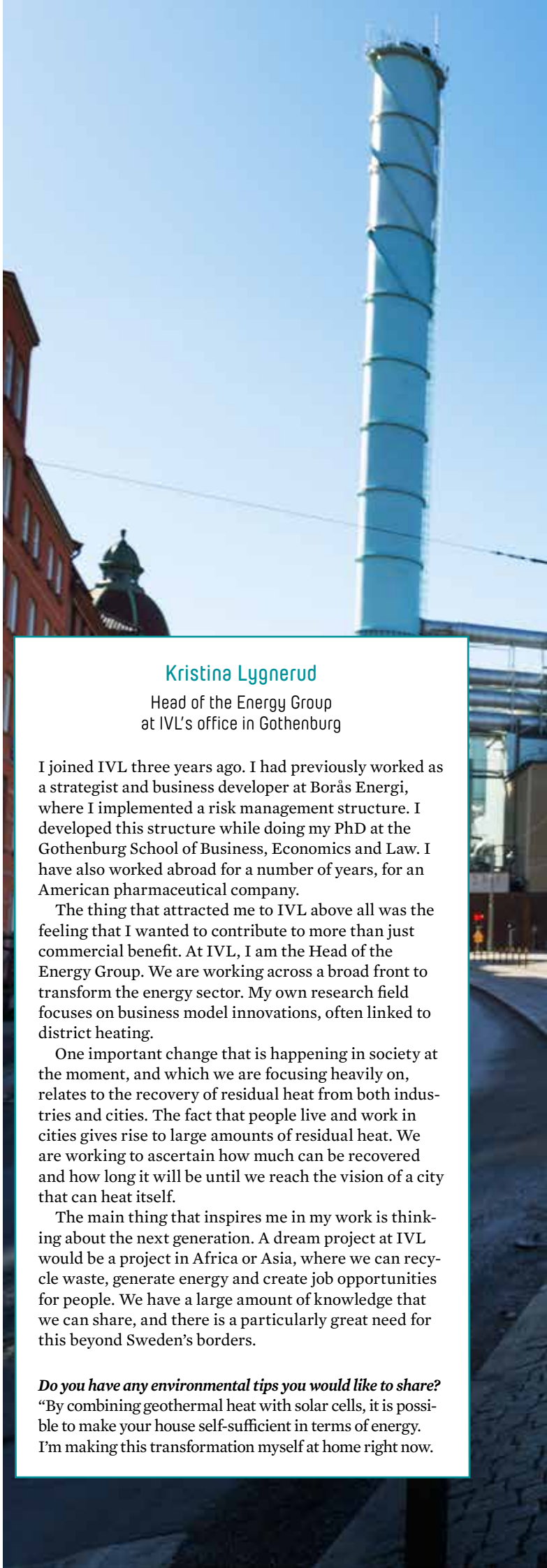
“By 2050, we can’t be using fossil fuels, and the amounts of waste being incinerated will be diminishing. By that time, we will be combining the heat sources we have – energy from the sun, wind, biomass and residual heat. We will be combining large-scale systems with smaller, local solutions. We will also have a society of ‘energy citizens’, a term coined by the EU that describes citizens who are actively working on their own energy use and energy efficiency,” says Kristina Lygnerud.

► **If you would like to know more about IVL’s work on district heating and energy systems, please contact:**
 Kristina Lygnerud, kristina.lygnerud@ivl.se, tel. +46 10-788 69 27

IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Ensuring access to modern energy sources (7.1)
- Increasing the share of renewable energy (7.2)
- Increasing the rate of improvement as regards energy efficiency (7.3)
- Strengthening international collaborations in the field of energy (7.A)
- Increasing awareness and capacity in terms of mitigating climate impact (13.3)

We are doing this by developing our knowledge and innovative solutions, and by demonstrating system solutions for recovering untapped low-temperature heat flows.



Kristina Lygnerud

Head of the Energy Group
 at IVL’s office in Gothenburg

I joined IVL three years ago. I had previously worked as a strategist and business developer at Borås Energi, where I implemented a risk management structure. I developed this structure while doing my PhD at the Gothenburg School of Business, Economics and Law. I have also worked abroad for a number of years, for an American pharmaceutical company.

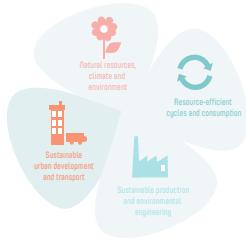
The thing that attracted me to IVL above all was the feeling that I wanted to contribute to more than just commercial benefit. At IVL, I am the Head of the Energy Group. We are working across a broad front to transform the energy sector. My own research field focuses on business model innovations, often linked to district heating.

One important change that is happening in society at the moment, and which we are focusing heavily on, relates to the recovery of residual heat from both industries and cities. The fact that people live and work in cities gives rise to large amounts of residual heat. We are working to ascertain how much can be recovered and how long it will be until we reach the vision of a city that can heat itself.

The main thing that inspires me in my work is thinking about the next generation. A dream project at IVL would be a project in Africa or Asia, where we can recycle waste, generate energy and create job opportunities for people. We have a large amount of knowledge that we can share, and there is a particularly great need for this beyond Sweden’s borders.

Do you have any environmental tips you would like to share?
 “By combining geothermal heat with solar cells, it is possible to make your house self-sufficient in terms of energy. I’m making this transformation myself at home right now.





We are monitoring emissions

Possessing knowledge about emissions from road traffic is a prerequisite for being able to reduce them. This is particularly the case since it has emerged that emissions from diesel cars in actual traffic are many times higher than the EU's limits. Following "Dieselgate", tougher legislation and controls are anticipated. IVL's emissions experts are involved in this journey.

"The continued high emissions of nitrogen oxides from diesel cars are an important explanation for why air quality in cities has not improved," says Åke Sjödin, emissions expert and project manager at the IVL Swedish Environmental Research Institute.

Long before the emissions fraud at Volkswagen was revealed in 2015, he and a number of his research colleagues had been warning that emissions from diesel cars were many times higher in real driving conditions than in the lab tests to which the car manufacturers referred, and on which the emissions legislation is based. Measuring in traffic, and not in a laboratory environment, is now the only reliable way of assessing the cars' actual emissions.

EMISSIONS DATA FROM A MILLION CARS

Since 2017, working alongside several European partners, IVL has measured and collated emissions data from almost a million cars across Europe. This extensive database has become an important tool for analysing traffic emissions.

IVL is now leading a three-year EU project, City Air Remote Emission Sensing (CARES), which will develop instruments as well as software to measure exhaust gases both vertically and horizontally across the road, from the side of the road and using measuring instruments on board a following car, known as "plume chasing". The measurements will be carried out in Milan, Prague and Krakow – cities that have significant problems with poor air quality, but also a high level of ambition to reduce traffic emissions.

EXCESSIVE EMISSIONS CAN LEAD TO FINES

"The major cities in Europe, and especially in China, are experiencing major problems in meeting the guide values for

nitrogen oxides and particulates in the air. This issue is high up on the agenda. For example, many cities are starting to introduce environmental zones where only low-emission vehicles are allowed to drive," says Åke Sjödin.

In the long run, the aim of the CARES studies is to be able to use the measurement results to e.g. fine or limit the driving of vehicles that are producing excessive nitrogen oxide emissions.

"We can see now that entirely different requirements are being introduced. This is a clear shake-up on the part of the European Union. The legislation has been lagging behind for far too long, and test methods are now finally being introduced that better reflect real driving conditions," says Åke Sjödin.

In parallel with CARES, another newly launched EU project is also in progress: uCARE ("You can always reduce your emissions. Because you care", as it says in the application). This project is based on identifying how people can reduce their emissions, both through their driving style and by the way they maintain their car.

DRIVING STYLES THAT REDUCE EMISSIONS

"The way you drive has a considerable impact on emissions. In one way, fuel consumption and ecodriving go hand in hand, although other parameters that the driver can influence also determine the extent of emissions of nitrogen oxides, particulates and other air pollutants. By adapting your driving style, you can reduce emissions," says Martin Jerksjö, who is leading IVL's work in uCARE.

Using the European emissions database, uCARE will produce an emissions picture for various car models in order ultimately to notify car owners about how they themselves can reduce emissions from their specific car. A number of behavioural



Milan is one city that is experiencing major problems with poor air quality, but it also has high ambitions as regards reducing traffic emissions.

scientists are therefore involved in the project, and will be working to ascertain how to persuade individuals to change their driving habits. According to researchers at IVL, it is not uncommon for drivers to manipulate their vehicles in order to increase power, for example by removing the particulate filter or tuning the engine. There is also widespread cheating in the form of AdBlue emulators in heavy goods vehicles. These simulate the effect of the diesel additive AdBlue, which represents a significant cost for many hauliers. Using an emulator, the truck stops treating nitrogen oxides completely. The researchers will study the effects of this.

AFFECTS THE MOST DEPRIVED

However, tougher emissions requirements also risk hitting the most deprived, i.e. those who drive the oldest cars. And even though diesel cars account for a significant proportion of the cars on the road, around 40 percent in Sweden, demand has decreased. Many people are opting for petrol cars again.

“Diesel cars are more energy-efficient than petrol cars, and it is now possible to drive using a higher proportion of renewable fuels. The latest models also produce significantly lower emissions of nitrogen oxides compared to older models. If only the legal requirements had originally been designed primarily to keep down emissions of air pollutants during real driving, and not just in simplified driving cycles in a laboratory environment, road traffic would have been having much less of an impact on air quality today,” says Martin Jerksjö.

► If you would like to know more about IVL's work with emissions measurements, please contact:

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Martin Jerksjö, martin.jerksjo@ivl.se, tel. +46 10-788 68 26

IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Reducing the effects of harmful chemicals and pollutants as well as contamination of the air, water and soil (3.9)
- Reducing the negative environmental impact of cities with regard to air quality (11.6)
- Integrating climate action in policies, strategies and planning (13.2)
- Improving awareness and increasing human and institutional capacity in terms of mitigating climate change (13.3)

We are doing this by developing measurement technology and measuring emissions both vertically and horizontally across roads.



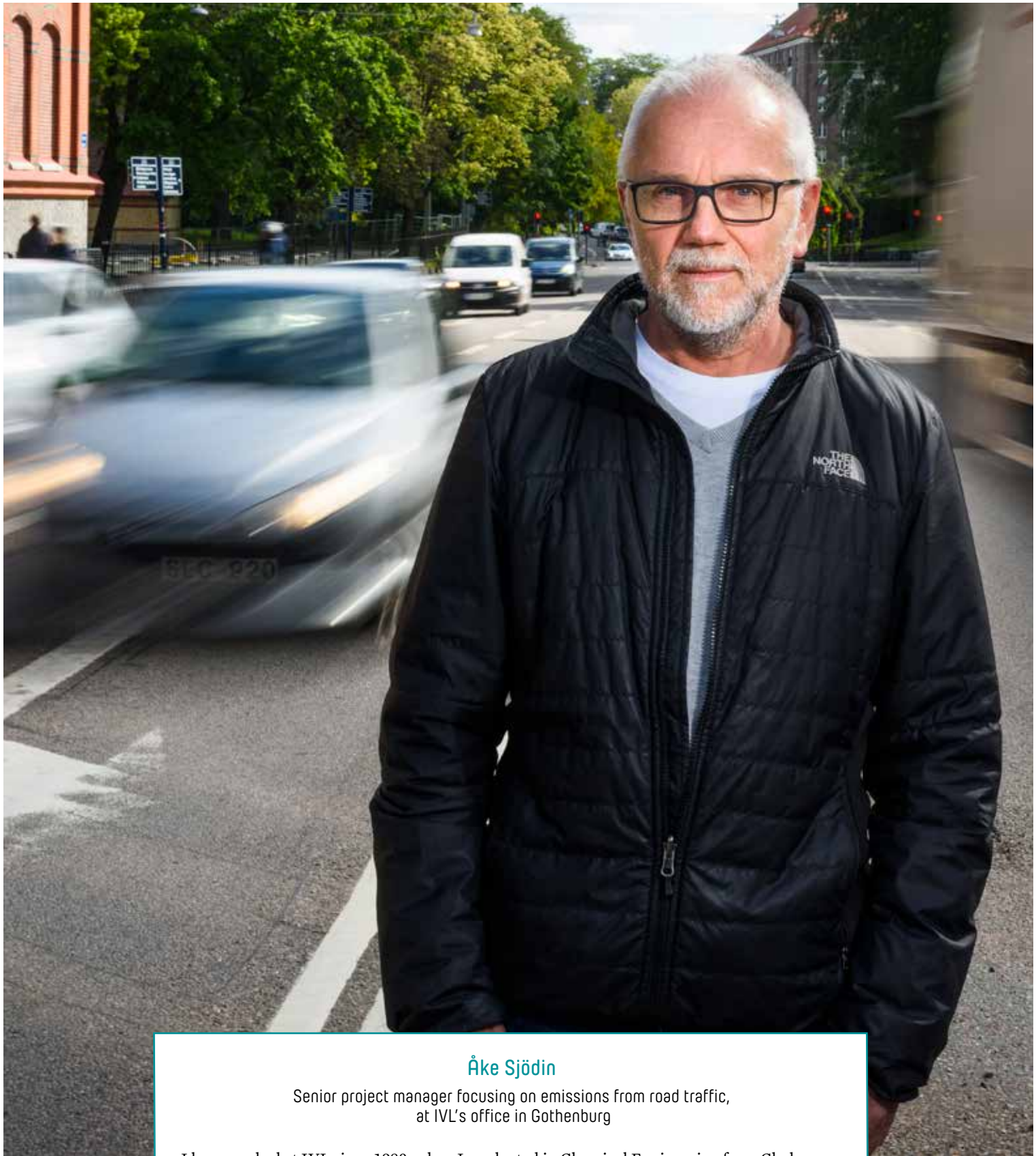
Martin Jerksjö

project manager for emissions from transport
at IVL's office in Gothenburg

I have been working at IVL's Gothenburg office for almost 15 years, coming here directly after finishing my chemistry studies at Chalmers. My work at IVL has always revolved around emissions into the air. At first I worked extensively with practical field work, including travelling around the country and setting up instruments to measure air quality on behalf of the country's local authorities. Nowadays I mostly work as a project manager within projects related to emissions inventories, as well as research projects relating to emissions from transport vehicles. Our work has helped decision-makers to open their eyes to the problem of cross-border emissions from traffic. This has resulted in tougher demands being imposed on the automotive industry, and we have actually seen a real reduction in emissions from new diesel vehicles in recent years.

My hope is that data stored by smarter, connected vehicles will be able to help us better understand the problems associated with e.g. inefficient transport, helping us to achieve a more efficient transport sector. Working with projects in this area is something I would like to do over the next few years.

My top environmental tip: Try to familiarise yourself with the environmental consequences of your purchases, travel habits, etc. In my opinion, it is only when you achieve this insight that you get a genuine motivation to live in as environmentally friendly a way as possible, and also to inspire others to do the same.



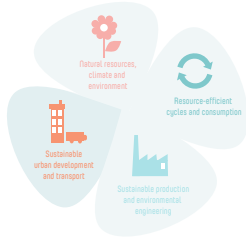
Åke Sjödin

Senior project manager focusing on emissions from road traffic,
at IVL's office in Gothenburg

I have worked at IVL since 1980, when I graduated in Chemical Engineering from Chalmers University of Technology. If I had to choose one project that has been particularly exciting over the years, it was in 2007-2008, when we were among the first to demonstrate that the actual emissions of nitrogen oxides from diesel vehicles in more recent Euro classes were not at all as envisaged in the EU's exhaust requirements.

My dream project is probably CARES, in fact, which I have been coordinating for almost a year. This focuses on issues I have been working with extensively over the years, and which I consider to be the most enjoyable. I may have contributed a little to the tougher exhaust requirements for diesel vehicles that have finally been introduced in recent years, as well as the need to monitor traffic emissions under realistic driving conditions on large, representative samples of the cars on the road.

My top environmental tip is to cycle to and from work all year round.



Locally cultivated solutions emerging in Solberga

An unusual cultivation project is being conducted in a residential area in Solberga, just south of Stockholm. In the basement of one of Stockholmshem's apartment buildings, basil, coriander and lettuce are being grown in a system connected to two large water tanks containing fish. The cultivation is part of Green Solberga – a test bed where companies can try out new innovations and climate-smart solutions along with the residents in the area.

The tropical, warm-water fish swimming around in the large water tanks in Solberga are called Nile tilapia. They grow quickly, up to a kilo in a year, and are one of the world's most farmed food fish. They are mainly farmed in Asia and South America.

In Solberga, the fish form part of an aquaponic farm, a cycle where water from the fish tanks is pumped into three different types of plant beds. This is known as hydroponic cultivation, where herbs and lettuce are grown in water instead of soil. The fish's water, including food residue and faeces, provides nutrients for the plants, which in turn purify the water before it is pumped back to the fish again. All that needs to be added are oxygen and fish food.

"We want to show that it doesn't cost much to farm both vegetables and fish in a residential building in the middle of town. I view this as part of a transition to more locally produced food that we need to carry out. We are utilising the heat from the building, growing produce without toxins and avoiding the need for transportation. The final stage is for us also to produce the food that we give to the fish, at which point we will have a closed cycle," says Torbjörn Frisö, founder of Kretsloppsbolaget, which has built the facility.

IMPORTANT TO GET THE RESIDENTS INVOLVED
According to Torbjörn, managing the aquaponic cultivation is no more difficult or labour-intensive than having an aquarium. Eventually, the tenants will manage the basement cultivation themselves. Kretsloppsbolaget has provided courses in cultivation using aquaponics and hydroponics, and there is a group that is interested in taking over the operation. Torbjörn Frisö sees considerable potential in the cultivations, and hopes that more similar facilities will be built around Stockholm. Interest in organic and locally produced food is growing, and there are many heated areas around cities that could be used for food production, he believes.

"It all depends on getting the residents involved in the sustainability work. The whole of Solberga is a showroom to demonstrate that this is possible," says Torbjörn Frisö.

Fish farming is one of the ideas being tested in Green Solberga, which is being run by the IVL Swedish Environmental Research Institute alongside Stockholmshem. The basic idea is the creation of a "green testbed" in the middle of the residential area – a type of research and experimental facility where companies that want to develop new innovations and solutions can try them out in a real residential environment.

"It's difficult to get the opportunity to test new ideas in existing infrastructure, such as roads and buildings. The lead times for introducing new technology and solutions are often so long that few companies or individuals are able to cope with them. Our aim with Green Solberga is to lower the threshold so that good products and ideas can reach the market more quickly," says Johan Strandberg, project manager at the IVL Swedish Environmental Research Institute.

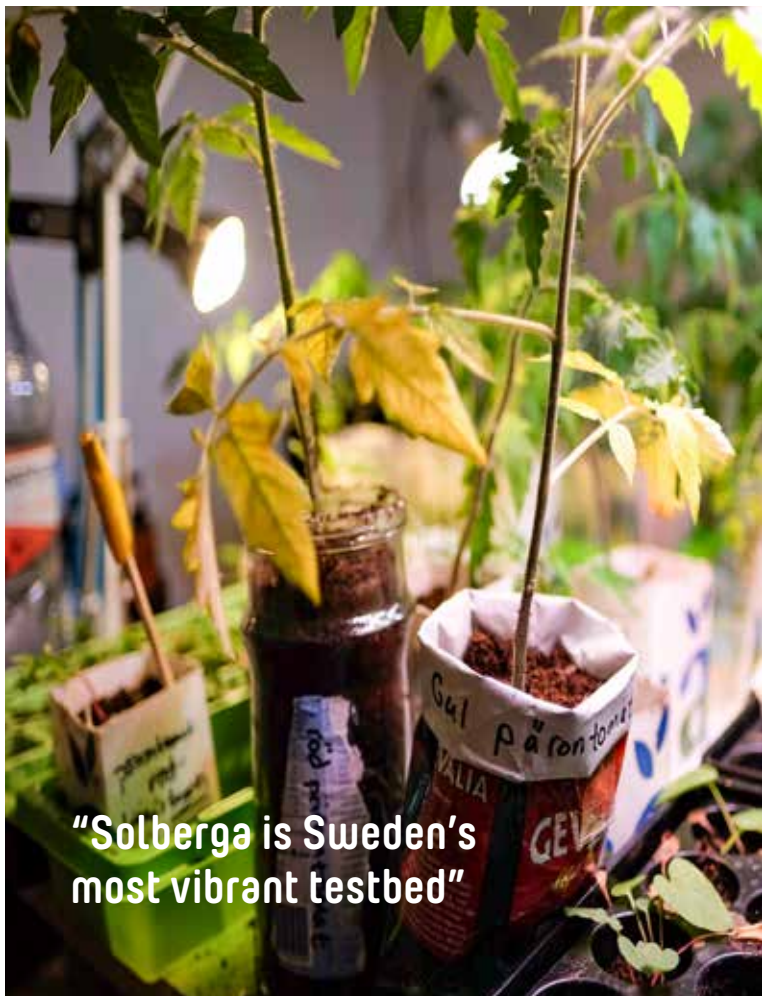
COMPANIES RECEIVE FEEDBACK STRAIGHT AWAY
Heating, ventilation, waste, sewage – there are many issues relating to our homes and human behaviour that are of interest to environmental research, as well as considerable opportunities to make climate-smart improvements.

"It's one thing to make improvements when building a new property, but a transformation also has to include the existing infrastructure. And in order for that to happen, we have to be able to conduct tests in an actual residential environment. This is the great advantage of Green Solberga – companies can interact directly with the residents here, getting feedback on what works and what improvements need to be made. This is vital in order for us to develop sustainable solutions that work in practice," says Johan Strandberg.

More than 50,000 people live in Stockholmshem's properties, the same number as in a medium-sized Swedish city. The aim of the project in Solberga is to demonstrate how residential areas can become more resource-efficient and sustainable. For example, the project is looking at various solutions in relation to



Torbjörn Frisö, from Kretsloppsbolaget, and Johan Strandberg, IVL, check out the fish farm in a basement in Solberga.



"Solberga is Sweden's most vibrant testbed"



GREEN SOLBERGA

The Green Solberga testbed is being run by the IVL Swedish Environmental Research Institute and Stockholmshem. The projects that have been carried out to date in the testbed have been financed by the European Regional Development Fund and Viable Cities. IVL is co-funding the project through the IVL Foundation.

stormwater and waste management. A number of projects are being carried out in the area, with prototypes and small-scale solutions being tested and demonstrated.

For example, trials are under way in respect of water staircases and plant ponds that collect rainwater from drainpipes and roofs. By utilising the rainwater rather than directing it down into the stormwater system, it is possible to reduce the load on the city’s stormwater pipes while at the same time protecting the properties. The water can be used for growing vegetables instead. There is also an eco-building where biotechnology is being used to remove unpleasant odours when sorting waste. The area also includes a meeting room for workshops and meetings for the newly formed farming association.

Open houses have been held on two occasions during the year, including a tour of the ongoing projects in the area. Entrepreneurs from various companies, as well as representatives from IVL and Stockholmshem, have been present at these open houses to describe what is going on and how residents can get involved to achieve a greener and more sustainable everyday life. Getting the residents involved in the sustainability work is important, points out Johan Strandberg.

“We want to make changes, after all, so it’s important for the residents to perceive these as something positive. The response we have received so far has been exclusively positive, I would say. Of course, it’s true that we are only working with a small group of pioneers from the district at present – not all of Solberga’s 3,000 tenants are involved – but people are frequently getting in touch and asking how they can get involved in the projects. It’s a lot of fun.”

For Green Solberga, it’s not simply a matter of identifying climate-smart solutions, but also about getting the residents involved and strengthening social cohesion. For example, the tenants have started up cultivation groups and a sharing project.

“At the moment, we are working to incorporate our experiences from the completed projects into the new production that is taking place in the area. It’s great that Stockholmshem has been so quick to pick up on and put into practice the things they have seen work well,” says Johan Strandberg.



Johan Strandberg
project manager and environmental injury expert,
IVL’s office in Stockholm

I joined IVL 15 years ago. I had just finished my degree in physical geography at the time, and I completed my thesis at IVL. I have worked on a variety of projects since then, mainly on issues relating to water and in the field of environmental technology. At present, I am working primarily as a project manager and as a team leader in relation to acute environmental damage.

My interest in environmental issues began back in the 1990s. I was captivated by the wave of environmental commitment that followed the emergence of Phocine distemper virus. I started an environmental council in secondary school, and while at upper secondary school I arranged environment days for the whole school. I remember us protesting against motoring, too. From that point on, it was obvious that I would end up studying something related to the environment at university. I wanted to work with water issues in India, which is something that I have also now done.

I tend to think that the best projects are those where the results cannot simply be put on a bookcase and forgotten. In cases of acute environmental damage, the environmental benefits are immediate and almost visible. People are often very relieved when somebody with experience comes and helps them make decisions, which is nice, of course. I also enjoy projects that are related to implementing some kind of change alongside other people.

Green Solberga is one good example of this, while a water project we are working on in India is another. We are also involved in a project that we refer to as the mining dialogue, where we are working with the central authorities and the mining companies to improve the environmental assessment process in Sweden. This is a slow process and absolutely not a quick fix, but is hopefully something that will have a lasting effect.

IVL CONTRIBUTES TO THE GLOBAL GOALS BY:

- Reducing the effects of harmful chemicals and pollutants as well as contamination of the air, water and soil (3.9)
- Promoting inclusive and sustainable urbanisation and improving the capacity for participatory, integrated and sustainable planning (11.3)
- Securing access to accessible green spaces (11.7)
- Strengthening resilience and the ability to adapt to climate-related change (13.1)
- Increasing awareness and capacity in terms of mitigating climate impact (13.3)
- Integrating the values of ecosystems and biodiversity in national and local planning and development, as well as in accounting strategies. (15.9)

We do this by testing various solutions for increased sustainability in an existing residential environment. Aquaponic cultivation is an example of the testing of integrated, local, sustainable food production.





Some of the companies and ideas tested in Green Solberga:

KRETSLOPPSBOLAGET is operating a test facility for aquaponics, a system where fish farming is combined with hydroponic plant cultivation (cultivation in water) in one and the same closed system.

Three types of plant beds are being tested.

- *Ebb and flow*: The plants stand on a stone bed, where the amount of water is regulated by a timer to mimic ebb and flow.

- *Deep water cultivation*: The plants stand in mesh baskets on a polystyrene plate that is floating in the nutrient-rich water.

- *NFT technique*: The plants are grown in a plastic gully where nutrient-rich water is pumped around.



REFO is a company that combines societal benefits with entrepreneurship through designed reuse and education. In Solberga, Refo has arranged workshops for the residents on the theme of reuse.

UNITED SERVICES SWEDEN is a company run by an innovator, which is conducting tests in Solberga whereby an oil emulsion is added to the radiator circuit to lubricate pumps and reduce the precipitation of iron oxides. This in turn will lead to a reduced need for servicing, quieter operation and more even heating in the apartments.

BIOTERIA has built an eco-building within Green Solberga where residents can discard their waste. The eco-building is self-sufficient as regards electricity and is equipped with biological odour control. When the waste is treated with beneficial bacteria, an odourless waste area is created without the need for refrigeration, ozone or chemicals. The idea is that the handling and recycling of waste will be much easier if waste plants do not give off odours and can be placed in the most appropriate location from a space perspective.

“GREEN SOLBERGA SHARES” is a project in which IVL, Stockholmshem, ÅWL Arkitekter and Lund University are developing a process whereby Stockholmshem can make it easier for residents to share the things they have at home or common resources such as workshops, cultivated areas or means of transport. For example, the Swinga app has been developed to facilitate sharing in Solberga.

VIRBELA ATELJÉ has developed a plant pond that is intended to fit in small areas in a city. In Solberga, water from rooftops is led down the plant pond.

The plant pond, in combination with a rainwater tank, becomes a buffer in the event of heavy rain, as the water stays in the bed and the tank rather than overloading the stormwater system. The water can be used for cultivation instead.



Basta launches logbook for the construction sector

As more and more districts and buildings are being built with high environmental standards, the need for environmental information about the constituent construction products is also increasing. IVL's subsidiary Basta, in cooperation with the industry database Finfo, has launched a logbook focusing on increased traceability and digital flows for construction products.

In the new logbook, it is possible to search among more than 160,000 articles that satisfy the Basta system's environmental requirements in respect of chemical content. Via an interface, it is also possible to search online in Finfo's database, which contains more than 1.8 million construction items and related documentation. The increased traceability of construction items entails quality assurance – a prerequisite for ensuring that the product you choose from the logbook genuinely is the same product as the one you subsequently incorporate in your building.

The logbook can be used as a digital logbook for environmental certification or in the event of requirements for non-toxic construction, as well as to document what is being incorporated in those cases where environmental requirements are not as clearly expressed.



Cooperation will make it easier for the construction sector to set climate requirements



The construction phase accounts for a large proportion of the real estate sector's climate impact. In the "Climate requirements at reasonable cost" project, IVL is working alongside Public Housing Sweden and the credit institution Kommuninvest with the goal of developing an industry standard for calculating climate impact as well as to set climate requirements in conjunction with new production. Nine housing companies are acting as test pilots for the project.

"We need an industry standard including regulations in order to produce climate declarations for buildings. Working on the basis of such an industry standard, various stringent requirements can then be imposed depending on the construction project, at the same time as ensuring that everyone in the sector is performing calculations in an equivalent manner," says Helena Ulfspärre at Familjebostäder, which is one of the first in Sweden to stipulate climate requirements for procurement across a broad front.

The current project also includes housing companies and contractors. Nine public housing companies, with ongoing construction projects ranging from Malmö in the south to Sundsvall in the north, have been

appointed as test pilots. They will draw up a climate declaration for a building using the Construction Sector's Environmental Calculation Tool (BM), which IVL has developed. The experiences of the test pilots will subsequently result in general guidelines regarding climate requirements in construction procurements.

"Being able to impose climate requirements on construction is an important step in the development of a fossil-free construction sector. This project and the work of the pilots will provide us with guidance on how to set these requirements successfully," says Anders Ejlertsson, project manager at IVL.



Record interest in Smart City Sweden

Swedish solutions in the field of smart and sustainable cities are attracting record numbers of foreign players to Sweden. In 2019, Smart City Sweden received nearly 1,700 visitors from 55 countries. Most of the visitors came from China and other parts of Asia.

“Through Smart City Sweden, we are able to show off the best that Sweden has to offer when it comes to smart and sustainable cities. The aim is to inspire others, while at the same time promoting Swedish exports in this area,” says Östen Ekengren, Executive Vice President of the IVL Swedish Environmental Research Institute and the person responsible for business development at Smart City Sweden.

Smart City Sweden’s display activities currently encompass well over 100 sites across the country, including solutions in the fields of environmental engineering, mobility, urban planning, digitalisation and social sustainability. The platform is run by the IVL Swedish Environmental Research Institute on behalf of the Swedish Energy Agency, with the support of six regional nodes, from Umeå in the north to Malmö in the south.

There were record levels of interest from abroad during 2019 – almost 1,700 visitors from 55 countries were received at the head office in Hammarby Sjöstad in Stockholm and at the regional nodes. The vast majority of the visitors came from China and the rest of Asia, although countries in South America have also become aware of the operation. The display activities within Smart City Sweden have resulted e.g. in projects in China, India and South Korea in areas such as urban planning, air quality and water treatment.

“During 2020, we will be continuing to strengthen the cooperation with foreign cities that have expressed an interest in Swedish solutions.

We are also working to link additional export-ready companies to the visitor operation. The aim is to export our Swedish solutions and attract overseas investors,” says Östen Ekengren.

ABOUT SMART CITY SWEDEN

Smart City Sweden is a government assignment running from 2018–2021. The assignment incorporates the Swedish Energy Agency, the Swedish National Board of Housing, Building and Planning, the Swedish Environmental Protection Agency, the Swedish Transport Administration, Lantmäteriet, the Swedish Agency for Economic and Regional Growth, Vinnova and Business Sweden.

The platform is operated by the IVL Swedish Environmental Research Institute, along with the regional nodes: Region North – North Sweden Cleantech through Kompetensspridning i Umeå, Region Central – Dalarna Science Park, Region East – IVL Swedish Environmental Research Institute, Region West – Business Region Gothenburg, Region South-East – Cleantech Östergötland, Region South – Sustainable Business Hub.

Read more at www.smartcitysweden.com



The local authorities that are best at climate adaptation

Uppsala is the best in Sweden when it comes to climate adaptation, followed by Sundsvall and Kristianstad in joint second place. This could be seen from the 2019 survey of the climate adaptation work conducted by local authorities.

This is the fourth time that the IVL Swedish Environmental Research Institute and Insurance Sweden have surveyed the work of Sweden's local authorities in respect of climate adaptation. The results have formed the basis for a comparison and ranking of the local authorities' work. The aim is to get more municipalities to work systematically with climate adaptation.

The most recent survey shows that the local authorities' average scores have increased and that more local authorities have taken the political decision to work with climate adaptation. At the same time, only six out of ten local authorities have analysed the way in which they have been affected by previous extreme weather events.

"This is remarkably low, bearing in mind all the weather events in recent years, such as forest fires, torrential rains and heatwaves," says Hanna Matschke Ekholm, project manager at IVL.

Smaller towns and local authorities in rural areas have generally not come as far as larger local authorities in their climate adaptation work. Many local authorities are expressing a need for more support in terms of knowledge, increased resources and good examples.

Climate change is posing major challenges for society. The extent of the impact will be dependent on the extent of the climate change, but also on society's ability to adapt to these changes.

"There is already a great deal of climate-related damage, and there is a risk of such damage increasing both in frequency and extent. The local authorities are playing a key role in the adaptation work. The survey clearly shows that all local authorities need to chart and carry out climate adaptation measures in order to reduce their vulnerability," says Anna Rudérus at Insurance Sweden.



The Construction Sector's Environmental Calculation Tool digitalised

The Construction Sector's Environmental Calculation Tool (BM) is a free, industry-wide tool that has been developed by IVL to calculate the climate impact of buildings. The tool can be used to provide support when setting climate requirements in procurement, as well as to make climate improvements as regards material choices and production methods.

In 2019, an important advance was made when the use of the tool became easier and more quality-assured with the aid of digitalisation. Climate calculations have previously been carried out manually, which is both time-consuming and expensive, but the cost estimates produced in construction processes can now be transferred digitally to the Environmental Calculation Tool. As a result, in addition to the actual construction cost calculation, users also get a climate declaration into the bargain. In the next step, it will be possible to replace general

environmental data for various construction products with company-specific data, known as environmental product declarations or EPD data from different suppliers.

"The idea is that this will encourage improvements, by making it possible to see how the building's climate impact can be reduced through altered material choices and production methods," says Martin Erlandsson, project manager at the IVL Swedish Environmental Research Institute.



Clean water in focus as IVL opens office in India

IVL is continuing to grow internationally – most recently in India, where a new office has been opened in Mumbai, a city with many millions of residents. A significant proportion of the activities are focused on water treatment, which is one of IVL’s strengths. In one of the larger projects, IVL will ensure that two large wastewater treatment plants in Mumbai are constructed to a high quality.

“The fact that we now have operations in India, and that we can contribute with our knowledge in the field of water treatment, is very positive. In countries like India, which is currently using up its groundwater reserves, there is a considerable need to develop complete solutions for reusing wastewater and utilising the resources it contains,” says Östen Ekengren, Executive Vice President of the IVL Swedish Environmental Research Institute.

The Indian economy has developed rapidly during the 21st century. At the same time, the country is one of the world’s largest polluters, with significant needs in terms of the environment. Like many other cities in India, Mumbai, with more than 18 million inhabitants, still lacks functioning wastewater treatment, for example.

ALMOST NO WASTEWATER TREATMENT

“Uncontrolled discharges of wastewater are a major problem in India. It is estimated that as much as 90% of all wastewater is discharged without any form of treatment. This has resulted in a large proportion of India’s surface water, and also its groundwater in some areas, being polluted,” says Rupali Deshmukh, business developer at IVL.

Access to water is another major problem. India is one of the world’s largest and most populous countries – 17.5 percent of the world’s population lives there – but the country only has 4 percent of the world’s water resources. With climate change, urbanisation and rapid industrialisation, water shortages are also expected to get worse in future.

In order to address water scarcity, the Indian Government

has launched a number of major initiatives, including within “Swach Bharat” or Clean India. One of the aims is to build wastewater treatment plants in all major cities over the next ten years. In Mumbai, the city’s leadership has decided to build seven large wastewater treatment plants. IVL has been awarded a contract to participate in the construction of two of them. Overall, IVL’s role involves quality-assuring the design and plan for the plants from an environmental perspective, proposing improvements and technical solutions in respect of wastewater technology and ensuring that the plants are built correctly.

IVL OFFICE IN MUMBAI

In conjunction with this, IVL has now established an office in Mumbai with both Swedish and Indian staff.

“Getting functioning wastewater treatment in place will contribute to improved health and living standards for many people in Mumbai, and we are delighted to be a part of this work,” says Rupali Deshmukh.

An important area of focus for IVL’s development work relates to the reuse of treated wastewater. IVL has previously demonstrated that, with the right technology, wastewater can be recycled both cost-effectively and in such a way that it is sufficiently clean to be returned to the groundwater or reused in agriculture and industry.

“It’s a matter of viewing the wastewater as a resource. With the right technology, in addition to providing clean, reusable water, the treatment plants can also generate biogas and nutrients that can be returned to nature,” says Östen Ekengren.

Dedicated employees are the most important factor for our success

IVL is a knowledge company, and it is of the utmost importance to be an attractive workplace and employer. We work actively to retain and develop our skilled employees, at the same time as attracting new talent.

At IVL, it is possible to find interesting work duties in all parts of the sustainability field, both nationally and internationally. We can offer our employees the opportunity to influence and contribute to sustainable social development, as well as to work with extremely relevant climate issues. Having the potential to combine research and consultancy projects in the field of sustainability makes us a unique workplace, with substantial opportunities for development.

At IVL we possess a wide range of skills, from engineers, chemists, biologists and geologists to behavioural scientists, political scientists, lawyers and economists. Almost a third of our employees have a PhD, guaranteeing high skills levels in many areas.

WORKING AT IVL

At IVL, our employees are given the opportunity to utilise their creativity and develop within the wide variety of projects that are carried out. They can find many opportunities to work with their specific area of expertise. This allows us to guarantee that you will receive personal and professional development at IVL.

At IVL, our employees work in various groups, as well as in projects with colleagues from other units and groups. This makes it easy for them to network and develop in their day-to-day work. Much of the work is now carried out digitally via Skype and video conferencing, since we are spread out across Sweden and have offices in India and China. It is still important to meet, of course, and our groups and sections come together regularly. When we are conducting meetings between different offices in Sweden, we always travel by train.

As an employee at IVL, it is possible to take part in our internal mentoring programme. The programme is launched once a year and is targeted at employees who have not been at IVL or

in working life for that long. The idea behind the programme is to enable you to receive support from an experienced colleague regarding any questions you may have. IVL trains new mentors every year. The mentoring programme is much appreciated, and a new programme is being launched in January 2020.

The social community is important at IVL, and we believe this is one reason why our employees have such a high level of job satisfaction and remain with us for a long time. The company sponsors sports clubs and art societies, and these associations arrange a wide variety of activities such as kayaking, beach volleyball, truffle tasting, ski trips and Christmas crafts for our staff's families. In addition, we arrange parties, pub evenings and other fun activities, such as IVL repair night.

WE ARE GROWING WITH DIVERSITY AND EQUALITY
IVL is undergoing a period of expansion, and the number of employees continued to grow in 2019. In order to meet our vision of a sustainable society, it is important to possess knowledge and creativity. For this reason, we need a wide range of employees with diverse backgrounds and experiences.

At IVL, we focus on expertise when recruiting staff, and over the past year we have brought in new employees with various nationalities and backgrounds. In order to integrate non-Swedish speakers, we have conducted Swedish language teaching in the Stockholm office during the year, which has been greatly appreciated. We have also expanded our operations in China during the year, as well as in India.

Development is important for us, and IVL makes it possible for staff to obtain a PhD and work one day a week at a university/college. We believe that this development will benefit IVL in our consultancy and research activities. When it comes to gender equality, IVL is at the forefront. 58 percent of our employees



are women, and this is also reflected in IVL's management team, where 55 percent are women. IVL also has a female chair.

SKILLS DEVELOPMENT

In order for IVL to be able to deliver applied research and consultancy assignments that meet the needs of society and our customers, while at the same time remaining competitive, the expertise and skills of our employees are absolutely crucial. IVL's approach to skills development corresponds to the "70-20-10 model", whereby 70 percent of skills development takes place in day-to-day operations, 20 percent through learning from experienced colleagues and 10 percent through more formal training activities.

A great deal of skills development takes place in our day-to-day operations, and many of our employees participate in seminars and conferences within their specialist areas. Since much of our work is carried out in projects, it is important to develop continually within the project work. IVL conducts internal project management training courses that are carried out several times a year at various levels. In 2019, 256 employees have taken part in some form of project management training.

Since 2013, IVL has run a leadership development programme that encompasses all managers. The programme is based on the success factors for leaders that IVL has defined, and combines joint training modules with individual coaching. During 2019, our two modules have been implemented for new group managers.

PERFORMANCE REVIEWS

Annual performance reviews give each employee the opportunity to work with their manager to set goals and view their contribution to IVL's overall development. The reviews result e.g. in individual development plans. We have upgraded the perfor-

mance reviews during 2019 to ensure that all the key areas are discussed.

RESTRUCTURING

In spring 2019, the organisation was notified that restructuring would be implemented as from 1 July 2019. During the restructuring process, IVL opted to reduce the number of its business units in order to focus on and develop various business areas. Within the restructuring, it was also vital to increase the focus on sales work in order to offer our services to more companies in the private sector.

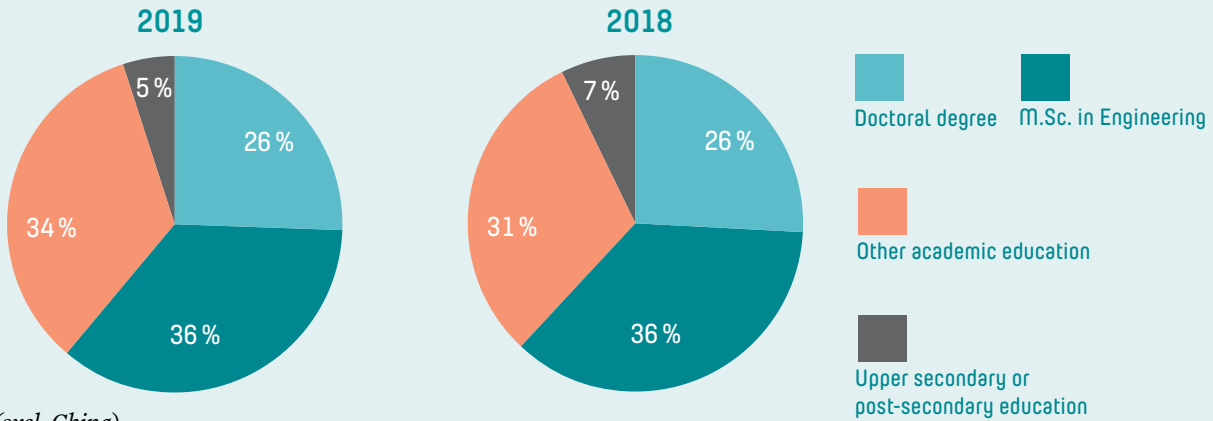
The restructuring also included the decision to elevate Human Resources such that it reports directly to the CEO, since IVL's staff are by far our most important resource. One essential aspect of the restructuring was the delegation of work duties and authority, primarily to our group managers. During the autumn, we have trained and provided our group managers with new tools in order to give them the knowledge they need.

The restructuring has had a positive impact to date.

ROLE STRUCTURE

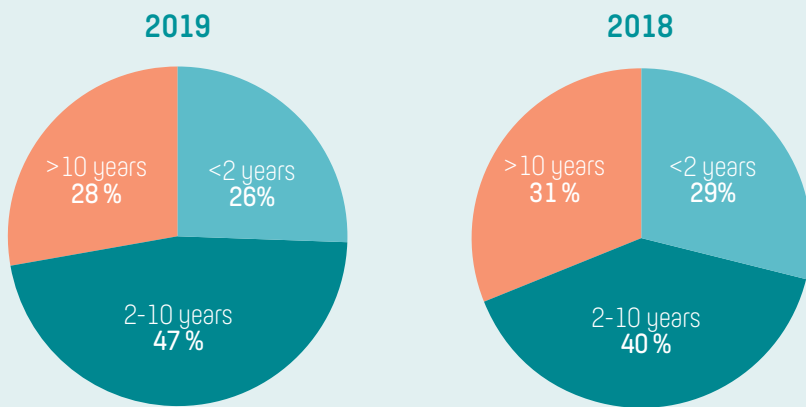
During 2019, work has been under way at IVL aimed at defining the roles that exist in the operational units. IVL views this as a step in becoming an even more attractive workplace. By creating clarity regarding the roles at IVL, we believe it will be easier for our employees to find career pathways and be able to focus on the tasks they are best at. We also believe this will help us when we are recruiting, introducing and developing our employees. The implementation of the role structure commenced at the end of 2019.

Training



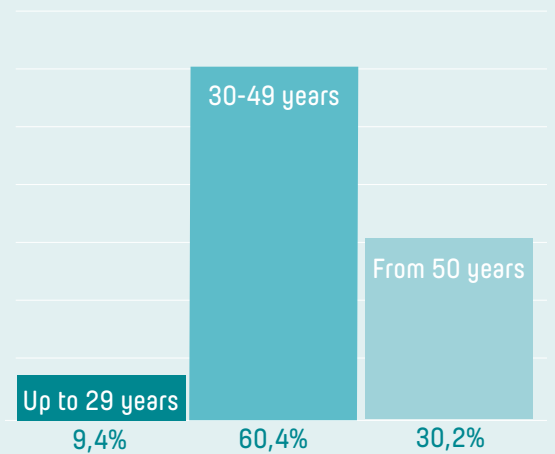
(excl. China).

Period of employment



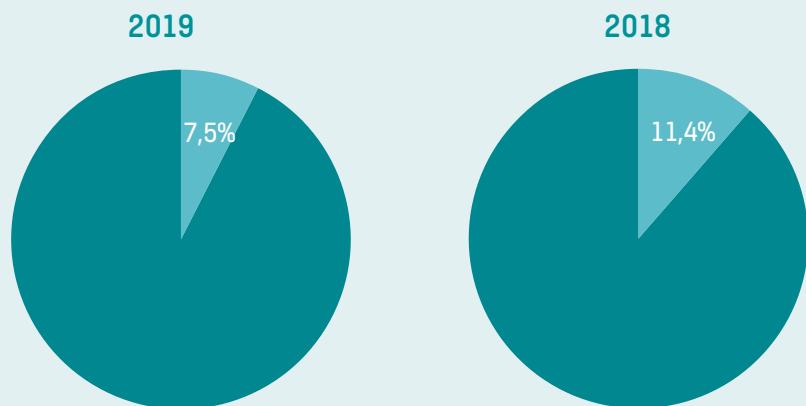
The average period of employment is 8.3 (9.86) years (excluding fixed-term contracts in 2019, excluding China).

Age distribution 2019



(excl. China).

Staff turnover



Percentage of employees who have left in relation to average employees, excluding pensioners and fixed-term contracts.



Ethics and integrity

For the IVL Swedish Environmental Research Institute, our independence is fundamental to our 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.

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. When introducing new employees, we conduct a brief review of what the code of conduct means and how to access it. Workshops were held for all employees during 2018, and new workshops are planned for 2020.

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, IVL is providing a system that allows employees to report suspicions, guaranteeing each employee the right to file complaints anonymously and without the risk of consequences. No reports were received in 2019.

RISK ASSESSMENT

IVL's management continuously assesses risks related to the company's operations, including risks associated with corruption, human rights, working conditions and the environment. Risk assessment is also an integral part of IVL's project process and is 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.

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

- Climate and energy
- Resource efficiency and circularity
- Sustainable use of chemicals

IVL's environmental management system, which covers operations in Sweden, is certified according to ISO 14001. The report below 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 241 (295) tonnes CO₂e, of which 196 (238) tonnes CO₂e comes from business travel and 45 (57) tonnes CO₂e from energy consumption. The majority of the emissions, 73 percent, come from business travel by air. Emissions per employee amounted to 801 (1,014) kg CO₂e.

Business travel

IVL has goals for reducing emissions from business travel, including always considering whether travel is necessary, as well as promoting video conferencing rather than physical meetings and trains rather than air travel. However, some travel is unavoidable in order to conduct operations and carry out assignments. IVL's travel policy has been updated and clarified during 2019. Despite the fact that operations have increased, the overall climate impact from business travel has decreased compared to the previous year. Domestic rail travel has been used to a greater extent in 2019. When it comes to the international operations, however, international travel by air is often unavoidable.

Energy use within operations

Total energy consumption for IVL's operations totalled 1,734 (1,935) MWh, of which 42 percent comprised electricity and 58 percent district heating. The reduction in energy consumption for 2019 is mostly due to the fact that Stockholm also used a temporary office during the renovation of the offices in Stockholm in 2018. Most of the energy supply comprises renewable energy. A small proportion of the district heating used in Stockholm comes from non-renewable sources, although in this case the supplier offsets 17,780 kg of CO₂e. An

energy study was carried out during 2019 to identify potential measures for reducing energy consumption. As part of this, a number of technical measures were identified regarding e.g. the adjustment of ventilation and spot extraction in the labs, as well as timers for lighting. The implementation of these measures will commence during 2020.

Climate fund

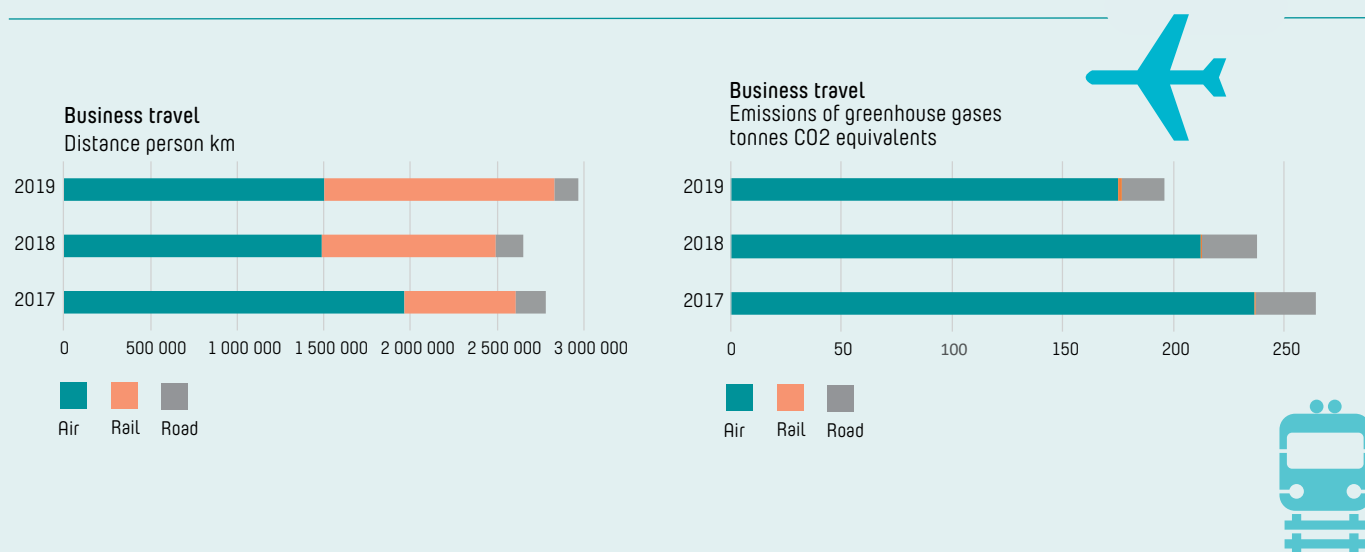
Since 2016, IVL has been setting aside funds for a climate fund, which is used to offset carbon dioxide emissions from business travel. Carbon offsetting is conducted by means of credible standards, which ensure genuine and long-term emission reductions as well as contributing to other global goals within 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, from employees and from society at large. The forms of climate compensation will be developed during 2020.

RESOURCE EFFICIENCY AND CIRCULARITY

IVL's operations will be run in a resource-efficient manner, with reuse and recycling being obvious elements. Recycled furnishings, IT equipment and mobile phones are used as far as possible, and priority is given to environmentally friendly alternatives when purchasing consumables. Any furnishings and equipment that IVL no longer requires are resold for continued use and reuse. Catering at meetings, conferences and other events that IVL arranges should be vegetarian, organic and seasonal, as well as being fairtrade and locally produced where available; food waste should also be minimised. In 2019, IVL launched a collaboration with a catering supplier that salvages sorted food from grocery stores that would otherwise have become food waste, and uses it in their dishes.

The total amount of waste from IVL's offices, measurement and analysis activities and Hammarby Sjöstadsværk amounted to 22.3 tonnes, of which 17.5 tonnes went to recycling, 4.4 tonnes went to incineration and 0.3 tonnes to other waste. A number of improvement measures have been identified with the aim of reducing the amount of waste and further increasing the proportion of waste that is recycled. These will start to be implemented during 2020.

CLIMATE AND ENERGY - BUSINESS TRAVEL



COMPARISON, CLIMATE INTENSITY 2018-2019

	Greenhouse gas emissions:	Premises	Business travel	Total	
2019	Per employee	150	651	801	kg CO ₂ equivalents/employee
	Per net sales	0.12	0.52	0.64	kg CO ₂ equivalents/SEK thousand
2018	Per employee	196	818	1 014	kg CO ₂ equivalents/employee
	Per net sales	0.16	0.52	0.68	kg CO ₂ equivalents/SEK thousand

SUSTAINABLE USE OF CHEMICALS

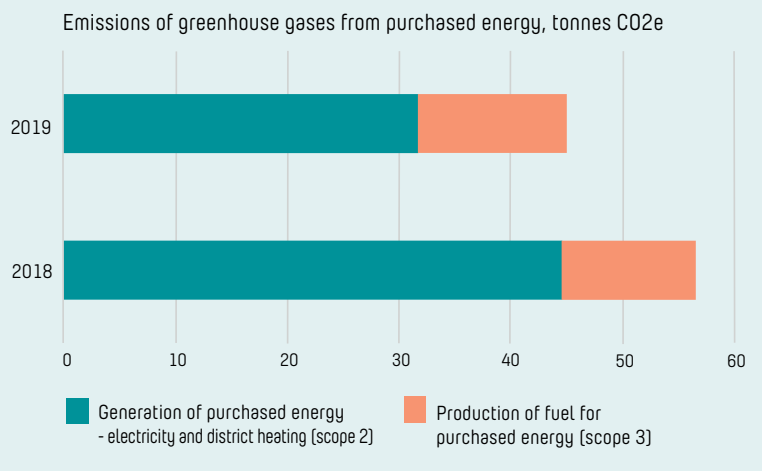
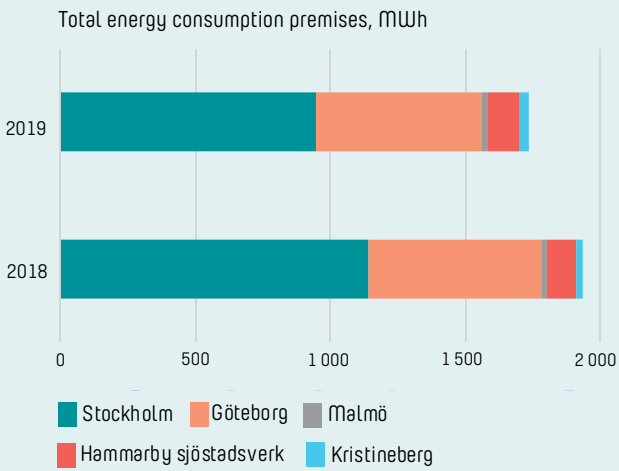
Chemicals are mainly used in IVL's measurement and analysis activities, where the choice of chemicals is largely governed by the analysis methods and the equipment used. When developing analysis methods and purchasing equipment, IVL therefore works systematically to reduce chemical usage and replace hazardous chemicals with alternatives that have a lower impact on the environment and deliver a safer working environment. In 2019, for example, IVL has developed a new combined analysis method for pharmaceuticals and antibiotics that allows for faster separations, streamlining the analysis of both solvent consumption and time.

A feasibility study was also carried out to identify additional improvement opportunities within IVL's handling and use of chemicals, in which a number of improvement proposals have been developed. These proposals will start to be implemented during 2020.

Chemicals are also used for water treatment within the research activities at Hammarby Sjöstadsverk. This facility develops techniques 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.



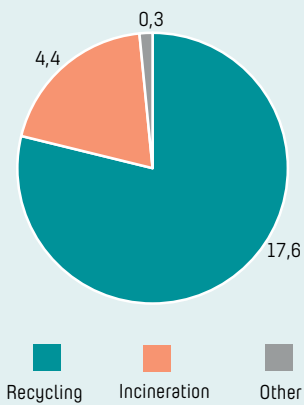
ENERGY AND CLIMATE FACILITIES



The reduction in energy consumption for 2019 is mostly due to the fact that Stockholm also used a temporary office during the renovation of the offices in Stockholm in 2018.

RESOURCE EFFICIENCY AND CIRCULARITY - WASTE

Waste distribution recycling and incineration, tonnes



Waste from all operations, totalling 22.3 tonnes

IVL can bolster your environmental and sustainability work

IVL has the expertise required to develop and strengthen environmental and sustainability work in various organisations, including monitoring and calculating environmental impact according to international standards. The graphs above show the follow-up of our own operations, and we can perform similar calculations for your company.

► **If you would like to know more about the development of environmental and sustainability work, please contact:**

Ann-Christin Pålsson, ann-christin.palsson@ivl.se, tel. +46 10-788 66 14

If you would like to know more about the following-up of transport and business travel, please contact:

Tomas Wisell, tomas.wisell@ivl.se, tel. +46 10-788 69 17

Directors' report

The Board of Directors and the CEO of the IVL Swedish Environmental Research Institute hereby submit their annual report for operating year 1 January 2019 – 31 December 2019, the company's thirty-eighth fiscal year.

Group operations

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

PARENT COMPANY

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. Activities are structured into three operational units, together with the unit for research, business development and international affairs, which operates laterally across the organisation. IVL's working methodology is characterised by an interdisciplinary and holistic approach. The company is active across the entire field of sustainability, and for this reason, in addition to its traditional expertise in the environmental field, IVL employs behavioural and social scientists and financial and communications experts.

Our activities extend across the entire industrial spectrum, and our customers represent Swedish society in its entirety, ranging from small and medium enterprises to large multinationals, industry and trade organisations, public agencies – of which the Swedish Environmental Protection Agency is the largest single contributor and client – as well as local authorities and other organisations.

Hammarby Sjöstadsverk

Hammarby Sjöstadsverk is one of Sweden's leading R&D facilities in municipal and industrial water purification technology. The facility, which is operated by IVL and KTH, is used in both national and international research projects and as a test and pilot facility for the private sector and other parties. The facility forms the basis for the Sweden Water Innovation Centre – SWIC.

The activities have grown strongly since they commenced in 2007, and municipal and industrial water purification technologies are now developed at the facility by researchers from institutes and universities as well as around 25 Swedish and international water purification companies. At present, some 30 IVL employees are working on 20 different R&D projects at Hammarby Sjöstadsverk.

Together with KTH, Uppsala University, the Swedish University of Agricultural Sciences (SLU) and Mälardalen

University, Hammarby Sjöstadsverk is part of the Research and Education Consortium in Mälardalen, which is a centre for municipal wastewater treatment with funding from the Swedish Water & Wastewater Association (SWWA) and municipal authorities in the Mälardalen region.

Since 2016, there has been a pilot plant at Hammarby Sjöstadsverk for Stockholm's future water treatment at the Henriksdal wastewater treatment plant, which will be the world's largest sewage treatment plant using membrane technology within a few years. This will provide the growing city with wastewater purification that can boast greater capacity and reduced discharges of eutrophication substances into the Baltic Sea.

In 2019, work has begun on the completion of two new, large-scale pilot plants: a plant for recovering nitrogen from wastewater and a facility employing membrane technology in combination with purification of pharmaceutical residues using powdered activated carbon. Both of these plants will become operational during 2020.

Fiskebäckskil

The company conducts most of its marine activities at the Lovén Centre Kristineberg research station in Fiskebäckskil. IVL is currently conducting extensive research into marine micro-debris and the maritime environmental effects caused by discharges of bilge and scrubber water, as well as the development and evaluation of new forms of aquaculture. Kristineberg is also the base for the development of the Kristineberg Research and Innovation Centre, a collaboration between Gothenburg University (GU), IVL, Chalmers, KTH, RISE and Lysekil Municipality. The Centre's vision is to create a nationally and internationally leading centre for marine research, innovation and sustainable blue growth.

During 2019, the cooperation within the Kristineberg Research and Innovation Centre has been developed through support from Region Västra Götaland and the Swedish Agency for Marine and Water Management. A number of research collaborations have been launched, with applications submitted to and projects given the go-ahead by e.g. Formas, the EU and Vinnova. The development of an innovation platform and collaborations with small businesses in areas such as aquaculture and marine energy have continued.

International operations

IVL is engaged in extensive international operations. Europe is regarded as the company's domestic market, while elsewhere the main focus is on China and India.

Communication

Communication is an important component in our research programmes and as a means of increasing awareness of IVL's activities. The focus is on understanding customer needs and driving forces to achieve the goal of creating a change in behaviour with applied research and increased climate benefit. In 2019, our external visibility has increased and our website, ivl.se, has evolved. Internal communications have focused on the new digital workplace and on supporting the change process. Financial information can be found at ivl.se.

EUROPEAN NETWORKS AND COLLABORATIONS WITH UNIVERSITIES AND COLLEGES

IVL's role is to build bridges between the research and business communities and to create arenas for collaboration between various actors in society. This is one of the reasons why IVL

plays an active role in networks and other cooperative ventures of various kinds. IVL is also involved in a long line of European technology platforms, such as WSST (water), ESTEP (steel), FBST (forest) and ECTP (construction).

Other examples:

SPIRE – a network working to increase resource efficiency in process industry.

ENERO – European Network of Environmental Research Organisations – is a group of European research institutes operating under the umbrella of the European Research Area (ERA). IVL is an active member.

EURAQUA – the European Network of Freshwater Research Organisations. IVL is the Swedish representative in the network.

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.

LIGHTHOUSE – Nordic centre for maritime expertise and a collaboration between Chalmers, the Gothenburg School of Business, Economics and Law, and the Swedish Shipowners' Association.

SMED – the Swedish Environmental Emissions Database, is a consortium formed in 2001 by IVL, Statistics Sweden (SCB), the Swedish Meteorological and Hydrological Institute

(SMHI), and the Swedish University of Agricultural Sciences (SLU) to gather and develop Swedish expertise in emission statistics related to actions in the fields of air and water pollution, waste and hazardous substances. SMED has supplied all of the data required for Sweden's international reporting in these areas since 2006, and the present framework agreement expires in 2022.

SKOGFORSK – Since 2018, IVL has had a collaboration agreement with the Swedish Forestry Research Institute, Skogforsk, to engage in research on the bioeconomics of the future. This collaboration has continued in 2019, for example in respect of the MISTRA Digital Forest research programme, which is focusing on digitalisation for efficiency and sustainability within forestry.

KTH – For a number of years, IVL has been involved in a collaboration with KTH regarding the development of collaborative research.

CHALMERS – In 2019, IVL and Chalmers entered into a collaboration agreement regarding the development of collaborative research within areas that are linked to fundamental societal challenges in the fields of the environment and sustainability, for example in respect of energy, transport, infrastructure, production systems and urban development.

Group companies

BASTAONLINE AB

The BASTA system has been in operation since 2005 and BASTAonline AB (corporate ID no. 556719-5697), which owns and operates the system, was founded in January 2007. The company is 60 percent owned by the IVL Swedish Environmental Research Institute and 40 percent by the Swedish Construction Federation. The operations of the new company began on 1 March of the same year. At the start, 55 suppliers were connected to BASTA, and by the end of 2019 more than 470 were affiliated. The number of products in BASTA by the end of the year totalled approximately 50,000 items (corresponding to over 160,000 individual items). Of these, approximately 800 products were registered in the BETA register and a risk analysis had been conducted on approximately 150. The new BETA group for BASTA, which has been introduced to show the difference between delivered and built-in products, contains some 700 products after one year.

BASTA Logbook was launched during the second half of the year, and resulted in increased demand for running projects in the database. A digital call is making it possible to search in the FINFO database, which contains more than 1.3 million quality-assured construction items. During the last months of the year, a similar call was made for the digital building product declarations database (eBVD), which will be commissioned in early 2020.

Three full-day supplier training courses were organised during 2019, as well as a large number of shorter courses, both in the form of direct visits and online. The much appreciated BASTA Day seminar was held in November once again.

During the year, BASTA-Online has continued to participate in a number of projects in the field of digitalisation, as well as other industry initiatives. The company has also participated in external seminars and exhibitions.

In September, a co-funding project was initiated to work alongside industry stakeholders and the IVL Swedish Environmental Research Institute to develop a guide on how endocrine disruptors should be handled in the construction industry. The project was completed in December and BASTA, based on the scientific report produced, has prepared guidelines and support documents in order to facilitate interpretation for affiliated companies and other stakeholders.

Net sales for the financial year amounted to SEK 7,743,000 (6,861,000) and profit after financial items amounted to SEK 614,000 (907,000). Equity amounted to SEK 2,922,000 (2,500,000). A previously announced increase in the price of the annual fee was implemented in 2019.

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 range of different industries and applications, such as environmental communication between companies, green public procurement and environmental certification of buildings. The company operates globally and has customers on every continent. EPD International communicates globally about the system, maintains and develops the rules and international collaborations, and registers and publishes approved EPDs. In total, EPD International has more than 1,250 EPDs from around 400 companies published on www.environdec.com. In 2019, more than 300 new EPDs were registered from companies in 28 different countries. The eighth EPD International Stakeholder Conference was held in Bilbao, Spain, during the year. EPD International AB developed a Code of Conduct and circulated it to partners during the year.

Net sales for the financial year amounted to SEK 6,895,000 (5,671,000) and profit after financial items amounted to SEK 1,268 (1,684). Equity amounted to SEK 2,620,000 (1,873,000).

EBVD I NORDEN AB

Since 2017, eBVD i Norden AB (corp. ID no. 559093-5390) has been 51 percent owned by the IVL Swedish Environmental Research Institute and 49 percent owned by the Swedish Association of Construction Product Industries. The construction sector in Sweden has accepted voluntary responsibility for declaring building products from an environmental perspective for more than 20 years. During 2013–2015, IVL performed a number of development projects to update the building products declaration and develop a digital format in collaboration with the industry. The aim of the company is to streamline and reduce the costs of preparing and using building products declarations according to the industry standard for digital building products declarations, contributing to a traceable digital flow of up-to-date environmental information from the materials manufacturer. At year-end 2019/2020, the company had approximately 211 (171) licensed users of the system and more than 4,000 (3,000) digital declarations.

Net sales for the financial year amounted to SEK 1,160,000 (900,000) and profit after financial items amounted to SEK 146,000 (-11,000). Equity amounted to SEK 190,000 (101,000).

IVL ENVIRONMENTAL TECHNOLOGIES (BEIJING) COMPANY LTD

IVL has had a wholly-owned subsidiary in China since 2014. The subsidiary is primarily dedicated to the provision of environmental consulting services and technology transfer for the Chinese market. IVL's China operations have been built up with grants, although more recently through the EU's research budget, funding from Swedish companies in China and from Swedish financing organisations such as the Swedish Agency

for Economic and Regional Growth, the Swedish Energy Agency, Vinnova and Formas. One aim is to obtain Chinese research funding.

In recent years, IVL has managed to obtain funding from the Ministry of Science and Technology (MOST). This is extremely important for IVL's long-term development in China. Several of these projects are intended to contribute to the attainment of SDG Objective 12.3, i.e. a halving of food waste losses. During the year, together with various Nordic companies, IVL has visited three cities and marketed a Nordic initiative – "zero waste".

China is currently exploring how to license companies that are starting up production and/or expanding production. They are interested in how Sweden handles this. During the year, IVL has completed a report describing how this is done in Sweden.

IVL has also had primary responsibility for a major Nordic-Chinese conference in Stockholm focusing on sustainable green urban solutions, at which more than 100 Chinese delegates participated.

Net sales for the financial year amounted to SEK 2,536,000 (2,514,000) and profit after financial items amounted to SEK -61,000 (176,000). Equity amounted to SEK 1,078,000 (1,135,000). The company has 6 employees.

SINO-SWEDISH ENVIRONMENTAL TECHNOLOGY DEVELOPMENT CENTER LTD (SEC)

For more than ten years, IVL and the Tianjin Academy of Environmental Sciences (TAES) have been joint owners of the Sino-Swedish Environmental Technology Development Centre Ltd (SEC), based in Tianjin. SEC has helped a large number of Swedish environmental technology companies enter the Chinese market.

Net sales for the financial year amounted to SEK 1,653,000 (1,670,000) and profit after financial items amounted to SEK 136,000 (26,000). Equity amounted to SEK 1,658,000 (1,738,000).

IVL INDIA ENVIRONMENTAL R&D PRIVATE LTD

Since 2019, IVL has had a wholly owned subsidiary in India, which will mainly be engaged in wastewater treatment projects on the Indian market. The company has won additional water-related projects during 2019. The new office in Mumbai was opened during the year, and the process of hiring an office manager was initiated.

Net sales for the period of the financial year from 1 April to 31 December amounted to SEK 2,353,000 and profit after financial items amounted to SEK 189,000. Equity amounted to SEK 204,000. The company has 5 employees.

Financial performance

GROUP

Consolidated net sales for the financial year increased by 9 (8) percent to SEK 383,309,000 (353,277,000), with earnings after financial items of SEK 20,299,000 (1,763,000). Profit for the year after tax amounted to SEK 15,436,000 (940,000). The return on equity was 16.5 (1.6)% and the return on total capital was 8.7 (1.1)%. The average return on equity over the last five years was 5.5 (4.8)%.

The Group's total assets increased to SEK 253,242,000 (230,108,000) and equity increased by 18.5% to SEK 103,605,000 (87,424,000). Cash flow was positive in the amount of SEK 43,812,000 (-20,505,000).

Investments for the year in tangible and intangible fixed assets amounted to SEK 5,912,000 (15,319,000). The equity ratio is slightly higher at 40.9 (38.2)%.

For a more detailed multi-year overview and definition of key figures, please refer to Note 2.

PARENT COMPANY

IVL's net sales for the financial year increased by 8 (8)% to SEK 376,037,000 (349,115,000), with earnings after financial items of SEK 11,363,000 (-6,840,000). Profit for the year after tax

amounted to SEK 1,029,000 (78,000).

The main reasons for the improvement in profit in 2019 are that major expenses, both external and internal, related to the development of our offices in Stockholm and Gothenburg have been completed in 2018, the fact that the chargeability ratio, which was generally too low in 2018 at 64.1%, has increased to 65.9% and that the hourly prices for fees increased by 3% on an annual basis.

The balance sheet total amounted to SEK 238,016,000 (219,274,000) and equity to SEK 57,824,000 (56,795,000). Adjusted equity is estimated at SEK 70,377,000 (61,920,000).

Cash flow during the year was positive in the amount of SEK 38,195,000 (-20,331,000) due to lower investment levels and a number of advance payments for EU projects.

The return on adjusted equity was 13.4 (negative)% and the return on total capital was 5.1 (negative)%. The average return on equity over the last five years was 2.6 (3.1)%.

Investments for the year in tangible and intangible fixed assets amounted to SEK 6,110,000 (-14,871,000). The equity ratio increased slightly to 29.6 (28.2)%.

For a more detailed multi-year overview and definition of key figures, please refer to Note 2.

Organisation and corporate governance

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 and proposes members to the board of IVL, partly by inviting nominations from representatives of the business community, and partly by inviting nominations from the government.

THE WORK OF THE BOARD

During 2019 financial year, the Board of Directors held five regular meetings in addition to the statutory meeting, one extra meeting, one per capsulam meeting and one strategy meeting. The tasks of the Board of Directors primarily include strategic issues, financial statements, 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 also presented at ordinary meetings. The CEO chairs the board meetings.

The Board of Directors appoints a remuneration committee from its members, which is tasked with drafting guidelines 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.

GROUP MANAGEMENT

IVL's executive management consists of the CEO, Executive Vice President, CFO, Vice President of Business Development and Marketing and the Director of Research. The company management group also includes the three heads of sections, the Director of Human Resources and the Director of Communications. The Director of Quality and Environmental Issues is a co-opted member of the management group.

ORGANISATION

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. There are also sections for research, business development and international business, HR as well as finance and administration. These sections operate across the entire organisation. All the sections collaborate in a matrix organisation with four thematic areas: *Natural resources, climate & environment; Resource-efficient recycling & consumption; Sustainable production & environmental technology; and Sustainable urban development & transport.*

Four operational councils with external stakeholders are associated with each thematic area. Participants in the operational councils are appointed by IVL's ownership foundation, SIVL.

IT

During the year, work continued on the development of the digital workplace. A new intranet based on SharePoint, with an integrated quality and environmental management system (Our Working Method), was launched during the spring. This was followed by the process of establishing collaboration sites in SharePoint for projects, teams and units. Several new digital tools have been introduced to facilitate smoother collaboration and simplified work outside the physical office. IT operations have been streamlined, with more functions being transferred to Office 365. Operating systems in computers and the mobile telephony system have been updated to satisfy new demands for flexibility and modern features for our employees. To make this journey of change possible, the IT department has e.g. expanded information and guides on the intranet and

conducted a number of training and information activities within the organisation. The IT Department has supported Finance and HR in the restructuring process that was implemented during the summer. The work on developing our information security has continued, and there are plans to introduce information security management systems during 2020. The IT Department's processes have been analysed, new procedures have been developed and a new system for support issues has been implemented. Several new test flows have been deployed in the lab data system, and the accredited laboratory operations, including lab data systems, have been reviewed by Swedac during the year. A model for the management of IT systems has been developed, adopted and is in the process of being implemented within the organisation.

Sustainability report

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 usefulness, 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. The full sustainability report can be found in the Annual Report 2019, which will be published on ivl.se.

Environmental and quality management

IVL works on sustainability, environmental and quality issues within the scope of an integrated management system. The system and its implementation at IVL are ISO-certified for environmental and quality management in accordance with SS-EN ISO 14001:2015 and SS-EN ISO 9001:2015 respectively. 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.

Quality

IVL's work on quality focuses on customer relations, and for this reason activities are regularly followed up to ensure that customers are satisfied with the company's work. This is done in the form of telephone interviews with at least two customers per operational unit. The customers represent the business community, local authorities and government agencies. The Customer Satisfaction Index (CSI) ranking, on a scale of 1 to 5, was 4.0 (4.5) for 2019. The analysis of the results of 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.

Significant events during the year

Strategic projects

In 2019, IVL launched a collaboration with IKEM and the Swedish chemical industry to establish SusChem Sweden, a Swedish node for the European technology platform SusChem. Within SusChem, work is being performed to initiate and inspire the European chemical industry to contribute to the major challenges in society. In SusChem Sweden, IVL, in collaboration with IKEM and the sector, has drawn up a research and innovation agenda that lays the foundations for the ongoing development of collaborations in Sweden and internationally. In 2019, the MISTRA SafeChem programme, led by IVL, was also given the go-ahead. The MISTRA SafeChem programme aims to facilitate and promote the expansion and implementation of a safe, sustainable and green chemical industry. The programme has been developed on the basis of the twelve principles for green chemistry, and combines innovative research into new manufacturing processes, new tools for risk screening and risk assessment, life cycle analysis as well as material handling with industrial ambitions. The programme is being launched in spring 2020. During 2019, the Vinnova initiative "Climate-leading process industry" was also initiated alongside the West Swedish Chemical and Material Cluster, to which IVL contributes with e.g. the charting of renewable raw material resources in the county of Västra Götaland.

A number of projects funded by Vinnova and the EU's research programmes are focused on digitalisation to support safe water management and supply. In these projects, IVL develops and applies combinations of digital tools such as sensors and models to ensure sustainable drinking water production (the EU's "Water Harmony" project) and, by applying open data in digital twins for water treatment plants, to develop innovative new products and services for efficient and sustainable water treatment (the Vinnova project "Open Water Digital Twin").

Digitalisation and traceability are the focus of the Vinnova-funded project "TraceMet", in which IVL, in collaboration with e.g. RISE, Boliden and LKAB, is developing an administrative system and a technical solution that enables a certified environmental declaration. With the aid of mass balance accounting and a blockchain database, it will be possible to see, throughout the entire value chain, both the carbon footprint of the metal and how much recycled material it contains. The project is expected to contribute to the growing debate regarding the increasing demand for metals and minerals, as well as increased concern about the negative impact of the mining industry on both the environment and local communities.

Chinese and Indian funding of R&D

IVL's operations in China have been built up with funding in the form of grants, the EU's research budget, funding from Swedish companies in China and from Swedish financing organisations such as the Swedish Agency for Economic and

Regional Growth, the Swedish Energy Agency, Vinnova and Formas. Thanks to its long-standing presence, IVL has now also managed to obtain funding from MOST (China's Ministry of Science and Technology). This is providing complementary support to the "Refresh Food Waste Project". The aim is to study food losses throughout the chain, focusing on the situation in Beijing, Shanghai and Shandong. IVL has also received funding from MOST to extend the R&D collaboration between China and the EU within Next Gen. A training programme for food management funded by CAS (Chinese Academy of Science) has been developed. IVL has also received funding from a Chinese refrigerator manufacturer with the aim of minimising food losses through proper refrigeration management.

For many years, IVL has also conducted project activities in India, mostly financed from Sweden, Swedish companies and the EU. In one project funded by the EU's aid budget, IVL has been advising Mumbai and Delhi on how to solve their water and waste problems. As a follow-up to this, IVL has won a tender whereby, together with a local consultant, we will be working for six years to evaluate the construction of the two largest municipal wastewater treatment plants in Mumbai. As a result, IVL has established an office in Mumbai. A follow-up visit to Pune has also resulted in a feasibility study regarding a waste-to-energy plant in Pune that is directly funded by the client.

IVL has also been working alongside technology companies on various Smart City initiatives, and is now working on a project aimed at returning treated wastewater to agricultural land in Pimpri.

From a sustainability perspective, it is gratifying to note that we are now receiving significant domestic R&D funding in both of these countries.

Visibility

IVL's strategic initiative regarding editorial visibility in the media and in the public debate has continued to produce results. In 2019, IVL has appeared in the media 3,385 times (2,190), measured in the number of press clippings.

This corresponds to an advertising value of SEK 94,924,988 (69,232,652), according to estimates by the TT-owned company Retriever.

Anticipated future developments, material risks and uncertainties

In 2019, IVL's management continually assessed and monitored the risks associated with the company's operations. Risks were also addressed at board meetings during the year. At the same time, risk analyses tied to daily operations, including the working environment, were conducted at the respective units.

Long-term expansion

IVL's long-term goals, adopted by the company's Board of Directors, include a specific target for expansion for 2020. This growth is to be achieved both organically and via acquisitions, although without compromising the quality of research and consultancy work. Expansion is necessary if IVL is to be able to continue contributing to sustainable development in the business sector and the rest of society, as well as in the international market.

Market

Europe, and the Nordic region in particular, is IVL's largest market. Customers are served in a number of sectors, including the energy, public and industrial sectors, as well as the construction and property sectors. The company consequently depends on stable growth in these areas in order to achieve its goals and manage the risks arising from economic and structural changes as well as evolving market trends. At the same time, IVL's vulnerability to short-term fluctuations is reduced by being active in multiple markets and in sectors and industries that are susceptible to different business cycles. Systematic and periodic assessments of IVL's situation relative to external factors create a high degree of readiness to cope with change.

Competitors

IVL contends with major international competitors and small local competitors in every market. This poses a risk, as there is fierce competition for the most attractive projects and the most highly skilled employees. Continuous assessment of these risks is therefore vital.

Employees

To attract and retain highly skilled employees, the company invests in continuous training, as well as skills and leadership development. IVL can also offer large, high-quality and international projects, which is attractive for prospective employees.

Employee reviews are conducted annually, in which individual growth plans are discussed and designed.

Financial risks

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 4.6 (3.0). A change of 10 öre in the SEK exchange rate will impact income in the amount of MSEK 0.5 (0.4), 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 2019. During the year, exchange rate gains totalled MSEK 0.5 (0.8).

The company's credit risks consist of outstanding, as yet unbilled revenue from consultancy projects. IVL's 30 largest

customers, accounting for approximately 75 percent of sales, consist exclusively of major international corporations, the European Commission, Swedish and foreign government institutions, as well as the owner, SIVL.

Sustainability

IVL operates in a global market, which increases risks related to sustainability factors, such as human rights, working conditions, the environment and corruption. These risks are reduced through systematic sustainability work and clear policies, such as the code of conduct and environmental and sustainability policies, which describe our approach to customers and the world around us. 2019 saw the continuation of the work that had been launched in 2018 regarding further strengthening and clarifying the structure, governance and development of IVL's sustainability work. Within the framework of this work, improvement activities are being carried out in respect of various aspects of the sustainability work. A whistleblowing channel has been established providing every employee with the opportunity to report any deviations from the code of conduct in a way that ensures privacy. No deviations were registered during the year.

Environmental impact

The company's most significant environmental aspects have been identified as customer advice (i.e. how IVL contributes to the improved environmental performance of customers and a sustainable society), climate and energy, sustainable chemical use, resource efficiency and circularity. Goals have been set for these aspects, which are followed up annually. After completing a project, IVL conducts a sustainability assessment. The methodology for the assessment has been updated in 2019, with the plan being to implement the updated method during 2020.

Environmental permits

The company's operations do not require permits under the Swedish Environmental Code. On the other hand, IVL is licensed to handle asbestos subject to regulations from the Swedish Work Environment Authority. As neither of the company's two laboratories, in Stockholm and Gothenburg, covers an area larger than 5,000 m², there is no registration obligation mandated under the environmental impact assessment regulation.

Sensitivity analysis

IMPACT ON	CHANGE, %	IMPACT ON INCOME, SEK 000		
		2019	2018	2017
Chargeability ratio	1	4,970	4,516	4,132
Hourly rate	1	3,276	2,893	2,720
Salary expenses	1	2,284	2,088	1,885
Overheads	1	751	716	671
Number of full-year employees	1	1,319	1,123	1,143

Research and development

RESPECTIVE SHARE OF RESEARCH AND CONSULTANCY WORK

During the year, the shares of fees earned and expenditures incurred in IVL research and consultancy activities accounted for 51 (51) percent and 49 (49) percent, respectively. In this context, "research activities" refers to (i) research co-funded by the central government and the business sector via SIVL, and (ii) activities funded through subsidies from central government research bodies, research foundations and the EU and its equivalents. Co-funded activities accounted for 15 (16) percent of fees earned and expenditures incurred during the year, while activities funded through subsidies represented 36 (35) percent.

Research is an integral part of IVL's operations and a key factor in IVL's ability to conduct a consultancy operation with cutting-edge expertise.

IVL's consultancy activities comprise not only short-term consultancies and analysis projects, but also more substantial research and development projects nationally and internationally.

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, water, waste and hazardous substances.

EU projects

Several projects were approved and launched during the year. These were financed in part by various EU agencies, including H2020 and JPI Oceans. The total research budget for granted projects increased significantly compared to 2018, and IVL was involved in 22 research projects under the Horizon 2020 programme.

Other current research programmes

IVL has had success with applications to national funding providers in 2019. The Mistra Research Foundation granted funding of MSEK 70 to the Mistra SafeChem research programme, which is being led by IVL. The consortium includes RISE, Stockholm University, KTH and a number of companies in the chemical industry. The focus is Green Chemistry, with the aim of developing new methods for risk characterisation of new chemicals, new synthesis methods for the chemical industry and tools for life cycle analyses.

Formas awarded IVL eight projects in 2019, focusing on areas such as climate transition, circular economy, urban farming and environmental toxins. Examples of projects include

"Implementation of circular economy through public procurement of construction products", "Assessment and development of the sustainability of urban vertical cultivation" and "Occurrence and effects of alkylated, substituted and heterocyclic PACs in marine coastal ecosystems".

Vinnova granted IVL a number of research and development projects in areas such as sustainable resource use, recycling and new business models, including projects on sorting and recycling of textiles, urban cultivation, deposit systems for takeaway packaging and on traceability of metals. The Swedish Energy Agency provided IVL with funding for research on energy transition, including projects on e.g. climate and sustainability aspects of aviation fuels, biofuels and the energy systems of the future. The Swedish Environmental Protection Agency granted several projects relating to plastics and circular plastic use in the automotive and construction industries. Finally, IVL was granted funding from the Swedish Transport Administration for research into ship noise above and below the surface of the water.

Digitalisation is a key aspect in many of the above examples, in line with IVL's ambition of developing digitalisation activities for increased sustainability.

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 state funding for co-funded research and development at IVL. Co-funding is conditional and requires a corresponding share from industry, and in 2019, research has been conducted in four thematic areas: Natural resources, climate & environment; Resource-efficient recycling & consumption; Sustainable production & environmental technology; and Sustainable urban development & transport.

During 2019, SIVL had a total of MSEK 37 (37) at its disposal for co-funded research through government appropriations of MSEK 17 (17) to the Swedish Environmental Protection Agency and MSEK 20 (20) to Formas. Government funding forms the basis for a total research budget of MSEK 84 (79.3) through co-funding of projects, with MSEK 19 (18.7) from the business community and MSEK 28 (14.1) from the EU. In 2019, MSEK 10 (10) was received through Formas for basic funding of the activities as a supplement to the co-funded research.

Affiliates outside of Sweden

IVL's operations in China are continuing to expand, with the Beijing office having eight employees at the end of 2019. The operations primarily focus on research and consulting, education and knowledge transfer, building relationships with Chinese authorities, companies and organisations, as well as technology transfer.

Collaboration with the Chinese research institute CRAES, one of the most prominent advisers to China's government, continues to be developed in the environmental field. IVL and CRAES are working together on the measurement of emissions into the air and have a joint laboratory, the Sino-Swedish Air Joint Lab. Additionally, IVL's employees at the Beijing office, together with IVL's air-quality experts, have developed and implemented an air conservation training programme targeting representatives of the environmental authorities in the city of Tianjin alongside with TAES, the Tianjin Academy of Environmental Sciences, which has been an established IVL partner for many years. Part of the training was conducted at

IVL's Gothenburg office.

Since 2015, IVL has had one employee from IVL's China office stationed in Wuhan, in the Hubei province in central China. The work there includes assisting a representation office for Dalarna County and Borlänge Municipality (IVL Wuhan Centre SweDalar Office), which has agreements with the city and the province, as well as helping with market research and the organisation of seminars and workshops.

Working environment

It is important for IVL to offer a working environment that promotes the creativity and the commitment necessary to be able to provide high-quality research and consulting services.

The systematic working environment activities at IVL are governed by a working environment policy and an annual working environment plan, which is drawn up in collaboration in the Working Environment Committee and then approved by IVL's management group. The systematic working environment work covers all employees as well as agency staff.

The Working Environment Committee is made up of representatives from the management group as well as the principal safety representative. The work is led by IVL's CEO. (GRI 403-4) The Working Environment Committee monitors the systematic work on the annual plan and ensures that the activities are carried out. (GRI 403-1) The work duties within the plan are delegated to members of the management group. The working environment plan is based on improvement activities, developed in collaboration within the Working Environment Committee, which arise e.g. from the results of staff surveys, safety rounds and amended or stricter legal requirements. IVL's Working Environment Committee holds meetings once a quarter. Safety rounds, risk analyses and other matters are discussed and conducted in collaboration with the safety representative organisation. (GRI 403-4) Much of the working environment work is carried out by IVL's group managers in day-to-day operations.

The challenges IVL faces in the working environment are mainly related to stress, sedentary work, laboratory and field operations. For stress-related disorders, we employ counselling

through the occupational health service, and we also use them for ergonomic issues. We also engage the occupational health service for taking samples, vaccinations and other health-related investigations. (GRI 403-3) All employees at IVL are covered by occupational health care. (GRI 403-3) IVL offers its employees massage treatments and encourages physical activity through its sports clubs. The fitness benefit is utilised to a great extent. Systematic working environment activities are essential for our laboratories, and these are followed up during annual safety rounds etc. For field operations, we work actively with risk analyses for certain types of projects. Using these preventive measures, we believe that we are minimising incidents, illness and accidents. Sickness rates have fallen during 2019

IVL works systematically with reports regarding incidents and occupational injuries. We have a registration tool that is well known among our employees. In 2019, there have been six incidents, one workplace accident, three accidents in traffic when travelling to and from work, as well as a handful of risk observations. Monitoring and measures are implemented continuously in the operation to ensure that incidents and accidents are not repeated. (GRI 403-2 & 403-9)

During 2019, training in respect of the working environment has been offered to new safety representatives at IVL. For the organisation as a whole, short information meetings have been held regarding stress, ergonomics and special safety regulations. Managers have also been trained in rehabilitation in relation to long-term illness and repeated short-term absences. (GRI 403-5) For 2020, a major training initiative is being planned for managers.



Equity

GROUP	Share capital	Other equity including profit for the year	Total
Opening balance	7,000	80,916	87,916
Recalculation difference		253	253
Profit for the year		15,436	15,436
Amount at year end	7,000	96,605	103,605

PARENT COMPANY	Share capital	Statutory reserve	Fund for development expenditure	Retained earnings	Profit for the year	Total
Opening balance	7,000	1,400	1,520	46,797	78	56,795
Appropriation of profit by AGM				78	-78	
Dissolution fund for development expenditure			-300	300		
Profit for the year					1,029	1,029
Amount at year end	7,000	1,400	1,220	47,175	1,029	57,824

Proposal for the allocation of profit

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

Retained earnings	47,175
Profit for the year	1,029
Total	48,204

The Board of Directors and the CEO propose that the profit be

distributed as follows (SEK 000)	48,204
Total	48,204

For more information on the company's and the Group's financial position and performance for the financial year on 31 December 2019, see the following income statements, balance sheets, statements of cash flows and notes to the financial statements.

Income statements

SEK 000		GROUP		PARENT COMPANY	
		2019	2018	2019	2018
Operating income					
Net sales	Note 3	383,309	353,227	376,037	349,115
Change in work in progress	Note 4	-390	-10,158	-7,418	-16,354
Other operating income		193	97	193	97
		383,112	343,166	368,812	332,858
Operating expenses					
Project expenses		-46,127	-45,229	-46,127	-44,515
Other external costs	Note 6	-71,236	-69,892	-68,836	-70,180
Staff costs	Note 7	-237,475	-217,879	-234,869	-216,833
Depreciation of tangible assets and amortisation of intangible assets	Note 8	-9,344	-7,729	-8,997	-7,506
		-364,182	-340,729	-358,829	-339,034
Operating profit		18,930	2,437	9,983	-6,176
Profit from financial postings					
Interest income	Note 9	1,540	16	1,539	15
Interest expenses	Note 9	-171	-690	-159	-679
Profit after financial postings		20,299	1,763	11,363	-6,840
Appropriations	Note 10			-9,400	7,521
Tax on profit for the year	Note 11	-4,863	-823	-934	-603
ANNUAL PROFIT		15,436	940	1 029	78

Balance sheets

SEK 000		GROUP	
		2019	2018
ASSETS			
FIXED ASSETS			
Intangible fixed assets	Note 12	6,447	7,271
Capitalised software development costs		223	430
Goodwill			
Tangible fixed assets	Note 13		
Machinery and equipment		36,219	38,607
Financial assets	Note 14		
Other securities held as fixed assets		46	35
Total fixed assets		42,935	46,343
CURRENT ASSETS			
Current receivables			
Accounts receivable		67,275	83,787
Receivables from Group companies		9,936	15,824
Tax assets		4,676	4,727
Other receivables		2,416	2,087
Earned but unbilled income	Note 5	8,325	6,446
Prepaid costs	Note 15	9,462	8,332
Total current receivables		102,090	121,203
Short-term investments	Note 20	29,653	28,050
Cash and bank balances	Note 19	78,564	34,512
Total current assets		210,307	183,765
TOTAL ASSETS		253,242	230,108
EQUITY AND LIABILITIES			
Equity			
Share capital	Note 21	7,000	7,000
Other equity, including profit for the year		96,605	80,916
Total equity		103,605	87,916
Provisions	Note 16	11,019	7,603
Non-current liabilities			
Liabilities to credit institutions	Note 18	2,388	2,840
Current liabilities			
Liabilities to credit institutions	Note 18	2,178	2,327
Ongoing work on behalf of others	Note 4	72,587	67,765
Trade accounts payable		24,007	29,725
Other liabilities		15,136	12,279
Billed but unearned income	Note 5	3,256	2,285
Accrued costs	Note 17	19,066	17,368
Total current liabilities		136,230	131,749
TOTAL EQUITY AND LIABILITIES		253,242	230,108

Balance sheets

SEK 000		PARENT COMPANY	
		2019	2018
ASSETS			
FIXED ASSETS			
Intangible fixed assets	Note 12		
Capitalised software development costs		5,060	5,908
Goodwill		223	430
Tangible fixed assets	Note 13		
Machinery and equipment		31,570	33,402
Financial assets			
Participations in Group companies	Note 14	1,278	1,262
Other securities held as fixed assets	Note 14	46	35
Total fixed assets		38,177	41,037
CURRENT ASSETS			
Current receivables			
Accounts receivable		65,703	81,907
Receivables from Group companies		12,899	17,573
Tax assets		4,720	5,030
Other receivables		610	441
Earned but unbilled income	Note 5	8,325	6,446
Prepaid costs	Note 15	9,206	8,263
Total current receivables		101,463	119,660
Short-term investments	Note 20	29,653	28,050
Cash and bank balances	Note 19	68,723	30,527
Total current assets		199,839	178,237
TOTAL ASSETS		238,016	219,274
EQUITY AND LIABILITIES			
Equity			
Restricted equity			
Share capital	Note 21	7,000	7,000
Statutory reserve		1,400	1,400
Fund for development expenditure		1,220	1,520
Total restricted equity		9,620	9,920
Non-restricted equity			
Retained earnings		47,175	46,797
Profit for the year		1,029	78
Total non-restricted equity		48,204	46,875
Total equity		57,824	56,795
Untaxed reserves	Note 10	15,971	6,571
Current liabilities			
Ongoing work on behalf of others	Note 4	106,424	94,454
Trade accounts payable		23,985	29,711
Other liabilities		11,696	12,186
Billed but unearned income	Note 5	3,256	2,285
Accrued costs	Note 17	18,860	17,272
Total current liabilities		164,221	155,908
TOTAL EQUITY AND LIABILITIES		238,016	219,274

Cash flow statement

SEK 000 (Direct method)	GROUP		PARENT COMPANY	
	2019	2018	2019	2018
CURRENT OPERATIONS				
Profit after financial postings	20,299	1,763	11,363	-6,840
Adjustment for postings excluded from the cash flow	12,420	5,953	8,734	5,811
Tax paid	-4,812	-437	-625	-497
Cash flow from current operations before changes in working capital	27,907	7,279	19,472	-1,526
CASH FLOW FROM CHANGES IN WORKING CAPITAL				
Decrease (+)/Increase (-) in receivables	22,071	-17,000	20,709	-15,075
Decrease (-)/Increase (+) in accounts payable	-5,718	7,587	-5,726	7,726
Increase (+)/Decrease (-) in other liabilities	2,708	224	-490	576
Increase (+)/Decrease (-) in advance payments for work in progress	4,822	-3,799	11,970	2,276
Cash flow from operating activities	51,790	-5,709	45,935	-6,023
INVESTMENTS				
Acquisition of intangible assets	-348	-1,285		-500
Acquisition of tangible fixed assets	-5,564	-14,034	-6,110	-14,370
Acquisition of financial assets	-11	25	-27	
Acquisition of short-term investments	-1,603	562	-1,603	562
Cash flow from investment activities	-7,526	-14,732	-7,740	-14,308
FINANCING ACTIVITIES				
New borrowing	-452	-63		
Cash flow from financing activities	-452	-63		
Cash flow for the year	43,812	-20,504	38,195	-20,331
Opening cash and bank balances	34,512	54,953	30,527	50,639
Exchange rate differences in cash and cash equivalents	240	63	1	219
Closing cash and bank balances	78,564	34,512	68,723	30,527

Notes

for the financial statements and accounting principles

Note 1

ACCOUNTING PRINCIPLES

1.1 COMPLIANCE WITH STANDARDS AND LEGISLATION

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.

1.2 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.

1.3 CHANGES IN ACCOUNTING PRINCIPLES AND DISCLOSURE REQUIREMENTS

No new accounting policies have come into effect with any impact on the Group during 2019.

1.4 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.

1.5 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.

Subsidiaries are accounted for using the proportional method. Under this method, as large a proportion as possible of the jointly owned company's income and expenses, and of its assets and liabilities, are recognised in the consolidated accounts.

The reason for choosing this principle of consolidation is that IVL was involved in the original establishment of Group companies and did not acquire them at a surplus or deficit value.

The new subsidiary during the year, eBVD i Norden AB, is not consolidated, because the activities were of limited extent in 2017. From 2018, eBVD i Norden AB is consolidated according to the proportional method.

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.

1.6 FOREIGN CURRENCIES

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 recognised at historical cost are recalculated at the exchange rate on the transaction date. 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 difference 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.

1.7 INCOME

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 funder 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. As a result, the invoicing and costs of expenses are deducted corresponding to the funds received, and are then paid out to other project partners.

1.8 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.

1.9 RECEIVABLES AND LIABILITIES

Accounts receivable are recognised in the amounts expected to be received, i.e. after deduction of bad debts, which are assessed on a case-by-case basis. Write-offs for accounts receivable are reported under the heading of operating expenses. Other receivables are classified as long-term receivables if they are outstanding for more than a year, and as other receivables if the period is less than a year. 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 term and are measured undiscounted at the 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.

1.10 TANGIBLE FIXED ASSETS

1.10.1 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.

1.10.2 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. Under operating leases, the lease fee is recognised as an expense on a straight-line basis over the term of the lease.

1.11 INTANGIBLE ASSETS

1.11.1 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.

1.11.2 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 costs as incurred.

1.12 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.

1.13 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.

1.14 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.

1.15 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.

1.16 PARENT COMPANY'S ACCOUNTING PRINCIPLES

The Parent Company's accounts have been prepared in accordance with BFNAR 2012:1 Annual Report and Consolidated Accounts (K3) and the Swedish 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. The Group's work in progress is reported at the customer price with a certain reservation as a precaution compared with the Parent Company, where only projects that have been 95% completed are reported at the customer price.

Note 2

SUMMARY OF FINANCES AND KEY FIGURES

SEK 000	GROUP					PARENT COMPANY				
	2019	2018	2017	2016	2015	2019	2018	2017	2016	2015
SALES AND PROFIT										
Net sales	383,309	352,227	327,664	294,741	274,232	376,037	349,115	323,273	292,570	272,812
Operating profit after depreciation	18,930	2,437	3,721	-287	4,969	9,983	-6,176	-1,545	-494	6,767
Operating profit after net financial items	20,299	1,763	4,663	256	5,392	11,363	-6,840	-606	46	7,173
Profit margin, %	5.3	0.5	1.4	0.1	2.0	3.0	Neg	Neg	0.0	2.6
CAPITAL STRUCTURE										
Fixed assets	42,935	46,343	38,777	35,591	29,889	38,177	41,037	33,674	30,985	26,052
Current assets	210,307	183,765	186,848	170,030	166,905	199,839	178,237	182,681	166,929	164,828
Equity	103,605	87,916	86,932	83,722	83,900	57,824	56,795	56,717	56,647	57,006
Untaxed reserves						15,971	6,571	14,092	15,292	15,293
Current liabilities	136,230	131,749	127,989	112,497	103,101	164,221	155,908	145,546	125,975	118,581
Non-current liabilities	2,388	2,840	2,903	2,227	2,487					
Provisions	11,019	7,603	7,801	7,175	7,306					
Balance sheet total	253,242	230,108	225,625	205,621	196,794	238,016	219,274	216,355	197,914	190,880
Adjusted equity						70,377	61,920	67,709	68,575	68,935
Equity, mean value for the year	95,761	87,424	85,327	83,811	81,883	66,149	64,815	68,142	68,754	66,260
Total capital, mean value for the year	241,675	227,867	215,620	201,208	184,774	228,645	217,815	207,135	194,397	178,975
Equity/assets ratio, %	40.9	38.2	38.5	40.7	42.6	29.6	28.2	31.3	34.6	36.1
Current ratio, times	1.54	1.39	1.46	1.51	1.62	1.22	1.1	1.26	1.33	1.39
PROFITABILITY										
Return on adjusted equity, %	16.5	1.6	4.3	0.2	5.1	13.4	Neg	Neg	0.1	8.4
Return on adjusted equity 5-year mean, %	5.5	4.8	7.0	8.1	11.5	2.6	3.1	8.2	11.1	13.6
Return on total capital, %	8.7	1.1	2.2	0.2	3.0	5.0	Neg	Neg	0.1	4.1
OTHER										
Investment in fixed assets	5,923	15,294	9,872	10,551	11,285	6,137	14,870	9,162	9,710	10,676
Invoicing/employee, incl. expenses	1,190	1,177	1,150	1,160	1,188	1,221	1,200	1,159	1,175	1,197
Invoicing/employee, fees and analysis	1,190	1,100	1,086	1,055	1,090	1,120	1,120	1,093	1,067	1,098
Chargeability ratio, %	65.9	64.1	65.8	63.6	66.3	65.9	64.1	65.8	63.6	66.3
Full-year employees	322	300	285	255	232	308	291	279	249	228
Payroll cost per employee	716	702	665	669	645	742	721	676	680	652

Profit margin

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

Adjusted equity

Equity plus untaxed reserves, less tax at the standard rate of 22%.

Equity ratio

Adjusted equity, as % of the balance sheet total.

Return on total capital

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

Chargeability ratio

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

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 21.4%, as % of average adjusted equity.

Current ratio

Current assets divided by current liabilities.

Note 3

NET SALES

SEK 000	GROUP		PARENT COMPANY	
	2019	2018	2019	2018
Net sales by				
Billed fees and analyses	347,987	330,044	340,715	325,932
Billed expenses	35,322	23,183	35,322	23,183
Total net sales	383,309	353,227	376,037	349,115

Of net sales for the year, billing to other Group companies – comprising remuneration for co-funded research that the company has conducted on a contract basis – accounted for 23.8 (24.4)%.

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

SEK 000	GROUP		PARENT COMPANY	
	2019	2018	2019	2018
Project costs	726,677	628,863	692,840	602,174
Advance billing	-799,264	-696,628	-799,264	-696,628
Book value	72,587	67,765	106,424	94,454
Change reported in				
Income statement	390	9,909	7,418	16,105
Balance sheet	4,432	-13,708	4,552	-13,829
Total change in work in progress for the year	4,822	-3,799	11,970	2,276

Note 5

INCOME EARNED BUT NOT BILLED/INCOME BILLED BUT NOT EARNED

SEK 000	GROUP		PARENT COMPANY	
	2019	2018	2019	2018
Earned but unbilled income				
Project costs	54,311	49,464	54,311	49,464
Advance billing	-45,986	-43,018	-45,986	-43,018
Book value	8,325	6,446	8,325	6,446
Billed but unearned income				
Project costs	41,584	21,971	41,584	21,971
Advance billing	-44,840	-24,256	-44,840	-24,256
Book value	3,256	2,285	3,256	2,285

Note 6

OTHER EXTERNAL COSTS

Auditor's fees

SEK 000	GROUP		PARENT COMPANY	
	2019	2018	2019	2018
R3 Revisionsbyrå KB				
Audit assignment	316	207	274	157
Other services	141	140	141	140
Rödl & Partner Nordic AB				
Audit assignment				
Other audit services				
Other services		23		23
Other auditors				
Audit assignment	31	32	13	14
Total	488	402	428	334

Leasing costs, Group and Parent Company

Lease fees for operating lease agreements during 2019 totalled SEK 26,005,000 (20,541,000). Lease fees include charges for leases on properties, company cars used by company staff, computers and some office equipment. The costs relating to future lease payments on these contracts are payable in the following years:

SEK 000	2020	2021	2022	2023	2024
Other lease fees	2,178	1,754	634		
Rental of premises	21,099	21,415	21,737	22,063	22,394
Total	23,277	23,169	22,371	22,063	22,394

Note 7

STAFF COSTS, GROUP

SEK 000	2019		2018	
	Salaries and other remuneration	Social costs (of which pension costs)	Salaries and other remuneration	Social costs (of which pension costs)
Board of Directors and CEO	2,676	1,734 (779)	2,489	1,671 (765)
Other employees	152,390	74,347 (26,968)	139,291	67,288 (23,997)
Total	155,066	76,081 (27,747)	141,780	68,959 (24,762)

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

	2019			2018		
	MEN	WOMEN	TOTAL	MEN	WOMEN	TOTAL
Stockholm	63	71	134	61	61	122
Gothenburg	58	86	144	53	86	139
Fiskebäckskil	3	5	8	1	4	5
Malmö	8	7	15	7	11	18
Beijing	4	8	12	5	8	13
Tianjin	2	2	4	2	1	3
Mumbai	4	1	5	-	-	-
Total	142	180	322	129	171	300

PERSONNEL EXPENSES PARENT COMPANY

SEK 000	2019		2018	
	Salaries and other remuneration	Social costs (of which pension costs)	Salaries and other remuneration	Social costs (of which pension costs)
Board of Directors and CEO	2,566	1,734 (779)	2,489	1,671 (765)
Other employees	150,858	73,473 (26,968)	138,526	67,175 (23,997)
Total	153,424	75,477 (27,747)	141,015	68,846 (24,762)

SICKNESS RATE PARENT COMPANY

	2019	2018
	2.19%	2.67%

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

	2019			2018		
	MEN	WOMEN	TOTAL	MEN	WOMEN	TOTAL
Stockholm	63	71	134	61	61	122
Gothenburg	58	86	144	53	86	139
Fiskebäckskil	3	5	8	1	4	5
Malmö	8	7	15	7	11	18
Beijing	2	5	7	2	5	7
Total	134	174	308	124	167	291

* Defined as the number of salaried full-year employees

NUMBER OF EMPLOYEES IN THE COMPANY'S MANAGEMENT TEAM (of whom, in executive management):

	2019	2018
Men	5 (4)	4 (4)
Women	6 (1)	7 (1)

MEMBERS OF THE BOARD

	2019	2018
Men	5	5
Women	5	5

SENIOR MANAGEMENT

Parent company

In accordance with a decision by the AGM, Board of Directors fees totalling SEK 621,000 (510,000), including social security expenses, were reported as costs. Of this amount, SEK 106,000 (94,000), excluding social security expenses, was paid to the Chair.

The period of notice for the CEO of the Parent Company is 12 months and severance pay in an amount corresponding to 12 times the CEO's fixed monthly salary is due if employment is terminated by the company. Should the CEO's role or areas of responsibility be altered as a result of material changes in the company's operations or as a result of any change in the ownership structure affecting the majority of the company's shares, the CEO is entitled to terminate his/her employment by giving six months' notice and is entitled to receive severance pay corresponding to 18 times his/her fixed monthly salary. The CEO is entitled to retire from the age of 62 years. The CEO's pension is of the defined-contribution type and an annual allocation is made in an amount corresponding to 35 percent of the salary for the particular year, including company car benefit. At retirement on reaching the age of 62 years, retirement pension premium payments will be paid as if the CEO had worked until the age of 65 years.

Group

The CEO of the joint venture company has been employed for a period of one year, calculated from 1 July 2019. 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

Interest income and yields of SEK 1,540,000 (16,000) are reported in the Group for short-term investments, and SEK 1,539,000 (15,000) in the Parent Company. Interest expense and negative return on short-term investments amounting to SEK -171,000 (-690,000) is reported in the Group, and SEK -159,000 (-679,000) in the Parent Company, and of the interest expense for the Parent Company, SEK 76,000 (0) pertains to Group companies.

Note 10

APPROPRIATIONS AND UNTAXED RESERVES

SEK 000	PARENT COMPANY	
	31.12.2019	31.12.2018
Opening balance, untaxed reserves	6,571	14,092
Change in accumulated depreciation according to plan (machinery & equipment)	9,400	-2,315
Change in tax allocation reserve	-	-5,206
Total appropriations	9,400	-7,521
Closing balance, untaxed reserves	15,971	6,571

Note 11

TAX ON PROFIT FOR THE YEAR

ESTIMATE OF EFFECTIVE TAX RATE, SEK 000	GROUP		PARENT COMPANY	
	2019	2018	2019	2018
Profit before tax	20,299	1,763	1,963	680
Tax at current tax rate, 21,4 (22) %	4,344	388	420	150
Non-taxable income	-	-3	-	-3
Non-deductible expenses	318	268	316	268
Standard income, tax allocation reserves	6	19	5	19
Standard income, funds	24	24	24	24
Tax from previous year(s)	-	1	-	1
Foreign tax expense	216	162	169	144
Deferred tax	-45	-37	-	-
Reported effective tax	4,863	823	934	603
Reported effective tax rate	24.0%	46.7%	47.6%	88.8%

Note 12

INTANGIBLE FIXED ASSETS

GROUP, SEK 000	DEVELOPMENT EXPENDITURE		GOODWILL	
	31.12.2019	31.12.2018	31.12.2019	31.12.2018
Opening acquisition cost	10,424	9,137	2,919	2,919
Acquisitions for the year	347	1,287	-	-
Closing accumulated acquisition value	10,771	10,424	2,919	2,919
Opening depreciation	-3,153	-2,220	-2,489	-2,265
Depreciation for the year	-1,171	-933	-207	-224
Closing accumulated depreciation	-4,324	-3,153	-2,696	2,489
Closing residual value according to plan	6,447	7,271	223	430

PARENT COMPANY, SEK 000	DEVELOPMENT EXPENDITURE		GOODWILL	
	31.12.2019	31.12.2018	31.12.2019	31.12.2018
Opening acquisition cost	8,589	8,088	2,919	2,919
Acquisitions for the year	-	501	-	-
Closing accumulated acquisition value	8,589	8,589	2,919	2,919
Opening depreciation	-2,681	-1,958	-2,489	-2,265
Depreciation for the year	-848	-723	-207	-224
Closing accumulated depreciation	-3,529	-2,681	-2,696	2,489
Closing residual value according to plan	5,060	5,908	223	430

Note 13

TANGIBLE FIXED ASSETS

SEK 000	GROUP		PARENT COMPANY	
	31.12.2019	31.12.2018	31.12.2019	31.12.2018
Opening acquisition cost	101 026	93,696	95 561	87 896
Purchases for year incl. finance leases	5 567	14,034	6 110	14 370
Exchange difference	8	1	-	-
Retirements for the year	-	-6,705	-	-6 705
Closing accumulated acquisition value	106 601	101,026	101 671	95 561
Opening depreciation	-62 419	-62,549	-62 159	-62 303
Exchange difference	-3	0	-	-
Retirements for the year	-	6,705	-	6 704
Depreciation for the year	-7 960	-6,574	-7 942	-6 560
Closing accumulated depreciation for equipment	-70 382	-62,419	-70 101	-62 159
Closing residual value according to plan	36 219	38,607	31 570	33 402

Financial leasing

In the Group, equipment held under finance leases is reported in an amount of SEK 4,566,000 (5,167,000). 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	
	31.12.2019	31.12.2018	31.12.2019	31.12.2018
Opening acquisition value, shares and participations	35	60	1,297	1,297
Acquisitions for the year	11	-	27	-
Reclassification	-	-25	-	-
Closing accumulated acquisition value	46	35	1,324	1,297

Shares and participations

Company, SEK 000	GROUP			PARENT COMPANY	
	Number	%	Book	Quota value	Book
Participation in IVL Svenska Miljöinstitutet AB's personnel foundation	1		5	5	5
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	546
IVL India Environmental R&D Private Limited	1	100%		16	16
eBVD i Norden AB	510	51%		25	25
RD Rent Dägvatten AB	245	11%	41	11	41
Total			46		1,324

Profit for the year, equity, registered office and corporate ID number appear in the administration report

Note 15

PREPAID COSTS

SEK 000	GROUP		PARENT COMPANY	
	31.12.2019	31.12.2018	31.12.2019	31.12.2018
Rentals for offices and other premises	5,793	5,123	5,793	5,123
Other prepaid expenses	3,669	3,209	3,413	3,140
Amount at year end	9,462	8,332	9,206	8,263

Note 16

PROVISIONS

SEK 000	GROUP	
	31.12.2019	31.12.2018
Deferred tax liabilities	11,019	7,603
Amount at year end	11,019	7,603

IVL takes the view that deferred tax due for payment in 2020 will be low because IVL's investment levels will continue to be high and interest rates low. As a result, the use of tax allocation reserves for consolidation purposes will continue to be advantageous. In the subsequent five-year period, the tax allocation reserves for 2014 and 2015, totalling SEK 4,388,000, will be dissolved in any event.

Note 17

ACCRUED COSTS

SEK 000	GROUP		PARENT COMPANY	
	31.12.2019	31.12.2018	31.12.2019	31.12.2018
Holiday and overtime liabilities	7,378	7,458	7,378	7,458
Accrued social costs	9,303	8,405	9,303	8,405
Other accrued costs	2,385	1,505	2,179	1,410
Amount at year end	19,066	17,368	18,860	17,273

Note 18

LIABILITIES TO CREDIT INSTITUTIONS

SEK 000	GROUP	
	31.12.2019	31.12.2018
Non-current liabilities		
Opening balance	2,840	2,903
Change in liabilities to credit institutions	-452	-63
Amount at year end	2,388	2,840
Current liabilities		
Opening balance	2,327	2,601
Change in liabilities to credit institutions	-149	-274
Amount at year end	2,178	2,327

Note 19

PLEGDED ASSETS AND CONTINGENT LIABILITIES, GROUP AND PARENT COMPANY

SEK 000	31.12.2019	31.12.2018
Pledged assets for liabilities to credit institutions		
Blocked bank funds	6,502	-
Chattel mortgages	10,000	10,000
Total	16,502	10,000
Contingent liabilities	None	None

Note 20

SHORT-TERM INVESTMENTS, GROUP AND PARENT COMPANY

SEK 000	GROUP		PARENT COMPANY	
	31.12.2019	31.12.2018	31.12.2019	31.12.2018
Opening balance	28,050	28,612	28,050	28,612
Change in value	1,603	-562	1,603	-562
Amount at year end	29,653	28,050	29,653	28,050

Note 21

DISCLOSURES ON SHARE CAPITAL, PARENT COMPANY

SEK 000	31.12.2019		31.12.2017	
	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 22

APPROPRIATION OF PROFIT OR LOSS, PARENT COMPANY

	31.12.2019	31.12.2018
Retained earnings	47,175	46,797
Profit for the year	1,029	78
Total	48,204	46,875
Carried forward to next year	48,204	46,875

Note 23

SIGNIFICANT EVENTS AFTER THE END OF THE FINANCIAL YEAR

New CEO

Marie Fossum Strannegård has been appointed the new CEO of the IVL Swedish Environmental Research Institute. She will take up the position on 15 April 2020, replacing Tord Svedberg, who announced that he will be stepping down as CEO in April after 12 successful years.

Stockholm, 2020-03-11

Annika Helker Lundström
Chair of the Board

Marie Louise Falkland

Peter Nygårds

Måns Nilsson

Karin Byman

Bo Olsson

Pär Larshans

Lena Callermo

Mikael Malmaeus
Employee representative

Hanna Ljungkvist Nordin
Employee representative

Tord Svedberg
CEO

Our audit report has been submitted in 2020
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*

Statement on the annual report and consolidated accounts

OPINIONS

We have conducted an audit of the annual accounts and consolidated accounts of IVL Svenska Miljöinstitutet AB for the year 2019. The company's annual accounts and consolidated accounts appear on pages 61-85 of this document.

In our view, the annual accounts and the consolidated accounts have been prepared in accordance with the Swedish Annual Accounts Act and provide in all material respects a true and fair view of the Parent Company's and the Group's financial position on 31 December 2019 and of its financial results and cash flows for the year in accordance with the Swedish Annual Accounts Act. The administration report is consistent with the other parts of the annual accounts and the consolidated accounts.

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

GROUNDS FOR OPINIONS

We conducted our audit in accordance with International Standards on Auditing (ISA) and generally accepted auditing standards in Sweden. Our responsibility according to these standards is described in more detail in the section on "Auditor's responsibility". We are independent in relation to the Parent Company and Group in accordance with generally accepted auditing standards in Sweden and have otherwise fulfilled our professional ethics responsibility according to 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

It is the Board and CEO who have the responsibility for the other information. The other information consists of 2019 Annual Report of the IVL Swedish Environmental Research Institute (not including the annual accounts, consolidated accounts and our audit report regarding these accounts).

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

Opinions

In addition to our audit of the annual accounts and consolidated accounts, we have also conducted an audit of the Board of Directors' and the CEO's administration of IVL Svenska Miljöinstitutet AB for 2019 and of the proposed allocation of the company's profit or loss.

We recommend to the Annual General Meeting that the profit be allocated in accordance with the proposal in the administration 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 responsibility according to these standards is described in greater detail in the section "Auditor's responsibility". We are independent in relation to the Parent Company and Group in accordance with generally accepted auditing standards in Sweden and have otherwise fulfilled our professional ethics responsibility according to 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 the company's profit or loss, we have examined whether the proposal is consistent with the Swedish Annual Accounts Act.

Stockholm, 20 April

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 company's Board of Directors 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 generated in commission and research projects alongside 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 sustainability and environmental policy describes the content and focus of sustainability work, including gender equality and diversity, the working environment, skills development, the environment and quality aspects, as well as requirements for suppliers and partners. IVL also has a general health and safety policy describing in more detail our ambitions for IVL as a workplace and working conditions within the organisation, as well as a gender equality and equal treatment policy. There is also a travel policy and an entertainment policy describing principles related to environmental, safety and ethical aspects of business travel and corporate entertainment. The travel and entertainment policies were updated in 2019.

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

During 2019, work has continued aimed at clarifying and strengthening IVL's sustainability work. Within the framework of this internal project, improvement activities are being carried out in prioritised areas. The work of clarifying objectives, roles and responsibilities for the sustainability work has continued, in part within the framework of the restructuring operation carried out during 2019. In addition, specific improvement activities have been initiated in two focus areas within IVL's sustainability work, as well as in respect of stakeholder dialogues:

- Within the focus area "Improved environmental performance of customers and a sustainable society", support is being developed in order, on the basis of the UN's global sustainability goals and interim goals, to identify and safeguard environmental and sustainability benefits at all stages of IVL's operations
- Within the focus area "Environmental impact", studies have been carried out to chart the current situation and define proposals for additional measures aimed at reducing IVL's own environmental impact. IVL's climate fund has also been further developed.
- With regard to stakeholder dialogue, work has been initiated to identify how we can further strengthen the dialogue with IVL's various stakeholders, for example by improving the systematics, planning and coordination of the dialogue.

In addition to the specific improvement activities that are carried out within the framework of this internal project, 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

Collaboration with various stakeholders is a key component in the work to achieve IVL's vision: a sustainable society. To keep the business up-to-date on the expectations and needs of various stakeholders, IVL maintains a continuous dialogue with customers, employees, business partners, suppliers, interest groups, politicians and authorities, as well as boards and owners. These groups have been identified as IVL's main stakeholders based on the nature of the business. The dialogue takes place through different channels, through customer and employee surveys, within the projects IVL operates, and through the networks IVL heads and in which IVL participates.

The operational councils

An important part of the dialogue takes place within IVL's four thematically oriented operational councils. These are: Natural resources, climate & environment; Resource-efficient recycling & consumption; Sustainable production & environmental technology; and Sustainable urban development & transport. Within the operational councils, IVL gathers stakeholders from various groups, such as customers, authorities, owners, and partners. The operational councils serve the dual purpose of identifying knowledge gaps and research needs, as well as presenting noteworthy outcomes of ongoing projects. The operational councils discuss matters such as market and world issues, general needs of certain industries, new project ideas and the development of IVL's research agenda.

In-depth investigations

In addition to the ongoing dialogue, in-depth investigations are also carried out regarding their expectations of IVL as well as the sustainability areas that IVL's stakeholders consider to be most important. The first structured and in-depth study was conducted in 2016 by means of a survey, in which employees, members of the respective operational councils and the boards were able to rank various predefined sustainability aspects based on importance. They also had the opportunity to highlight additional issues that had not previously been defined in the list of sustainability aspects. Since then, targeted interviews have been conducted with selected stakeholder groups in 2017 and 2018, with the aim of better understanding their perception of IVL's sustainability report and sustainability work. A number of specific issues related to sustainability work have also been integrated into regular customer surveys.

In 2019, a feasibility study was initiated within the framework of the work aimed at clarifying and strengthening IVL's sustainability work, in order to chart how the stakeholder dialogue is conducted through different channels. The aim of the study is to identify the potential for improvement and the opportunities for further extending the dialogue, as well as to strengthen the ways in which the results of the dialogue are used as a basis for developing our sustainability work and activities.

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.

An evaluation of the materiality analysis has been carried out during 2019, in which 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 the environmental performance of customers and a sustainable society	Customer and sustainability benefits
Attractive workplace	Working environment, health and safety Gender equality, equal opportunity and diversity Competence and management 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

The IVL Swedish Environmental 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, as well as the annual report, pertains to the 2019 financial year and includes 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 2019 financial year, is submitting its fourth report according to GRI and its third report according to GRI Standards, level Core. IVL published its most recent sustainability report in May 2019.

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, 6	Front page of the report
102-2	Activities, brands, products and services	6-7, 12-13, 62-64	
102-3	Head office location	62	
102-4	Countries in which the organisation operates	62-64	
102-5	Ownership structure and legal form	62, 94	
102-6	Markets in which the organisation operates	62-64, 70	
102-7	Scale of the organisation	Note 2	
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305-1 Direct greenhouse gas emissions (Scope 1)	58-59	Emissions from cars leased by the business are included in the reporting of business travel
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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 end 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 of Directors include five women and five men and they are presented on pages 96-97.

THE BOARD OF DIRECTORS AND ITS WORK IN 2019

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 accordance with the rules of procedure, the Board of Directors held four ordinary meetings in 2019 in addition to the statutory meeting held in May in connection with the AGM, as well as an extraordinary meeting in November. As is customary, the regular board meetings were held in conjunction with reporting of the company's full-year or interim results, 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 meeting in September, the Board of Directors discussed the company's long-term strategy. At the board meeting in December, the agenda included the company's budget for 2020, 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

At the 2018 Annual General Meeting (AGM), fees were approved for the Chair and members of the Board of Directors. The remuneration was set at SEK 64,000 in fixed remuneration to the Chair and SEK 16,000 in fixed remuneration to the members, as well as SEK 6,000 per participation at each meeting. This resulted in remuneration of SEK 106,000 (94,000) to the Chair of the Board and a total of SEK 392,000 (308,000) to the other members. 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, represented by Tomas Nöjd and Christina Kallin Sharpe as senior auditors, has been elected as auditor to serve during the period up to the 2020 AGM. Tomas Nöjd and Christina Kallin Sharpe are authorised public accountants and have led the auditing task on behalf of 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 24 May 2019 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 group also includes three heads of sections, the Director of Communications, the Director of Research, the Director of Human Resources as well as the Director of Key Accounts and Assignments. The Director of Quality and Environmental Issues is an adjunct member.

- Tord Svedberg, born 1958, M.Sc. in Chemistry, KTH (1983), has served as Chief Executive Officer at IVL since 2008. He formerly served in a range of executive roles at Pharmacia (1984–1990), Astra (1990–1999) and AstraZeneca (1990–2007), including as head of production at the company in Sweden and a member of its executive management. Member of the Royal Swedish Academy of Sciences, Department IV.

- Östen Ekengren, born 1952, M.Sc. in Chemistry, KTH (1978), serves as Executive Vice President. Employed since 1978.

- Anna Jarnehammar, born 1965, M.Sc. Mechanical Engineering, 1991, Luleå University of Technology, Director of Research, 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 subsidiary Bastaonline AB.

- Mats Ridner, born 1955, MBA, Stockholm School of Economics, has served as CFO since 1994.

The heads of sections, the CFO, the Director of Research, Business Development and International Business, the Director of Human Resources as well as the Director of Key Accounts and Assignments all report to the CEO.

The Director of Communications and the Director of Quality and Environmental Issues report 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 via 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 performance of the Board of Directors is evaluated annually. In 2016, this evaluation was carried out through a survey conducted by the Swedish Academy of Board Directors, which was presented 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



*From the left, bottom row: Bo Olsson, Tord Svedberg, Mikael Malmaeus, Karin Byman and Måns Nilsson.
Middle row: Peter Nygårds, Annika Helker Lundström and Marie Louise Falkland
Top row: Henrik Sundström and Anders Björk.
Lena Callermo, Hanna Ljungkvist and Tina Skårman are missing from the picture.*

ANNIKA HELKER LUNDSTRÖM

Chair

Member since 2010

National Environmental Goal Coordinator

KARIN BYMAN*Member since 2016*

Energy expert, IVA

LENA CALLERMO*Member since 2017*

Head of the Department for a Resource-Efficient Society, The Swedish Energy Agency,

MARIE LOUISE FALKLAND*Member since 2017*

Vice-President, Research Outokumpu Stainless

PÄR LARSHANS*Member since 2017*

Head of Sustainability Ragn-Sells

MÅNS NILSSON*Member since 2019*

CEO, SEI

PETER NYGÅRDS*Member since 2008*

Chair, Swedish Institute of Water and Air Conservation Research Foundation

HANNA LJUNGKVIST

Employee representative

MIKAEL MALMAEUS

Employee representative

BO OLSSON*Member since 2014*

Head of Innovation and Safety, IKEM

DEPUTIES**HENRIK SUNDSTRÖM**

Head of Sustainability AB Electrolux

ANDERS BJÖRK

Employee representative

TINA SKÅRMAN

Employee representative

SIGNIFICANT ASSIGNMENTS CARRIED OUT BY IVL BOARD MEMBERS**MARIE LOUISE FALKLAND**

- Member of the Board at Outokumpu PressPlate AB
- Member of the Board at Outokumpu Prefab AB

ANNIKA HELKER LUNDSTRÖM

- Chairperson at the Swedish Recycling Industries' Association
- Chair of the Programme Board for the Mistra Sustainable Consumption research programme

LENA CALLERMO

- Member of the National Agency for Public Procurement's Advisory Board

MÅNS NILSSON

- Member of the Board at Blekinge Institute of Technology

BO OLSSON

- Chairperson at Chemnotia AB
- Member of the Board at OneWell AB
- Member of the Board at Mistra TerraClean

PÄR LARSHANS

- Sustainability Manager, Ragn-Sells
- Member of the Boards of SIWI, WATERAID Sweden, Cradlenet
- Expert appointed by the Minister for the Environment to the Environmental Objectives Committee
- Expert appointed by the Minister for Enterprise and Innovation to the Cooperation Group for Economic Climate Change at the Ministry of Enterprise and Innovation

PETER NYGÅRDS

- Chairperson at Mid Sweden University
- Chairperson at the Swedish Tourist Association
- Chairman of the Board at Almi Green Tech Fund AB
- Chairperson at Ecoclimate Group AB
- Chairperson at Mistra Carbon Exit
- Chairperson at Compita AB
- Chairperson at Pn Extended Strategies AB
- Member of the Board of the Swedish Energy Market Inspectorate Advisory Board

Management group



TORD SVEDBERG
Chief Executive Officer



ÖSTEN EKENGREN
Executive Vice President



MATS RIDNER
Chief Financial Officer



ANNA JÄRNEHED
Head of Section,
*Research, Business
Development and
International Business*



JOHN MUNTHE
Vice-President, Research



KARIN SJÖBERG
Head of Section,
*Environmental Permits
and
Abatement 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
Director of
Communications



ELIN ERIKSSON
Director,
*Key Accounts and
Assignments*

ADJUNCT



JOAKIM TORÉN
Director of Quality and
the Environment

Scientific articles and book chapters

Thematic area: Resource-efficient cycles and consumption

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