

Research for a better future



www.ife.no

IFE Annual Report. IFE bears no responsibility for printing errors. Graphic design and print: CopyCat AS

Contents

- O4 About IFE
- 05 Key figures
- 07 From the President
- 11 Organisation chart
- 12 Materials and Process Technology
- 16 Centres for Environment-friendly Energy Research (FME)
- 20 Fluid Flow and Environmental Technology
- 24 Digital Systems
- 26 Radiopharmacy
- **30** IFE's nuclear activities
- 34 Nuclear Waste Management and Decommissioning
- **38** Environment and safety
- 41 Innovation and commercialisation
- 42 Income statement
- 43 Report of the Board of Directors

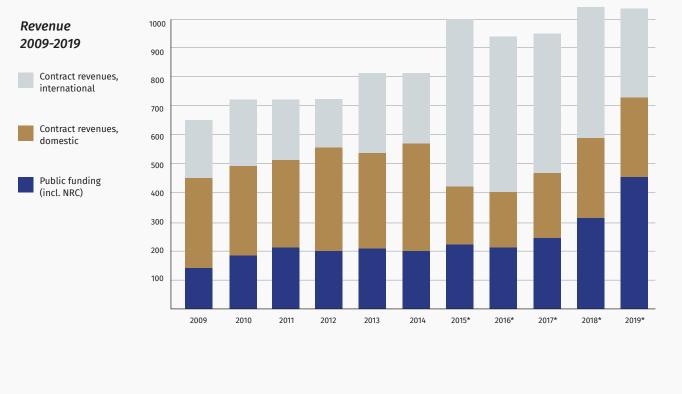
About IFE

The Institute for Energy Technology (IFE) conducts research for a better future. Since 1948, we have been a frontrunner in international energy research. The knowledge we have developed has saved the petroleum industry several hundred billion kroner. We have contributed to the development of ground-breaking cancer medicine, new solutions in renewable energy, more energy-efficient industrial processes, zero-emission transport solutions and future-oriented energy systems.

At IFE, we build bridges between research, education and industry. We have extensive infrastructure and full-scale laboratories where theoretical models are transformed into commercial activities. IFE has unique expertise and systems within radiation protection and environmental monitoring of radioactive and chemical emissions. This makes us an important partner for companies that want to research, develop and produce new solutions for renewable energy and medicine using radioactive sources.

The digitalisation of society is seeing the emergence of a new era. IFE has broad digital expertise and contributes to quality assurance and efficiency improvements for customers in the public sector and in trade and industry. When the next chapter in Norway's history is written, it will be about how we adapt. We must create new and sustainable jobs. At IFE we have already begun – we are conducting research for a better future.





	2009	2010	2011	2012	2013	2014	2015*	2016*	2017*	2018*	2019*
Contract revenues, international	202	233	243	229	267	324	571	522	484	461	311
Contract revenues, domestic	287	307	303	355,6	324,5	367	191	199	212	290	293
Public funding (incl. NRC)	167	184	211	201	217	210	231	225	243	323	467

The change in domestic and international revenues from 2014 to 2015 is due to the reclassification of revenues from the Xofigo production. In 2015 and subsequent years, approximately 200 MNOK related to Xofigo was classified as international contract revenues instead of domestic revenues.

IFE's vision:

A leading international research institute

Scientific papers published annually

1 + 0



billion

Turnover

No. of employees



600

Nationalities: 38 Researchers: 226 PhDs: 105 25 🗐

Advanced laboratories

International projects > 2000



Centres for Environment-friendly Energy Research (FME)

IFE, equipped for a new era

IFE has a proud history stretching back more than 70 years. The institute has evolved as a result of major changes during this period. This is worth remembering, as at the time of writing, Norway and the rest of the world are experiencing a coronavirus pandemic that will radically change how we live. No one knows what the outcome of the coronavirus crisis will be, but IFE's activities are long-term by their very nature and are linked to the efforts to find solutions for a sustainable society. The challenges will still be there after the international community has dealt with the coronavirus pandemic.

Decision on the JEEP II Reactor

2019 has also been a year of transition. The work to transform IFE from an institute with a strong nuclear profile and two operational nuclear reactors, to an energy institute without nuclear reactors continued in 2019. In 2018, it was decided to close the Halden Reactor permanently, and this year the decision was made to close the JEEP II Reactor at Kjeller. After a comprehensive control programme and a review of the reactor in January 2019, corrosion was found on several safety critical components. The repair would require a lengthy shutdown of the reactor and incur significant costs that exceeded IFE's financial capabilities. Based on an overall assessment of technical and financial factors, it was therefore decided to close the reactor. Consequently, 68 years of reactor operations in Norway were brought to an end, something which has also changed the premise for the national decommissioning of nuclear plants. Since the reactors are no longer used for research purposes, considerable socio-economic savings can be made by transferring nuclear facilities and expertise from IFE to the Norwegian Nuclear Decommissioning Authority (NND), thereby safeguarding nuclear plant expertise for use in decommissioning.

Adapting IFE's nuclear activities to a new situation has characterised 2019. The nuclear activities at the reactors in Halden and Kjeller had been experiencing financial challenges for several years, which curtailed the development of IFE's other research and activities. IFE's organisation and personnel have historically been tailored to the institute's nuclear activities. The termination of all reactor operations has changed the need for expertise as well as the need to adapt the organisation in line with new tasks. Nuclear activities at IFE are entering a new phase, where the focus is on ensuring that dormant facilities remain safe whilst preparing for decommissioning.

It was therefore essential to restructure operations and cut staffing levels in order to ensure a sustainable financial situation to protect jobs, tailor the organisation to future needs and develop the research that IFE will focus on in the future. The restructuring and staff reduction process started in earnest in the spring and summer of 2019 and continued into the autumn. The work was carried out in close cooperation with the employee organisations, and restructuring interviews were held with 103 employees. It is gratifying to note that satisfactory solutions were found for almost all employees involved. After a challenging year, IFE is now of a size that is proportional to ongoing projects.

In the spring of 2019, IFE's management was notified of possible irregularities in customer projects at the Halden Reactor dating back a number of years. Management immediately initiated an externally led preliminary investigation, and in the summer of 2019, it was decided to initiate an externally led inquiry. The inquiry started in 2019 and continued into the first quarter of 2020. It was concluded that irregularities had occurred in some projects at the Halden Reactor. These entailed data or tests being modified contrary to IFE's test procedures and customer specifications, and those responsible had gone to great lengths to conceal evidence of their activities. The inquiry is working to clarify whether the situation may have safety implications for facilities abroad. IFE considers this to be a very serious situation which contravenes everything we stand for as a research institute. The inquiry report was submitted to the Norwegian National Authority for Investigation and Prosecution of Economic and Environmental Crime (ØKOKRIM) in April 2020.

The matter is a sad chapter in IFE's nuclear history, which has otherwise been a tremendous success. Based on the institute's nuclear expertise, technology has been developed that has been adopted by Norwegian and international industry, including the processing industry, the oil and gas sector, the IT industry and the pharmaceutical industry. This technology has created a value of several hundred billion Norwegian krone. IFE's nuclear operations have now shifted their focus from safe operations to safe decommissioning. The goal is for the decommissioning of the facilities to be another successful era, with opportunities for technology development and new activities.

Good cooperation with government agencies

In 2018, the government established the Norwegian Nuclear Decommissioning Authority (NND), headquartered in Halden, whose remit was to safeguard the decommissioning of the reactors and the safe clear-up of nuclear waste for Norway. It quickly became apparent that IFE and NND had to work closely together and support each other to ensure that the decommissioning process was safe, responsible and cost-effective. In 2019, IFE and NND have taken great strides towards becoming a unified organisation in this regard. Thanks to government budget allocations, the institute has secured a satisfactory framework to facilitate the safe and effective clear-up of nuclear waste in cooperation with NND.

IFE is in a transitional phase

Since autumn 2019, IFE's strategic focus has concentrated on the period 2020–2022, which coincides with the transition phase that IFE will undergo. A strategy is needed to deal with

major changes and to guide IFE's efforts to facilitate the decommissioning of nuclear facilities and the cooperation with NND, the further growth within Radiopharmacy and Research and Development, and how to deal with new types of risk for the foundation.

The goal is to exploit the potential for growth and further development in the areas that IFE is accomplished in, and further develop the research on energy, digitalisation, nuclear technology and radiopharmaceuticals. The institute will continue to engage with other research communities to investigate the possibilities for closer collaborations. Radiopharmacy aims to steer its strategy towards an independent commercial entity. IFE's nuclear departments are working closely with NND to transfer nuclear activities from IFE to NND, with the aim of gradually becoming one organisation.

Research and radiopharmacy

The research activities have achieved a number of good results in 2019. Renewable energy systems have had a breakthrough this year for projects and increased activity in the field of floating solar power. This has been accomplished in close dialogue and cooperation with Norwegian industry, and IFE is now leading two major projects for Environment-friendly Energy Research (FME) in this area. IFE's battery technology activities saw strong growth in 2019, with new employees, increased activity and the establishment of new laboratories that are unique in a European context.

IFE has been working on carbon capture, transport and storage (CCS) for a long time. Through its research in multi-phase transportation and corrosion in CO2 pipelines, and its work on CO2 storage, IFE has accumulated unique expertise and is an important contributor to CCS inNorway. The institute has developed an advanced infrastructure, and the laboratories for controlled CO2 impurities analysis, both in relation to corrosion and transport, are among the world's leading laboratories for this type of testing. These installations were allocated funding for infrastructure upgrades by the Norwegian Research Council in 2019, which confirms IFE's leading position in Norway within CCS.

Norway is in an especially good position to take an international leading role in offshore wind power. This market is experiencing considerable growth and may be an element in the forthcoming restructuring of Norwegian petroleum activities. In 2019, IFE has reinforced its status as a leader within simulations of offshore wind turbines and wind farms. The institute's 3DFloat simulation program is one of the best tools for simulating floating structures. A new project was initiated this year in which IFE, in collaboration with business partners, is developing the next generation of simulation software for full-scale wind farm simulations.

In our radiopharmaceutical activities in 2019, we have maintained the high delivery precision of products, for both commercial and clinical purposes. The close collaboration with Bayer, both in relation to Xofigo® and other products, has continued. It is an interesting time for radiopharmacy in Norway, with several new start-up companies. IFE's steady increase in collaborations with these and other partners, such as the Oslo Cancer Cluster, bodes well for future growth in this market.

Human centered digitalization and human centered AI

Innovation and commercialisation are important for IFE, and the institute has created numerous companies and jobs over the years. IFE Invest AS is IFE's wholly owned investment company and our key tool in commercialisation. This activity showed good results in 2019.

It is particularly gratifying that IFE's ZEG technology for emission-free hydrogen production is nearing a breakthrough. In March 2020, the company ZEG Power AS, which is based on IFE's advanced technology, received backing from several international technology funds and a new co-owner in the form of state-owned Nysnø Klimainvesteringer AS. As a result, ZEG Power received in excess of NOK 130 million. Some of the new funds will go towards building the first full-scale hydrogen production plant with CO2 management at the CCB base at Kolsnes. IFE Invest is still the largest shareholder in the company, with a stake of 21%. New capital has also been raised for the companies Visavi AS and Sunphade AS, which shows IFE's ability to transform research and technology into robust growth companies.

A changing world

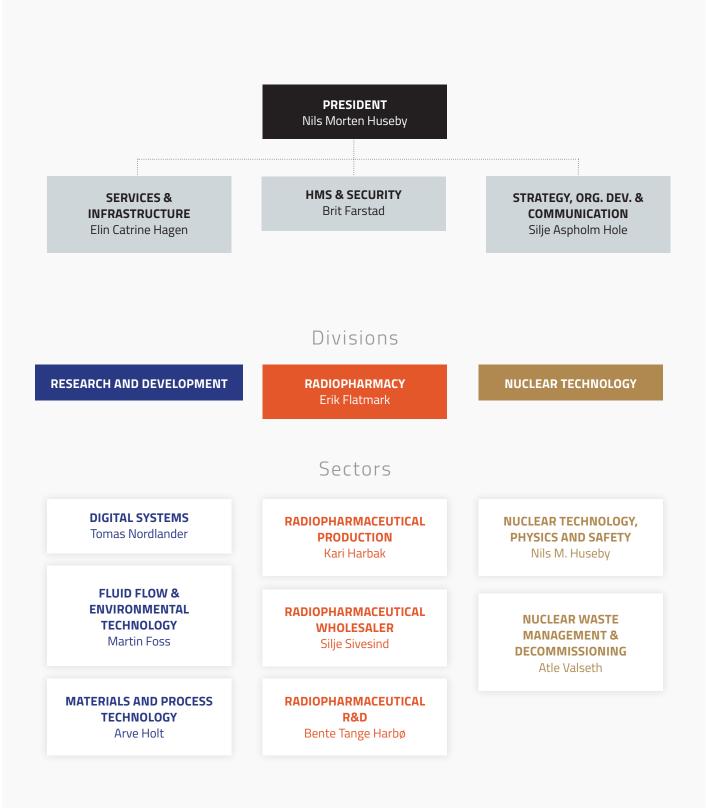
The words of the Greek philosopher Heraclitus; Panta rhei, everything flows, meaning that nothing stays the same and there is perennial movement, are more relevant now than ever before. In its more than 70 years of existence, IFE has always adapted to major shifts that have taken place in the world. The UN's Sustainable Development Goals and the EU's targets have been guiding our research for a long time, putting global energy and climate challenges at the heart of our activities. We recognise that renewable energy is the future. Most energy companies have ambitious emission targets and IFE has solutions that can help companies achieve these targets.

The major changes that the world and the global energy markets are now undergoing can also mean new development and new opportunities. IFE's motto 'Research for a better future' motivates us to be the industry and business sector's partner in this transition.



Nils M. Huseby, President

Organisation chart as of 1 June 2020



Sector Materials and Process Technology

Through research and development, this sector will contribute to a better society and cleaner environment by serving as a leading resource centre within renewable energy and environmentally friendly industrial processes. We will achieve this by enabling IFE's customers and spin-off companies to apply improved or new processes and methods. We develop new solutions and products for the private and public sectors, mainly within renewable energy and materials and process industries.

In 2019, Materials and Process Technology had 65 employees and a turnover of NOK 207 million.

The sector consists of six departments:

- Solar energy
- Battery technology
- Renewable energy systems
- Neutron materials characterisation
- Computational materials processing
- Environmentally friendly industrial processes

The sector is currently conducting research in renewable energy systems, solar energy, batteries and hydrogen as future energy carriers, new energy materials and nanotechnology, advanced neutron materials characterisation, and environmentally friendly industrial processes.

Our main revenue is generated from the research and development of new solutions and products for both the private and public sectors. Many of our projects involving expertise and innovation are cofunded through the system of policy instruments in the Research Council of Norway and the EU programme Horizon 2020, together with the business sector.

To aid our research, we have an advanced infrastructure that includes, inter alia, laboratories that undertake the following:

- Production of silicon-based solar cells, with the associated characterisation and analysis equipment
- Production of materials for use in solar cells and batteries
- Production of materials for CO2 capture for use in hydrogen and energy production processes
- Development and testing of batteries
- Production of hydrogen through reforming or electrolysis
- Development of the hydrogen systems of the future
- Advanced neutron materials characterisation
- Advanced simulation and modelling platform for use in the development of new kinds of materials processing

The sector hosts two of Norway's eight new Centres for Environment-friendly Energy Research (FME): FME Research Centre for Sustainable Solar Cell Technology (SuSolTech) and FME Mobility Zero Emission Energy Systems (MoZEES).

We are partners in three other FME centres: one in bioenergy (Bio4Fuels), one study the role of the energy system in the transition to the zero-emission society (NTrans) and the FME Centre for Sustainable Energy Studies (CenSES). The programme period for the latter is 2011–2019.

In addition, we are involved in over 100 other ongoing projects with external partners.

Highlights in 2019

The Renewable Energy Systems Department (ENSYS) has been working systematically over time to establish projects and increase activity within floating solar power. This has been carried out in close cooperation with the Norwegian business sector. Our efforts have paid off, and in December 2019 the department was awarded two major projects by the Research Council of Norway. It is extremely gratifying that both projects involve a collaboration between ENSYS and the Solar Energy and Computational Materials Processing departments, something that reflects the importance of both internal and external collaborations. The department also received approval for FME N-TRANS, which is important recognition in that the same consortium as in FME CenSES was allowed to continue for a further eight years. IFE will lead two of the research areas in the FME.

Over time, the Solar Energy Department (SOL) has built up an interesting activity profile in metal oxyhydrides, with a focus on the use of the material in smart, energy-saving windows. This activity has resulted in a number of published papers, two new research projects in 2019, the company SunPhade, and an NFR IPN project (Research Council of Norway's Innovation Projects for the Industrial Sector), with SunPhade starting up in 2020. There are several promising applications for these materials in a sustainable society and the department will continue to explore these. 2019 was a year of major adaptations for our partners in the production of silicon products for the solar cell industry. REC Solar Norway is currently developing a new recycled silicon product with a very low carbon footprint for solar cell production. IFE is involved in a major IPN project where we are contributing to this development. In 2019, the SOL and ENSYS departments established a test laboratory for solar cell modules. IFE therefore has activities that span the entire solar energy value chain. The Battery Technology Department has also developed a robust international network through its many EU project applications, which has provided new opportunities.

The Neutron Materials Characterisation Department has received considerable recognition for the results of the Solid-State Electrolyte project and a positive evaluation of the research conducted on JEEP II.

The Environmentally Friendly Industrial Processes Department: Both the business sector and the system of policy instruments in the EU and the Research Council of Norway provide good support for the research on hydrogen production and mineral refining. The EU project, AlSiCal, with a total budget of almost NOK 70 million, is a good example of this. The Computational Materials Processing Department has been assigned a new project in Additive Manufacturing, with Elkem and Arendal Fossekompani. This project is aimed at the development and production of metal alloys for powder-based 3D printing. The project mainly entails the development and generation of knowledge in production technology for siliconcontaining powders, as well as the subsequent 3D printing of this powder. Silicon-containing alloys have properties such as high corrosion resistance and high-temperature tolerance. These are two properties that help generate interest in siliconcontaining materials, for example in the automotive industry.

Market outlook

The global energy market is going through a major shift away from centralised energy supplies using nuclear, gas and coal power towards a more distributed energy production based on renewable sources such as hydro, solar, wind, bio and geothermal energy. This shift is leading to a major upward trajectory in megatrends in all these areas, particularly in wind and solar energy, as well as energy storage using batteries and hydrogen. IFE is well positioned to take part in this growth.

In the materials and process industries, there will always be a need for materials with new types of properties. IFE is well positioned within this segment due to our powerful simulation and modelling tools, our ability to produce brand new materials using our expertise in nanotechnology, and our knowledge of industrial processes.

The market situation for the sector is very favourable, with a good supply of new projects which are either funded solely by the business sector or co-funded through the system of policy instruments. The sector had a healthy economy in 2019.





Centres for Environmentfriendly Energy Research (FME)

Centres for Environment-friendly Energy Research (FME) is a programme under the auspices of the Research Council of Norway, with up to 8 years of support for Norwegian research centres of a high international standard in research on environmentally friendly energy. IFE hosts two FME centres; MoZEES and SuSolTech.

MoZEES - Mobility Zero Emission Energy Systems

The main purpose of MoZEES, a research centre for environmentally friendly energy, is to contribute to the development of new battery and hydrogen materials, components and systems for existing and future applications in the transport sector (road, rail and sea). The research centre contributes to the design and development of safe, reliable and cost-effective zero-emission transport solutions. There is also a strong focus on educating doctoral and postdoctoral research fellows.

The focus areas for the research at MoZEES are as follows:

- New materials and processes for industrial niche markets for batteries and hydrogen
- Battery and hydrogen components and technologies for products aimed at the export market
- Battery and hydrogen systems for application in existing and new transportation markets (road, rail and sea), with a special focus on maritime applications

 New systems solutions and services, with a focus on sustainable and techno-economic navigable roads and zero emissions in the transport sector.

MoZEES is a collaboration between four research institutions: IFE (host), SINTEF, the Institute of Transport Economics (TØI) and the Norwegian Defence Research Establishment (FFI), in addition to three universities (UiO, NTNU and USN), six public sector partners, two private interest groups and 22 business and industry partners, including suppliers of materials, key components, technology and systems within batteries and hydrogen. Formal collaboration agreements have also been established with four international universities: RWTH Aachen University (Germany), Uppsala University (Sweden), the University of California, Davis (USA) and the University of Genoa (Italy). The Institute for Energy Technology (IFE) at Kjeller hosts FME MoZEES.

Highlights in 2019

MoZEES has seen a high level of activity in 2019, and many meetings and presentations have been held at national and international conferences. A large number of papers have also been prepared for publication.

In January, approximately 40 participants attended an internal workshop at TØI, which focussed on battery technology and hydrogen in the maritime



sector and for heavy duty transport. Both areas are being followed up on an ongoing basis in various research projects in the centre. For the second year running, a two-day meeting on batteries was held in February, which included a battery technology course at IFE (MoZEES Battery Days 2019). Approximately 40 participants attended the event, including members of the MoZEES Board and the scientific committee. MoZEES' Annual General Meeting was held in April, and more than 80

Norwegian and international delegates attended.

In May, June and July, several of the partners in MoZEES gave presentations at major conferences in Europe: EVS32, ICE2019 and EFCF 2019.

In October, MoZEES' Heavy Duty Transport Workshop was held in Oslo. This was an open event with more than 60 participants, including many commercial actors.

In addition to numerous talks at various conferences, seminars and meetings (more than 60), in 2019, 5 reports and 12 articles were published in international journals, and several more are in the pipeline. An article on hydrogen safety in hydrogen powered speedboats has been proposed for an Eni Award 2020, which is confirmation that the work in MoZEES is attracting international attention. In collaboration with the Norwegian Academy of Science and Letters (DNVA), MoZEES has also provided input for the publication of an EASAC report (European Academies' Science Advisory Council) on the decarbonisation of the transport sector in Europe. This report will form the basis for open national meetings with DNVA and the Ministry of Transport in 2020, focusing on a roadmap and policy for zero-emission transport.

In 2019, approximately 80 researchers and students were actively working on various research projects at the centre, including 11 professors, 20 senior researchers and 25 junior researchers. In addition, about 25 technologists from industry partners participated in meetings and actively contributed to the research. MoZEES currently has 14 doctoral students (7 fully funded) and 4 postdoctoral research fellows (1 fully funded) directly affiliated with the centre.

In 2019, 7 Master's students also linked their work to various research areas in MoZEES, from cathode materials for NMC batteries (NTNU) to membranes for PEM fuel cells (UiO) and battery and hydrogen safety (NTNU).

There is a growing desire among students to be affiliated with the centre as this expands their network and gives them access to extra supervision from research institutes and industry partners in MoZEES. The doctoral students and postdoctoral research fellows are now part of the MoZEES Research Training Network headed by UiO. In June, the two FMEs, MoZEES and Bio4Fuels, held a joint PhD summer school on the topic of sustainable transport, with numerous speakers from universities, research institutes and end-user partners in MoZEES.

An independent scientific committee was also established in MoZEES, consisting of members from Uppsala University (Sweden), RWTH Aachen University (Germany), the Fraunhofer Institute for Solar Energy Systems and the University of California, Davis (USA). Their objective is to advise on the scientific work in order to ensure that the research in MoZEES maintains a high international standard. A separate innovation committee is planned for 2020.

SuSolTech - Research Centre for Sustainable Solar Cell Technology

SuSolTech was established in 2017 and brings together leading research groups in Norway with major players in the solar cell industry from Norway and abroad. Today, the solar cell industry is completely dominated by silicon-based solar cells, which we expect will continue to be the case for many years to come.

A shift to a more sustainable energy system based on renewable resources will therefore depend on access to an increasing volume of sustainable silicon materials, ingots and wafers that enable the production of ever-more efficient solar cells, solar panels and solar power systems. The anticipated further growth in the solar cell industry represents a huge commercial opportunity, also for Norwegian companies. Silicon materials for global use in industry are a Norwegian industrial speciality. The centre helps to strengthen these companies in a competitive industry through the development of new production processes that enable cleaner production, lower costs and a higher quality of materials. The centre achieves this through research along the entire value chain.

The centre monitors the production in solar cell plants in order to demonstrate the effect of the planned development of materials and processes on both the environmental footprint and the costs. The activity in solar cell plants supports a rapidly expanding industry in Norway within the field of installation and operation. This industry is expected to grow further in the years ahead.

The centre is also partnered with companies that are not currently considered to be part of the solar cell industry, such as organisations, architectural firms and energy companies. These draw on the centre's broad expertise in order to develop new business opportunities. The FME SuSolTech centre will be the main national focal point for expertise and innovation within the growing solar power industry in Norway up to 2025.



Sector Fluid Flow and Environmental Technology

IFE Fluid Flow and Environmental Technology is an industry-oriented sector that mainly works with the energy and operating companies in Norway and abroad. The sector has a special focus on aligning research with international agreements, such as the Paris Agreement and the EU's Green Deal, and helps ensure that Norway and the world can achieve the relevant targets. We do this by working closely with our customers in the oil and gas sector, where we conduct research into more environmentally friendly production through efficient operations, electrification, carbon capture and storage (CCS). We also have one of Norway's leading research communities in the field of wind energy, where we have ambitions to help make Norway a world leader in floating wind power. Within the environmental field, the sector is working on pollution tracking and emission analysis. The sector also operates the welding workshop at IFE, where there is internal activity and a considerable volume of external contracts within electron beam welding (EBW).

The sector's projects have a significant element of purely industrial projects, which reflects the value of the research for our partners. The departments have been developing digital tools for the petroleum and processing industry for more than 30 years, and, as the financially most significant innovation in the Norwegian research industry, the development of OLGA is a landmark. OLGA is a modelling tool for the transportation of oil, gas and water in the same pipeline, known as multi-phase transportation. The multi-phase technology was voted the most important Norwegian invention since 1980. Turnover was approximately NOK 120 million, and the sector has 80 employees in a total of six departments:

- Wind energy
- Corrosion technology
- Flow engineering
- Tracer technology
- Reservoir technology
- Welding workshop

In 2019, the sector has worked to reinforce its position as world leader in the field of fluid flow technology and corrosion in the oil and gas sector. These are traditionally strong areas in which IFE holds an important international position and has exceptional laboratory facilities. The steady supply of industry-driven key projects in 2019 confirms that the sector's departments are valuable international partners in these fields. In addition to this, the sector has also continued to focus on recapturing its position as Norway's most important contributor to the field of tracer technology in 2019. IFE has historically been at the forefront of tracer technology for more than 20 years, but faced challenges after priorities changed in 2013. IFE is now on its way to once again becoming a leading premise setter in this area. This is exemplified by our position as one of the main partners in the National IOR Centre of Norway - one of the Centres for Research-based Innovation - along with the University of

Stavanger and NORCE. In 2019, IFE also sold its stake in Restrack, which makes the institute a more neutral and attractive partner for international companies. IFE's role as a service provider within reservoir technology for Norwegian and international operators was also strengthened in 2019, with the establishment of a new Reservoir Technology Department. In reservoir studies and characterisation, IFE has traditionally been a preferred supplier, and this field was re-established as a focus area in 2018/2019.

In addition to the specialist areas that are mainly associated with oil and gas, the sector also has a significant focus on wind energy. IFE has long been a leader in aerodynamics in Norway, particularly in relation to offshore wind energy. This expertise has previously resulted in spin-off companies such as Kjeller Vindteknikk, which is a major player in the field of wind measurement and analysis. Within the wind energy field, we are also working on new software products that we believe will give our partners an even greater competitive advantage internationally. The sector also has a long-term commitment to further develop the work on floating structures, and our 3DFloat simulation tool affords us a major competitive advantage.

In addition to wind energy, the sector is in the process of escalating its environmental technology activities. Our extensive expertise in analysis gives us a significant competitive advantage and will enable us to develop IFE as a pivotal environmental technology arena in collaboration with other actors in the Greater Oslo region. In particular, the work on fingerprinting based on isotope analysis is a field IFE seeks to further develop, with a view to becoming the market leader in this type of analysis and research.

The sector also has a focus on carbon capture, transport and storage (CCS). Through its work in multi-phase transportation and corrosion in CO2 pipelines and work on CO2 storage, the sector has accumulated unique expertise and is an important contributor to CCS in Norway. The sector's departments have developed a unique infrastructure that forms much of the foundation for research in this field. The laboratories for controlled CO2 impurities analysis, both in relation to corrosion and transport, are among the world's leading laboratories for this type of testing. Theseinstallations were awarded infrastructure upgrade funding in 2019, which reflects their leading position in Norway. In the years ahead, we will work towards becoming a natural partner in the modelling of problems related to full-scale CO2 storage on the Norwegian continental shelf.

The sector helps Norwegian industry to be more competitive in a globalised market and to develop more sustainable solutions. The sector has two focus areas we are working on in 2020; environmental monitoring of repositories and landfills, and patient-adapted health care. This work will represent a new diversification of operations in the coming decades, whilst also addressing the challenges facing industry and the public sector both home and abroad. In order to maintain an interdisciplinary approach and safeguard the development of robust expertise, these initiatives are closely linked to the existing activities.

Highlights for the sector in 2019

In 2019, the sector has continued the successful economic turnaround that has been taking place in recent years. The fact that the sector was able to achieve a significant profit for the departments exposed to the oil and gas sector shows that our restructuring efforts have been successful. The inclusion of the welding workshop in IFE R&D was also a positive and important event in 2019. This gives IFE a new dimension in the maintenance of our technical equipment and, in time, the welding workshop will be able to exploit the closer contact with R&D in general. Among the contracts awarded to the sector, some key projects should be highlighted.

In 2019, IFE has strengthened its position as a leader in simulations of offshore wind turbines and wind farms. Our 3DFloat simulation tool is one of the very best tools for rapid simulation of floating structures, and laid the foundation for the project IPN NEXTFARM, where IFE develops the next generation simulation software for fullscale wind farm simulations. In the project, which includes partners such as Equinor, Aibel and NREL, a tool is being developed that can calculate the practical life expectancy of single wind turbines in an entire wind farm. This project forms much of the foundation for IFE's future in wind energy and paves the way for new opportunities in both Norway and Europe.

Throughout 2019, IFE has been strengthening its position within corrosion research by winning

contracts for industrial projects and projects funded by the Research Council of Norway. IFE has developed an international leading position particularly in the work on corrosion in flexible pipes, where the Kjeller Flexible Cracking I (KFC-I) project is central. The project started in 2018 and focuses on crack formations in flexible pipes used in oil production, with contributors such as TechnipFMC in France, Chevron in the USA and Petrobras in Brazil. In terms of industrial projects, IFE has been a supplier of high-quality testing for over 20 years. In 2019, this continued with the recycling of chemicals in connection with oil and gas production and the testing of production chemicals for projects throughout the world.

Within the field of fluid flow technology, the work carried out in the industrial JIP (joint industry project) MULTIFLOW is a particular highlight of 2019. This project entails fluid flow testing that is necessary for production from fields in very deep waters and is pivotal to many of the major offshore projects in the world. Within CCS, IFE has also continued to build its transport research portfolio. Our strong position can be exemplified through the CLIMIT Demo project KDC-III and the industrial project CO2FACT. KDC-III focuses on corrosion in CO2 pipelines and injection wells for CO2, while CO2FACT conducts testing in CO2 flows at high pressure. The research communities that carry out these projects formed the basis for the infrastructure funding from the Research Council of Norway, which shows our strong position within these areas. Winning projects within CCS is important for IFE and affords us the opportunity to build further on our world-leading CCS laboratories.

In 2019, IFE has also been developing the next generation of the Tracer Club. This project is the cornerstone of the efforts to develop new tracers for industry that will lay the foundation for future EOR (enhanced oil recovery) projects. The project is a JIP (joint industry project) with industry funding, which reflects the industrial relevance of the project. Market outlook

The sector is still feeling the effects of the fall in oil prices in 2014. Consequently, companies have been more hesitant to participate in research projects, which resulted in fewer contracts being signed than in previous years. Several oil companies have also changed their strategy; they are now more likely to allocate funds on a year-to-year basis and refrain from participating in long-term research projects in the oil and gas sector. This reduces predictability in the sector and increases the need for Research Council-funded projects outside the field of petroleum. However, over the past year, the sector has seen a resurgence of enquiries from oil companies, and the volume of work in oil and gas seems to be increasing. The sector will continue its strong focus on relevant oil and gas research projects for Norwegian and international partners.

Oil companies are also investing in new areas, and the sector's work in wind energy, geothermal energy and the environment will have major growth potential for collaborative efforts with traditional partners in the years ahead. Developing a network of public sector actors such as inter-municipal enterprises and local authorities will be a strong focus area.

The market for health technology is also a focus area for IFE in the years ahead. This market is experiencing strong growth and is mainly rooted in the Greater Oslo region. Through our current efforts in building networks with the university hospitals in the Oslo area and various start-up companies, IFE will create new opportunities and use our expertise to contribute in a growing market.

Sector Digital systems

IFE Digital Systems researches areas that are complex and of critical importance to society that are affected when organisations undergo digitalisation. The sector consists of the following departments:

- Risk, safety and security
- Virtual and extended reality
- Intelligent systems
- Control rooms and interaction design
- Human-centred digitalisation
- Humans and automation
- Applied nuclear science

The Digital Systems sector (DS) has 82 employees and had a turnover of NOK 121 million in 2019. IFE hosts the Halden Reactor project for the OECD/NEA and 46% of the sector's turnover stems from these projects. The sector handles all kinds of projects that involve interaction between people, technology and organisation, and safety in complex process industries. The sector generates considerable revenues from national and international contracts and is making systematic efforts to increase the percentage of research projects (EU, the Research Council of Norway, etc.) in the project portfolio. For DS, it is vital to continue to draw on the generic competence acquired in the Halden project and to apply this to areas other than nuclear power.

Focus areas

For many years, the sector has derived approximately half of its turnover from the international Halden project. This has enabled us to develop competence that is relevant and to some extent unique to support organisations in their digital restructuring.

The DS sector designs efficient control rooms for a range of different clients (nuclear power stations, railways, remote-controlled control towers). One example is the design of the control room for the European Spallation Source in Lund, Sweden, one of the world's largest scientific and technological infrastructures currently under construction. We develop software, such as VR software for the design of control rooms used for the safe decommissioning of nuclear power plants in several countries. We assist businesses with assessment of risk, safety and security needs. We use machine learning and big data to aid companies with condition monitoring, maintenance, automation and user monitoring. We help contractors with organisational design, enabling them to effectively implement digital technology and analyses when it comes to complex decisions.



Photo: Gry Slotterøy

Highlights in 2019

2019 has been a good year for DS. The reorganisation of the sector has been completed and forms the platform for the sector's 5-year strategy. Considerable efforts have been made to increase the number of research applications to the EU and the Research Council of Norway as well as to boost the number of scientific articles. This has resulted in many successful applications in 2019, and the number of articles has increased by 87% compared with the previous year. Active efforts have been made to increase the visibility of our sector, which has received more attention in different forums and the media. In 2019, the new Cybersecurity Centre was opened in the presence of the then Minister of Digitalisation, Nikolai Astrup, and is the first IAEA Collaborating Centre in nuclear decommissioning. In partnership with Østfold University College, Smart Innovation Norway and the Halden eSMART company, this year the IFE has initiated and launched the Applied AI (Artificial Intelligence) Cluster. This will promote the use of AI as an important tool in private and public enterprises. This initiative has attracted considerable attention and was highlighted in the Norwegian government's AI strategy.

Division Radiopharmacy

The Radiopharmacy division has a staff of approximately 140 and had a turnover of NOK 312 million in 2019. The division works with radioactive medications (radiopharmaceuticals) and has the following key areas:

- Contract production of radioactive medications for commercial and clinical use
- Wholesaler and retailer of radiopharmaceuticals in Norway and internationally
- Research and development in radiopharmaceuticals

Radioactive medications (radiopharmaceuticals) are used to create images of organs and lesions, and to treat various diseases, such as cancer. The increasing need for pharmaceuticals offers considerable growth potential, both in Norway and globally. IFE's Radiopharmacy division has wideranging expertise and an infrastructure for the development, production, control and distribution of radiopharmaceuticals that places us in a unique position to take part in global growth.

IFE also safeguards the production of medications that are not commercially available on the market. We adapt products according to the needs of our clients, including radioactive labelling of peptides, proteins and other relevant substances for use in research and clinical studies.

The Radiopharmacy division has dedicated laboratories for the production, packing and quality

control of radiopharmaceuticals. The laboratories are classified both in respect of purity classes in accordance with international GMP (Good Manufacturing Practice) regulations and radiation protection legislation. All radiopharmaceuticals to the Norwegian market are distributed from here.

The Radiopharmacy division is divided into three sectors:

- Radiopharmaceutical R&D
- Radiopharmaceutical Production
- Radiopharmaceutical Wholesaler

The three sectors work closely together. The R&D sector develops and delivers new production projects to the Radiopharmaceutical production sector, and the Radiopharmaceutical wholesaler sector has distribution expertise that is used by the other two sectors.

Radiophamaceutical Research and Development (R&D)

The sector's key task is to support start-up companies and research communities in developing radiopharmaceuticals from the early stages to clinical trials. This includes process development, analysis development and studies that are needed to document stability, robustness and reproducibility. The sector's task is to produce radiopharmaceuticals for early-stage clinical trials. In our 'satellite' in the Oslo Cancer Cluster Incubator (OCCI), the sector is involved in the development of cell labelling and the labelling and bonding (chelation) of radioactive nuclides. The research communities at Oslo University Hospital and the University of Oslo as well as smaller new startups are all important partners. At the end of 2019, a new radiology B laboratory was opened in the sector. This makes it possible to conduct technical development studies in client projects and continue early-phase work at OCCI.

Radiopharmaceutical Production

The sector is responsible for the contract production of radiopharmaceuticals for both commercial use and clinical trials (late phase). The most important client is Bayer AG (with Bayer AS, Norway, as the point of contact) and the contract production of Xofigo®, a medication used to treat prostate cancer patients. In addition, we produce other Bayer pipeline products for clinical trials.

Another important client is Nordic Nanovector. We assist in development work and manufacture and deliver products for major clinical trials. In 2019, the sector has been engaged in continuous streamlining of processes and has focused on developing its position as a national resource centre for the production of radiopharmaceuticals for both clinical and commercial use. In addition, the sector carries out analysis assignments for external clients.

Radiopharmaceutical Wholesaler

The sector is a national wholesaler and retailer of radiopharmaceuticals in Norway. All radiopharmaceuticals to Norwegian hospitals are controlled and distributed through the wholesaler sector at Kjeller. Our distribution activities ensure that Norwegian patients have access to good-quality radiopharmaceuticals at the right time through controls and traceability as well as validated and efficient transport routes. The sector is also a resource centre for the development and use of pharmaceuticals.

The distribution of radiopharmaceuticals for clinical trials nationally and globally as well as the distribution of our own products are key tasks. Importing and distributing short-lived products that are not yet manufactured at Norwegian PET centres is also an important area of activity.

In 2019, the sector has completed the development and implementation of a new, specially adapted ERP system in SAP, with the aim of enhancing quality and safety in the sector's wholesale processes. We work closely with our contractors and clients to develop and provide distribution services and products that are in demand in the market.

Highlights in 2019

2019 has been a good year for the division, with a high level of activity in most areas.

First and foremost, we have maintained the very high delivery precision of our products, for both commercial and clinical purposes. We collaborate closely with Bayer both in relation to Xofigo® and other products. Our collaboration with the Norwegian pharmaceutical industry is also increasing, particularly in the case of Nordic Nanovector but also other early-phase companies.

In Norway, and Europe, there is a considerable need for more floor space for the development and manufacture of radiopharmaceuticals. In 2019, we have invested substantial resources in order to be able to provide this to our partners, and construction work has been ongoing for most of the year and will be completed in 2020.

The division has also developed its expertise in the distribution of radiopharmaceuticals and

medications in general with the aim of improving control and traceability, validation of packages in transport and transport routes as well as the handling of hazardous goods. We have also assisted in facilitating the introduction of Lutathera® to Norwegian hospitals following the decision that this treatment could be offered in Norway.

Lutathera® is used in the treatment of gastroenteropancreatic neuroendocrine tumours.

The field of radiopharmacy is experiencing exciting developments at present, and a number of startup companies have been founded. An exciting cluster has been established where the research communities within cancer treatment and product development at the Oslo Cancer Cluster and Oslo University Hospital work with new entrepreneur communities. IFE and the Pharmaceutical division have the ambition of being an important part of this future-oriented business cluster and promoting the social mission of creating new jobs and developing a viable pharmaceutical industry in Norway.



IFE's nuclear activities

Changes in IFE's nuclear activities and framework conditions

In April 2019, IFE's Board decided to close down JEEP II permanently because of extensive corrosion on components that are critical to safety. This means that all operation of reactors in Norway has been terminated, and this has changed the premise for the national decommissioning of the nuclear facilities and the Norwegian Nuclear Decommissioning Authority's (NND) mandate. Since the reactor is no longer in operation or used for research purposes, this opens up the possibility of significant socio-economic savings in the decommissioning of the facilities. IFE can now transfer the nuclear facilities and competence to NND so that the associated expertise is safeguarded and used in the decommissioning process. The work of adapting IFE's nuclear research activities to a new situation has stamped its mark on 2019.

The closing down of the reactors changed the purpose of the nuclear part of the organisation from reactor operation and research to preparing for and over time carrying out the decommissioning process. Moreover, the framework conditions for nuclear research activity have changed significantly with the introduction of new licensing terms and requirements for security at the nuclear facilities:

 Increased need for security: A new decision in 2017 by the Ministry of Health and Care Services designating IFE's nuclear research facilities as a sensitive object in need of special protection means there is a need for comprehensive measures to improve security at the facilities.

- Increased cost of clear-up: Cost estimates for handling nuclear waste and decommissioning the nuclear facilities have increased considerably, garnering attention in political circles and society at large.
- 3. Establishment of the Norwegian Nuclear Decommissioning Authority (NND) in 2018 to carry out the decommissioning of the Norwegian nuclear facilities and the handling of radioactive waste.
- 4. Stricter licensing terms: In connection with licensing recommendations, the Norwegian Radiation and Nuclear Safety Authority (DSA) introduced new licensing terms for the nuclear facilities at Kjeller as from 2019. The safety reports on the nuclear facilities must be updated with respect to new requirements by the end of 2020. IFE is now subject to wideranging new requirements in relation to the updating of safety documentation and the establishment of a new management system and security organisation.
- Closure of the Halden Reactor and JEEP II: IFE's Board resolved in June 2018 to close down the Halden Reactor and the JEEP II reactor in April 2019. The closure of both reactors means that 68 years of nuclear activities have come to an end.

The changes in framework conditions and objectives entail changes in competence and capacity needs, in addition to new management and documentation needs. This means adapting the organisation of operations in line with new work tasks and processes, as well as the need for new competence. Consequently, in 2019, IFE has carried out a comprehensive restructuring and staff reduction process in order to adapt the organisation to future needs. While it was necessary to reduce the number of staff in operations, at the same time more staff were needed in new roles in respect of safety, security and emergency preparedness.

Safety has always been IFE's first priority and the nuclear facilities are manned in line with safe operations. New licensing requirements and reinforced safety measures have resulted in a need to undertake significant changes in safety organisation, including security duties and emergency preparedness. IFE has reinforced safety by establishing its own security staff who impose requirements and play a controlling and advisory role.

Storage of fuel

The safe storage of fuel is essential in safeguarding safety and the progress of decommissioning. In August 2019, IFE submitted revised safety calculations (criticality calculations) to DSA for the handling and storage of fuel. The fuel cannot be moved until DSA has assessed and approved the calculations. This means that the reactor tank at the Halden Reactor still contains fuel. IFE received a licence for the Kjeller facilities even though conditions in the JEEP I rod wells are not satisfactory for long-term storage. Storage conditions and the state of the fuel stored in the JEEP I rod wells are challenging. IFE has previously confirmed corrosion damage in the fuel of the JEEP I rod wells, and water in the storage positions. IFE has expanded the monitoring programme for the JEEP I rod wells, and no leakage from the storage facility has been recorded. Safety is maintained. Based on safety assessments, IFE decided in 2019 to stop all work on the fuel itself in the JEEP I rod wells while at the same time setting up its own working group to revise the proposed working plan. This group concluded its work in 2019 and will establish an action plan with follow-up measures in early 2020. The storage facility must either be improved, or the fuel must be moved. The following alternatives have been identified for future handling of the fuel in the JEEP I rod wells: A) Modification of the JEEP I rod wells, B) Establishment of a new storage facility in Ponden (Kjeller), C) Storage in casks from Orano (at Kjeller) and D) Transport for inspections and storage at Studsvik (Sweden).

Status of the nuclear facility

The Halden Reactor has an operating licence that is valid until 31 December 2020, and an application for an extension was submitted to the Ministry of Health and Care Services on 30 August 2019. In that connection, safety reports and other procedures have been reviewed, revised and quality assured. The safety of the nuclear facilities is ensured, and the status of the facilities is as follows:

- JEEP II: There has been normal monitoring of the reactor and normal follow-up of the facility according to the current safety report. Heavy water has been drained from the reactor and the fuel has been transferred to the storage pool at JEEP II.
- Met. Lab. II: There has been normal monitoring of the reactor and normal follow-up of the facility according to the current safety report.
- Radwaste: Activities at the facility were normal up to April 2019 when it was decided to shut down operations until all procedures had been reviewed. This was due to a breach of IFE's internal routines. The Radwaste facility resumed operations in May. Routine testing, inspections and maintenance have been carried out.
- KLDRA in Himdalen: IFE discontinued all depositing of waste in April 2018. The reason for this was that following a review, IFE discovered that the applicable work procedures were designed in such a way that waste could be deposited that did not comply with the operating licence given for the facility pursuant to the Pollution Act. The depositing of waste was resumed in August 2019.
- Halden Reactor: There is still fuel in the reactor tank, and the primary circuit and some other systems containing water remain in operation. There is also 24-hour monitoring of emissions to water and air. Because of the reactor's

- location inside the rock cavern, it is still necessary to control the seepage of water from the rock.
- Metallurgy laboratory 1 at Kjeller and the fuel instrumentation workshop in Halden: IFE applied to the Ministry of Health and Care Services in 2019 to have these nuclear facilities removed from the regulatory control of the Norwegian Atomic Energy Act, by verifying the absence of radioactive contamination and nuclear substances at the
- facilities. IFE is preparing a final plan for the work. The work is expected to be completed in the course of 2020.

Safety

In order to ensure overall implementation of the safety measures, IFE has established a programme on the upgrading of basic safety at IFE with the aim of ensuring that the level of basic safety at safety-critical facilities complies with the applicable regulatory framework pursuant to the Atomic Energy Act and the Security Act. The main purpose is to achieve an acceptable level of security in terms of basic safety.

The programme covers physical safety, electronic security and logical security as well as human and organisational measures. The establishment of a new security-controlled area at Kjeller and a strengthening of the security-controlled area in Halden are included in the programme.



Photo: Espen Solli

The programme coordinates the implementation of measures to strengthen safety at IFE and to respond to non-conformities found on inspection, including DSA's inspection in

October 2017 and the report of the joint supervisory board of the Norwegian National Security Authority (NSM) and DSA in March 2018 with accompanying orders. An action plan for all safety measures and planned measures for remedying non-conformities has been prepared. Current status is reported to DSA on a monthly basis and to both DSA and NSM every six months.

IFE has established a specialist group – Security – organised as part of the security staff with professional responsibility for object security. This group has the role of setting requirements and controlling compliance in the follow-up of the programme on upgrading basic security at IFE.

In 2019, NFD granted NOK 60 million to the programme on upgrading basic security at IFE. The funding has been distributed or represents committed funding in 2019.

The Halden project

In 2019, NFD granted NOK 42 million for the extension of the Halden project. The current agreement for the Halden project is for the period 2018–2020, and the project consists of two parts: Man-Technology-Organisation (MTO) and Fuel and Materials Research. The MTO part of the project has been carried out in accordance with the original plan. The work programme for fuel and materials research was renegotiated and reduced in 2018 after the decision was made to close down the Halden Reactor permanently.

NFD's grant to the Halden Project was transferred to the Digital Systems sector (DS) on 1 July 2019 as part of R&D activities, in keeping with the transfer of all nuclear research activities to DS.

IFE is currently taking part in negotiations with the OECD/NEA and its members about continuing MTO activities in the Halden project as a new programme under the OECD/NEA from 2021. There appears to be considerable support for such a programme, both from the OECD/NEA and from most of the current members of the Halden project. Continuing the Halden project is important for IFE's research activities in Halden.

Sector

Nuclear Waste Management and Decommissioning

The Nuclear Waste Management and Decommissioning sector was established on 1 January 2017 with a view to addressing the recommendations made in official reports (concept studies, 2015 and 2016) on solutions for Norwegian nuclear waste and future decommissioning of nuclear facilities in Norway. The reports clarified the need to initiate efforts to find final disposal solutions for the historical nuclear waste stored at IFE's nuclear facilities in Halden and at Kjeller.

The nuclear waste comprises spent fuel from the operation of IFE's research reactors, the remains of experiments on the handling of spent fuel, and long-lived radioactive waste from hospitals and industry etc. for which there are no final disposal solutions at present. Storage is regarded as just a temporary solution, and a final solution would be either the recycling of waste where possible or depositing it in a satisfactory manner in perpetuity.

Transfer of the Historical Waste and Decommissioning Programme to NND

The Historical Waste and Decommissioning Programme was established by IFE in 2017 to find solutions for the handling of nuclear waste stored at IFE's facilities in Halden and at Kjeller, and to make preparations for the decommissioning of IFE's nuclear facilities. The programme was transferred to NND on 1 July 2019, and as of this date, NND is the project owner and responsible for fuel studies – for example, following up future studies on spent fuel by Studsvik and Orano. IFE retains the ownership licence for the fuel and administers information about this in compliance with the applicable legislation. IFE will continue to be responsible for projects associated with the facility that are subject to licensing. IFE's staff and their knowledge are of key importance in relation to fuel studies and other projects in the transition phase between operations and decommissioning (pre-decommissioning phase). A project board and programme board have been set up for the cross-coordination of projects, and close cooperation between IFE and NND is therefore a prerequisite for the success of this work.

Reports

In June 2018, NFD commissioned IFE to prepare basic documentation up to KS1 stage 2 for future decommissioning of IFE's nuclear facilities. The final report was prepared by DNV-GL in close cooperation with IFE. The report was submitted in July 2019 and was presented to NFD, NND, Oslo Economics and Atkins in autumn 2019.

The updating of KVU stage 2 has shown that the scope of the decommissioning work has changed and has increased significantly since the 2015 report. This means that all IFE's nuclear facilities at Kjeller must update their decommissioning plans in line with the new information. The change from operations to closure must be included in these plans. As part of the safety reports, the decommissioning plans will be updated when the safety reports are revised.

Environmental mapping of the whole IFE area is a key part of the work to prepare decommissioning.

This long-term project is included in the decommissioning plans in Kjeller and Halden. The project will map ground conditions and contamination in order to gain an overview of contaminant levels at IFE Kjeller and Halden (conventional, radioactive). The environmental planning work has been ongoing at Kjeller since 2018 and commenced at Halden in autumn 2019. The work is expected to be completed in the course of 2020. In July 2017, IFE entered into a contract (Contract 1) with a UK supplier for the transport and recycling/disposal of mainly unused metallic uranium and surplus fuel with low enrichment (less than 1% 235U). Contract 1 requires a new contract to be concluded for uranium with a higher degree of enrichment (Contract 2). The supplier is preparing draft of Contract 2, which will be signed in the course of 2020 at the earliest. IFE requires permission from either the producer of the fuel it has received or the appropriate state body to reexport the fuel to the supplier.

Sector organisation

The Radwaste Department receives, handles and stores solid and liquid radioactive waste from IFE's own activities, and also from external activities in the trade and industry sector, defence, the public health service and research. IFE's facilities constitute the national centre for these services. The aim of the technical processes at the facility is to reduce the volume of waste so that the amount to be stored is as small as possible. Thereafter, the waste is encapsulated so that it is suitable for longterm storage. The purpose of the encapsulation is to prevent the release of radioactive materials into the environment. The department is responsible for the operation of a combined deposit and storage facility for low- and intermediate-level radioactive waste (KLDRA) in a rock cavern in Himdalen in Aurskog-Høland municipality. The Norwegian government, represented by the Norwegian Directorate of Public Construction and Property, is the owner of the Himdalen facility.

KLDRA Himdalen is designed with a capacity of 10 000 tonne equivalents (TE- 210 litres tonne/barrel) distributed in 16 concrete stalls. Four of the stalls (2 500 TE) are for storage. As per 31 December 2019, the amount deposited and stored was equivalent to a fullness ratio of 66.43% (volume)/0.28% (radioactivity), in relation to the current functional requirements.

In April 2018, IFE discontinued all depositing of waste. This was because following a review, IFE discovered that the applicable work procedures were designed in such a way that waste could be deposited that did not comply with the operating licence given for the facility pursuant to the Pollution Act. The depositing of waste was resumed in August 2019.

The Security and Emergency Preparedness Department is responsible for operative security at IFE, and in 2019 the department was upsized. This has been part of IFE's investments in overall security, through appropriate organisation of the department and the ability to deal with events and support basic security measures.

During the 2019 restructuring process, 70% of the required staff were recruited internally. The remaining 30% were recruited in autumn 2019 when internal staff were also retrained. The department is also responsible for ensuring that the plans governing IFE's emergency preparedness are functional and operative.

Transfer, restructuring and reorganisation programme office

To head the restructuring of IFE's nuclear activity and the future transfer and organisation of the nuclear facilities, the IFE has established the transfer, restructuring and organisation programme, led by the Nuclear Waste Management and Decommissioning sector. The programme plans, coordinates and follows up the reorganisation of nuclear activity such that it safeguards IFE's responsibility for safety and ensures a smooth transition to NND, using a 'plug-and-play' principle. Processes for transferring the facility and organisation to NND are also covered by the programme.

The focus in 2019 has been on establishing a new organisational design for IFE's nuclear activities.

NFD has begun the work of establishing a basis for the government's decision to transfer activities from IFE to NND and has set up a working group to which NND and IFE are also invited to contribute. The aim of the work is to ensure an anchoring and joint understanding of the tasks to be solved, and the risks this may entail for the state.

Interface and cooperation with NND

Cooperation between NND and IFE has been excellent in 2019. IFE's nuclear division (IFE NUK)

and NND have established shared values in 2019: Safe, Credible and Responsible – which form the basis of the interaction. Interaction between NND and IFE is necessary to ensure progress, maintain safety and underpin essential competence, and lay the foundation for cost-effective clear-up activities following the discontinuation of Norwegian nuclear activities.

The 2020 state budget stipulates that provision is being made for the swiftest possible transfer of tasks from IFE to NND in order to ensure a clear division of responsibility and avoid costly parallel functions in IFE and NND. NND and IFE submitted a joint plan on 1 November 2019 – an overarching plan for the transfer of operational tasks to NFD.

IFE and NND have established how projects will be conducted: work method, priority criteria for projects, form of cooperation between NND and IFE, project management and project portfolio. NND owns the project schedule for the preparation and implementation of the decommissioning. IFE and NND allocate resources to the projects, and external expertise is hired if necessary. The burden of work falling on IFE's staff in nuclear activities is uneven. There is a heavy burden on those performing safety analyses, preparing safety reports and planning projects as opposed to those carrying out the practical work. The aim is to even out the burden.

A good framework and predictability for the work in 2020 and in the future has been established through the following: government grants to IFE and NND, close cooperation and interaction between NND and IFE, the joint overarching plan for the transfer of tasks from IFE to NND, and the work carried out by NFD's working group on the transfer of the activity.



Environment and Safety

IFE is subject to a strict body of regulations on safety and emissions. Our safety is closely monitored both nationally and internationally. In the case of emissions, the Norwegian Radiation Protection Authority sets limits for how much radioactive materials we are allowed to discharge to air and water. The emissions licence sets specific emission limits per radio nuclide. In addition, limits are set for the maximum dose of radiation to which individuals in the most vulnerable population groups can be exposed.

The limits are very low. However, our emissions are far lower than the maximum values. In 2019, radioactive emissions to air and water from the Kjeller and Halden facilities amounted to < 1% of the annual dose limit. The fact that both of IFE's research reactors in practice were out of operation throughout the whole year helped to ensure that emissions for 2019 were extra low.

Ongoing surveillance of radioactivity – environmental monitoring

The Environment and Radiation Protection Departments at Kjeller and the Radiation Protection Department in Halden have wide-ranging expertise in radiation protection, radioecology and radioactive waste, and play a key role in Norway's nuclear emergency preparedness. We conduct research and support industry, the public health service, the authorities and research institutes, using expertise developed at IFE. IFE has laboratories for measuring radioactivity in a variety of sample types, for dosimetry and calibration of radio protection instruments in addition to its own electronics laboratory.

The responsibility of the Radiation Protection Department is to ensure that all use of radioactive sources and materials is in accordance with national laws, regulations and guidelines. Moreover, the department evaluates and follows up the recommendations of international organisations. The aim is to limit and reduce any radiation doses for employees at work and check that emissions during normal operations do not exceed the emission limits. The Radiation Protection Department plays an important role in IFE's emergency preparedness should unforeseen events occur.

IFE's environmental monitoring ensures that we have a full overview of our total footprint. This partly takes place through the environmental monitoring programmes in Kjeller and Halden in relation to the emission of radioactivity. IFE is certified by ISO 14001:2015 and works constantly to map significant environmental aspects in a lifetime perspective. IFE's broad research activities in renewable energy make a positive contribution in this connection. Meanwhile, as an environmentally certified institution, IFE has a purposeful attitude to and monitors activities that may have a negative impact on the environment.

Focus on safety culture

IFE's board and management take a targeted approach to improving our safety and security culture, and we set high standards in terms of this. We will continually strive to become better, to adopt best practice and to gain experience and knowledge from international, leading-edge research communities.

In 2018, a group of experts from the International Atomic Energy Agency (IAEA) conducted an Independent Safety Culture Assessment (ISCA).

The IAEA's main conclusion was that IFE's local cultures are strong, its safety culture is continually being improved and its employees assume responsibility for safety. Meanwhile, the IAEA also pointed to area that could benefit from strengthening and improvement, such as systematic management development, standardised training, experience exchange across the organisation and internationally, organisational learning, and a clearer management and quality system. In 2019, IFE has used the ISCA's findings and the IAEA's recommendations in the efforts to develop IFE's management system and to strengthen IFE as a learning organisation.

In July 2019, the Safety, Quality and Environment sector was established with a specific mandate related to safety investigations, interpretation and dissemination of requirements and internal control in the form of internal audits and event reports. The sector appointed a separate MTO specialist, and this has strengthened work related to internal investigations and causal analyses when following up non-conformities and has laid a solid foundation for boosting learning across the IFE organisation.

The Safety, Quality and Environment sector has spearheaded the development of IFE's management system, and this has been adapted to the activities and context of the different parts of the organisation.

Security and basic safety

Ongoing work on IFE's object security is governed by the new Security Act of 1 January 2019, which presents functional requirements in relation to safety measures in particular. A new aspect of the Act is the introduction of 'basic national functions', and the Ministry of Trade, Industry and Fisheries has designated IFE as having the basic national function in the nuclear area. This entails new analysis and safety requirements and in 2019, IFE started its preparations for this.

Considerable efforts have been made to upgrade IFE's basic security in relation to physical safety, security duties and emergency preparedness, organisational measures, and also electronic security systems and information security.



Innovation and commercialisation

Through the years, IFE has created a series of new companies and jobs based on the research. In 2019, the institute further strengthened its investment in innovation and commercialisation.

IFE Invest AS is a wholly owned investment company set up to establish and develop companies that commercialise technology developed at IFE. As an active owner, the company provides support for daily management, market development, upscaling and capital injections.

ZEG Power's IFE-developed emission-free hydrogen production technology has received much interest. In March 2020, various international technology funds and state-owned Nysnø Klimainvesteringer acquired a stake in the company to the tune of NOK 130 million. IFE Invest still holds the majority interest and will remain the company's largest shareholder.

ZEG Power's technology enables efficient production of emission-free hydrogen from natural gas with integrated carbon capture. The technology has been developed by IFE and some of the fresh funds will be used to build the first full-scale plant on the CCBbase at Kolsnes.

Visavi Technology AS obtained NOK 15.1 million through a private placing with Proventure Seed II AS and SINTEF Venture V AS in order to secure further development and upscaling of the company. Working in partnership with IFE, Visavi has also been awarded NOK 16 million from the Norwegian Research Council to develop the technology further under an innovation-for-business project (IPN).

Sunphade, which was formed as an IFE spinout company in 2018, received NOK 2 million of the IPN funds in 2019 in order to realise the potential of their technology. These capital injections are evidence of IFE's ability to transform research and technology into robust growth companies.

Furthermore, Giamag Technologies carried out a minor share issue, and Norsk Innovasjonskapital III paid out dividends to the tune of NOK 10 million.

In 2019, IFEs Boligselskap closed down its premises in Halden. The company will be merged with IFE Invest as of 1 January 2020.

IFE is an active partner in the innovations environment at Kjeller, which probably represents Norway's most complete innovations system alongside the NTNU and SINTEF environments in Trondheim. IFE Invest's investment capital totals approximately NOK 40 million. The portfolio includes companies like ZEG Power, Visavi Technology, Giamag Technology, Sunphade and Wirescan.

IFE Invest holds a stake in the Norwegian private equity fund Norsk Innovasjonskapital III which was set up to develop, commercialise and sell companies based on technology from NTNU and IFE.

Income statement

Parent company

Group

Figures in NOK thousand Figures in NOK thousand					OK thousand
2019	2018	Resultatregnskap pr. 31.12.	Note	2018	2019
621 285	655 481	Contract revenues	11	655 910	621 362
407 113	351 651	Government subsidies	10	351 651	407 113
42 132	65 358	Contributions from international partners at Halden		65 358	42 132
1 439	2 093	Other operating income		2 337	7 461
1 071 970	1 074 583	Total operating revenues		1 075 256	1 078 068
598 513	575 914	Pensions	12	577 345	600 098
62 968	70 350	Cost of sales		70 350	62 938
336 223	365 543	Other operating expenses	12, 13	364 512	336 841
22 468	25 539	Depreciation, fixed and intangible assets	2	25 539	22 468
6 235	15 566	Write-down of fixed assets	2	15 566	6 235
1 026 377	1 052 911	Total operating expenses		1 053 311	1 028 580
45 593	21 672	Operating profit		21 945	49 489
3 482	1 675	Financial income	14	2 080	13 894
1 900	1 825	Financial expenses	14	11 073	14 050
1 581	-150	Net financial items		-8 993	-156
47 175	21 522	Profit before tax		12 952	49 333
0	0	Tax	9	2 454	709
47 175	21 522	Net profit for the year	17	10 498	48 624
		Allocation of net profit for the year			
47 175	21 522	Other equity	17	7	

Report of the Board of Directors

About the Foundation

The Institute for Energy Technology was established in 1953. The foundation's objective is to work on a not-for-profit basis for the public good by conducting research and development in the field of energy and other areas where the foundation's expertise is of particular relevance. The Annual Report provides a consolidated income statement for the IFE foundation and the group. The group comprises IFE, IFE Invest and IFEs Boligselskap AS (to be merged with IFE Invest in 2020). IFE is a research institute for engineering and industrial development and receives core funding from the Research Council of Norway.

IFE is a significant research institute within the areas of energy, the environment and digital systems, and it is Norway's largest centre of nuclear technology excellence. The foundation's main offices are at Kjeller in the municipality of Skedsmo. The business is run from our premises at Kjeller and in Halden.

Main activities and outlook

In 2018, IFE decided to close the Halden Reactor permanently and in 2019 the decision was made to also close the JEEP II Reactor at Kjeller. This marks the end of IFE's 70 years of nuclear reactor operations in Norway. The institute has therefore gone through a comprehensive restructuring process in 2019, in order to prepare for the decommissioning of the nuclear facilities while making a substantial investment in the continued development of the institute's other activities.

In the course of 2019, the institute conducted its activities in three divisions, one of which is Research & Development, with energy, environment and digitalisation as the main focus areas. IFE carries out considerable research activities in Halden and at Kjeller. The second division is Radiopharmacy, based at Kjeller. IFE works with partners to develop radiopharmaceutical drugs, while also producing and distributing radiopharmaceuticals. The third division is Nuclear Technology. IFE is responsible for the safety and security of the nuclear facilities in Halden and at Kjeller while preparations are made for their decommissioning and the transfer of licenses, facilities and staff to the government as represented by the Norwegian Nuclear Decommissioning Authority (NND).

New licensing regime and stricter safety requirements

The Norwegian Radiation and Nuclear Safety Authority (DSA) introduced a new licensing regime as the nuclear facilities at Kjeller were granted renewal of their licence to operate from 1 January 2019. The new licensing regime introduced stricter operating and safety requirements for all of IFE's nuclear facilities and these apply even though the reactors have been closed down. In 2019, IFE took considerable steps to meet the requirements of the new licensing regime, including a strengthening of the safety organisation and drawing up new safety reports for the nuclear facilities.

IFE is governed by the Norwegian Atomic Energy Act and the Norwegian Security Act. In 2019, IFE put further resources into safeguarding its nuclear activities by strengthening the safety organisation and boosting the physical and logistical security measures in compliance with new requirements. These requirements were introduced in response to the national security authorities' assessment of Norway's general security status.

Restructuring and staff reduction

To safeguard the expertise, safety and security of IFE's nuclear facilities, the Nuclear Technology Division receives government funding via Budget allocations. At the beginning of 2019, IFE was facing a challenging financial situation because the government funding was lower than the cost of maintaining the necessary operation and safety levels, and of sustaining the planned level of nuclear waste management activity while preparing for the decommissioning of the nuclear facilities.

The financial situation was further exacerbated in the winter of 2019 when it became clear that the JEEP II Reactor would have to close, which resulted in further losses of income for the business. In the Revised National Budget of spring 2019, IFE was awarded the necessary funds to carry out a controlled restructuring and staff reduction process, while maintaining the safety of all facilities. In the period from May to the end of August, IFE restructured operations and cut staffing levels, involving a large portion of the foundation's employees. Approximately 90 jobs were cut, while approximately 70 new jobs were introduced – mainly within the areas of security/emergency preparedness and research. As a part of this process, some employees agreed to take out their contractual retirement pension while others accepted an offer of career guidance combined with handing in their notice.



Photo: Espen Solli

Thanks to the restructuring and staff reduction process as well as other cost-reducing measures, IFE's financial situation stabilised in the beginning of 2020.

New strategy for 2020-2023

Throughout 2019, IFE worked to draw up a new strategy for 2020-2023. This strategy specifies the institute's objectives, frameworks and directions, thereby providing a basis for prioritisations in the years ahead. In the period 2020–2023 IFE will see major changes as plans and preparations are made to transfer all nuclear licences, facilities and organisational resources to NND by 2023. Radiopharmacy and R&D are growth areas with major potential, but the two sectors are very different and must be developed accordingly. In this strategy period, IFE will consider whether the Radiopharmacy Division should be separated out as a company in its own right and whether the R&D Division should be transformed into a research corporation, both of which would be owned by the IFE foundation. IFE's premises in Halden include two large commercial properties, and the foundation owns the 38-acre site at Kjeller. This represents a considerable potential for research development and value creation. IFE will drive developments in Halden, at Kjeller and nationally, by growing its activities and using its properties to create new specialist jobs.

Research and Development highlights in 2019

There is considerable demand for IFE's research in many markets and there has been a need to recruit researchers and technical staff. In connection with the closing of the reactors in Halden and at Kjeller, nuclear technology researchers have been transferred to the other research sectors. Some of the research within nuclear technology will continue and will be further developed, while some researchers will retrain for work in other project growth areas.

Since 1958, IFE has hosted the Halden Reactor Project, which is an international research programme run by OECD/NEA (Nuclear Energy Agency). The Halden Project is Norway's largest and most international research project with 100 members from a number of countries and organisations. Norwegian funding of the project is matched two times over by contributions from members in other countries, so the project is financially and scientifically beneficial to Norway. The current project period is 2018–2020, and the annual budget is NOK 118 million.

Although IFE's operation of the Halden Reactor formed the original starting point for the project, its work has developed through the years so that currently more than 50 per cent of activities are not linked to the reactor. In 2018, it was decided to close the Halden Reactor permanently. An important activity in 2019 has been to wind up the work that can no longer continue without the reactor operating, and to lay the foundations for carrying on with the project for another 3-year period. IFE finds that there is significant interest in continuing the Halden Project, both from Norwegian authorities and from other project members. Parts of IFE's nuclear research will now focus on decommissioning, which is an international growth market because a number of reactors will be decommissioned in the years ahead. Norway and IFE will therefore have a unique competitive advantage thanks to the expertise and network developed under the Halden Project since 1958.

IFE continues to focus on EU-funded research projects and was awarded funding for a number of projects in 2019. The Research and Development Division has put in targeted efforts to establish research projects in association with industry partners and the Norwegian Research Council and has been successful on both counts. The Board of Directors is satisfied with the positive development and growth in IFE's research activities.

In 2019, IFE further strengthened its focus on publishing. Over the year, 130 scientific articles were published in international journals and other publications approved for the Norwegian Science Index. The Board considers it important that IFE maintains its ambition to publish at a high international level.

Radiopharmacy highlights in 2019

Radiopharmacy has seen formidable growth in turnover and staffing levels in recent years. IFE works in close partnership with Bayer on contract production of the cancer drug Xofigo, and also works with other companies on numerous innovations. In 2019, IFE has acquired a number of new customers who wish to develop and produce radiopharmaceuticals. The Radiopharmacy Division has continued to deliver good results in 2019, despite reduced revenues from the Xofigo production.

Therapeutic radiopharmaceuticals represent a global growth market. Norway and IFE are uniquely set to take a leading position as we cover the entire value chain from excellent research environments to upscaling, production and distribution. IFE has decided to invest in the Radiopharmacy Division in order to boost the value creation and development of radiopharmaceuticals for export in collaboration with established pharmaceutical companies as well as start-ups. In 2019 and 2020, IFE is implementing a NOK 40 million investment programme in order to expand the Radiopharmacy Division's developments and production activities.

Nuclear Technology highlights in 2019

In 2019, it was decided to close the JEEP II Research Reactor at Kjeller. Having operated since 1967, the reactor formed an important part of the national neutron research infrastructure. It was used by IFE and other research institutes at home and abroad for neutron-based research in physics, materials technology, radiopharmacy, energy storage, CO2 management and hydrogen technology. Its closure has impacted heavily on Norwegian neutron research.

IFE is working with the Norwegian neutron research environment to investigate the potential for Norwegian researchers to access reactors in other European countries. There is a positive dialogue with several reactor communities in Europe, and in the course of 2020 we will be able to clarify whether Norway has the financial capacity to enter into a long-term agreement with another country about access to radiation time.

The current licence for the reactor facilities in Halden will expire on 31 December 2020. In 2019, an application was submitted for a renewal of the licence to own and operate the Halden Reactor and its fuel repositories from 1 January 2021 until 31 December 2030, or until such time that the licence may be transferred to NND.

The closure of the JEEP II Reactor at Kjeller in 2019 means that IFE no longer has an operational reactor. Since the reactors are no longer operational for research purposes, there is an opportunity to make considerable socio-economic savings in decommissioning the facilities. Nuclear facilities and expertise can now be transferred from IFE to NND to ensure that the specialist expertise associated with the facilities will be safeguarded and used for decommissioning purposes.

The Norwegian Nuclear Decommissioning Authority (NND) has been set up by the Norwegian government to be in charge of the demolition of the nuclear facilities and the handling of the spent fuel. Considerable efforts are being made to plan and prepare for the decommissioning, and to arrange for the transfer of licences, facilities and organisation to NND. NND and IFE have been working together to draw up a roadmap for the transfer, aiming to have all facilities transferred by the end of 2023.

In 2019, IFE was notified of possible scientific irregularities in projects conducted at the Halden Reactor dating back a number of years. The situation has not put the environment, health or safety in Halden at risk. The information came to light as preparations were made to decommission the reactor. The Board of Directors considers this to be a very serious situation and has initiated an external inquiry.

IFE has reported the matter as a potentially serious contravention of recognised research ethical standards to the Norwegian National Research Ethics Committees and to the National Commission for the Investigation of Scientific Misconduct.

Continued operation

The Board confirms, pursuant to section 3(3)(a) of the Norwegian Accounting Act, that the criteria for continued operation are present and that the annual accounts for 2019 have been prepared on a going concern basis.

The annual financial statements

In 2019, the group's consolidated turnover amounted to NOK 1 078 million (NOK 1 075 million in 2018) while the IFE foundation's revenue amounted to NOK 1 072 million (NOK 1 075 million in 2018). The turnover is at the same level as last year, but a larger share of the income stems from government subsidies. Out of the total government subsidy of NOK 407 million taken to income, NOK 204 million was an extraordinary allocation towards the operation of the Halden Reactor, while NOK 48 million is funding for the safeguarding of nuclear facilities.

The group and foundation's other operating revenues stem from contracts and contributions from research activities, the Halden Project and the radiopharmacy business. The research activities conducted by the group and the foundation are part-funded by the Norwegian Research Council, the EU and other industry partners. A considerable share of the income was generated by the radiopharmaceutical activities, which in 2019 amounted to NOK 312 million (NOK 326 million in 2018). The fall in turnover was caused by lower incomes from the production of the Xofigo drug and from the wholesale operation.

The group accounts show a profit of NOK 49 million (NOK 10 million in 2018), while the foundation's profit amounts to NOK 47 million (NOK 22 million in 2018). The nuclear activities break even thanks to government subsidies. The positive development in the year-end profit compared to 2018 is due to improved revenues from the group's research activities. The year-end profit generated by IFE's non-nuclear activities meet the Board's requirements, and are the result of years of work to improve revenues.

As of 31 December 2019, the group's consolidated equity amounted to NOK 393 million (NOK 344 million in 2018) while the foundation's equity amounted to NOK 339 million (NOK 292 million in 2018). The equity ratio is 45 per cent, which is considered satisfactory. The cash-flow statement is positive for the foundation as well as the group. The group's consolidated cash balance has been strengthened by NOK 170 million while the foundation's cash balance has been improved by NOK 165 million. The positive cash balance has been achieved thanks to improved net incomes and a higher volume of early settlements of accounts receivable, including unused subsidies.

Financial risk

The foundation aims to keep financial risks at the lowest possible level. The liquidity risk is moderated by an overdraft facility agreement with the bank, and a focus on cash-flow in major projects. No hedging instruments were employed in 2019, but this remains a possibility in case of considerable exposure to currency risks.

Liquidity risk

In 2019, the foundation's cash-flow development was positive. Bank deposits less restricted tax withholdings amounted to NOK 257 million at the end of 2019, which is NOK 165 million higher than at the end of 2018. For the foundation's liquidity risk to be acceptable, the available cash balance should be in the range of NOK 100 million in order to cover current liabilities. The foundation has a cash pool agreement with IFE Invest AS as well as IFEs Boligselskap AS, and this provides flexibility with regard to short-term liquidity fluctuations. The foundation has agreed with its bank that an overdraft facility will be made available as required.

Market risk

The market risk to which the group and the foundation are exposed is principally associated with currency, partly from income in foreign currencies and partly from costs in foreign currencies. Measures to reduce exposure to currency risks are implemented with regard to any large individual transaction, but there are no ongoing hedging transactions because the risk is considered to be low.

Credit risk

Both the group and the foundation are exposed to credit risks associated with accounts receivable and lending. The group has made provisions for bad debts to the sum of NOK 21.0 million, of which the corresponding sum in the foundation is NOK 11 million. There is also a potential credit risk associated with advance payment to suppliers, but such transactions are subject to the provision of a supplier's performance bond.

The organisation

In 2019, the Board of Directors held eight board meetings and discussed 36 agenda items.

IFE received considerable government funding in 2019 to subsidise the operation, safety and security of its nuclear facilities and the handling of nuclear waste. As from 2019, IFE's nuclear activities are subject to a management control system (MCS) designed by the Norwegian Ministry of Trade, Industry and Fisheries. IFE's management dialogue with the government, as represented by the ministry, involves two management dialogue meetings per annum, to be attended by the Chairman of the Board, the President and other relevant members of IFE's management team. Officials from the ministry met with IFE's Board in order to inform the directors about the management dialogue procedures and the government's priorities with respect to nuclear activities in 2019.

The administration

The foundation employs 583 permanent staff (609 in 2018) and 27 per cent are women. Of these, 216 (226) have a higher education, and 26 per cent of these are women. A total of 108 (105 in 2018) permanent and temporary members of staff hold a PhD and 37 of these are women.

The working environment

The working environment is considered to be good and staff satisfaction rates have increased markedly since the previous survey was conducted in 2017. The organisation is currently following up on the staff survey that was carried out in 2019 in order to continue improving the working environment. IFE has been an IA company since 2010 and work areas and tasks are adapted to suit individual employees.

In 2019, IFE employed permanent and temporary staff from 37 different nations. The resulting diversity enriches the organisation both professionally and socially and the mix of many nationalities makes it easier for new staff with less experience of Norwegian culture to adapt to working life in Norway. IFE has found that this is a competitive advantage when it comes to recruitment.

Total sick leave was 6,602 days, which amounts to 3.9% of total working hours for the year, down by 0.1% compared to 2018.

The rate of sick-leave and personal injuries (H1/H2) was 3.08 for the last 12 months. There were only minor injuries and preventive measures have been implemented.

In 2019, IFE reported to the Norwegian Radiation and Nuclear Safety Authority (DSA) seven incidents arising from the institute's activities that could potentially have impacted on the environment, health or safety. The situations were handled in a way that ensured any such impact was avoided.

Equal opportunities

IFE aims to be an equal opportunities employer that offers full equality between men and women. There must be no gender-based discrimination. The company's permanent staff includes a total of 583 employees, of whom 219 are women and 364 are men. At present, three women and four men sit on IFE's Board of Directors. There are six women and six men in the current management group. No special equal opportunities initiatives were implemented in 2019.

Discrimination

IFE works actively to prevent discrimination based on disability, ethnicity, nationality, skin colour, religion or faith. Activities include recruitment, pay and working conditions, promotion, career development opportunities and protection from bullying. The foundation's pay policies are gender neutral and the pay band of individual employees is determined on the basis of gender-neutral criteria. Promotions are considered on the basis of gender-neutral criteria.

IFE is constantly working to actively build robust gender-neutral systems that apply to all staff. There must be no discrimination or other obstacles to equal opportunities.

External environment

IFE's activities are rigorously monitored to ensure that that they cause no harm to the external environment. IFE operates in compliance with emission permits issued by the Norwegian Radiation and Nuclear Safety Authority (DSA) with respect to various nuclides and radiation levels that may affect staff and the environment. The limits have been set at extremely low levels, and in 2019 IFE emitted only a fraction of what is permissible. IFE has a very comprehensive environmental monitoring programme at Kjeller and in Halden with regular testing of the water, sediments, fish, grasses and aquatic plants.

Since IFE's formation in 1948, the institute has been operating under licences and permissions granted by the Norwegian government as represented by the DSA, the Norwegian Environment Agency and other bodies that regulate our activities and monitor compliance with current rules and guidelines for the management and storage of Norway's nuclear waste.

Because Norway was one of the first countries to have a nuclear reactor, we were an early producer of nuclear waste. In total, Norway has produced almost 17 tonnes of spent reactor fuel. At the start of 2018, a further four tonnes of other radioactive waste were stored at IFE's premises. This is waste that cannot be deposited in the National Combined Disposal and Storage Facility (KLDRA) at Himdalen in Aurskog-Høland municipality.

The rules for managing nuclear waste have changed considerably since the reactor was commissioned in the early 1950s. The requirement for detailed specifications of the stored waste was far less stringent at the time. The storage facilities that were constructed in Halden and at Kjeller were never intended to house nuclear waste over many decades. One of IFE's main priorities in 2019 was to improve our spent nuclear fuel storage facilities. The fuel is currently securely deposited at Kjeller and in Halden and poses no risk to health, safety or the environment. Norway needs new intermediate facilities for storing the fuel for several decades before it is transferred for final disposal. IFE has set up a specialist group to boost the work of building new storage facilities for nuclear waste in Halden and at Kjeller in close partnership with NND.

Outlook

In 2019, IFE took a systematic approach to formulating strategies and conducting market analyses for the years ahead. In the Board's view, the outlook is very promising for the institute's R&D and radiopharmaceutical activities. These activities deliver new and sustainable solutions that address societal challenges in areas with large emerging markets, both domestically and globally. IFE continues to win new markets and projects in Norway and abroad and is a desirable partner to Norwegian industry, international industrial collaborators, and R&D groups at home and abroad.

The Board of Directors deems the future prospects of the foundation to be positive.

Halden, 26 February 2020

Olav

Nils M. Huseby President

Chairman of the Board

Anne Marit Harris **Deputy Chairman**

Jo Døhl

Board Member

Camilla I. England 1 er Terje Bodal **Board Member**

Kerstin Elisabet **Dahlgren Persson Board Member**

han Einar listad

Board Member

Camilla	veiter			
Engeland				
Board N	lember			



KJELLER PO Box 40, 2027 Kjeller

Visiting address Instituttveien 18, Kjeller

Tel.: +47 63 80 60 00

HALDEN PO Box 173, 1751 Halden

Visiting address Os allé 5, Halden Visiting address , reactor plant: Tistedalsgata 20, Halden

Tel.: +47 69 21 22 00

firmapost@ife.no • www.ife.no

facebook.com/energiteknikk

- 🥑 @ife_norway
- 🖬 🗧 Institute for Energy Technology
- @ @humansofife