

# Sustainability report 2018



# Highlights 2018



## Eramet Group: CSR at the heart of ERAMET’s strategic vision

Eramet aims to be a company recognized for its strategic model, management system and social commitment. This objective is fully integrated in the 5-year strategic vision of the company.

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## Eramet Norway: In the process of drawing up a roadmap for social responsibility

Eramet Norway will, in 2019 and 2020, also work to implement goals related to our social responsibility in a broader perspective in line with the company’s guidelines.

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## Completes a shift to environment-friendly electrode masses

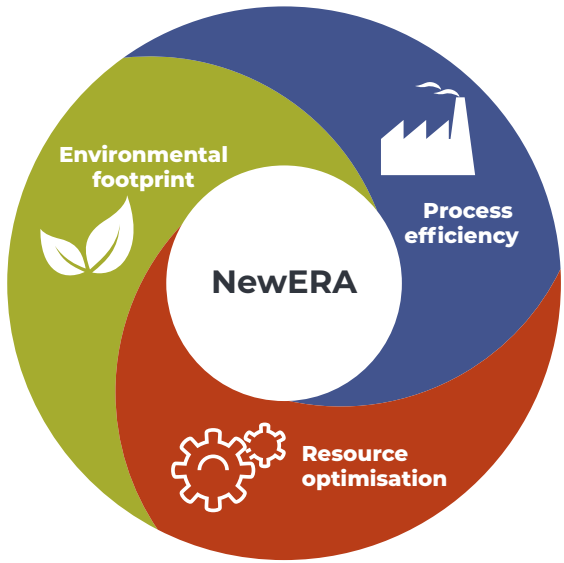
The first quarter of 2018, Eramet Kvinesdal converted an entire smelter furnace unit to PAH-free electrode masses. In May, the world’s largest PAH-free Söderberg electrode was put into operation with great success at Eramet Sauda.

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## NewERA – first investment concluded

NewERA made a breakthrough in 2018. Eramet Norway is investing a total of 5 million Euros in a pilot project on energy recovery in Sauda.

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## Increased research effort on Biocarbon

Eramet Norway has a new goal of reducing CO<sub>2</sub> emissions by 43% by 2030. Putting into operation biocarbon-based reduction agents is identified as a major contribution factor.

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The greatest challenges are resolved through team work

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# The greatest challenges are resolved through team work



by Bjørn Kolbjørnsen,  
CEO, Eramet Norway

Eramet Norway is one of the world's most sustainable and profitable producers of manganese alloys. The world is undergoing change, and the challenges now seem greater and more comprehensive than what we humans have experienced before.

We are in a time that calls for cooperation. We cannot resolve the climate challenges on our own. We need clear political leadership, companies that assume real social responsibility, and a high level of awareness among us as individuals and as consumers.

**Important questions that every industry needs to ask are: Does our product have a place in the future? Is our end-product a part of the solution or a part of the problem?**

Eramet Norway produces manganese alloy, a metal only a few of us have a relationship with, but one that makes steel harder and more durable. A significant growth in global population and prosperity in highly populated regions such as Asia and Africa, has increased the need to build up infrastructure - buildings, transport networks, and carbon-free energy production. Manganese steel is a critical and durable building material and this results in manganese being a central

contributor to the low emission society of the future.

Steel can also be recycled many times without diminished value. In our main markets in Europe and North America, about 80% of steel today is recycled. Our products are thus part of the circular economy based on the reuse of steel, but we are fully dependent on others working along with us when it comes to finding areas of use and to increasing the degree of reuse.

**Another question we must ask ourselves is: Do we manufacture our products in a resource efficient – sustainable – way?**

In our part of the production chain, we have some built-in advantages. We live in a country with forests and waterfalls. Hydroelectric power enables us today to be among those producers that have the smallest climate footprint per ton of manganese alloy produced. However, this is not good enough. Our goal is to reduce emissions per ton of manganese by at least 43% before 2030, and by 80% before 2050. To succeed in this, we must, inter alia, make use of another natural advantage, the forest. Manganese alloys are made when oxygen in the ore is reduced in the presence of carbon in large smelter furnaces. Ac-

cording to chemical laws, CO<sub>2</sub> is created. In order to be sustainable, we have to use biomass as a carbon source, in such a way that the CO<sub>2</sub> uptake and emissions are balanced. This is pioneering work, and we are dependent on a number of different collaboration partners, namely, forest owners and actors who refine these resources, including research stations and competency actors within and outside Norway. In this way we can become an actor in the circular economy value chain.

We also are working on how we can manage our furnace gases, which are a mixture of CO and CO<sub>2</sub> which end up as CO<sub>2</sub> emissions. Here we have two possibilities: we can find technical solutions where the furnace gases are used as a resource in other product chains, or we can ensure that we are capable of capturing and storing CO<sub>2</sub> to avoid it being released into the atmosphere. Here also, we are totally dependent on collaboration with other actors. We are working on developing new circular value chains, and are working cooperatively with, inter alia, Gassnova in their CCS (Carbon Capture Storage) project. We are a part of strong networks in the regions where our smelteries are located, for example Eydeklyngen in Sørlandet (Southern Norway), Industrial Green Tech in Grenland, and

EnergiRike in Haugalandet. These networks do not only work on climate-related problems, but also in other areas where we see it as natural to exercise social responsibility, for example, education, commercial development, environmental improvement, and upgrading projects.

**Common goals, knowledge sharing and development of more circular value chains will accelerate the development of smarter production models, improved resource utilization, and sustainable solutions.**

We are combining our internal sustainability culture and everyday learning with active involvement in external networks. In this way, Eramet Norway will be a part of guiding the way forward and will remain one of the world's most efficient producers of manganese alloys.

Bjørn Kolbjørnsen

**Our goal is to reduce emissions per ton manganese by at least 43% before 2030, and by 80% before 2050. To succeed in this, we must, inter alia, make use of another natural advantage, the forest.**



**Eramet Norway is one of the world's most sustainable manufacturers of manganese alloys.**



**Manganese is a metallic element belonging to group 7 in the periodic table of elements.**

Pure manganese is a steel-grey metal. It is hard, but at the same time so brittle that it can be pulverized. On a worldwide basis, there are large deposits of manganese. In the earth's crust, there are some 900 ppm, making it the second most common metal after iron. It is primarily extracted from the mineral pyrolusite ( $MnO_2$ ), also known as brownstone. More than 80 per cent of occurrences are found in South Africa and Ukraine. Other important deposits are in China, Australia, Brazil, Gabon, India and Mexico. Manganese is also found in the form of nodules on the ocean floor.

**Manganese is necessary to make steel ductile and durable.**

For one tonne of steel, about 10 kilograms of manganese alloy is needed. Nearly 90 per cent of the world's total manganese alloy production goes into the production of carbon steel: steel for the construction, energy and transport sectors, and the tool industry, and special steel produced for the aeronautics and aerospace industries.

# Nearly 90 % of the world's total manganese alloy production

is used to make carbon steel and specialty steels for the construction industry, the aeronautics and aerospace industry, the energy and transport sectors, and the machine tool industry.

The construction market alone accounts for more than half the steel used worldwide.

Eramet Norway supplies the world's steel producers with a complete range of high-quality manganese alloys. In our processing plants in Norway, raw manganese is refined and processed into ferro-manganese and silicomanganese. These additive ingredients comprise 0,5–1 per cent of the composition of steel, graded by quality.

525 000

tonnes of manganese alloy sold by Eramet Norway in 2018



## Building materials

The biggest outlet for manganese is carbon steel, which is used to make the essential parts of all modern buildings. Concrete reinforcing rods contain manganese which makes them stronger and stiffer. High speed steel saws are used extensively to cut structural parts on construction sites. On average around the world, it takes 7 kilos of pure manganese or 10 kilos of manganese alloys to make 1 ton of steel.



## Aviation

These steels and superalloys are used to produce an aircraft's vital parts, delivering the essential qualities of strength and safety. In the extreme heat and corrosion of engines, for example, safety is paramount. Landing gears, comprising many high-performance steel, aluminium and titanium parts, are subject to severe mechanical constraints.



## Energy sector

High-grade steel is a critical factor in the global transition to renewable and more efficient energy sources over the coming decades.



## Transport

Manganese steels are valued for their great wear and distortion resistance. They are used to make a range of rail infrastructure parts as they can withstand the weight of trains and keep tracks straight. Vehicle manufacturers use them for the same properties. In this area, some high-tech applications use closely alloyed manganese steels.



## Batteries

Manganese is used to make alkaline batteries, for which it is the main raw material. It is also a key component in cathodes for lithium ion batteries.



## A world leader in the production of refined manganese alloys

The French industrial group ERAMET is the second largest producer of manganese ore and the world's largest producer of refined manganese alloys. The company is in the business areas of manganese, nickel and special alloys.

Eramet Norway is part of ERAMET with processing plants at Sauda, Kvinesdal and Porsgrunn, and an R&D group in Trondheim. The company employs 510 full-time equivalents, and its operations make the ERAMET Group the world's second largest producer of manganese ore and manganese alloys. ERAMET Norway has a workforce of about 500 employees. It is a part of the ERAMET group, which is the world's second-largest producer of manganese ore.



**13 000**  
employees in Eramet  
throughout the world



**3.8 billion**  
euro revenue  
in 2018

**510**

FTE in Eramet Norway



### World-class Norwegian metallurgical expertise

Metallurgy is a broad field with a long tradition in the ferroalloy industry, in which Norway enjoys high international standing. Metallurgy is metal technology. The employees working in this specialized field range from apprentices and process operators to doctoral level researchers. Modern metal technology has become increasingly more sustainable over recent years.



### Contribution-based organizational philosophy

The company has a very flat organizational structure built on a strong contribution-based philosophy and the Nordic model of collaboration.



### From smelter to modern processing plant

The Norwegian processing plants maintain the traditions and expertise that the ferroalloy industry has built up since industrialization accelerated in Norway in the early 20th century. Today, Eramet Norway supplies manganese alloys to the international steel industry market.



### All production is exported

Eramet Norway exports all its production of manganese alloys, primarily to Europe and North America. The processing plants transport 98 per cent of their production by ship and the remaining percentage by road and rail.



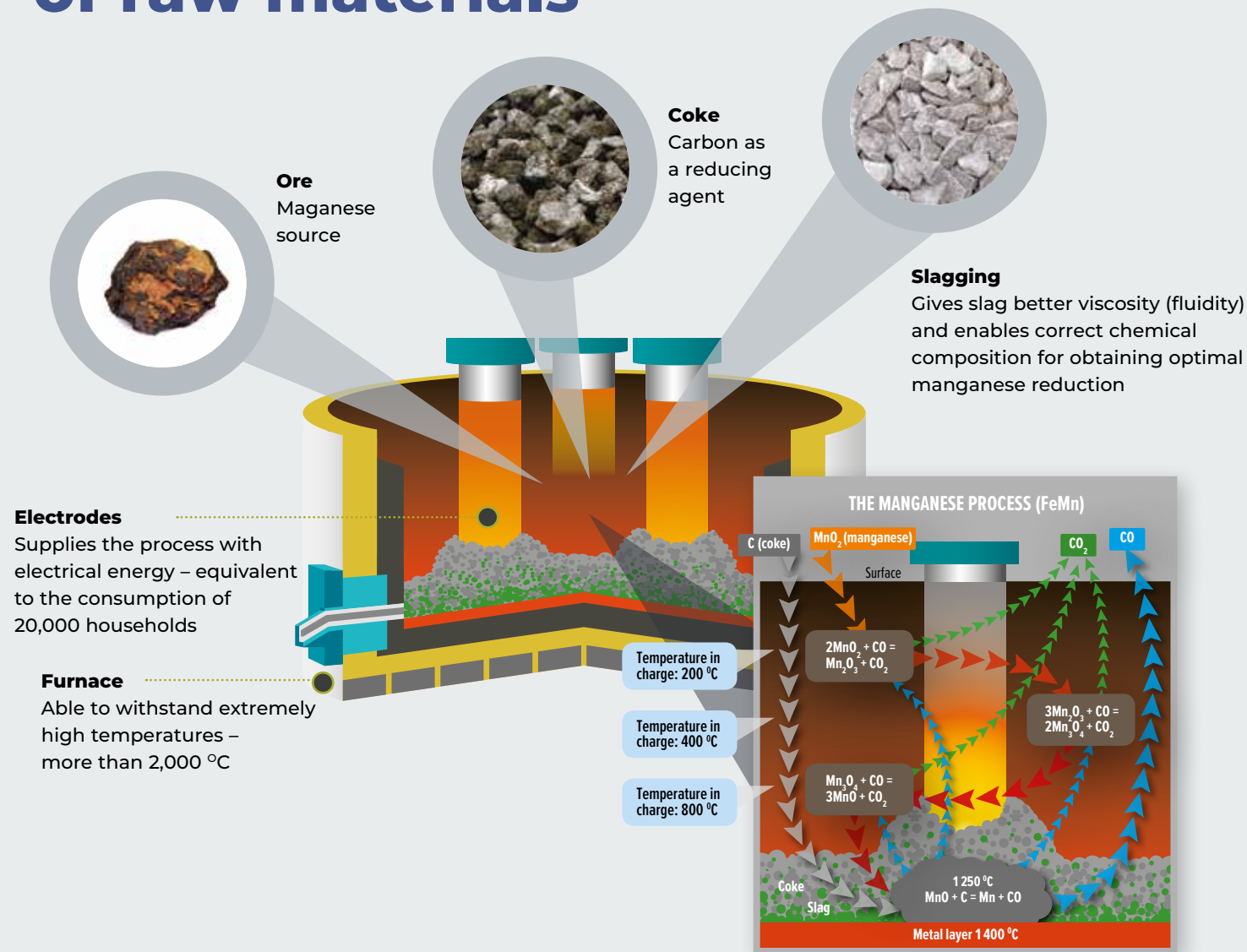
### The world's cleanest manganese alloy production

Eramet Norway realized early on that environmentally sustainable onshore industry is the way of the future for Norway. Since 2001, when ERAMET acquired the processing plants previously owned by Elkem, about half a billion Norwegian kroner has been spent on developing and adopting green technology. Today, Eramet Norway can proudly boast that we operate the world's cleanest manganese alloy production facilities.

### International competitiveness

One challenge in operating and developing business in Norway is that, in cooperation with Norwegian authorities, we need to adapt our framework conditions so as to create the basis for strengthening our international competitiveness. Eramet Norway maintains good dialogue with governmental authorities and other relevant actors.

# Production of manganese alloys and consumption of raw materials



## Raw materials from our own mine

Eramet uses significant quantities of raw materials in its production every year. These raw materials come from both foreign and domestic suppliers, and they are mainly:

- Manganese ore, with Eramet having access to its own mine in Gabon via its part-owned company, Comilog
- Metallurgical coke
- Quartz and limestone

## Other factor inputs

Other important factor inputs are electrode paste and metallic silicon sources. During the smelting process, a number of internal products are produced and consumed. They are transferred as required to other parts of the same plant and between the three processing facilities.

## Energy consumption

The combined electrical energy consumed in the smelting processes, including auxiliary power, was about 2.0 TWh in 2018. The required amount of natural gas and propane used as thermal energy sources amounted to almost 599 tonnes. Eramet Norway is also one of the country's largest consumers of industrial gases, particularly liquid oxygen, in production processes.



# World-class technology

**Eramet Norway has a century of experience in manufacturing manganese alloys. This knowledge base, developed over generations, is Eramet Norway's most important resource and asset. This expertise has also made the company a leader in smelting and refining manganese alloys.**

Today, the refining process is an advanced, highly technological process that few other countries in the world are able to emulate. From the time an optimal mix of ore and coke is blended and sent to the furnace, and until the crucial refining process has been completed, precision and experience are essential. With the aid of an advanced control system, every stage of production is monitored in detail, and the laboratories take samples at regular intervals to test quality.

955 312

TONNES OF MANGANESE ORE CONSUMED IN 2018

237 935

TONNES OF METALLURGICAL COKE CONSUMED IN 2018

112 024

TONNES OF QUARTZ CONSUMED IN 2018

11 464

TONNES OF ELECTRODE PASTE CONSUMED FOR THE SØDERBERG-ELECTRODES CONSUMED IN 2018

2.035 TWh

OF ELECTRICAL ENERGY AND AUXILIARY POWER CONSUMED IN 2018

599

TONNES OF NATURAL GAS AND PROPANE CONSUMED IN 2018

Eramet Norway is founded on longstanding industrial traditions. The three Norwegian processing plants are located between the fjords and mountains of Rogaland, Vest-Agder and Telemark.



# Eramet Norway Porsgrunn

Porsgrunn is a city of 35,000 residents in Telemark county.

As the successor to a plant first established in 1913, Eramet Norway Porsgrunn is a modern, high-technology business with long and proud traditions. Average seniority among the workforce is 23 years, and it is not uncommon to encounter second- and third-generation employees manning the smelting furnaces.

The plant is considered an attractive workplace locally and currently employs 148 people. Equipped with two smelting furnaces and a refinery facility, the plant produces 75,000 tonnes of silicomanganese and 105,000 tonnes of refined ferromanganese annually. The plant consumes 630 GWh of electricity annually, from which it recovers almost 200 GWh of thermal energy by supplying carbon monoxide gas to Yara’s ammonia factory at Herøya.



Porsgrunn

Residents:  
**35 000**



**148**  
FTE



# Eramet Norway Sauda

The local rivers were harnessed for hydroelectric power generation in the early 20th century, paving the way for industrialization in Sauda. Eramet Norway’s processing plant in Sauda employs about 159 people and, with its two 40 MW furnaces, is the largest ferromanganese producer in northern Europe. Production has more than doubled since the 1960s, and over 75 per cent of the plant’s revenue is from refined products. Annual power consumption totals 740 GWh when the plant is operating at full capacity. Measured in tonnes produced, Sauda is the largest plant in the Eramet Norway family. Sauda has the highest output of refined ferromanganese alloys, processing about 60 percent of the manganese ore imported by Eramet Norway. Eramet Norway Sauda is a driving force in the region’s socioeconomic development and takes its corporate social responsibility seriously, benefiting both the company and our stakeholders.



Sauda

Residents:

5,000



159

FTE

# Eramet Norway Kvinesdal

Established in 1974, Eramet Norway Kvinesdal is centrally located in the Lister region. Kvinesdal is a community of 5,800 residents, 191 of whom work at Eramet Norway in 2017. The modern, highly versatile processing plant is a key player in the local community and an undisputed leader in energy recycling, flexibility, adherence to emissions requirements and, not least, customer satisfaction.

The plant consumes 730 GWh of electrical energy annually and is strongly committed to energy recycling. As long ago as 1981, a thermal power plant was built, which now supplies nearly 90 GWh annually. Wastewater is reused by the plant itself and by external customers, including a turbot farm producing 250 tonnes of fish annually. A district heating plant, built in 2007, supplies hot water to five external customers for heating off-site workshops.



Kvinesdal

Residents:

5,800



191

FTE



# Researching for a greener production

Eramet Norway’s development group in Trondheim consists of three researchers with access to the facilities and expertise of NTNU and SINTEF.

Working as a team, they are all acknowledged experts in applied research who continuously pursue enhanced understanding and greater insight. The development group supports the processing plants at Kvinesdal, Sauda and Porsgrunn, and contributes to innovation and knowledge dissemination within Eramet Norway.

The R&D department at Eramet Norway works with several prominent research bodies, including ERAMET Research within the group and external organisations such as SINTEF and NTNU in Trondheim, Teknova, Tel-Tek, FFF, Elkem Technology and PFI.



## NTNU

NTNU (Norges teknisk naturvitenskaplige universitet) is the country’s biggest and leading supplier of engineers, covering areas of technology that range from nanotechnology and IT, to petroleum technology and ship design. NTNU, which has its own research environments, works together with some of the country’s most important technological and industrial companies.

## Teknova

Teknova AS is a technology and science research institute. Its operations are aimed at contract research, technological development and innovation. The institute aims to develop knowledge and technology, and to create value for its users, for society and for its owners. Teknova aims to create proximity and cooperation between the University of Agder, Agder Research and trade and industry in the Sørland region. Due to the international nature of its research activities, Teknova will develop a broad, international field of activity and international collaboration relationships

## SINTEF

SINTEF is a broad and multidisciplinary research organisation with international core expertise in technology, science, medicine and social science. SINTEF conducts contract research as an R&D partner for industry and administration and is amongst the four biggest contract research organisations in Europe.

## FFF

This organisation was founded by the Norwegian ferroalloy industry in order to collaborate on research in ferroalloy processes and products. The aim of the FFF is to maintain the position of the Norwegian ferroalloy industry at the forefront in ferroalloy production and of electrometallurgical technology. Its biggest member companies are Eramet Norway and Elkem, and together they contribute something like 80 per cent of the organisation’s subscription funding, with each accounting for almost equal parts. At the same time, the Norwegian Ferroalloy Producers Research Association (FFF) is the most important arena for joint research within the industry. In particular, Eramet Norway is a member of the Eyde cluster, where R&D occupies a central position.



Eramet Group:

# CSR at the heart of ERAMET’s strategic vision

Due to the nature of its mining and industrial activities, and aware of its strong interaction with the local areas in which it operates, Eramet is resolutely focused on all matters related to sustainable development and corporate social responsibility (CSR).

The Eramet Group has a long-standing commitment to a responsible approach and continuous improvement. It aims to be a company recognized for its strategic model, management system and social commitment. This objective is fully integrated in the 5-year strategic vision of the company.

# A new CSR roadmap for the period 2019-2023

The Eramet Group’s board of directors has adopted in March 2019 a CSR Roadmap to effectively manage its CSR performance. This Roadmap, which links the CSR priorities with the pillars of the Group’s five-year strategic vision, covers the period 2019-2023. The Roadmap also provides a framework for the Group’s contribution to the United Nations Sustainable Development Goals. **Each of the 13 objectives of the roadmap comes with a quantitative target to be achieved by 2023.**

The CSR Roadmap focuses on the Group’s commitment in three areas:

**Committed to women and men**

1

Ensure the Health and Safety of our own employees and subcontractors

2

Enhance skills, promote talent and career development

3

Strengthen the commitment of our employees

4

Integrate and promote the richness of diversity

5

Be a respected and contributive partner for our host communities

**A responsible economic player**

6

Be a leader in metals for the energy transition

7

Actively contribute to the development of the circular economy

8

Set the standard in human rights in our field of activity

9

Be an ethical business partner of choice

10

Be the go-to responsible business in mining and metallurgy

**Committed to our planet**

11

Reduce our air emissions

12

Protect the water resources and accelerate the rehabilitation of our mining sites promoting biodiversity

13

Reduce our energy and climate footprint

# Environmental performance: A key component of Eramet’s CSR roadmap



The definition of Eramet’s environmental objectives included in the CSR roadmap has been done through a specific project, coordinated by the Corporate Environment Division, linking the best experts of the Group and its subsidiaries. Eramet Norway has been fully involved and contributive in this approach, helping the Group with its environmental expertise and recognized excellence.

**To define the most material issues for ERAMET and ambitious but achievable 5-year targets, we used a multiple-step methodology:**

- analysis of Eramet’s actual environmental footprint
- analysis of our stakeholder’s expectations
- benchmark with best-in class companies and other players in the Mines and Metallurgy sector
- best practices collection coming from our subsidiaries.

**As a mining and metallurgical company, our most relevant and material environmental challenges are:**

- Circular economy
- Atmospheric emissions
- Protection of water resources and biodiversity
- CO<sub>2</sub> emissions and climate change.

This is the reason why these major issues have been selected to be included in the CSR roadmap. The following targets have been set.

7

**Actively contribute to the development of the circular economy**

- 2 Mt of low-grade ores or mining residues valorized over 2019-2023
- 10 Kt of industrial waste valorized over 2019-2023 instead of being disposed of

The performance indicator is relative to additional materials that Eramet will valorise during the period which means that pre-existing recycling flows will not be taken into account. R/D actions are needed to implement this objective.

11

**Reduce our air emissions**

- - 80% of stack dust emissions in 2023 vs 2018

Stack dust was chosen as a representative indicator of Eramet’s impact on air quality.

12

**Protect the water resources and accelerate the rehabilitation of our mining sites promoting biodiversity**

- Ratio of rehabilitated surface areas/cleared surface areas ≥ 1 during the period 2019-2023 (excluding long-term infrastructure)

The most efficient way Eramet can contribute to biodiversity protection and, at the same time, protect the watersheds is through mining site rehabilitation and especially revegetation. As far as we know, very few mining companies have made such a commitment so far.

13

**Reduce our energy and climate footprint**

- Reduction t CO<sub>2</sub>/t outgoing product: - 26% in 2023 vs 2018

Of which 16.5% is due to the business mix effect related to the Group’s strategic choice to develop its mining activity which is lower in emissions than the Group’s processing activities.



The progress of these objectives will be closely monitored by the Executive Committee of Eramet, as well as by the Board of Directors – which has a dedicated strategy and CSR committee.

Every subsidiary within Eramet is expected to define the way it will contribute to these objectives and possibly go beyond these commitments.

# Roadmap for climate and environment

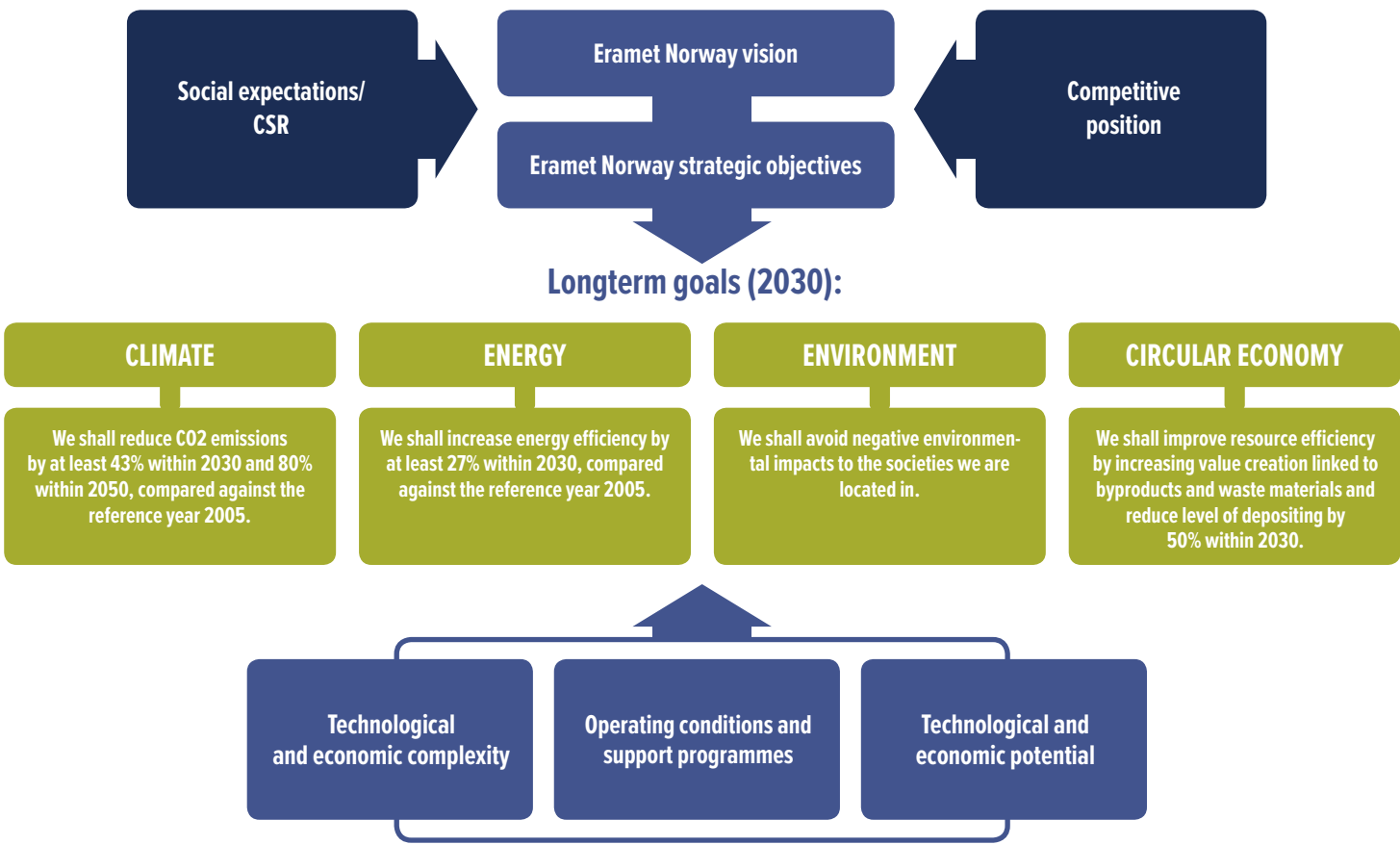
In 2018, Eramet Norway set the long-term goal of a new roadmap for the environment and for a circular economy. This goal was in addition to corresponding long-term goals and the roadmap for climate and energy that was launched in the prior year’s sustainability report.

The roadmaps in Eramet Norway (ENO) are a link in the company’s adoption of the process industry’s road map of 2016, “Increased value added with zero emissions in 2050”, including our ongoing work with risk management.

The objective of ENO’s roadmap is to strengthen the basis for achieving our goals and to further develop our competitive strength through strategic planning and effective execution of development processes and projects.

For each goal we have established roadmaps describing key projects and activities on the way towards goal achievement. The roadmaps are regularly updated based on new knowledge.

## Longterm goals – climate and environment



## Four factors affect how we determine our long-term climate and energy goals:

1

### The society’s expectations

The society’s expectations of us, which are established national and international ambitions, goals, and regulations, and the larger society’s perception of our company’s role in a future low-carbon and low-emission society.

2

### Our competitive position

Our competitive position in the market given both internal strong and weak aspects and the situation's possibilities and challenges.

3

### Constraints

Constraints relating to climate, energy, and environment, including research politics and access to relevant support- and financing arrangements for developing and implementing new technology.

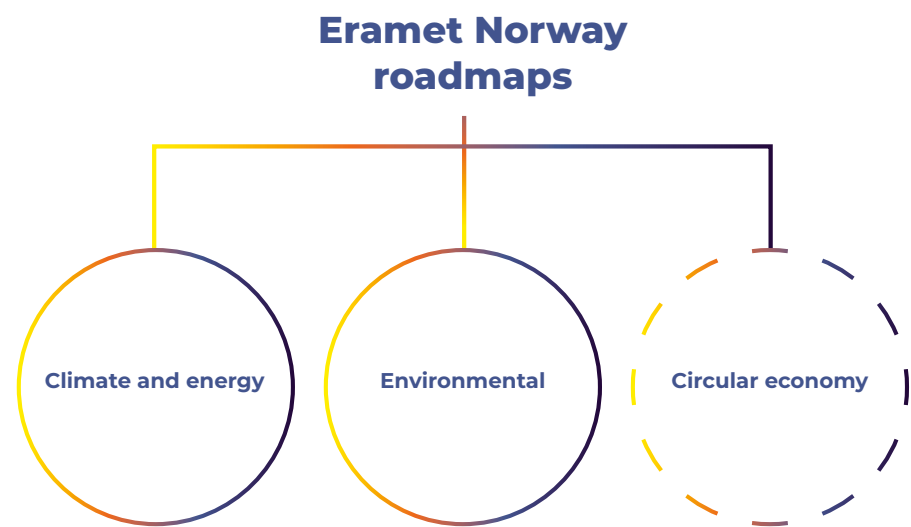
4

### Technological and economic aspects

Technological and economic potentials weighted against the complexity involved in development and execution of new technological solutions.

Eramet Norway is in the process of

# drawing up a roadmap for social responsibility



**In 2018, the Eramet company intensified its efforts on formulating its road map for social responsibility.**

Eramet Norway is taking an active part in this work, and will, in 2019 and 2020, also work to implement goals related to our social responsibility in a broader perspective in line with the company's guidelines.

In the year's sustainability report, we also present the Eramet company's work on creating a road map for social responsibility (CSR). The road map connects the company's priorities relating to social responsibility with the pillars in the company's overarching vision for the period 2019 – 2023. The company places much emphasis on the adaptation of goals and areas of focus to local conditions.

## Steel is a critical input factor in the low-emissions society of the future.

Sustainable development requires new energy solutions and more robust structures. Steel can, in addition, be recycled indefinitely without losing its properties, Eramet produces useful products in a resource-efficient manner.

## Climate and environment strengthen our competitiveness

**Eramet Norway's strategic goals are founded on a clear perception that a leading position on climate and environment would increase our competitive edge, and this would strengthen the company's profit picture on a long-term basis. This occurs, inter alia, through:**

- Better utilization of our most important raw materials; ore, reduction agents, and energy
- Increased stability and process efficiency in our production processes.
- Increased revenue through circular economy solutions for by-products and waste material.
- Reduced environmental costs, for example, those associated with emission quota costs and levies.
- Increased attractiveness which improves possibilities for future recruiting of competent and engaged employees, as well as for collaboration with external competency environments.
- Access to financial support and funding arrangements for research and development and investment projects.

# Shows possibilities for a circular processing industry

**Spiller inn muligheter:** Gunnar Grini, bransjesjef gjenvinning og Marit Holtermann Foss, fagsjef energi- og miljø i Norsk Industri spiller inn muligheter og tiltak til nasjonal strategi for å utvikle sirkulær prosessindustri.

Norsk Industri has prepared a feasibility study that describes what a circular economy will mean for the processing industry, as well as the measures and modes of operation that are important for strengthening the efforts of the processing industry in a circular economy.

The study highlights good examples of a circular economy that are already in practice within the Norwegian processing industry, including at Eramet. Several examples from Eramet Norway show that the company is contributing actively to establishing a sustainable circular processing industry in practice".

**Make better use of resources**

The essence in a circular economy is constantly to improve the resource use efficiency of materials, energy, and other input factors. This is not new for the processing industry. High resource efficiency results in lower costs and is one of the competitive advantages in Norwegian industrial operations. In 1996, the processing industry generated 16 % of the

total of ordinary waste in Norway. In 2008, the proportion was 10 % and at present, the waste amount generated by the processing industry is estimated at approx. 3 %. At the same time, the value added by the processing industry has remained stable at around NOK 45 billion per year.

**Long-term innovation**

This positive development is the result of long-term innovation and development projects aimed at identifying solutions that make use of resources found in one's own, or in other parties', by-products or waste.

**Prioritized policies**

The circular economy is a prioritized policy area within Europe. In Norway, the government is preparing its own strategy on a circular economy. The Norwegian Parliament has requested the government to table a national strategy for a circular economy.

The feasibility study is based on Norsk Industri's roadmap for the processing industry from 2016 and represents the input from the processing industry concerning important measures for further strengthening the efforts toward a circular economy.

**For the processing industry, a circular economy is not a matter of making a lot of money out of nothing. They are few projects that would yield large revenues, in any event, in the short term.**



## 5 IMPORTANT INITIATIVES

Norsk Industri's feasibility study points to five important initiatives in developing a circular processing industry:

1

### Harmonizing and simplifying European waste regulations

The extent to which a material is a by-product or waste must be determined through the interpretation of European criteria. It is critical that the EU definitions be included into the Norwegian regulatory framework and that the regulations be applied in the same way.

2

### Maintaining good dialogue between the environmental authorities and the processing industry

Industry side-streams regarded as by-products are often in demand and are simpler to convert than if the side-streams were defined as waste. It is important that the flexibility in the regulatory framework be utilized and that increased exploitation is arranged for side-streams in the processing industry.

3

### Increasing the demand for environment-friendly and resource-efficient products

Selecting environment-friendly products is a strong driver within a circular economy. Emphasizing environmental concerns in government procurement provides opportunities for growth in the Norwegian industry that can lead to minimizing the environmental footprints of their products.

4

### Increasing the focus on industry-oriented Research and Development (R&D)

Increased focus on industry-oriented R&D within a circular economy must be included in the government's new strategy. Important research areas are the development of environment-friendly products, increased resource efficiency of by-products, technology related to material recovery, and effective solutions for recycling rare metals.

5

### Facilitating collaboration within the industry

Knowledge of what side-streams exist, how these can be utilized, and the technologies that are required for this are all critical factors in bringing about a circular raw material loop. Government authorities should support collaboration between operations in the processing industry aimed at identifying and exploiting their own, or third parties', industrial side-streams. In many cases, collaboration within industry groups or industrial parks is an excellent starting point for this.

# Eramet show potential in practice

The Norsk Industri feasibility study for a circular processing industry highlights several examples from Eramet that show excellent potential in practice.

## ERAMET: SALE OF DUST FROM REFINING FACILITIES

There are annual sales of about 20,000 tonnes of dust generated as a by-product in the refining facility. The dust has a high Mn content that, among other things, may be used in other smelters and for the production of metals and metal components. Because of a considerable pigment content, the dust may be used in paint-manufacture and the manganese content makes it usable also in animal feed.

## ERAMET: REPLACES FOSSIL FUELS

Whenever ore is smelted, CO gas is a by-product of the process. This gas is collected, put into pipes, and re-used. CO gas is used year-round at the plant in Kvinesdal for the production of electricity which is then delivered to the central grid. From the plant in Porsgrunn, gas is delivered to the artificial fertilizer plant at Yara on Herøya via a pipeline between these two industrial facilities which are located close to each other. Yara thus replaces more expensive virgin energy sources with reasonably priced by-products.

### Recovery and use of thermal energy

Hot water is delivered to the fish farming facility in Kvinesdal and to Sauda municipality. In Sauda, hot water is delivered to Sauda Fjernvarme AS (Sauda Remote Heating, Ltd) and this is used for heating of streets and municipal facilities. This source is of benefit to both Eramet, which earns money from the by-products and the local community which receives increased access to electric energy and heat energy.

## ERAMET:

### USE OF SLAG (SIMN SLAG) IN CEMENT, WALL CLADDING, ASPHALT, AND AS GRAVEL / FILL FOR CONTRACTORS AND FOR COVERING MATERIAL

There is an annual production of about 300,000 tonnes of slag which is a by-product marketed by Eramet. Approx. 200,000 tonnes are sold annually. The consulting company, [illegible], has carried out baseline analyses of the slag in accordance with the guidelines of the Environmental Directorate. The covering tests show lower covering ability than that provided by natural rock types which nowadays are used as covering material. The slag is therefore a chemically stable and environment friendly product.

Eramet has been successful in finding clients who use the slag for the following purposes:

- A raw material for aggregate (cement / Norcem)
- Wall cladding
- Asphalt (contractors)
- Road ballast (contractors)
- Gravel fill (contractors)

- Covering material (municipalities / counties)

A determining factor is that often in the Norwegian industry, many companies know each other and opportunities arise through informal dialogue followed up by more formal dialogue. In more recent times, this is still important and is reinforced through "group collaboration" and the fact that people interact at relevant conferences. However, emphasis is also placed more and more on active marketing and case-work in order to find potential clients.

This is of benefit both for Eramet, which earns money from by-products, as well as for the client who can replace more expensive iron-containing raw materials with more reasonably-priced by-products.

## EYDE GROUP: WASTE TO VALUE

The project is based on a pre-project, Eyde Zero Waste, which identified all the waste streams in seven of the group's core operations. The objective was to develop groundbreaking technology for production of Fe-Mn-Ni metals and raw materials for manganese production based on combining and treating oxide and carbon-containing waste streams. The project is aimed at contributing to significant reduction in the need for waste disposal. Recycling of manganese and iron reduces the need for new production, with an resulting reduction in discharges and energy consumption.

The potential for minimizing of byproducts and waste from the participating com-

panies (Glencore, Eramet, and Alcoa) was clearly demonstrated, as well as a further potential for creating products from the by-products or the waste, alone or in collaboration. A reduction in the side-streams was achieved and it was demonstrated that alloy products can be created. Economically, it is a challenge to build an industrial facility for the latter as the costs for the developed process is higher than the market price. Since the companies underline the significance of these solutions over the long term, the project will be continued within an EU Horizon 2020 application with an expanded consortium.

# Increased research effort on Biocarbon

Experiences and new knowledge from the innovation project, "Eyse Biokarbon" is utilized in further research"

The innovation project "PyroGass" that is now ongoing will, with the completion of a biocarbon test centre, receive an effective boost for developing biocarbon.

Eramet Norway has a new goal of reducing CO<sub>2</sub> emissions by 43% by 2030. Putting into operation biocarbon-based reduction agents is identified as a major contribution factor.

Eramet Norway has identified the replacement of fossil carbon material with biocarbon as one of the most promising technologies for a major reduction of CO<sub>2</sub> emissions from the smelting process.

Commercially available biocarbon materials present a number of challenges that could limit their use in Eramet Norway's closed furnaces. In order to be able to replace large quantities of today's fossil carbon materials with biocarbon, Eramet Norway is actively participating in a number of research and development projects aimed at increasing knowledge, as well as developing biocarbon materials suitable for Mn production.

The projects are a mixture of innovation and competency-building projects and several are supported by the Norwegian Research Council.

## 2014-2018

**"Eyde Biocarbon" with the Forestry Owners' Association, AT Skog, was shut down in 2018.**

Biocarbon material was produced at pilot plant scale under realistic process conditions and the project partners acquired important new knowledge. Although the objective of establishing environment-friendly production of biocarbon for the metallurgical industry based on Norwegian forestry was not fully realised, the knowledge can still be used in other projects. AT Skog is an organisation owned by family-based forestry concerns in Agder and Telemark. Teknova (Norway) heads the project and industry partners have been Eramet Norway, Elkem, Saint Gobain, and Alcoa"

## 2017-2021

**"PyroGass" The objective is to develop renewable biocarbon reducing agents based on wood products.**

PyroGass was initiated in 2017 by Norske Skog Saugbrugs, one of the world's largest and most modern production entities for magazine paper. The objective was to develop new technology for combined production of biogas fuels and biocarbon through the use of surplus raw material from paper production. The intention is to develop a combined pyrolysis and agglomeration process for the production of biocarbon which would replace fossil carbon material in the manganese industry. If the PyroGass project is successful, Norske Skog Saugbrugs can become a producer of sustainable biocarbon reducing agents for the Norwegian ferrous alloy industry.

The project is being conducted in partnership with RISE PFI in Trondheim, the University of South-Eastern Norway in Porsgrunn (USN) and Cambi (technology supplier of biogas plants), Eramet Norway and Ferroglobe Mangan Norway (end-user).

## 2018-2022

**SINTEF competency project: The ambition is to build a "biocarbon test centre".**

In 2018, the four-year competency-building project "Reduced CO<sub>2</sub> Emissions in Metal Production" under the management of SINTEF, was initiated. The objective was to develop a platform for reducing the effect on climate from production of Si, FeSi, manganese alloys, and TiO<sub>2</sub> slag. The ambition was to build a "Biocarbon test centre" that will provide the metallurgical industry and Eramet Norway with an effective tool for assessing carbon materials and developing bio carbon as reducing agent in production processes. The work will contribute to reaching the goals outlined in "The roadmap for the process industry" relating to increased value creation, a 30 percent CO<sub>2</sub> reduction by 2030, and zero CO<sub>2</sub> emissions by 2050. In addition to the research institutions, SINTEF, NTNU, and CICERO, partners from the Norwegian Ferroalloy Producers Research Association, FFF (ERAMET, Ferroglobe, Elkem, Wacker, and Finnfjord), and TiZir are also participating.

# NewERA – first investment concluded

NewERA made a breakthrough in 2018.  
Eramet Norway is investing a total of 5 million Euros in a pilot project on energy recovery in Sauda.

In 2018, we achieved a breakthrough in two important areas:

**Energy recovery – 5 million to a pilot project in Sauda**

In December, Eramet Norway was granted the tender following its investment application for the pilot project in Sauda. The total investment was approx. 5 million Euros. Selection of collaborating partners (sub-contractors) for the project and requisitioning of the pilot facility are planned for the first part of 2019. The facility will then be ready for testing in the summer of 2020. The pilot phase will be critical for the further planning of a full-scale energy recovery facility.

Enova supports the project in Sauda as a component in its industrial pilot program launched in 2017.

**Drying / sifting of ore and agglomerating of by-products and waste materials**

In 2018, testing was carried out of "NewERA briquettes" in Eramet's own technology Centre in Trappes outside of Paris. The test results were promising and it was decided to conduct a more comprehensive testing program in the spring of 2019. The next phase in the project will be large-scale testing in our smelter ovens in order to then conduct our pre-project aimed at drawing up an investment application.

Enova supports this sub-project in the project phase carried out from 2016 to 2019.

"Eramet Norway will have the lightest environmental footprint in our sector. That is our strategic goal."

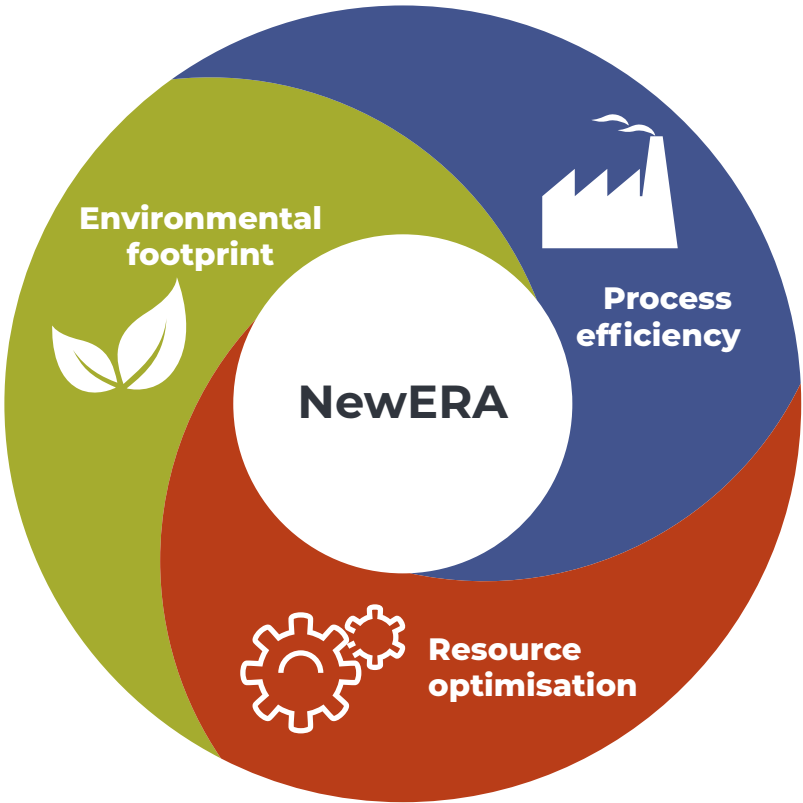
The investment is a consequence of Eramet Norway's goal of having the lightest environmental footprint in our sector and is thus a component in our roadmap for climate, energy, environment, and the circular economy. NewERA was developed in several phases.

**NewERA shall ensure::**

- Increased efficiency in Eramet's core processes
- Improved total resource exploitation
- Higher environmental standards

**Principal goals:**

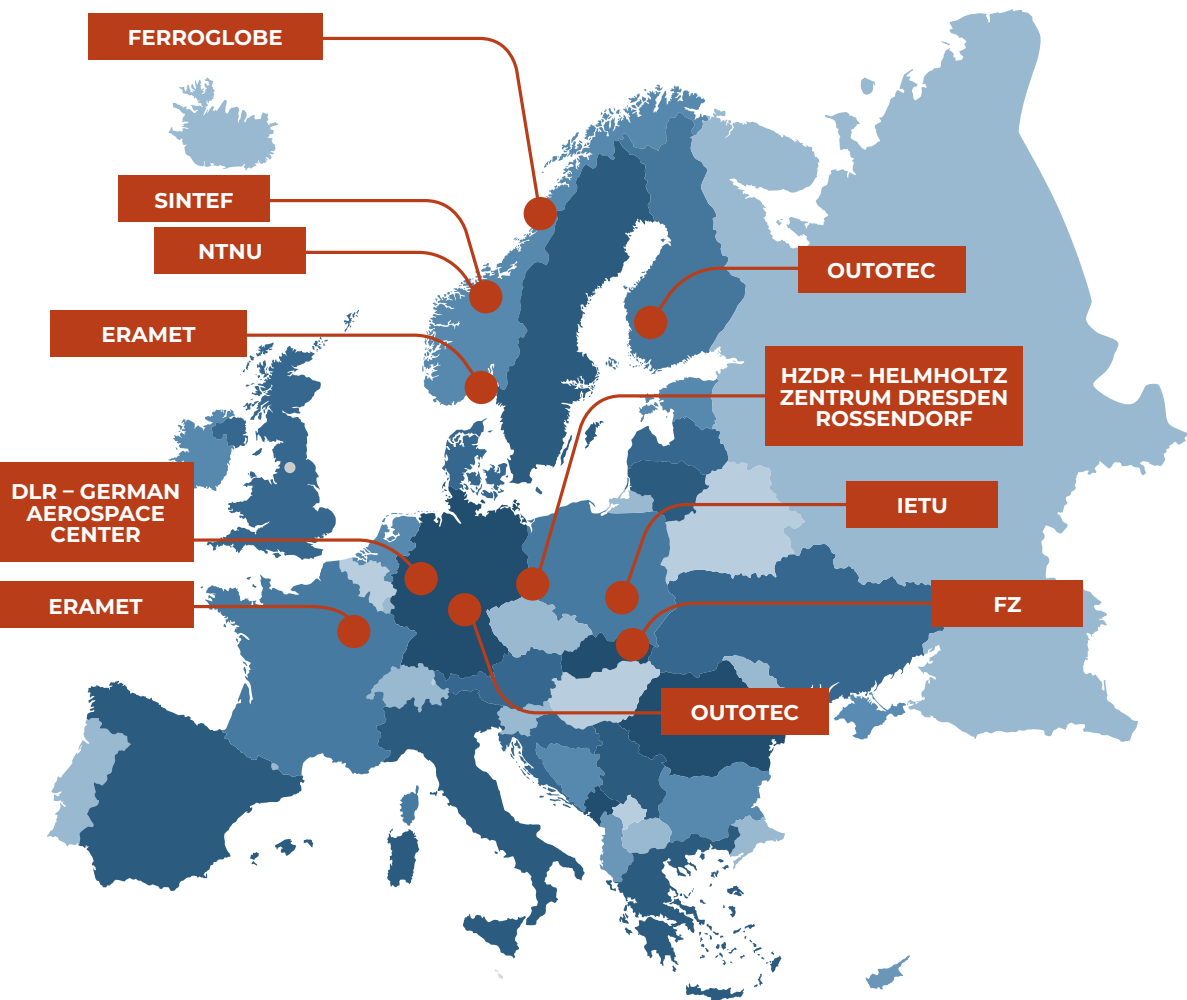
- Increase energy exploitation by at least 250 GWh (reduce energy losses by 30 percent)
- Increase the stability in the oven processes and reduce the specific energy consumption in the production of manganese alloys by at least 6 percent
- Reduce the specific carbon consumption and thus CO<sub>2</sub> emissions per produced tonne by at least 2 percent
- Ensure sustainable handling of by-products and waste materials



EU-Horizon 2020: PREMA

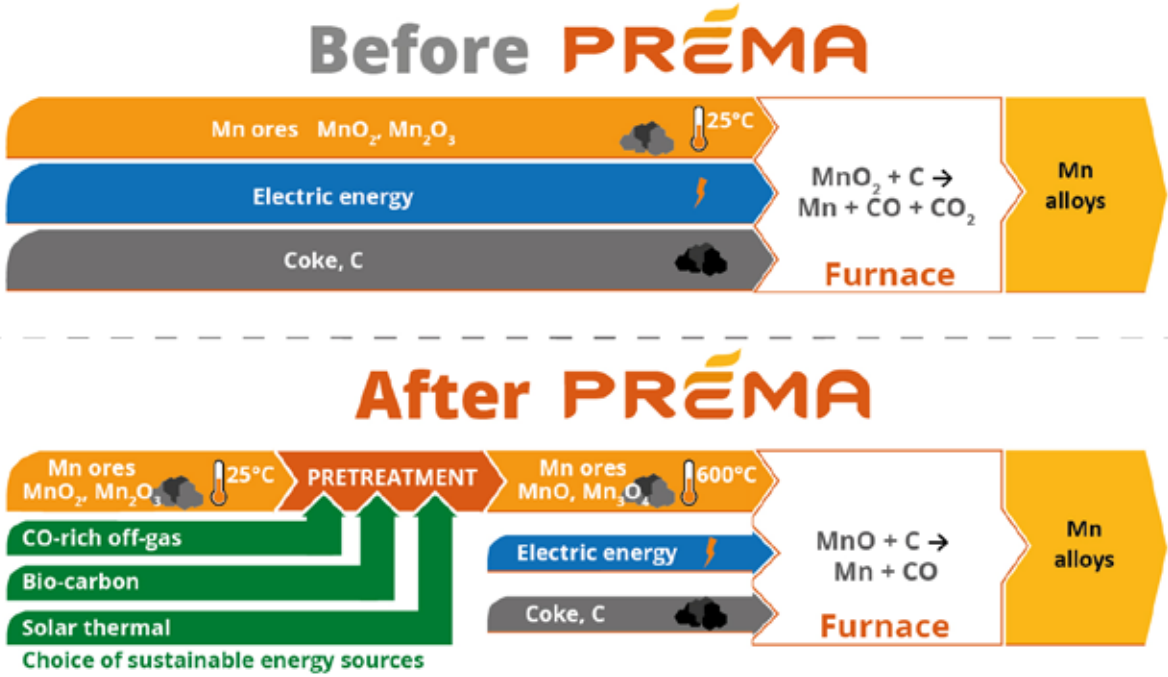
# Aiming at an energy shift Renewable and reduced consumption

Eramet Norway is participating in its first EU Horizon 2020 research project, PREMA, along with a consortium of 12 partners representing all the manganese alloy producers in Europe.



The key concept in PREMA is to increase energy flexibility with the possibility of using sustainable energy sources and reductants. The objective is to achieve sustainable manganese production through the reduction of total energy consumption and CO<sub>2</sub> emissions. PREMA will extend over four years and will have a budget of 12 million Euros.

Implementation of PREMA pretreatment technologies in the processing unit will yield huge potentials. Energy and raw material flexibility will increase, but at the same time, will contribute to a reduction in fossil fuel consumption of by 20%. The solution is energy-efficient and provides the potential for a 20% reduction in total energy consumption and 10% lower operational costs. PREMA's ambition is to scale up the technology for use in manganese production both in Europe and in South Africa.



Choice of sustainable energy sources

The project will develop and demonstrate innovative technologies which can utilize various energy sources, CO-rich industrial overflow gases, biocarbon, and solar energy in the production of Mn alloys and Mn steel.

Establish a pretreatment step

This can be achieved through dividing production into two separate units as well as by establishing a pretreatment step prior to the smelter process.

Task Force EuroAlliages:

# Eramet Norway contributes to the low-carbon society

In 2018, Eramet Norway actively contributed in the Euro Alliages' feasibility study "The contribution of the energy Intensive Industries to the EU strategy for long-term emission reduction of greenhouse gases".

The EuroAlliages feasibility study describes possibilities and solutions that can contribute to the transition to a low-carbon society through the reduction of emissions from European ferroalloy and silicon industries, while the industry, at the same time, ensures its competitive edge, innovation ability, and its central position.

The study was submitted to the EU in September as well as to 11 other EU energy-intensive sectors.

**Plays an active role**

Eramet SA and Eramet Norway are members of EuroAlliages together with 95% of Europe's ferroalloy and silicon producers. The industry actors play an active role in the realization of a low-carbon economy in Europe.

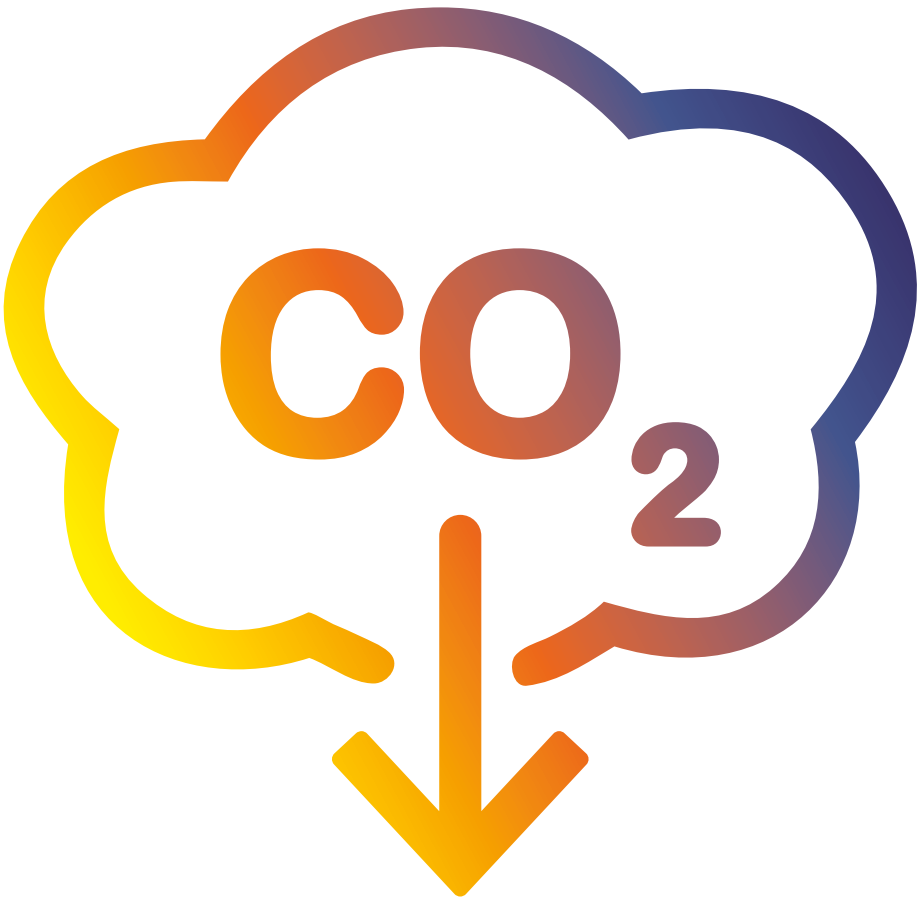
EuroAlliages' members demonstrate engagement in the realization to a transition to a low-carbon society by investing in, developing, and making use of new environment-friendly technology.

This contributes, and has contributed, over years to improving energy efficiency and significantly reducing emissions.

**Demonstrates important milestones towards a low carbon society**

The study that EuroAlliages has set up is an analysis and overview of the most important milestones in enabling the transition to a low-carbon society as a part of "Vision 2050".

**Eramet Norway actively contributes, inter alia, by sharing its own studies on reducing CO<sub>2</sub> emissions from manganese production**



**Eramet Norway contributes actively in enabling the transition to a low-carbon society as part of the European "Vision 2050"**

Shows the way to PAH-free smelter furnaces:

# Completes a shift to environment-friendly electrode masses

Eramet Norway has achieved two milestones in its work on the introduction of new environment-friendly electrode masses in manganese smelter furnaces in 2018. During the first quarter of 2018, Eramet Kvinesdal converted an entire smelter furnace unit to PAH-free electrode masses and in May, the world's largest PAH-free Søderberg electrode was put into operation with great success at Eramet Sauda. This all started at Kvinesdal in 2017 when the world's first successful industrial testing of PAH-free electrode masses on large Søderberg electrodes was carried out. **We are the first in the world to succeed in running large electrodes using new environment-friendly electrode masses".**

### Combined successes eliminate emissions

The introduction of new environment friendly electrode masses has overall been a success for Eramet Norway, but especially so for the environment and health-related issues. Smelter furnaces with PAH-free electrode masses play a large role in the elimination of emissions from harmful tarry substances, PAH (polycyclic aromatic hydrocarbons), which have a negative effect on the environment and on the working environment.

### A major shift

The introduction of PAH-free electrode masses on large, heavily-loaded Søderberg electrodes represents a major shift for manganese production and for the ferrous alloy industries.

**Despite massive R&D efforts since its invention by Carl Wilhelm Søderberg in 1917, the industry has been unable to find satisfactory alternatives to tar-based electrode masses. PAH-containing coal tar pitch has been the dominant binding agent in Søderberg electrodes right up to the present.**

### Collaboration

The success of Eramet Norway is a result of close collaboration between the processing plants at Kvinesdal and Sauda, the International Electrode Competency Group (ICG8) within the ERAMET enterprise, contractors, as well as internal and external R&D resources.

### Heightened interests

Up to now, there has only been one contractor providing PAH-free electrode masses. However, interest is growing. Eramet's breakthrough shows that PAH-free binding agents can also be used in large, heavily-loaded elec-

**During the first quarter of 2018, Eramet Kvinesdal converted an entire smelter furnace unit to PAH-free electrode masses and in May, the world's largest PAH-free Søderberg electrode was put into operation with great success at Eramet Sauda.**

trodes. This, together with a steadily increasing interest from European industry, is causing other contractors to aim for test-deliveries of new environment-friendly electrode masses to Eramet in 2019.

Eramet Norway Sauda 2018:

# Runs the world's largest PAH-free electrode

On the basis of the excellent results from Kvinesdal in 2017, an electrode at Eramet Sauda was converted in May 2018 to the new, PAH-free, environment-friendly electrode mass.

With a diameter of 1.9 metres, the electrodes at Sauda are among the largest in the world. Throughout the year, Sauda demonstrated a reliable and efficient operation, and was the first to show that the new PAH-free electrode mass could be used in the largest Søderberg electrodes.

**Kvinesdal runs the world's first smelter furnace equipped with environment friendly electrode masses containing no PAHs.**

After carrying out the first successful industrial testing of PAH-free electrode masses at Kvinesdal in 2017, new milestones were reached in 2018. Kvinesdal carried out a full conversion to PAH-free electrode masses in the entire smelter furnace 1. The furnace was the first in the world that was run on large Søderberg electrodes using the new environment friendly electrode mass with no PAH.

### R&D efforts are continuing

Even if some of the Eramet Norway electrodes have now demonstrated satisfactory operation using PAH-free electrodes, the need still exists to increase the competency around the use of the new electrode masses. Fundamental properties are altered due to the new binder agents and there is a need for operational adjustments to be made in order to run the new qualities in an optimal fashion.

A unique possibility to study the properties of PAH-free electrodes presented itself when Smelter furnace 2 at Kvinesdal was shut down for renovation in 2018.

### «Controlled Tapping»

In the competency-building project, "Controlled Tapping", a systematic stripping of the furnace was carried out in order to study conditions inside the smelter furnace. In this connection, electrodes were inspected and tests were taken to compare properties between the various electrode qualities. The results will be used in further R&D work, and with the help of mathematical modelling, optimal operation of the new PAH-free qualities will be simulated.



New venting system developed:

# Can reduce air emissions by 90 percent

Eramet Norway's R&D department and Eramet Sauda, in a scientific and practical teamwork, have collaborated to solve the problem of atmospheric emissions from the slag pit at Sauda. The result is a new venting system that is being built at the processing plant in 2020.



Eramet Norway's R&D department and Eramet Sauda have together developed and optimized a venting system that will reduce atmospheric emissions by about 80-90 percent compared with today's levels. The venting system is being built at the Sauda plant in 2019.

### R&D collaboration for environmental improvements

The Research Department in Eramet Norway is collaborating with all the other plants to solve industrial problems. Eramet Norway's goal is to come up with solutions in advance of demands from government authorities and from the community at large to develop and implement sustainable production processes that would minimize its environmental footprint. Reducing diffuse emissions from the production processes is an area in which much effort has been invested and this has resulted in major improvements for the environment.

### Scientific interdisciplinary teamwork leads to increased success

Systematic and scientific teamwork, combined with the experience and knowledge of plant personnel, theoretical studies, modelling projects, industrial measurements, and implementation of proven ideas, constitutes a teamwork effort that increases the chance for success in R&D projects. The collaboration between Sauda and the R&D department in Eramet Norway was initiated in 2017 in response to the need to reduce diffuse emissions from slag pits at Sauda.

Extracted slag is a valuable by-product of the smelting process which contains a considerable quantity of manganese oxides. The slag is cast out and cooled in slag pits and afterwards broken up to the desired size distribution at the plant. It is then used as raw material in the production of another type of manganese alloy called silico-manganese.



## About the project

### Project objectives

The goal of the project was to design a venting system with a fume hood over the slag casting process at Sauda. A hood was already in use but it needed optimization in order to achieve more effective emission handling.

### Simulation methods being used

In this project, we used CFD modelling, a recognized simulation method for problems where gas in flows play an important role. Simulations of existing conditions in the pit was carried out in order to obtain a good knowledge of air and emission flows during slag casting. A number of physical and chemical phenomena are involved in this process and these were taken into account in the assessment in order to create an optimal design for a new fume hood.

### New optimized solution

Based on meetings and discussions with plant personnel at Sauda, suggestions for practical issues and restrictions related to the slag casting process were taken into consideration in the design of proposals for new fume hood solutions. Advantages and disadvantages of various solutions were outlined through the use of CFD modelling tools (ANSYS Fluent). Results show that the optimal solution is able to reduce about 80-90 percent of the daily diffuse emissions from the slag pits at Sauda.

### To be built at Sauda

Based on the results, new optimized solutions were selected and shall be installed at the plant in 2019. The optimal solution has two ventilation fume hoods. One fume hood is located in the furnace housing in order to extract emissions from the ladle while the other is located outside the furnace housing over the slag pit in order to capture as much of the emission from the pit as possible during casting.

An article from  
Eramet Norway's  
2015 sustainability  
report

# A road map for the processing industry

The climate meeting at Paris COP21 set a number of ambitious climate targets. The target of the average temperature on earth not increasing by more than two degrees in the period to 2050 is still in place, but it was also decided to limit this increase to 1.5 degrees.

COP21 also decided that from 2050 to 2100, greenhouse gas emissions from human activity should not exceed levels that can be absorbed naturally and by means of CCS. This will provide the framework for the low-emission society of the future.

In order to ensure that Norwegian society is prepared for this low-emission society, the Norwegian government has commissioned an expert committee to prepare a strategy for green competitiveness. The committee has been tasked with presenting proposals for an overall strategy to ensure that industry will still be able to compete globally once environmental policy is reinforced by stricter measures.

## A new road map for an innovative and value-creating Norwegian processing industry

Just before the close of the year, the committee asked the Federation of Norwegian Industry to draw up a road map for the processing industry for the period leading up to the low-emission society of 2050. The Federation, which is the industrial organisation for the processing industry, enthusiastically accepted the challenge, and work on drawing up the road map is underway, with submission to the expert committee planned for May 2016.

The Norwegian processing industry is extremely energy-efficient and based on clean, renewable hydroelectric power, making it the world-leader in terms of climate and the environment. It represents an important part of Norwegian wealth-creation and accounts for significant expert values. The companies that go to make up the processing industry are located throughout the country, with most being important keystone industries in their respective local communities. The Federation of Norwegian Industry believes that the processing industry should account for a larger proportion of Norwegian wealth-creation in the low-emission society than it does at present. For this to happen, there has to be a demand for the industry's products in the global market, as well as competitive conditions and access to renewable energy at competitive prices, and the industry has to reduce its greenhouse gas emissions in line with the EU-ETS and international agreements.

## Norwegian research – a decisive area of expertise in a global context

The processing industry is an expertise-driven sector that has responded to continuous and increasing global competition with continuous efficiency-improvements. The result is that the

Norwegian processing industry, together with a number of research environments and educational institutions, now represents a significant expertise resource – and one that will prove entirely decisive in developments to come.

## We have to strengthen our position in the low-emission society

In the low-emission society of the future, there will be an increased demand for products with a small carbon footprint. This is also the case for products which contribute to reduced energy consumption, products used in energy production and storage installations, and products based on renewable raw materials.

The Norwegian processing industry is currently extremely well placed, with everything required to further strengthen its position in the low-emission society – as long as we have an innovative and wealth-creating Norwegian processing industry before 2050. The aim of the road map is to show us how to achieve this. It should describe technological opportunities and barriers, and which tools and general conditions are required if we are to succeed.



Øyvind Slåke  
Technical Director of the  
Energy and Environmental  
Department  
The Federation of  
Norwegian Industry

An article from  
Eramet Norway's  
2016 sustainability  
report

ENVIRONMENT AND SUSTAINABILITY

## ENERGY-MARKING GUARANTEES OF ORIGIN ARE A MARKING SCHEME FOR ELECTRICITY

Guarantees of origin are a labelling scheme for electricity that shows the electricity customer that a certain quantity of energy has been generated from a specified energy source. The scheme was introduced with the EU's first renewables directive (Directive 2001/77/EC) in 2001 in order to give consumers a choice between renewable and non-renewable energy. At the same time, energy producers who sell guarantees of origin receive an additional income from their renewable energy production.

It is the energy suppliers who buy the guarantees of origin from energy producers. The energy suppliers can then give a guarantee to the customer that the energy the customer is paying for is renewable, and that an amount of renewable energy is being generated that is equivalent to the amount used by the customer.

Source: The Norwegian Water  
Resources and Energy Directorate  
(NVE)

Neither the climate  
nor Norwegian value  
creation are served by a  
system that contributes  
to green-washing coal  
power generation

# GREEN ENERGY SHOULD PAY FOR ITSELF



Ole Børge Ytredal,  
Director of the Federation  
of Norwegian industries

One of the most important advantages for industrial production in Norway is emissions-free and green hydroelectric power.

Green hydroelectric power, combined with Norway's position as one of the world's most technologically-advanced countries, provides an extremely good basis for continuing industrial production in Norway. The government also stresses this in its Industrial Report, which was presented on 31 March.

## Going on the offensive on environmentally-friendly initiative

Industry is now high on the political agenda because we have emissions-free hydroelectric power and because industrial companies in Norway, in their road-map for increased value-creation and reduced emissions up to the year 2050, have adopted an extremely aggressive attitude to continued environmentally-friendly initiatives in Norway.

The underlying principle for further industrial initiatives is energy security for competitive conditions. It is important that there should be no doubt that energy bought in Norway really is green! Physics says so, but a financial instrument known as guarantees of origin has been created which is contributing the confusion on this point.

## Industry in Norway runs on emissions-free energy

The Federation of Norwegian Industry is actively working to change the guarantees of origin system in order to eliminate any doubt that Norwegian industrial production uses emissions-free energy. Following consideration of the Energy Report last summer, the Storting has instructed the government to look more closely at the system.

The system has its origins in Brussels. The draft for a new renewables directive envisages a continuation of the system, but at the same time there is also scope for adaptations that ensure that the green nature of Norwegian hydroelectric power and industrial production is not undermined.

Neither the climate nor Norwegian value-creation is served by a system of guarantees of origin that contributes to the green-washing of energy production based on burning coal. The system has to be changed, and the Federation of Norwegian Industry aims to play a constructive part in ensuring that this happens.

# Improves performance and sets records

Eramet Norway Sauda improves discharge results in important areas in 2018.

Environment-related facilities had no violations of the discharge permits. Despite some unstable periods in the processing unit, Sauda again set new reduction records in its furnaces and refining units in 2018.

**Stable processes yield good environmental performances**

The results in Sauda again reinforces the connection between stable production processes and excellent environmental performances.

However, a few short periods with unstable production processes lead to a slight increase in marine discharges of suspended material and some metal elements to the sea compared to 2017. Still, the plant kept the marine discharge level far below the permit limits. Despite these unstable periods, the processing unit at Sauda again showed a year with production records for the furnaces and the refinery unit.

# Our neighbours are the driving force to environmental improvements

The processing plant at Sauda is located in such a way that many of the municipality's residents have a good overview of the plant's activities and emission situation at all times. Every year, the plant's neighbours are invited to open house events along with the plant operators, specialists, and managers from the processing plant. These arenas are used as inspiration for achieving improved environmental performance and at the same time, they enable the company to share information on environmentimproving processes that are relevant for good neighbourliness. Achieving and maintaining good neighbourhood relationships at Sauda is an important driving force in reaching zero dust emissions.



Measurement equipment set up at the local marina.

# Put in use micro sensors

Eramet Norway Sauda is the first smelter operation in Norway to deploy a network of micro sensors around its processing plant.

The sensors make continuous measurements of the amount of fine dust (PM10) in the air. These are reasonably-priced sensors that are conceivable as becoming standard for measuring air quality throughout industrial operations in the future. The processing plant at Sauda is an early adapter in applying new technology aimed at helping the industry achieve more knowledge regarding what effect our activities are having on the surrounding environment.

**Measurement campaigns**

During 2018, two long-term measurement campaigns have been carried

out at several locations around the processing plant. A variety of measurement instruments were used.

FIDAS, an instrument which continuously measures the dust concentration in the air and at the same time, records meteorological data, is in use for collecting information and identifies whatever effects on air quality result from activities around the processing plant. The measurements show that the dust concentration in the air is affected by the weather and winds but it also appears that there is an effect from our daily activities. These measurements assist us in identifying our major contributors of diffuse emissions and enable us to initiate the measures that would give the best results in reducing diffuse dust emissions.



Measurement equipment set up at a neighbour.

# Energy efficiency

The operation achieved a total reduction in specific energy consumption per tonne produced of 4.7%, corresponding to 30 GWh in 2018.

This represents an improvement of ca. 10 MNOK, and demonstrates the value of achieving and maintaining stable processing controls in primary processing over time. Furthermore, a reduction in consumption of auxiliary power was achieved corresponding to 8% measured with respect to the reference year of 2012.

In 2012, we used 25 tonnes of propane per month. In 2018, the total consumption for the year was 24.8 tonnes. The improvement was result of goal-oriented work overtime. The conversion of the pilot lights at the mercury purification unit and the conversion of the skjenketørkene (2 units) from propane to CO gas are important contributors.

**In 2018, we reached our objective of reducing propane consumption by 90% measured with respect to the reference year of 2012.**



## Collaborates in forward-looking research environments aimed at obtaining new knowledge on atmospheric dust emissions.

In 2018, Eramet Norway Sauda collaborated closely with Dr. Hege Indresand at NORCE in developing increased knowledge on actual diffuse dust emissions and on the general air quality in the immediate vicinity of the process unit. NORCE is a new and forward-looking research institute with a broad professional scope and a strong knowledge environment. NORCE provides research and innovation within the energy, health, climate, environment, society, and technology fields. Its results respond to central societal challenges and contributes towards adding value on a local, national, and global scale.



## Barrier strategy reduces dust emissions by several tonnes per year

A number of barrier strategies for reducing dust emission from the heart processes were put in place and expanded in 2016. One of these involved connecting laser meters for dust and particle emissions emanating from the production building (diffused dust emissions) to automatic on and off control of "water-fog covers" over the largest openings in the production building.

Mn measurements of this water has shown that the Sauda plant with these "last-ditch" barriers had reduced the diffuse atmospheric emissions by several tonnes during the year.

In the cold operations area, an automatically-controlled "Smart sprinkling unit", consisting of four sprinkling outlets, was put in operation.

These extract water from the fjord (salt water) and sprinkles the outside area on the finished product side that is not paved with asphalt. This initiative results in non-asphalted surfaces remaining wet at all times and ensures minimum dust production during transport activities.

# Focus on noise at Porsgrunn

Eramet Norway Porsgrunn is taking the noise problem very seriously and will work systematically to reduce noise from our processing plant at Herøya.

Regular dialogue with our neighbours on current problems such as noise is an important source in our continuous improvement efforts. In 2017, a comprehensive program was carried out involving noise measurements and modelling of initiatives that could possibly be effective; following this, a plan was drawn up for execution of the initiatives in 2018.

In the Sustainability Report for 2017, results were presented from the noise measurements and noise maps were drawn up by Brekke & Strand. In addition, a briefing was done on the important noise-reduction measures that were identified and whose

implementation should be prioritized. In 2018, all the prioritized initiatives were carried out. In March 2019, new measurements were carried out in order to confirm the effect of the improvements, as well as for planning whatever new initiatives to be carried out in 2019.

Initiatives carried out in 2018 have yielded excellent results. The estimated noise level is now 2-3 dB lower than in the survey in 2017. The initiatives have had the greatest effect in reducing noise from fans, from repair ports for scaling of ladles, and new sound suppressors in the ventilation systems on the finished goods crusher filters

and the environmental filter on furnace 11. These are noise sources that, in the survey of 2017, were the most dominant. And in addition to these initiatives, noise shields were also installed on furnace 11 on each side of the grate, since this was perceived as an annoying sound source by the neighbours. After installation, there have been no neighbour complaints related to this project execution.

Eramet Porsgrunn feels that the upgrading project has been very successful, but more work should be done on new initiatives in 2019 to reduce the noise levels further.



Initiatives carried out in 2018 have yielded excellent results. The estimated noise level is now 2-3 dB lower than in the survey in 2017.

The most important technical initiatives carried out in 2018

- Sound suppressors installed in chimneys of the finished product crusher
- Sound suppressors at various fans around furnace 11
- Environmental filters at furnace 11 (fans and checks of the existing sound suppressors)
- Process ladle cleaning

New planned initiatives

- **Shore power for boats**  
application for funding is being processed at ENOVA. When the application has been approved, implementation is planned during the subsequent year.
- **Noise-shielding furnace 11**  
Noise-shielding gas supply unit furnace 11 - further sound-insulation of fans
- **Reduce noise from MOR-fan**  
MOR fans occasionally emit intense low-frequency noise. This is sound that is not included in the calculations within the new report. The fan occasionally emits intense low-frequency noise (20-25 Hz). Investigations are in progress to locate the cause of the sound and to find improvement options.

# New initiatives for cleaner air in Kvinesdal

In 2018, a comprehensive upgrading effort was initiated at the Kvinesdal plant whose goal was to improve ambient air quality.



Three upgrading teams composed of managers and plant operators, with a focus on a material handling, mapped out how raw materials and liquid and cast materials were to be handled at the plant. The project has resulted in a number of suggestions for measures that are now being carried out and prioritized.

### Focus on material handling

Upgrading work was initiated in the fall of 2018 with the goal of finding possible initiatives for reducing the spread of diffuse dust emissions from the plant at Kvinesdal. The work was concentrated around how the handling of materials is carried out, both for raw materials, liquid metal and slag, and for cast slag. Three upgrading teams were estab-

lished: One was for furnace activities after pouring, one for handling of raw materials and cast slag, and one was for breaking up and storing of slag. The teams were composed of both management and operational staff. Over the fall and winter, the groups made ongoing assessments of how the activities in the respective process-

The project has so far resulted in a number of suggestions for measures that are now being carried out and prioritized.

ing areas created dust emissions to the environment. In parallel with this, possible initiatives for minimizing such emissions were outlined and discussed.

### New initiatives are carried out on an ongoing basis

Initiatives that involve improvements to work routines, better communication, enhanced awareness, and more specific re-training are carried out on an ongoing basis within the operational organization. Other initiatives that can be carried out within the operational budgets are assessed and prioritized for execution on an ongoing basis. The initiatives that require major investment are assessed and prioritized for execution within the company.

### Measuring the effects of the initiatives

Work is also being carried out on improving the measurement of dust dispersed to the surrounding environment. It is important to assess the effect of the measures taken. Dust measurements are planned and carried out in close co-operation with external professional communities with recognized competency in the field. During 2019, an assessment will be made of whether the installation of measurement equipment in the surrounding areas of the plant is called for in order to follow up on the execution and effectiveness of the improvement initiatives decided upon.

**The work by the upgrading teams is planned to continue until the summer of 2019.**



## "Eramet invests both in us and in the local community"

**"One cannot prepare oneself for a job in industry only by sitting in a classroom", state Paulina (17) and Ole Sivert (18). These two Sauda residents are students in Rogaland's only YSK (Professional and Study Competency) class and are enjoying every single working week.**

In cooperation with Eramet Norway Sauda, among others, Sauda Videregående Skole (Sauda Upper Secondary School) is offering the YSK (Professional and Study Competency) program. In this program, the students study profession-mandated subjects and Special Study Competency training for four intensive years.

YSK is considered as the pilot project in Rogaland. The two Sauda students, Paulina Draugelyte (17) and Ole Sivert Birkeland (18) are enrolled in the first year of the study program. After four years of study, both will have special

study competency and professional credentials as process operators.

### **Experience is the key**

The students who undergo YSK training at Sauda all receive a salary corresponding to that paid to apprentices for those days they take part in the operations. During the first three years, they work two days per week at the plant. During the last year, they work three days per week. This provides the students with important insight into Eramet's daily work routines and procedures. In other words, they are very well equipped to build a career at Eramet Norway, whether they go directly into a job or select a further study program.

– "To me this seems more difficult than normal studies. The weeks are varied and interesting as we are at school three days and on the job, two. In addition, we earn a salary while carrying out our studies. We enjoy every single work week", relates Ole Sivert.

**Ole Sivert (18) are enrolled in the first year of the study program.**

The two students are convinced that they see major advantages in sharing of school attendance and practical work at Sauda.

– "One cannot prepare oneself for a job in industry only by sitting in a classroom. One must acquire experience and learn about the various processes, procedures, and routines through active participation. Theory is important, but practical experience is totally necessary. One grows as a person", states Paulina.

**It is natural to come back**

– "The fact that Eramet commits itself actively to being a place of learning for such a study program is both smart and future-oriented", state the two students. They believe that over time, Eramet will recover a lot for its

investment. Both Paulina and Ole Sivert clearly have definite plans. Ole Sivert will go further in Engineering studies up to the Bachelor level, while Paulina will enrol in a college education program, of course, as soon as military service is completed.

– "Eramet is helping us by setting study goals for us and they do a good job following up with us. We are becoming familiar with all that goes on here and it is only natural to consider a job here when our studies are finished. In any event, I have a clear plan in that regard", relates Ole Sivert.

The two students describe Eramet's commitment as an investment both in themselves and in the local community.

– "In this way, they are working actively to engage people who have suitable practical experience, and who in addition, are well-educated. Furthermore, that is extremely attractive for us students", says Paulina, who also has plans to move home to Sauda after finishing her studies.

**Attractive for Eramet**

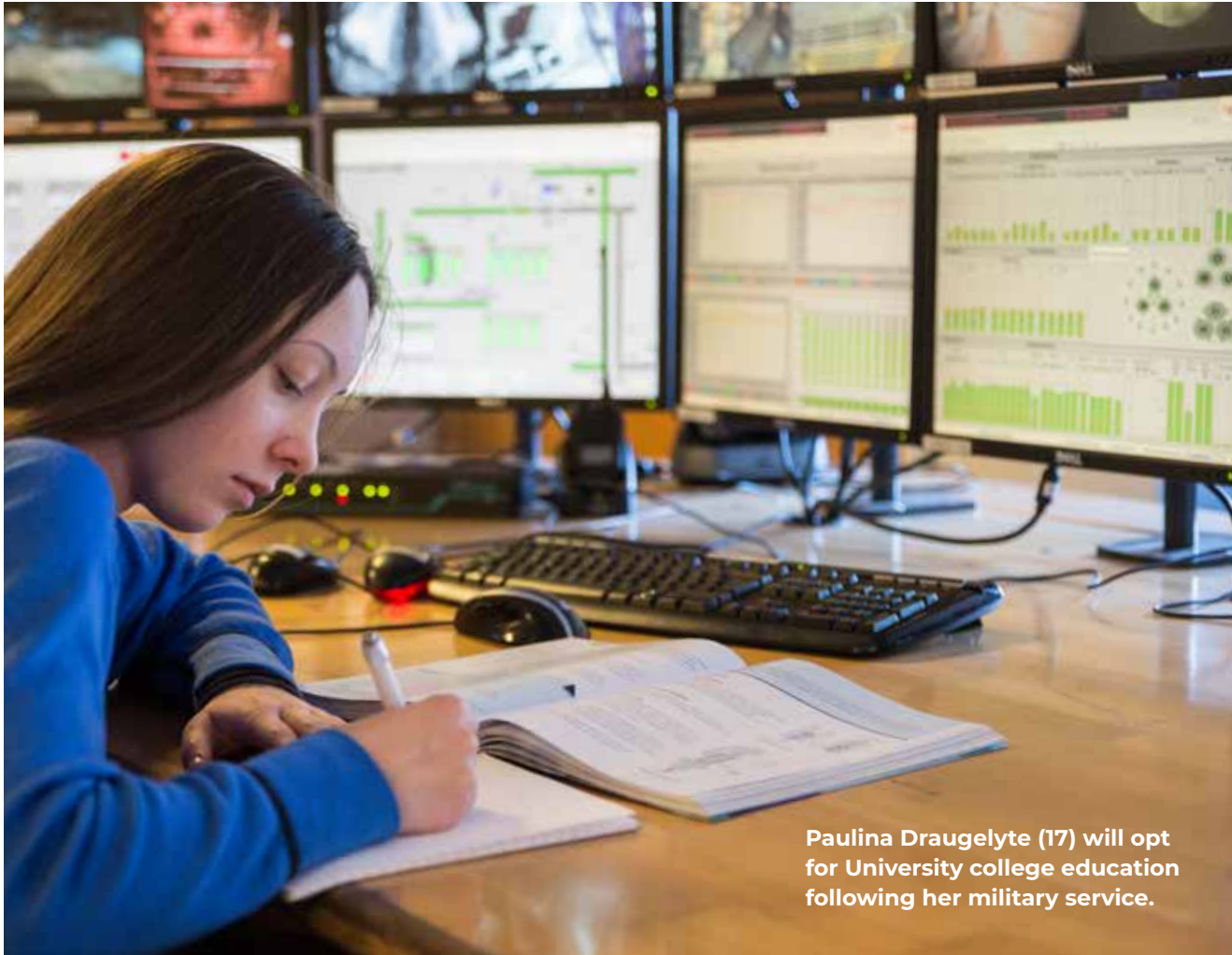
Erik Aareskjold, HR Head at Eramet Norway Sauda, feels that these students are making a very intelligent choice in considering their futures in the job market.

– "For some of these students, this is only the beginning. Some will, for example, go on to Engineering Studies at NTNU. Others will perhaps go in a completely other direction. Some will use their professional credentials as



**HR Head at Eramet Norway Sauda, Erik Aareskjold feels that engineers with certification will always have a fundamental understanding and practical insight that make them highly attractive for Eramet"**

**Eramet Norway has 55-60 apprentices at all times.**



**Paulina Draugelyte (17) will opt for University college education following her military service.**

process operators and begin their careers with us. One has a very good point of departure regardless of what one wishes to do, and this study program achieves that very well", he says.

The fact that Eramet Norway Sauda has committed itself as an apprenticeship and cooperative placement operation for Sauda Upper Secondary School can be seen as a smart bet considering the challenging recruitment situation experienced by the smelter industry, not least because special study competency with advanced studies in mathematics, physics, and chemistry opens a direct avenue to further studies in engineering.

**– It is no secret that it is crucial to recruit an academically trained workforce. Our participation in YSK is a long-term investment for which we will see the results in a few years.**

– "We hope to see recently graduated process operators who wish to join our staff, but also, students who have taken the step further and have received an engineering degree. Engineers with professional credentials will, all things considered, always have a fundamental understanding and practical insight which make them very attractive for us", relates Aareskjold.





### Eramet Norway exercises social responsibility by:

- Owners receiving an expected return on their invested capital
- Employees feeling a sense of security for themselves and for their families
- Our suppliers having a demanding customer
- Our customers getting their products on time and with the agreed quality
- Keeping our environmental impact to a minimum
- Taking the initiative to make changes in response to circumstances
- Producing useful products needed by the world in a way that is environmentally effective

Eramet Norway is also interested in helping to build robust industrial regions. Initiatives that strengthen social structures in communities where we are located also strengthen our competitive position.

#### A robust industrial region is characterised by:

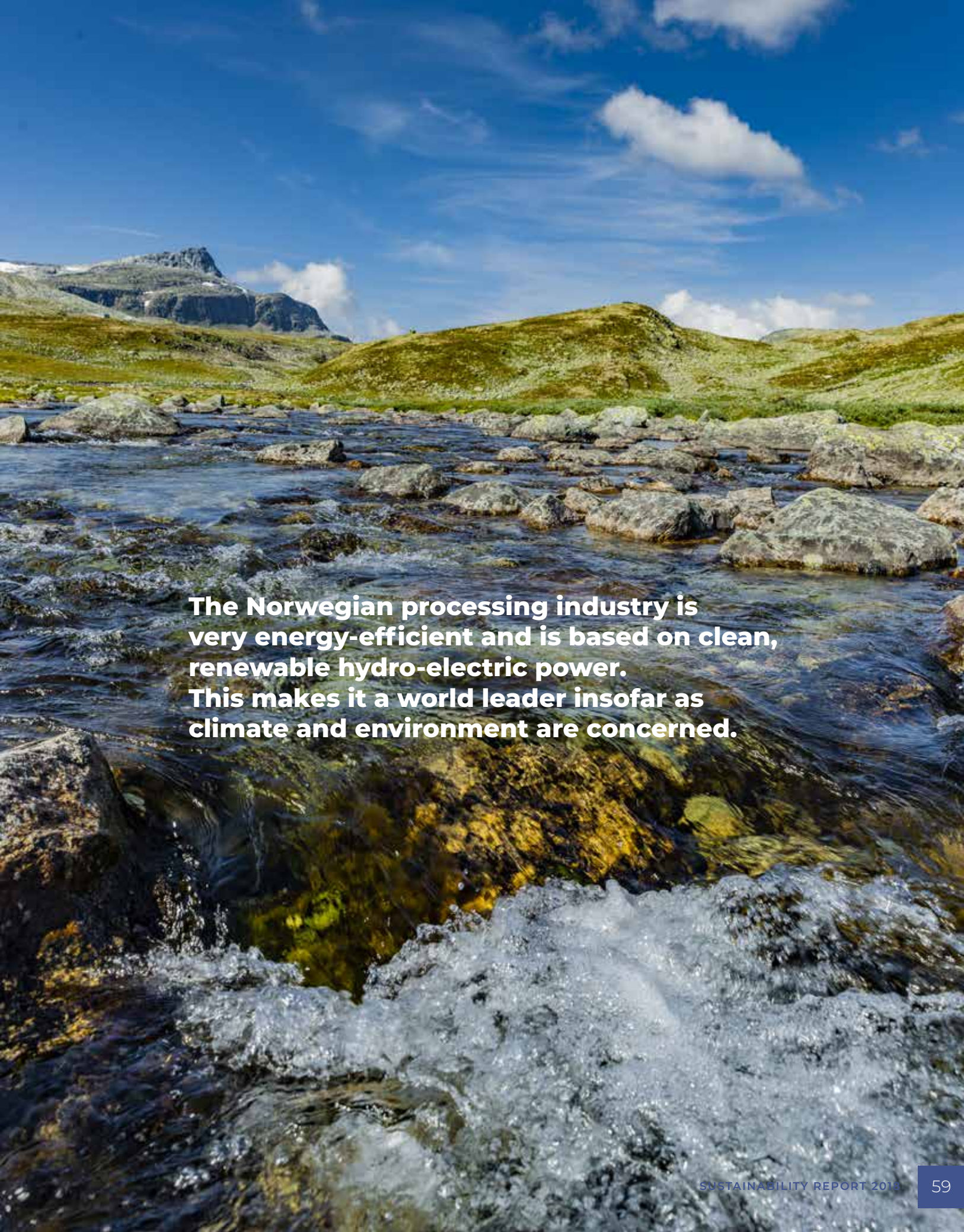
- Equitable and stable welfare provision
- A competitive, profitable and adaptable commercial sector
- Good access to skills
- Access to a varied jobs market, accommodation and services

## Reporting in the event of breach of ethical guidelines

The email address [varsel@erametgroup.com](mailto:varsel@erametgroup.com) can be used by all ERAMET employees, and by ERAMET's customers and partners, if they believe there has been any violation of a principle or value set out in the code of ethics.

#### Any knowledge or suspicion of the following should be reported:

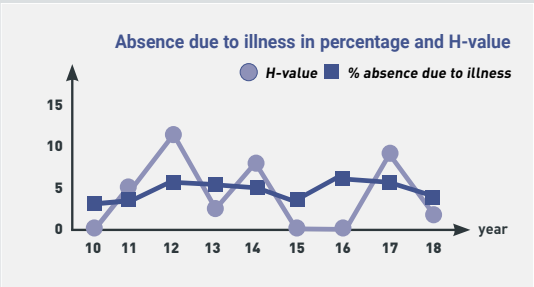
- Corruption, fraud or conflict of interest
- Anti-competitive actions
- Discrimination and harassment in the workplace
- Behaviour contrary to the group's guidelines and standards on health, hygiene, workplace safety or environmental protection
- Serious violation or risk of violation of the human rights of the group's employees or other persons affected by the group's operations



**The Norwegian processing industry is very energy-efficient and is based on clean, renewable hydro-electric power. This makes it a world leader insofar as climate and environment are concerned.**

SAUDA

Injury figures H1 and absence due to illness

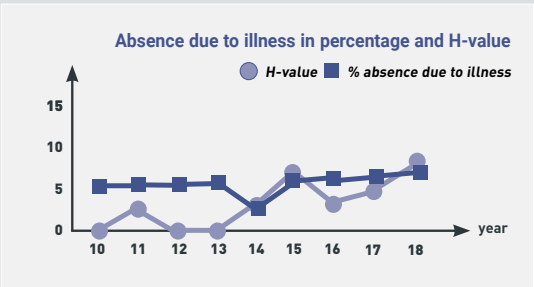


HES figures

| CATEGORY                         | 2017  | 2018  |
|----------------------------------|-------|-------|
| Absence due to illness           | 5,3 % | 3,6 % |
| Injuries with absence            | 3     | 1     |
| Injury figures H1 (H-figures)    | 6,9   | 2,0   |
| Undes. incidents - environmental | 139   | 94    |
| Complaints from neighbours       | 47    | 12    |
| Violation of discharge permit    | 0     | 0     |

PORSGRUNN

Injury figures H1 and absence due to illness

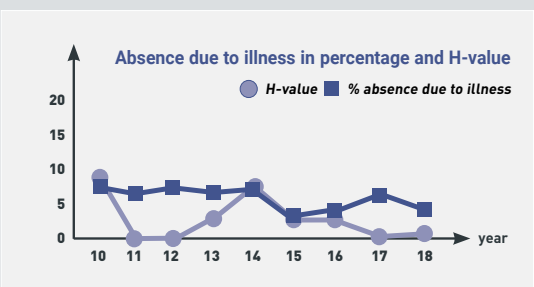


HES figures

| CATEGORY                         | 2017  | 2018  |
|----------------------------------|-------|-------|
| Absence due to illness           | 5,5 % | 6,0 % |
| Injuries with absence            | 1     | 2     |
| Injury figures H1 (H-figures)    | 3,3   | 6,9   |
| Undes. incidents - environmental | 121   | 54    |
| Complaints from neighbours       | 24    | 47    |
| Violation of discharge permit    | 0     | 1     |

KVINESDAL

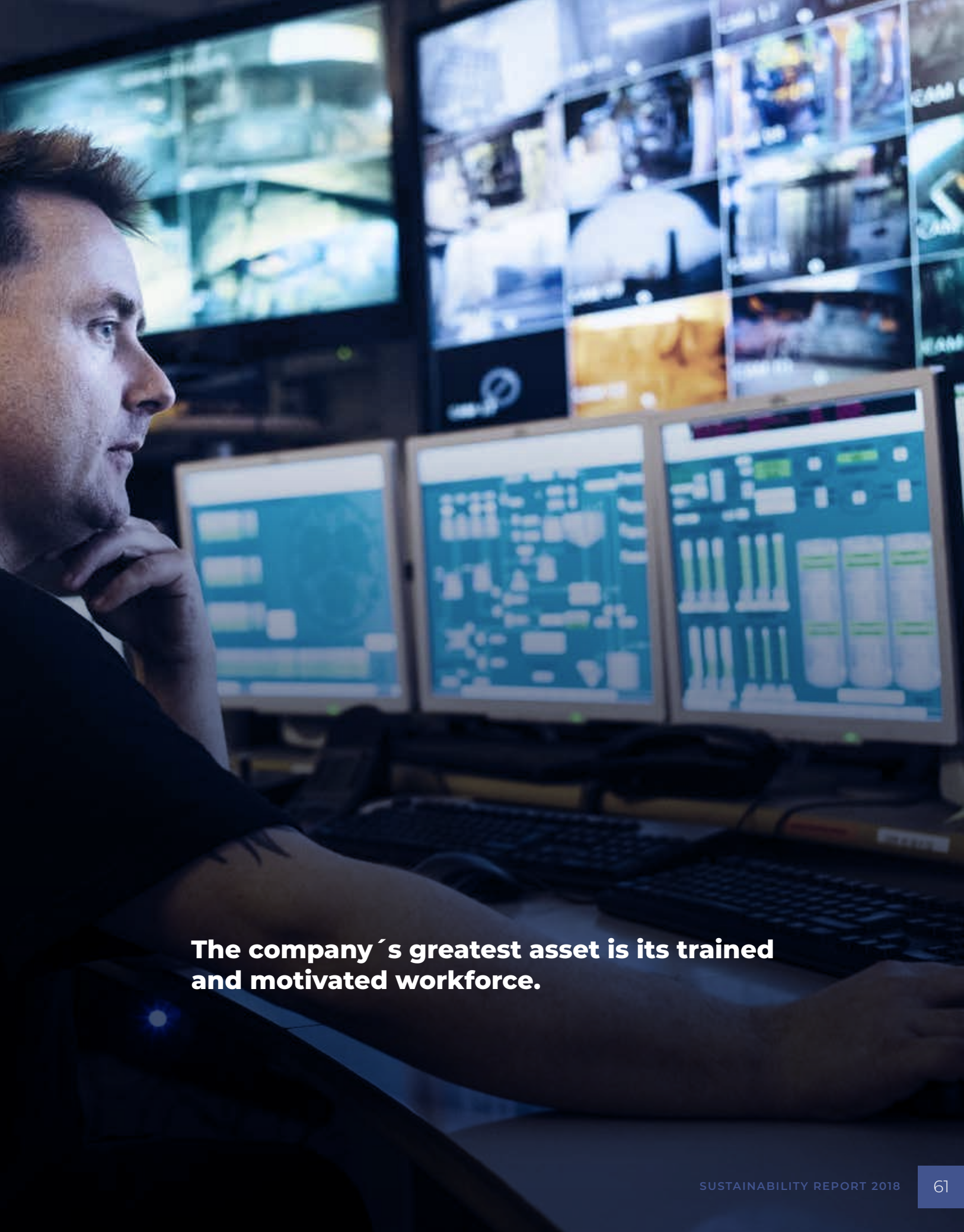
Injury figures H1 and absence due to illness



HES figures

| CATEGORY                         | 2017  | 2018  |
|----------------------------------|-------|-------|
| Absence due to illness           | 6,2 % | 4,6 % |
| Injuries with absence            | 0     | 1     |
| Injury figures H1 (H-figures)    | 0     | 2,6   |
| Undes. incidents - environmental | 48    | 28    |
| Complaints from neighbours       | 1     | 2     |
| Violation of discharge permit    | 1     | 1     |

\* External workers



The company´s greatest asset is its trained and motivated workforce.

# ERAMET NORWAY HES-POLICY

### Objective

At Eramet Norway, we seek to conduct our business in such a way as to minimize potential harm to health, the environment and safety throughout the value chain. Metals, materials and other products are to be manufactured using resource-efficient processes with due regard for health, the environment and safety. As an environmentally conscientious company, we are committed to maintaining a safe working environment that protects our employees, facilities and assets. The twin goals of preventing environmental damage and continuously improving our performance on health, the environment and safety underpin all our activities.

### Prioritization

Health-, environment- and safety-related activities are to be integrated into all aspects of our operations. Our chief concern is to protect our employees and other stakeholders from workplace injuries and adverse health effects. We are committed to complying with all applicable statutory and regulatory requirements, and with all codes of practice endorsed by the company. Environmental and safety aspects will be a key consideration when we make decisions on capital expenditure, operating methods and changes.

### Responsibility

Managers at all levels have overall responsibility for health, the environment and safety in their respective areas. They are responsible for planning, organizing and training, for implementing health, environmental and safety procedures, and for ensuring that practices comply with statutory and regulatory requirements.

Managers are to set specific targets for improvement and seek the cooperation of employees in achieving those targets. All managers and employees have a shared responsibility to create a safe workplace, to protect the environment, and to protect the company's resources and equipment. All employees are personally responsible for protecting themselves and for safely performing their duties according to established instructions and guidelines.

### Improvement

Health, the environment and safety are integral parts of Eramet Norway's management system. A continuous improvement program is to be put in place, based on careful evaluation of the potential for undesirable incidents and suggested improvements. Reporting of undesirable incidents is to be a priority, as the starting point for implementing corrective and preventive measures.

### Prevention

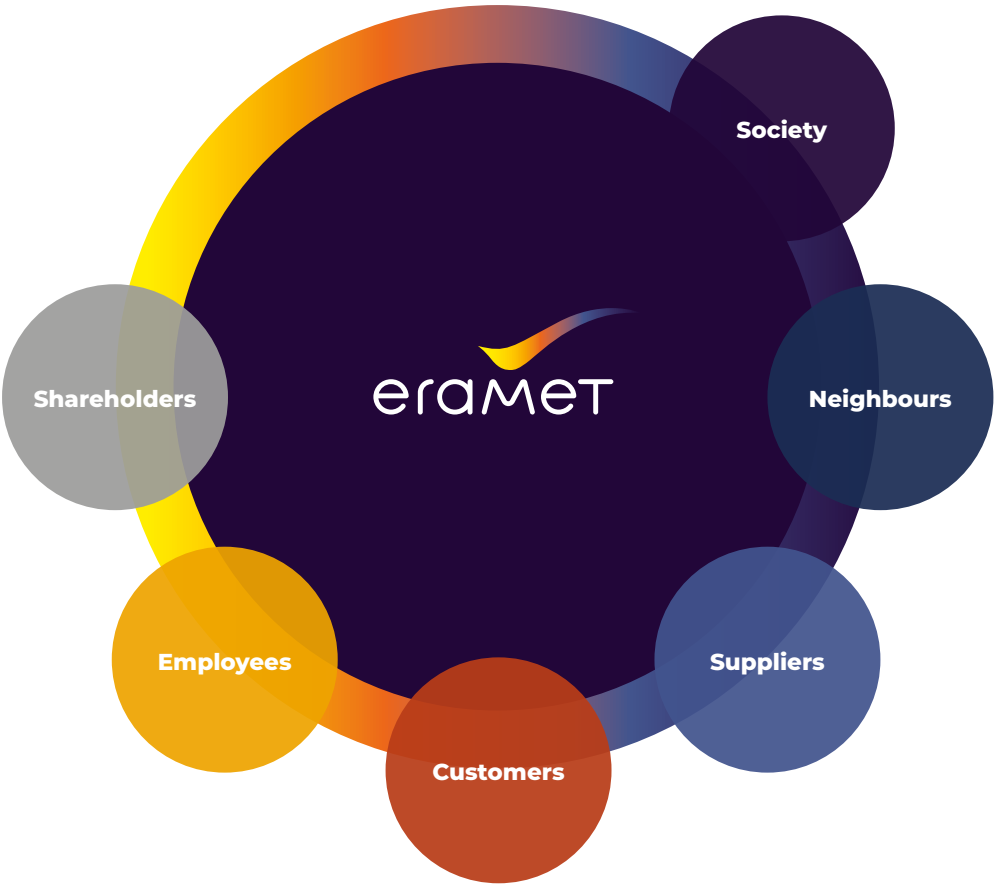
Health, environmental and safety procedures and practices, and any changes to these, are to be based on a thorough risk assessment. Operational plans and capital projects will likewise be subject to an assessment of the health, environmental and safety risks. Potential hazards are to be identified and assessed. Undesirable incidents such as near mishaps, accidents, injuries to health and environmental damage are to be recorded and investigated to determine the root cause and prevent recurrence.

### Follow-up

To ensure compliance with statutory and regulatory requirements, and respect for Eramet's own environmental goals, policies and guidelines, a system must be in place for ongoing reporting, record keeping and review. Eramet Norway is to publish an annual health, environment and safety report.

**As an environmentally conscientious company, we are committed to maintaining a safe working environment that protects our employees, facilities and assets.**

# SUCCESS FOUNDED ON TRUST



### Supporting the local community

Eramet Norway supports clubs, organizations, cultural activities and individual events at each of its production locations. It is important that the local community around our company continues to provide opportunities for cultural and leisure activities.

### Customers making ever-greater demands

Sustainable products and processes are also increasingly being discussed in the context of our customer relations. As a leading supplier of manganese alloys, we work actively in order to satisfy our customers' requirements, as set out in their overall policies, specifications of requirements and guidelines. Regular audits are also conducted together with our main customers.

### Collaborating for knowledge

Through our membership of forums such as Grenland Industrial Cluster, the Eyde network and EnergiRike, we are committed to sharing knowledge among regulatory authorities, politicians, centres of expertise and our own industry on major issues of mutual concern.

### Collaborating with Bellona

Eramet Norway and the Bellona environmental foundation have instituted a formalised collaboration, the aim of which is to make use of each other's core skills in order to improve society's environmental results.

### Collaborating with the industry

Through the Norwegian Ferroalloy Producers Research Association (FFF), Eramet Norway has played a role in a number of important collaboration projects between the industry, Sintef and the Norwegian University of Science and Technology (NTNU).

# Energy balance status 2018

Eramet Norway's three manganese processing plants focus on systematic energy conservation to bolster the sustainability of our operations.

The manganese alloy industry is very energy-intensive, but Eramet Norway's three plants at Kvinesdal, Porsgrunn and Sauda all hold ISO 50001 certification as proof of their healthy energy balance sheet. Energy consumption can be divided into three main groups (see illustration), with "electrons" and "hydrocarbons" each representing 44 and 42 per cent respectively of the total 4.4 TWh for 2018. The remainder is accounted for by the energy used in the consumption of metallic materials (silicon and manganese) in the furnace and refining processes.

### Energy consumption

The consumption of 2.03 TWh of electrical energy represents 0.63 TWh, 0.69 TWh and 0.71 TWh at Porsgrunn, Sauda and Kvinesdal respectively. Coke and anthracite are primarily used as reductants in the smelting furnaces, but the energy content of 1.96 TWh is included in the balance sheet.

### Energy use

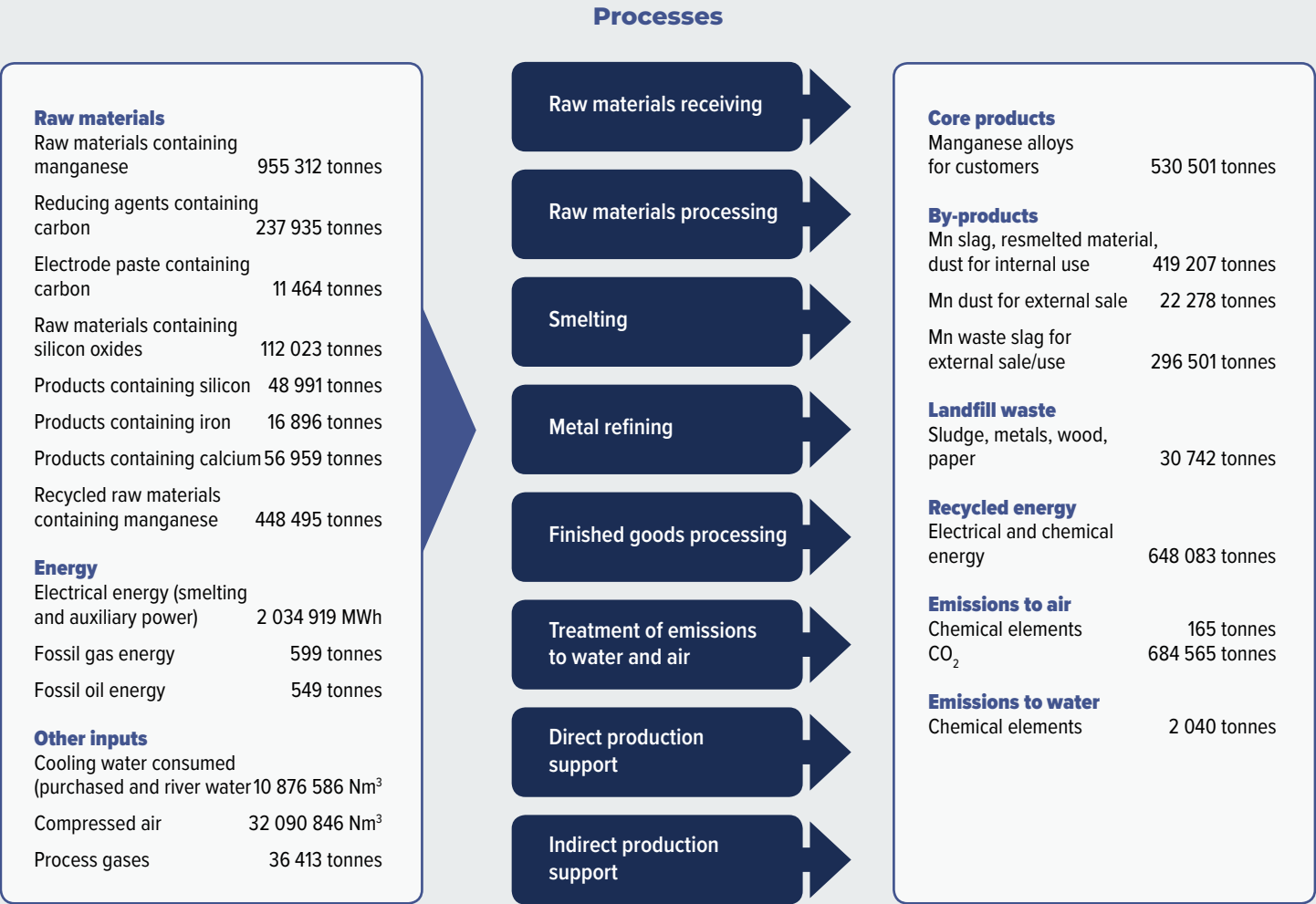
With a sellable production in the order of 602,000 tonnes of manganese alloys in 2017, we estimate that 1.98 TWh of energy is used in the production of these products – or roughly 45 per cent of the total energy used in the processes for standard and refined FeMn and SiMn. The major challenge is how much energy we succeed in recovering as fuel and in heat flows, such as air and water. For 2018, this was roughly 0.6 TWh, which is about 13 per cent of the added energy. The energy recovery plant at Kvinesdal produced about 76 GWh net, which is something less than the total capacity due to an implemented scheduled shut-down. Supplies of furnace gas to Yara's ammonia plant in Porsgrunn usually also produce a significant effect. The hot water supplies to the fish farm in Kvinesdal, the compressor heat recovery plant in Porsgrunn and the internal use of furnace gas for refractory activities and building heating in Sauda are all activities that make a solid contribution to energy recycling. In

Porsgrunn, a system for recycling hot water from slag beds was commissioned in 2016.

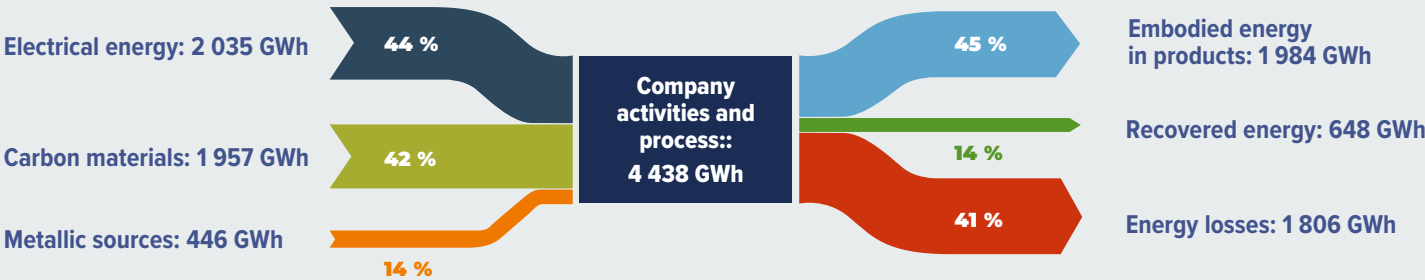
### Further increasing energy recovery is a challenge

As a residual item, we also ended up with 1.8 TWh on the tap side. The energy teams at each of the processing plants are all involved in this work, ranking their plans for improvement measures according to investment needs, implementation time and potential gain. Location factors have some significance for the potential use and attractiveness of recycled energy. Use is made of public support schemes arranged via Enova. Internally, each of the three processing plants receives a dedicated annual sum that is earmarked for energy conservation measures.

# Eramet Norway resource balance sheet 2018



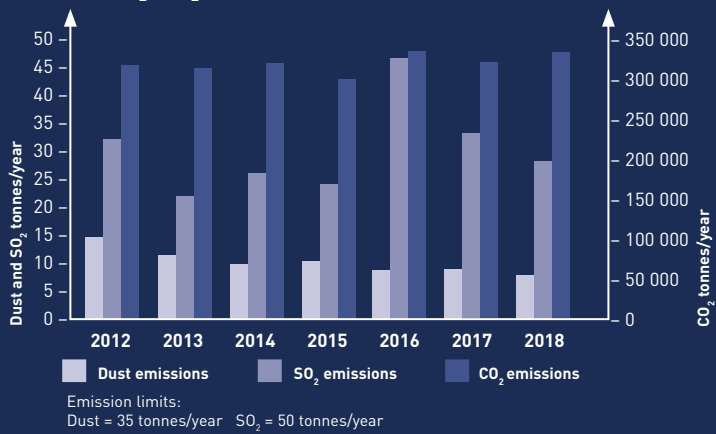
## ERAMET NORWAY ENERGY BALANCE 2018



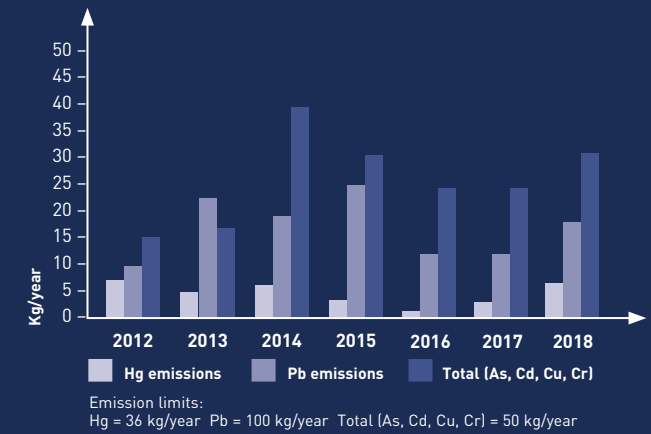


Since 2001 we have invested almost half a billion kroner in developing and installing new, environment-friendly technology.

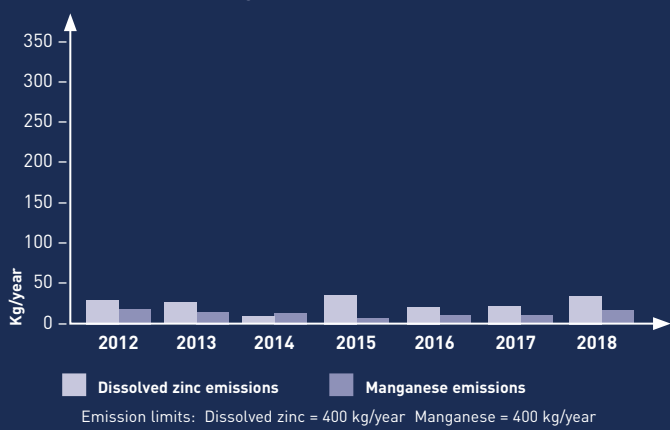
DUST, SO<sub>2</sub>, CO<sub>2</sub> emissions to the air 2012-2018



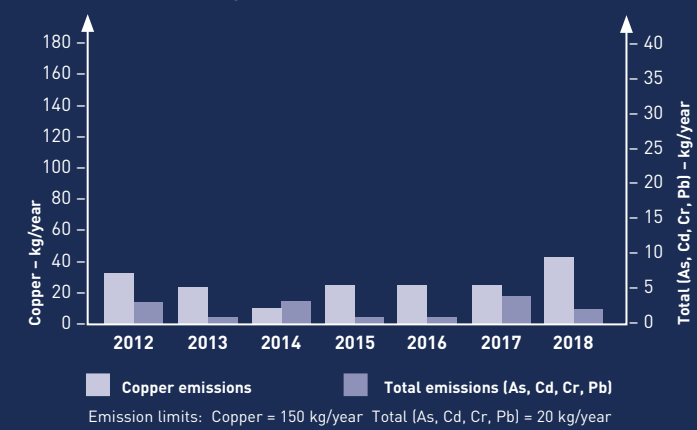
Hg/Pb/Total (As, Cd, Cu, Cr) emissions to the air 2012-2018



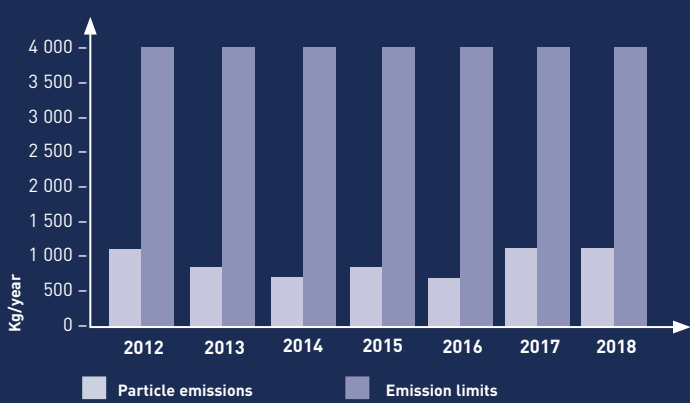
ZINC/MANGANESE emissions to Saudafjorden 2012-2018\*



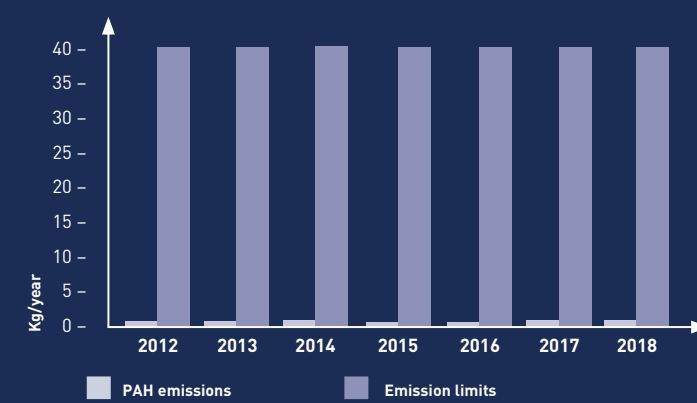
COPPER/TOTAL (As, Cd, Cr, Pb) utslipp til Saudafjorden 2012-2018\*



PARTICLES emissions to Saudafjorden 2012-2018\*



PAH emissions to Saudafjorden 2012-2018\*



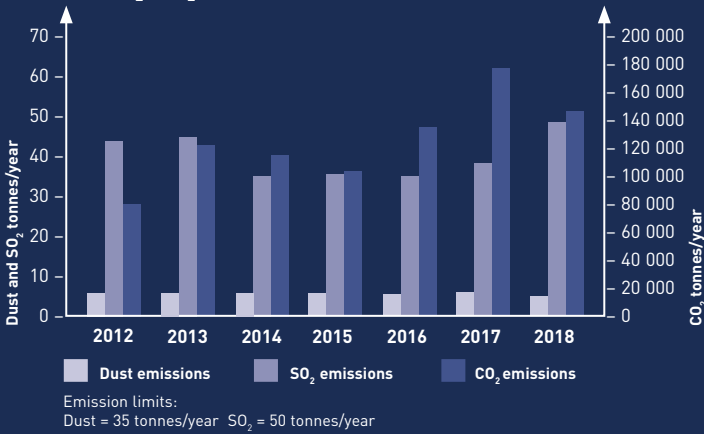
\*Emissions from purifying plants.

Waste

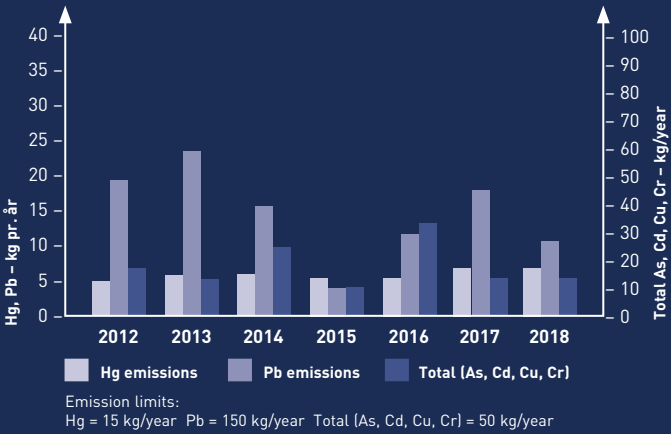
| CATEGORY                   | 2018         | 2017         |
|----------------------------|--------------|--------------|
| Slag                       | 0 tonnes     | 0 tonnes     |
| Sludge and dust (landfill) | 3 633 tonnes | 3 338 tonnes |
| Residual waste             | 153 tonnes   | 116 tonnes   |
| Metal waste                | 159 tonnes   | 301 tonnes   |
| Special waste              | 58.1 tonnes  | 72.9 tonnes  |

| CATEGORY            | 2018       | 2017        |
|---------------------|------------|-------------|
| Paper and cardboard | 7.3 tonnes | 8.86 tonnes |
| Wood waste          | 175 tonnes | 193 tonnes  |
| Plastic             | 4.6 tonnes | 3.1 tonnes  |
| Asphalt             | 0 tonnes   | 0 tonnes    |

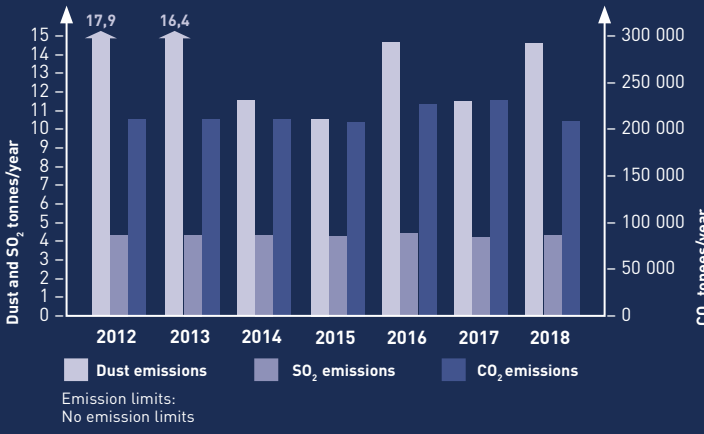
DUST, SO<sub>2</sub>, CO<sub>2</sub> emissions to the air 2012-2018



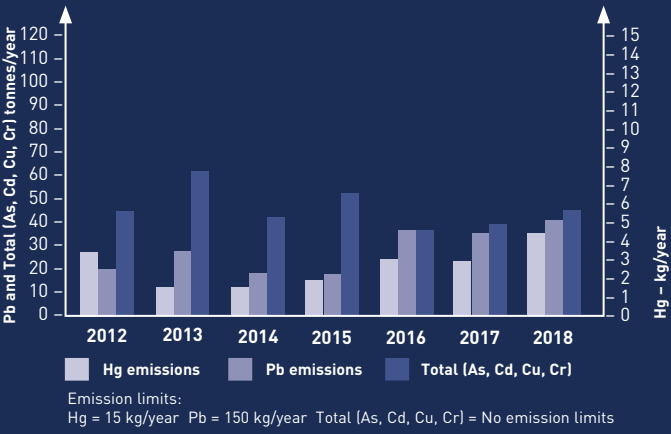
Hg/Pb/Total (As, Cd, Cu, Cr) emissions to the air 2012-2018



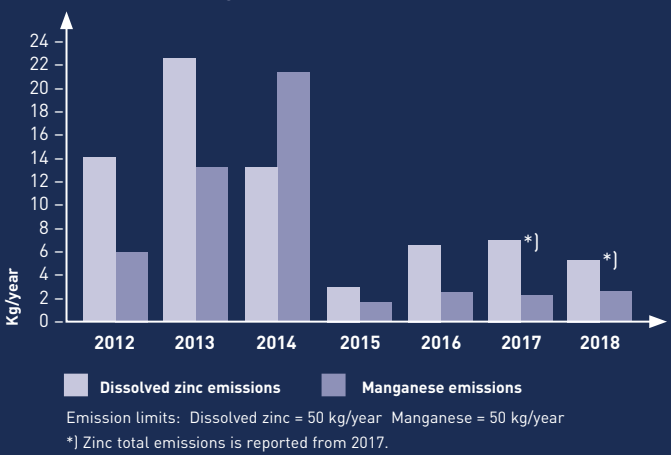
DUST, SO<sub>2</sub>, CO<sub>2</sub> emissions to the air 2012-2018



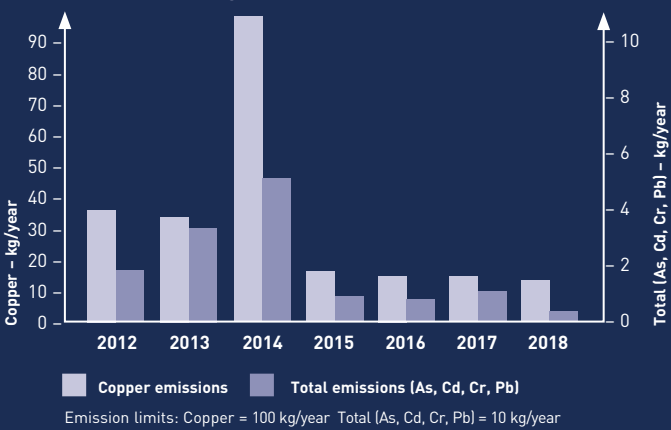
Hg/Pb/Total (As, Cd, Cu, Cr) emissions to the air 2012-2018



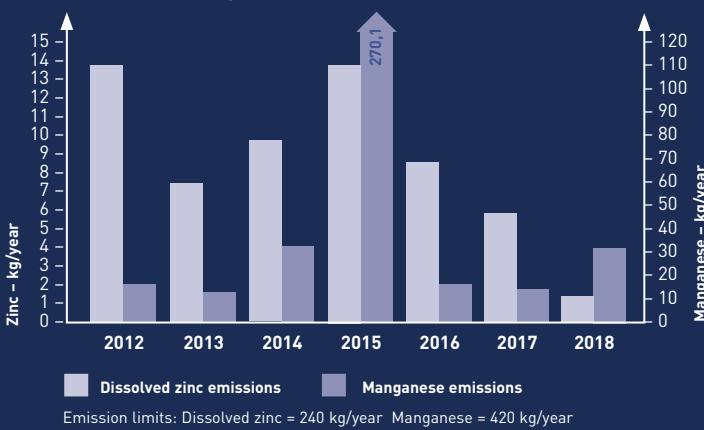
ZINK/MANGANESE emissions to Frierfjorden 2012-2018\*



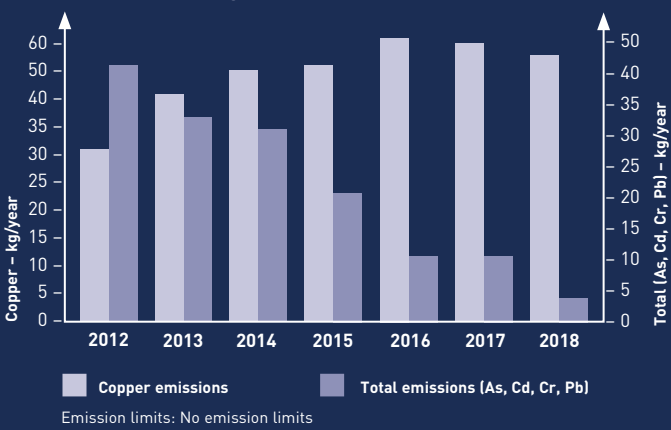
COPPER/TOTAL (As, Cd, Cr, Pb) emissions to Frierfjorden 2012-2018\*



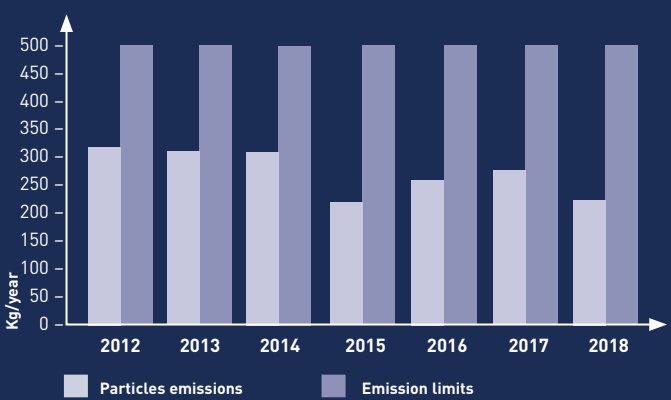
ZINK/MANGANESE emissions to Fedafjorden 2012-2018\*



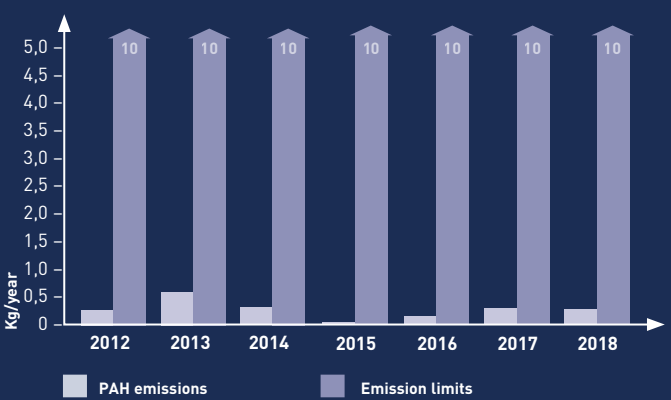
COPPER/TOTAL (As, Cd, Cr, Pb) emissions to Fedafjorden 2012-2018\*



PARTICLES emissions to Frierfjorden 2012-2018\*



PAH emissions to Frierfjorden 2012-2018\*



\*Emissions from purifying plants.

Waste

| CATEGORY                   | 2018          | 2017          |
|----------------------------|---------------|---------------|
| Slag                       | 98 811 tonnes | 87 687 tonnes |
| Sludge and dust (landfill) | 5 858 tonnes  | 6 029 tonnes  |
| Residual waste             | 168 tonnes    | 148 tonnes    |
| Metal waste                | 171 tonnes    | 120 tonnes    |

| CATEGORY            | 2018        | 2017        |
|---------------------|-------------|-------------|
| Special waste       | 9.3 tonnes  | 65.4 tonnes |
| Paper and cardboard | 3.4 tonnes  | 3.8 tonnes  |
| Wood waste          | 156 tonnes  | 142 tonnes  |
| Mixed rubber waste  | 16.9 tonnes | 20.2 tonnes |

Waste

| CATEGORY                   | 2018         | 2017         |
|----------------------------|--------------|--------------|
| Slag                       | 216 651 tonn | 221 816 tonn |
| Sludge and dust (landfill) | 19 325 tonn  | 26 446 tonn  |
| Residual waste             | 95,2 tonn    | 92,2 tonn    |
| Metal waste                | 1,1 tonn     | 92,7 tonn    |

| CATEGORY            | 2018       | 2017      |
|---------------------|------------|-----------|
| Special waste       | 223 775 kg | 83 947 kg |
| Paper and cardboard | 5 930 kg   | 2 061 kg  |
| Wood waste          | 75 520 kg  | 35 300 kg |
| Plastic             | 13 311 kg  | 4 752 kg  |

\*Emissions from purifying plants.



## Environmental income 2018

Environmental income from sale of CO gas to Yara's ammonia factory at Herøya in Porsgrunn, and sales of manganese dust and sale of electrical energy at Kvinesdal.

Sales of CO-gass to Yara in Porsgrunn  
**37.6**  
M NOK

Sales of manganese dust  
**134.5**  
M NOK

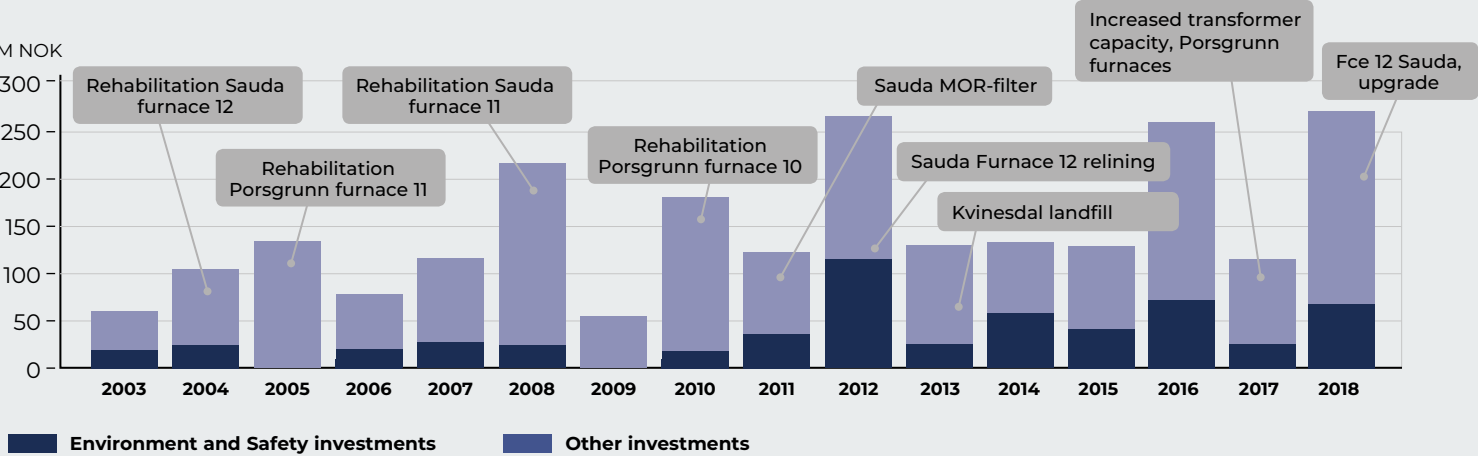
Sales of recovered energy in Kvinesdal  
**43.2**  
M NOK

## Investments 2007–2018

Yearly investments in M NOK for Porsgrunn and Sauda during the period 2007-2018, and Kvinesdal for the period 2010-2018.

| 2 plants (PORSGRUNN, SAUDA)        |      |      |      |      | 3 plants (PORSGRUNN, SAUDA, KVINESDAL) |      |      |      |      |      |      |      |      |       |
|------------------------------------|------|------|------|------|----------------------------------------|------|------|------|------|------|------|------|------|-------|
| Year:                              | 2007 | 2008 | 2009 | 2010 | 2011                                   | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | SUM* |       |
| Environment and Safety investments | 27   | 25   | 11   | 18   | 43                                     | 113  | 37   | 55   | 45   | 67   | 24   | 69   | 762  | 29 %  |
| Other investments                  | 86   | 192  | 40   | 166  | 81                                     | 144  | 103  | 86   | 92   | 187  | 94   | 199  | 1884 | 71 %  |
| Total investments                  | 113  | 217  | 51   | 184  | 123                                    | 257  | 140  | 141  | 137  | 254  | 115  | 267  | 2646 | 100 % |

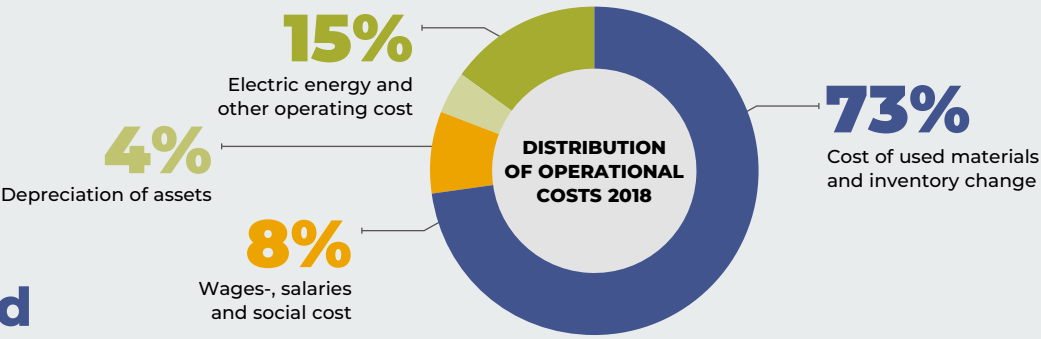
\*) The total figure includes from year 2000.



## Profit & loss statement for 2017 and 2018

Figures for the Sauda, Porsgrunn and Kvinesdal plants in M NOK.

|                                              | Last year 2018 |        |      | Previous year 2017 |        |      | Change | %     |
|----------------------------------------------|----------------|--------|------|--------------------|--------|------|--------|-------|
| GROSS INCOME                                 | 6 803          |        |      | 7 156              |        |      | -353   | -5 %  |
| Cost of used materials and inventory change- | -4 243         |        | 73 % | -3 463             |        | 69 % | -780   | -23 % |
| Wages-, salaries and social cost             | -459           |        | 8 %  | -440               |        | 9 %  | -19    | -4 %  |
| Depreciation of assets                       | -243           |        | 4 %  | -220               |        | 4 %  | -23    | -11 % |
| Electric energy and other operating cost     | -892           | -5 837 | 15 % | -908               | -5 030 | 18 % | 16     | 2 %   |
| OPERATING RESULTS                            | 965            |        |      | 2 125              |        |      | -1 160 | -55 % |
| Interest-/financial cost                     |                | -102   |      |                    | -168   |      | 66     | 40 %  |
| Corporate taxes                              |                | -196   |      |                    | -467   |      | 271    | 58 %  |
| NET RESULT                                   | 668            |        |      | 1 490              |        |      | -822   | -55 % |



## Turnover and operating result

History of the Sauda, Porsgrunn and Kvinesdal plants. Figures are in M NOK.

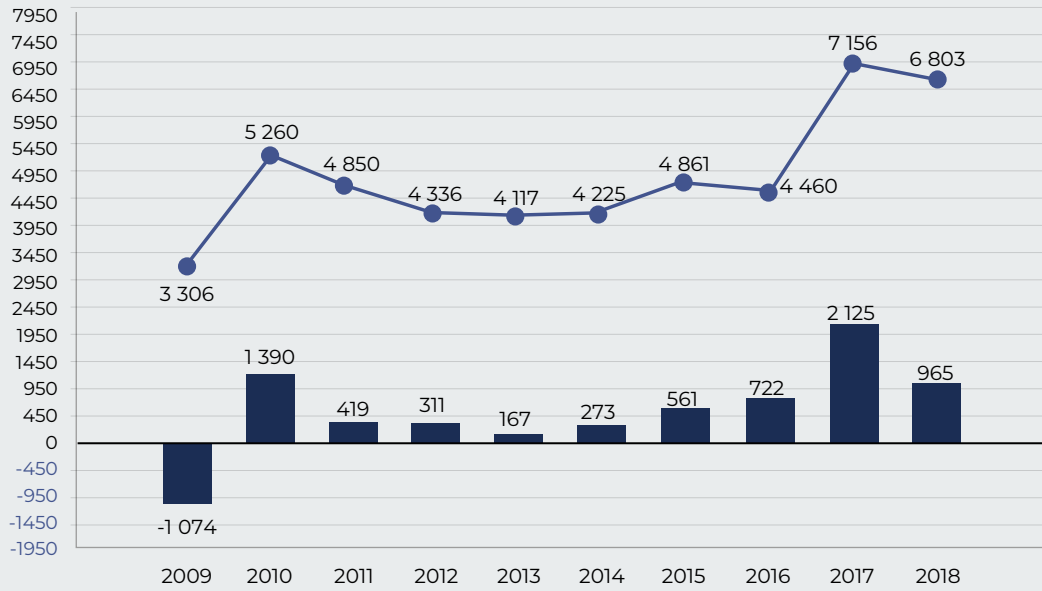
|              | 2009    | 2010   | 2011  | 2012  | 2013  | 2014  | 2015   | 2016   | 2017   | 2018   |
|--------------|---------|--------|-------|-------|-------|-------|--------|--------|--------|--------|
| Operational  | -1 074  | 1 390  | 419   | 311   | 166   | 273   | 560    | 722    | 2 125  | 965    |
| Turoner      | 3 306   | 5 260  | 4 850 | 4 336 | 4 117 | 4 224 | 4 861  | 4 460  | 7 156  | 6 803  |
| Oper. margin | -32.5 % | 26.4 % | 8.6 % | 7.2 % | 4.0 % | 6.5 % | 11.5 % | 16.2 % | 29.7 % | 14.2 % |

Operating results 2018:

**6 803**  
M NOK

Turnover 2018:

**965**  
M NOK



Figures in M NOK ● Operating results ■ Turnover

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