

VTT

Annual report 2021

Exponential hope through science and research



beyond the obvious

VTT in brief

VTT is a visionary research, development, and innovation partner and one of Europe's leading research institutes. We bring together people, business, science, and technology to solve global challenges. On this basis, we create sustainable growth, jobs, and wellbeing, and ultimately bring exponential hope to the world. We promote the use and commercialisation of research and technology in business and in society at large. We have 80 years of experience in cutting-edge research and science-based results. Carbon neutral solutions, sustainable products and materials, and digital technologies are at the core of our activities. Finland's national metrology institute and national standards laboratory MIKES is also part of VTT.

[Read more about VTT](#) ➔

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The year 2021 was a great year for us: we achieved visible results.

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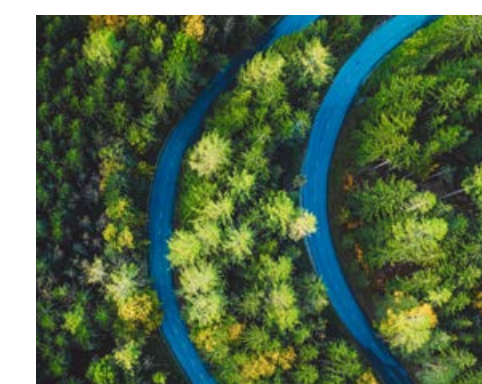
According to our customers, our strategy is well-defined and it clearly states the contents of our core task.

[Read more on page 10](#) ➔



Cooperation and networked activities have an increasingly important role in research.

[Read more on page 24](#) ➔



Responsibility is one of our strategic choices, and we work every day to prove that we are committed to develop sustainable solutions for our customers.

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The year 2021

For VTT, the year 2021 was characterised by success. There was growing interest in innovations based on science and technology in Finland and in the world. In cooperation with our customers, we want to contribute to a better future.





Many of the major problems facing the world can be solved.

Research matters

VTT achieved major successes in 2021. Our work produced visible results.

The year 2021 was a successful year for VTT: we worked hard and achieved visible results. COVID-19 and the global situation have given a boost for research. There was a growing interest throughout the world and in Finland in products and methods based on science and technology that are needed to tackle such global challenges as climate change and dangerous diseases. VTTers have responded to the demand for new ideas with vigour: we are doing work that matters.

The impact of our work arises from the ability of companies and actors in society to use our expertise in their activities. Customer satisfaction is at excellent level and despite the exceptional global situation brought on by the pandemic, we have been able to increase the volume of our customer work. We have been able to help companies in such matters as international networking.

In accordance with our new strategy, we grouped our business areas in three sectors: carbon neutral solutions, sustainable products and materials, and digital technologies. We promoted a wide range of different projects. We produced the first batches of coffee from coffee beans grown from [cells in a laboratory](#). A [new source of protein](#) was developed from rapeseed, and VTT's researchers also discovered that tailoring based on genetic information can improve [blood thinner treatment](#) outcomes. Our research also determined that [tests and effective diagnostics](#) are required to tackle future pandemics. Additionally, we now have a [quantum computer](#) that is operational. There are also plenty of impressive examples from other areas and it is great to see that our long-term research on such fields as food production is now bearing fruit.

Growth in demand for research increased the amount of incoming work. Working remotely was also a factor impacting wellbeing at work. However, according to our personnel survey, the workplace atmosphere at VTT has improved, and VTTers are satisfied with our corporate culture and feel that this workplace can also be recommended to others.

According to our strategy, VTT must provide answers to the critical questions asked by companies and actors in society at large and, in this way, build hope for the future. It has become easier to place each research project into a larger package of solutions and to determine the expertise that the project requires from us and our partners. Our customers now also better understand their role in the overall process and what our special expertise can offer. By following the five choices set out in our strategy, we can maximise our impact and value for our customers in the most effective way possible.

Our view is that science and technology will develop at a faster pace in the 2020s. This is a hopeful sign: many of the major problems facing the world can be solved as cutting-edge scientific solutions create sustainable growth and wellbeing. We have a lot of work to do and solving the problems plaguing the world is not easy. This is also what makes our work inspiring, and it serves as an incentive for us to do our best. For this reason, there is now a great deal of vigour in the fields of research and innovation. The decade of hope is progressing.

President & CEO
Antti Vasara

The new strategy gives VTT a clear direction

The key to 2021 was a new strategy, which gave VTT a clear direction for its work.

The introduction of VTT's new strategy and the grouping of business areas were the highlights of the year. With the new strategy, we can now define our direction more clearly. The document also lays out the key challenges of our time which provide the focus for our work. According to economic and satisfaction indicators, the managed change process was carried out without problems. VTT's public image has continued to improve and there was an increase in external demand for research.

The focus of VTT's research and development activities is on matters with broad impact that may later be launched as concrete products by commercial operators. Such projects include the quantum computer, which became operational in 2021, and a study on emission-free heat generation. The knowledge and expertise accumulated in these projects will bring long-term benefits. The basic task of VTT is to impact society and the business world by means of research and to develop matters that will become important and be in demand in the future. For this reason, projects that are no longer relevant have been discontinued.

COVID-19 has posed a serious challenge for the operating environment. Remote work boosts productivity in the short-term. However, it means that there are fewer exchanges of views and only occasional contacts with partners and colleagues. These points of contact are particularly important to a research institute and as they become less common, there is little learning outside one's own domain. COVID-19 was also an administrative challenge: most of our board meetings were held as virtual events.

VTT has been highly successful in its efforts to achieve impact and it is one of the top performers in the world in this respect. In the field of renewable energy, VTT is among the world's top ten research institutes and companies in terms of publication activity. This is a great achievement.

VTT has also been successful in its societal role. It received highly positive marks in a recent reputation survey. This shows that VTT is doing the right things and going in the right direction, which is also reflected in the growing number of customer assignments. VTT wants to be the most preferred long-term research and development partner, one which challenges its customers to overhaul their activities and create sustainable business in selected areas. It enhances Finland's competitiveness and generates a global impact because international activities account for a large proportion of its work. Our aim is to ensure that the expertise generated through VTT is the best in the world.

VTT wants to be a good employer and provides opportunities and interesting tasks for both experienced professionals and also individuals at the start of their careers. It has been highly successful in this: in the 2021 Universum employer survey, VTT was ranked among the top ten workplaces by natural science and engineering professionals.

VTT is going in the right direction, and it is excellently placed to continue as a successful actor.

Chair of the Board
Pekka Tiitinen



VTT's task is to develop matters that will become important and be in demand in the future.

VTT 2021 in figures

The importance of science and research is indisputable. They provide reliable solutions to global challenges. There is demand for VTT's expertise, and customers appreciate and benefit from collaborating with us.

Impact is created when customers and society adopt the solutions we have developed together.

2021 was a successful year for VTT and our 2,000+ skilled VTTers. Our scientific and technological excellence and passion to create new solutions for customers' needs are reflected in our results and impact.

Impact is created when customers and society adopt the solutions we have developed together. VTT creates impact beyond individual projects by expediting research and product development and by strengthening the knowledge and expertise base, amongst other ways.

We are particularly pleased that our customers are looking beyond the pandemic and want to build sustainable business in the long term and in a responsible manner.

The adjacent figures describe 2021 for VTT and our ability to create impact and exponential hope for the world during such an exceptional period.

Operating income, EUR million

254

Number of employees on
31 December 2021

2,093

Doctors and licentiates

675

Scientific articles

540

Patent families on
31 December 2021

~430

Invention disclosures

166

The figures are for the entire VTT Group

Success stories in 2021



Award-winning catcher of microplastics

Ilona Leppänen, a researcher at VTT, was recognised for her microplastics innovations in the annual Blue Sky Young Research & Innovation Award competition organised by CEPI (Confederation of European Paper Industries). Together with her colleagues, she is devising ideas and developing ways to replace plastic and recover microplastics from water. With her microplastics innovations, Leppänen, who is working on her doctoral thesis, also won the bio economic-focused ForestBioPitch competition in Finland.

Finland boasts a top expert in superconduction circuits and quantum computing

The Finnish Foundation for Technology Promotion named **Joonas Govenius**, D.Sc. (Tech.), as Young Researcher of the Year 2021. Govenius, Research Team Leader at VTT, is studying superconductors and how powerful quantum computers could be built with them. The Finnish Foundation for Technology Promotion cited top research carried out by Govenius to build the quantum computer and a Finnish research ecosystem around it as reasons for the award.



The new VTT office building serves as a research platform for smart energy

VTT's multipurpose headquarters in Espoo, VTT FutureHuB, also serves as a versatile research platform called a Living Lab. The building itself, inaugurated in 2020, forms a local energy system that contains intelligent solutions and supports VTT's research and piloting.

In addition to serving as a platform for smart energy research, VTT FutureHub also boasts a 5G network and indoor and outdoor positioning devices. The building is utilised for multiple purposes, including research on virtual power plants, energy communities, and regional operator models. It is also integrated into the research laboratories and simulation environments of VTT.

"VTT FutureHub Living Lab serves as an important platform for our research and development projects and opens up new opportunities for international cooperation," explains **Kari Mäki**, Research Professor of Smart Energy Systems.

A new innovation to cut construction emissions

With its partner companies, VTT has developed a solution to reduce carbon dioxide emissions from the production of cement and quicklime. As one of the primary ingredients for concrete, cement is the most widely used building material in the world and is responsible for about 7% of the world's carbon dioxide emissions.

By using low-emission electricity instead of the combustion process to decompose limestone and turn it into quicklime (which is the main raw material in the making of cement), and by therefore capturing the carbon dioxide generated in the production process, it becomes possible to build a cement plant with close to zero emissions. This can be achieved with a gas-tight, electrically heated rotary kiln.

"Replacing combustion processes with electricity-based solutions and significantly increasing emission-free electricity generation is an effective means of curbing climate change," explains **Eemeli Tsupari**, Principal Scientist at VTT.

Could industry be almost emission-free?

Riikka Virkkunen, Professor of Practice at VTT, was appointed as the co-chair of Made in Europe, which promotes emission-free industries. Made in Europe is an EU partnership which studies digitalisation and green transition of manufacturing industries. The aim is to make industries more environmentally friendly and companies more resilient in a rapidly changing world and to create competitiveness and jobs in Europe. Made in Europe is part of the Horizon Europe programme, the largest research and innovation input ever made by the EU. Virkkunen was appointed to the post by EFFRA (European Factories of the Future Research Association).



Financial statements

VTT Technical Research Center of Finland Ltd is a Finnish non-profit limited liability company owned by the state. The company falls within the mandate of the Ministry of Employment and the Economy. According to the law VTT is an independent and impartial research organisation. VTT operates as a research, development and innovation partner to help the society and companies to grow through technological innovations.

Despite the challenging operating environment due to the pandemic, VTT coped well with the situation both financially and taking care of the health and safety of its employees. VTT has succeeded in maintaining the trust of its customers. Ongoing customer projects have progressed as planned and significantly more new contracts have been signed than in the previous year. The parent company's net turnover increased in 2021, mainly due to the growth of the foreign private sector income. For 2020 and 2021, VTT received an additional 10 M€ government grant to restore manufacturing jobs in Finland and to develop the reliability and flexibility of the intelligent energy system. VTT is building Finland's first quantum computer, for which VTT was granted a 20.7 M€ special government grant (investment grant) for years 2020–2024. The quantum computer co-development laboratory (QuCoLab) that will house the Quantum computers was completed in June 2021.

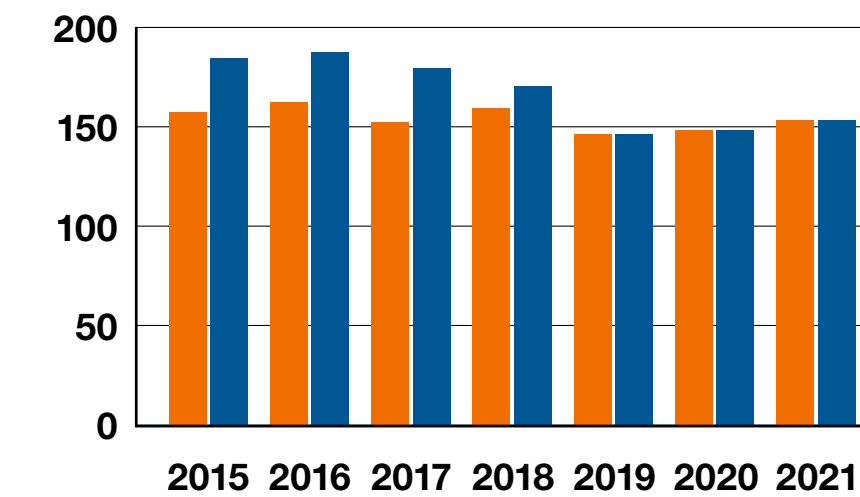
Key financial figures

	VTT Group			Parent company		
	2021	2020	2019	2021	2020	2019
Net turnover (1,000 euros)	154,229	149,403	147,471	153,716	148,863	147,179
Other operating income (1,000 euros)	99,437	94,586	97,549	101,270	95,506	97,728
Government grant	83,579	84,425	78,509	83,579	84,425	78,509
Government special grant	1,493	2,133	10,400	1,493	2,133	10,400
Other	14,366	8,028	8,640	16,198	8,947	8,819
Operating result before special items* (1,000 euros) (operative, unaudited)	7,257*	8,585*	-5,630*	9,788*	10,492*	-4,819*
Operating result (1,000 euros)	13,966	11,351	3,129	16,498	13,259	3,940
Operating result (%)	9.1	7.6	2.1	10.7	8.9	2.7
Result of the financial year (1,000 euros)	12,071	9,578	3,644	11,590	11,475	2,997
Return on equity (%)	7.2	6.1	2.4	8.6	7.3	1.5
Equity ratio (%)	69.5	69.5	66.0	68.5	69.3	64.6

VTT Technical Research Centre of Finland Ltd's net turnover consisted of 58% public sector revenue (Group 58%) and of 42% private sector revenue (Group 42%). The domestic revenue accounted for 55% (Group 55%) and foreign revenue for 45% (Group 45%) of the net turnover.

* Comparable operating result before special items does not include the government special grants for the decommissioning of FIR1 research reactor and restoration old hotcell facilities and the building of the quantum computer (2021: 1.5 M€, 2020: 2.1 M€, 2019: 10.4 M€). Other operating income in 2021 includes revenue from the derecognition of debt due to the reduction of the nuclear waste management liability (7.6 M€).

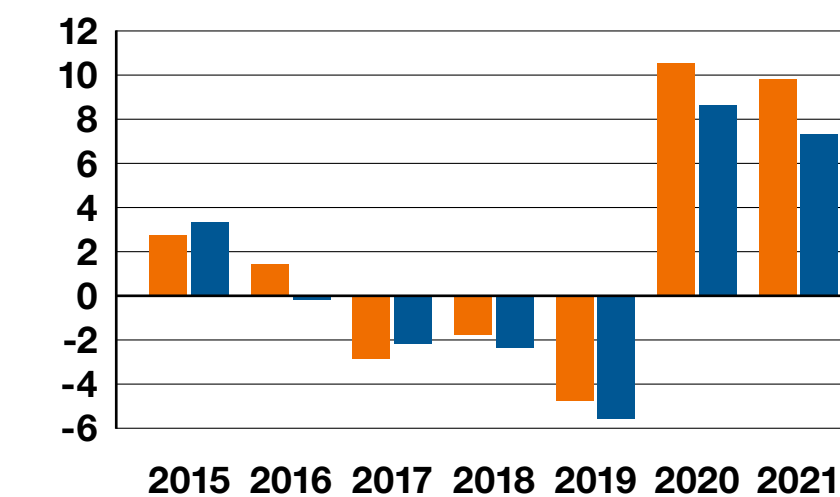
Net turnover M€



The parent company's **net turnover increased 3%** during the financial year, mainly due to higher income in the foreign private sector.

Parent company VTT Group

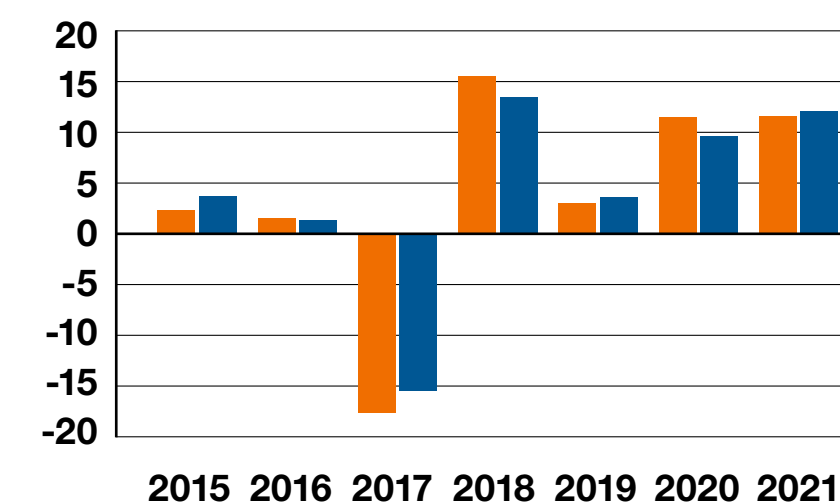
Comparable operating result M€



The comparable (adjusted) operating result* of the parent company and the Group **were positive**.

Parent company VTT Group

Result of the financial year M€



The parent company's and the Group's **result of the financial year were positive**.

Parent company VTT Group

Strategy

Our new strategy provides a clear direction for VTT's core task and gives a better focus for our work. The world is facing difficult challenges and is increasingly turning to science and technology for solutions. Our focus is on seven challenges in which we can achieve the maximum impact.





Building hope with science and research

The new strategy for the period 2021–2025 has clarified our core task and the way in which the steering of research is structured. It has changed our operating practices and organisation, helped us to take a more in-depth approach to customer work and inspired our personnel to achieve our goals.

Our new strategy, introduced in early 2021, has been a highly visible part of our work throughout the year. Using the strategy as a basis, we overhauled our organisation by grouping VTT's research, development, and innovation activities into [three business areas](#): carbon neutral solutions, sustainable products and materials, and digital technologies. We develop solutions for companies and society at large in all these areas.

We introduced a seven-point challenge frame, which defines the focus areas of our research in the research sector. With the new framework to guide us, we can proceed on the path set out in the strategy and tackle the challenges that we have selected. Our daily work is guided by five key strategic choices and our shared values: respect, together, passion, and forerunner.

According to our customers, both our strategy and the challenge frame are well-defined and clearly state the contents of our core mission: the use of science and research to find solutions to the major problems facing the world.

The strategy also serves as an incentive for our own personnel, and it encourages us to develop our corporate culture: we share the sense of meaningfulness and the same values. We are aware that VTT is well-placed to play an influential and important role in society. Science and technology are assuming an increasingly important role, and they are used more and more as a basis for solutions to the difficult challenges facing the world, such as the climate crisis, loss of biodiversity, lack of resources, and providing healthy and good life for a growing population in increasingly unstable conditions.

As an actor in the front line, we can see that there is important innovational work under way in many sectors and the pace of development is accelerating. We know that problems can be solved by means of science and technology and that at the same time, it is also possible to create sustainable economic growth and wellbeing.

The vision of concrete solutions brings hope to a complex world.

We are developing ways to bring the best solutions to our customers by combining expertise.

Concrete solutions bring hope to a complex world. We want to contribute to a better future. We have the tools and the expertise needed for the work.

Impact can only be achieved by working together

In 2021, VTT began to act in accordance with its new strategy with our customer work at the core of our activities. Focusing on customer work has produced visible results. We want to have a long-term approach in our customer work to find solutions with them.

We develop customer work by enhancing our capabilities in such areas as in-depth understanding of the markets and business operations. In addition to engaging in an active dialogue, we also use new forms of cooperation, such as hackathons, which attract experts from companies and VTT, and other models of co-creation.

We are now increasingly implementing the strategy in our research and research groups' daily work. By engaging in a dialogue and cooperation, researchers play a key role in achieving goals set out in the strategy. We are developing ways to bring together expertise in different fields of science and to jointly create the best solutions for our customers.

We monitor the achievement of the strategic objectives using a set of long-term indicators extending over the entire strategy period. Continuous monitoring is carried out on an annual and tertile basis. There was also a notable improvement in the following strategic indicators during 2021: responsibility index (Reputation & Trust survey by T-Media), the role of VTT in the promotion of its customers' international cooperation (NPS in the customer impact survey), private equity funding raised by VTT's spin-off companies (more than EUR 100 million), and the index measuring our organisational culture (personnel survey).

We place people at the core of what we do as a company, and this applies to both our customers and our personnel. Impact is achieved by working together.

Generating sustainable growth by focusing on seven key challenges

We want to focus our expertise and energy on the systemic and technological challenges in which we can achieve the maximum impact. They are currently as follows:



Systemic challenges

- 1. Carbon neutrality:** Reaching a carbon neutral economy in the coming decades.
- 2. Productivity leap:** Achieving a 10-fold productivity leap from resources.
- 3. Societal resilience:** Securing society's functions, fiscal sustainability, and wellbeing as demographics shift.

Technological challenges

- 4. Quantum leap:** Bringing about the quantum leap in computing.
- 5. Super-performing materials:** Creating superior-performing materials and shortening their design cycle by 50%.
- 6. Superior digital systems:** Unleashing superior performance and sustainability in digital systems.
- 7. Synthetic biology:** Matching nature's engineering skills through synthetic biology and bioinspired production.

In addition to these seven challenges, we are also exploring emerging technologies and continue to support the public sector.

The five choices that we make every day to achieve our goals

The 2,000 top professionals, the VTTers, are the ones who will make our strategy a reality. With these five choices, our goal is to achieve exponential hope.

1. Always aim for **impact**.
2. Always **create** impact together with the **customer**.
3. Always lead for **excellence**.
4. Always drive **sustainable** business.
5. Always build the world's **most meaningful** place to work.

The choices are supported by our values:

- Respect
- Together
- Passion
- Forerunner

Our strategic objective is to cooperate with our customers in a more meaningful and impactful manner to achieve sustainable growth. The research, development, and innovation work performed in cooperation with VTT must always provide a basis for new sustainable business and wellbeing so that we can build a bright future.

Our strategy 2021–2025: The path of exponential hope

OUR PEOPLE

Top professionals capable of systemic and technological breakthroughs that can bring about fundamental transformation.

OUR PURPOSE

We bring together people, business, science and technology, to solve the world's biggest challenges, creating sustainable growth, jobs and wellbeing.

5. Always build the world's most **meaningful** place to work

4. Always drive **sustainable** business

OUR AMBITION

We bring exponential hope to a world that needs to deal with the climate crisis, achieve resource sufficiency, drive industrial renewal, provide safety and security, and enable good life for all.

The **choices** we make every day

1. Always aim for **impact**

2. Always create impact together with a **customer**

3. Always lead for **excellence**



Impact

As an actor in the front line of science and technology, we can see that there is important innovational work under way in many areas and the pace of development is accelerating. As Finland's largest research organisation and one of the most important research organisations in Europe, VTT is an influential actor and plays an important role in global society. We are an active part of a worldwide network promoting innovation and sustainable economic growth and wellbeing.



1/7 GREAT CHALLENGES: Carbon neutrality

Reaching a carbon neutral economy in the coming decades

Challenge

Mobility, construction, industrial sector and energy must all become carbon neutral quickly so that we can mitigate the most serious impacts of the climate crisis. It is no longer just a matter of reducing emissions and ending dependency on fossil fuels. We must also create new economic activities that are based on low-carbon and carbon-negative technologies and carbon reuse.

A new understanding of energy system compatibility is needed. To reduce emissions, we must find new ways to produce food sustainably and to build energy-positive urban districts and living environments based on the circular economy.

Climate action cannot wait. Working together with our customers, we are promoting the transition to a clean energy system and helping the world to free itself from fossil fuels.

Activities and strengths of VTT

We help to find the best solutions for making industrial processes carbon-free or carbon negative. In cooperation with industry, including actors in the energy field and local government, we are developing new models for different parts of the energy value chain. We are a partner in the energy system transformation in which smart power networks, solar and wind power, as well as small modular reactors are assuming an increasingly important role.

We offer carbon capture solutions for industrial sector, transport, power generation and heating as well as for agriculture and forestry. Our emissions research services help the transport sector to reduce its energy use and its negative environmental impacts.

We are active player in many fields of applied battery research and in the development of biofuels.

We create solutions for the sustainable and smart design, construction, use, and maintenance of buildings, infrastructure, and cities. We support the transition towards a sustainable food system and health-enhancing nutritional solutions. We are partners in the development of plant biology, protein modification, and food solutions.

We are helping Finland to meet its emissions targets with hydrogen-based technologies. We contribute to the emergence of exports of hydrogen economy products based on Finnish expertise.



Hydrogen opens up opportunities for low-carbon solutions and new business.

Case

Using hydrogen to innovate industries and mitigate climate change

As an emission-free energy carrier, hydrogen is an important tool in climate change mitigation. It is key to climate-neutral industries, plays a major role in the transformation of heavy traffic, and serves as an important means of storing energy in energy system, power generation and heating.

“However, there is no single winning technology based on hydrogen. Instead, we have winning business concepts that utilize a wide range of different technological solutions,” explains **Antti Arasto**, Vice President, Industrial Energy and Hydrogen at VTT.

We develop solutions for all stages of the hydrogen value chain and promote ways for Finland to develop its potential for a hydrogen economy. Successful solutions require agile ecosystems, and digital structures play a key role in the scaling of solutions and especially in sector coupling. Hydrogen is always about

joining many different actors and in addition to producing technology innovations, VTT is also responding to this challenge by bringing actors together and by offering potential solutions for tomorrow’s potential problems. We are leaders in technological development in areas such as solid oxide electrolysis, Power-to-X synthesis processes, as well as the integration and operation of hydrogen systems.

The complex subject of hydrogen requires experience in the development of the different technologies of the value chain combined with systemic understanding and an energy system-based approach. This increases understanding of both: the most potential low-carbon solutions and new business. Our ambition is that a major export industry based on the hydrogen value chain will emerge in Finland, and that it will supply equipment, services, and training globally.

2/7 GREAT CHALLENGES: Productivity leap

Achieving a 10-fold productivity leap

Challenge

The need for sustainable materials and consumer goods is growing around the world. Where will the raw materials for them come from, and will there be enough raw materials for them? A shortage of critical raw materials, such as metals required for the electrification of different areas of society, will be a major challenge facing the world in the coming decades.

With effective solutions, renewable raw materials, and the circular economy, we can ensure that there will be enough resources for everybody. We must have full understanding of each phase of a product life cycle, from raw materials to the recycling of the end product. In this way, we can save important natural resources, reduce emissions, and create new markets.

By-products created in industrial production often remain unused. As the side streams become large, using them as raw materials can be planned on a new basis. Using new technologies, we can convert so-called by-products into valuable resources. This means we can appropriately recycle materials, introduce new production processes, and create new renewable materials without creating additional waste.

Activities and strengths of VTT

Key areas of research at VTT include finding renewable raw materials that are strong and easy to use, creating and sharing value in the circular economy, and recovering materials from challenging sources.

We are a research and innovation partner in the efficient recovery of valuable raw materials from side streams of industries and residential areas. We help to find new business opportunities in the recycling of materials that are difficult to process, such as plastics and chemicals. Metals and minerals can be produced and recycled in a sustainable manner from such sources as challenging ores. Through our research, VTT has developed a zero-waste concept for mines.

We help to create development projects and new bioeconomy solutions based on renewable materials in Finland. With the business activities created around them, we are boosting the value of Finnish industrial exports.



Bioplastic produced from processing residues has huge potential.

Case

Bioplastic from soy residues

We are a partner in a project in which bioplastic has been developed from the surplus raw material of soy production for the first time in the world. A joint development project between Finnfoam, Brightplus, and VTT led to a process innovation in which ecological lactic acid polymer or bioplastic can be produced from the side streams of soy production. With this innovation, raw materials that can be used for food are no longer needed to produce bioplastic. Producing biomaterials from food production side streams also makes the production more profitable and allows arable land to be used more efficiently.

Products made from soy-based bioplastic can be used to bind carbon dioxide from the

atmosphere for long periods through building insulation and packaging materials.

Growing soy produces more protein per area than any other plant, and this protein is produced in large amounts in different parts of the world. In fact, bioplastic produced from processing residues has huge potential as a scalable export product for the circular economy. On a global scale, about 22 million tonnes of bioplastic could be produced from soy residues each year.

To pilot the new biomaterial innovations, the companies involved are building a pilot plant in Uusikaupunki, which is expected to become operational in 2022.

3/7 GREAT CHALLENGES: Societal resilience

Securing society's functions, fiscal sustainability, and wellbeing while demographics shift

Challenge

The environmental crisis, the COVID-19 pandemic, and other global challenges are making societies increasingly unstable. However, using new technologies, we can anticipate and manage risks during periods of instability and give people a chance to enhance their health and wellbeing. It is difficult to anticipate crises, such as the COVID-19 pandemic, and adapting to them requires persistence and resilience. For this reason, we need solutions that protect our health, make our lives safer, and provide a sound basis for business operations. With risk analysis, anticipation, and preparedness, Finland and other European countries can recover more quickly from emergencies, natural disasters, and cyber-attacks.

Using technologies, we can collect up-to-date health data and test and anticipate the spread of diseases, and also collect information on the impacts of physical exercise, diet and sleep on our body. With this knowledge, we can adopt healthier lifestyles. Citizens can use AI algorithms to make decisions on their wellbeing. This also opens up new opportunities for Finnish health-tech growth companies.

Activities and strengths of VTT

VTT boosts the resilience and cyber security of societies and organisations by helping them to use the necessary technologies. We provide risk analyses and action plans that ensure the functional capacity of welfare, education, security, and defence systems in exceptional and disruptive situations.

We design scalable cyber security development programs and test environments. We provide solutions for acquiring, managing, and sharing information so that citizens, companies, and decision-makers can make the right decisions in changing circumstances. We safeguard the availability of critical natural resources including food and goods and their efficient and consistent distribution in emergency conditions.

We develop measurement technologies to enhance the wellbeing of citizens. Using these measurement technologies, we can help people to meet their personal wellbeing needs, help the health care system to move in the direction of preventive treatment, and to evaluate the economic impacts of different technological solutions.

Our services include smart health and wellness solutions, diagnostics technologies, health care technologies, and wearable technology.



An ecosystem developing rapid point-of-care testing methods.

Case

Defeating pandemics with sensitive diagnostics

The COVID-19 pandemic created the need for rapid, sensitive, and cost-effective testing methods that can be used outside laboratories, such as in home health care and self-monitoring.

Several Finnish research organisations and companies in the diagnostics sector are now joining forces in the Future of Diagnostics-FUDIS Co-innovation ecosystem project coordinated by VTT.

“The focus in our development work is on rapid methods suitable for sensitive point-of-care testing, which can be used to measure small concentrations reliably. With current solutions, such diagnostics often require central

laboratory methods,” explains **Anu Mursula**, a Senior Scientist at VTT.

VTT's role in this project involves the development of rapid COVID-19 testing technology and equipment for reading the test results. The methods can also be used in basic healthcare.

The ecosystem also supports cooperation for future epidemics. In addition to VTT, the consortium also includes four universities (Aalto University, the University of Helsinki, the University of Turku, and the University of Oulu) and 11 business partners (Actim, Biohit, Canatu, Ginolis, Kaivogen, Labrox, PerkinElmer, Screentec, ArcDia, iStoc, and BiopSense). The project will continue until the end of 2022.

4/7 GREAT CHALLENGES: Quantum leap

Bringing about the quantum leap in computing

Challenge

Quantum leap means a fundamental change in technology, which may exceed the impacts of the digital revolution. Quantum technologies and algorithms can help to speed up the development of drugs and materials and open new paths to combat the climate crisis by, for example, reducing the emissions generated by industrial logistics chains. Quantum technology provides the tools to solve the most important challenges facing humanity.

The greatest expectations arising from the quantum revolution are focused on quantum computers. The sector has had an impressive start: on a global scale, billions of euros have been invested into the development of quantum computers and they are expected to generate significant benefits compared to conventional computers.

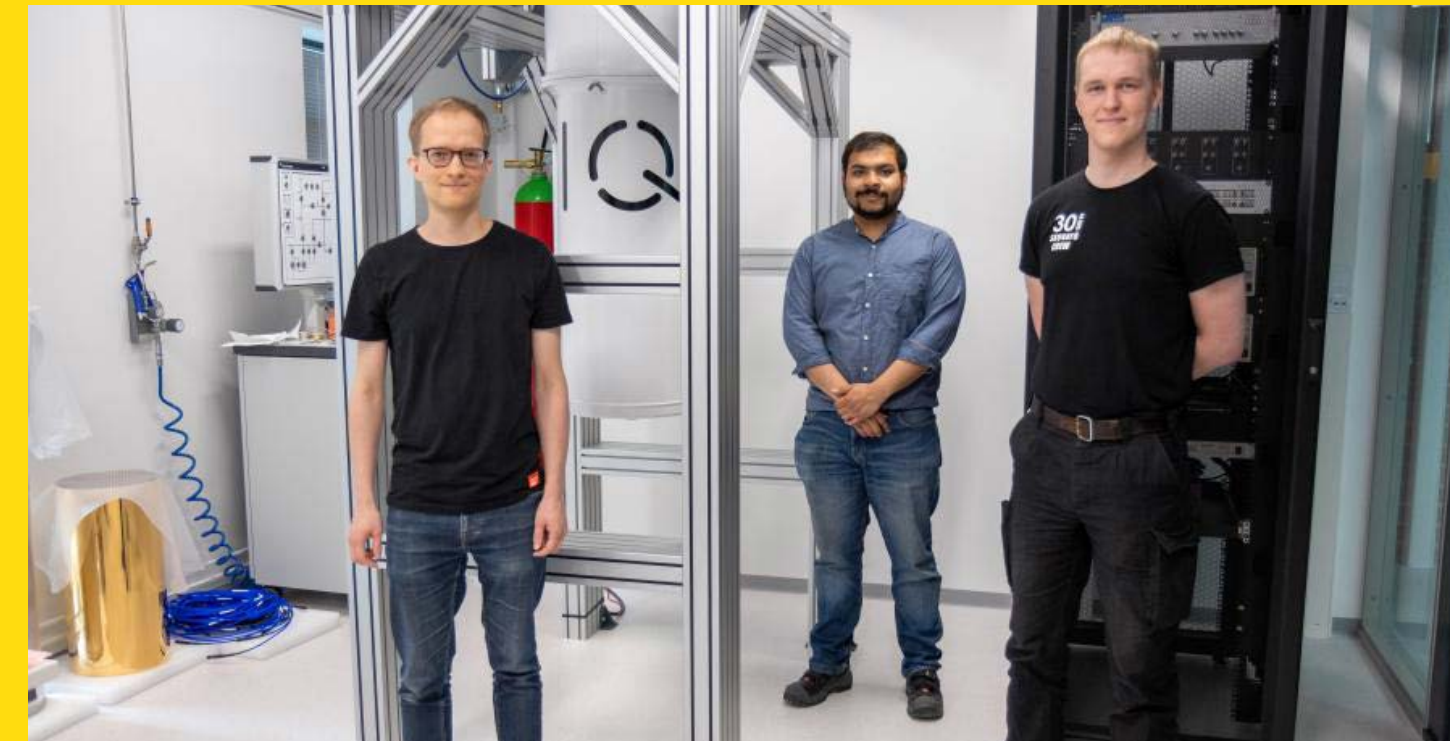
We believe that quantum computing will become the mainstream data handling platform by 2030. The size, usability, and availability of quantum computers will be leveraged to help companies solve their business challenges. We want to ensure that quantum computing also benefits society at large.

Activities and strengths of VTT

VTT is a top expert in quantum technology and provides a full range of quantum technology services, such as quantum computing and practical quantum computing applications. We help organisations developing quantum technology in the scaling, integration, and connection of the equipment. Our expertise covers superconducting, photonics, and semiconductor platforms.

VTT has built Finland's first fully functioning quantum computer in cooperation with the Finnish quantum start-up IQM. With the ecosystem built around the quantum computer and quantum expertise, VTT helps Finnish companies to prepare for the quantum era.

We supply components to companies building quantum computers, and also produce practical equipment and software solutions. We speed up quantum software development with our expertise in AI, machine learning, and cryptography. Additionally, we help companies to adapt their offerings to the opportunities offered by quantum technologies and to create competitive products and services for international markets.



Finland is home to top expertise in quantum technology.

Case

The Finnish quantum institute brings together top talent in the sector

VTT was one of the co-founders of the Finnish quantum technology institute in 2021. InstituteQ is jointly operated by VTT, Aalto University, and the University of Helsinki, and it coordinates the expertise in quantum science and technologies in Finland.

Quantum technology is one of the key technologies of the future, and Finland possesses top expertise and competitiveness in this sector. The research and development in the field of quantum technology taking place under the auspices of VTT, Aalto University, and the University of Helsinki is already well-known internationally.

Quantum information, new quantum materials, and different types of quantum equipment and sensors are the key areas of this expertise. InstituteQ provides a basis for closer cooperation between actors in the sector, which is a prerequisite for Finnish successes in an increasingly tough competition internationally.

Quantum technology creates exponential and sustainable opportunities for future growth, while cooperation in the sector creates added value for all actors. The task of VTT is to ensure that development in the quantum field brings new opportunities for both research and business.

5/7 GREAT CHALLENGES: Super-performing materials

Creating superior-performing materials and shortening their design cycle by 50%

Challenge

Material science lies at the very heart of the matter of life and death on this planet. How can we ensure that there are enough resources on the globe for all of us in the future? How do we replace fossil raw materials with renewable and carbon-neutral alternatives?

We must find answers to these questions, and some of the answers are to be found in the new ways in which materials are designed and produced. Modern synthetic biology and advanced materials science provide tools for developing sustainable biobased materials. Thanks to virtual materials developed through AI, materials are no longer developed through trial and error. Instead, they can be designed and modelled to meet the final needs. This means the development cycle can be halved, which allows industrial operators to select the most sustainable and cost-effective materials for their products.

Efficient and sustainable materials design is critical for the future of companies. This is because the world is running low on many raw materials, such as precious metals needed to meet the computational needs of a growing populace. As well as relying less on natural resources, virtual material design can also save businesses time and money.

Activities and strengths of VTT

We are using AI to create new materials and significantly shorten the time required to develop them. We possess top talent in the development of synthetic biology and biobased, renewable, and recyclable material innovations.

We know how to manage material challenges and produce cost-effective solutions. We offer our customers services based on optimised materials planning and studying friction and wear. VTT ProperTune® is an integrated computational materials engineering (ICME) concept. Optimising materials planning with multilevel modelling can replace expensive and time-consuming testing.

The more we can reduce the friction and wear of machines and equipment, the greater the savings of energy. Effective management of friction and wear can extend the usefulness of equipment and components and boost their performance. We can find the best solutions for individual customers and applications through experimental research and comprehensive tribo-analysis.

We are strengthening our expertise in cooperation with universities and research teams on a global scale. We take part in international tribology research, such as the [EU project i-TRIBOMAT](#).



Antimicrobial properties were discovered in wood-based compounds.

Case

Antimicrobial substances for patient curtains from tree bark

Could resin and tree bark compounds stop the spread of bacteria in hospitals?

A joint project involving VTT, JAMK University of Applied Sciences, Central Finland Health Care District, and other companies in the sector has identified certain wood-based compounds that are effective against microbes.

Curtains in hospital patient rooms must have antimicrobial properties, in that they must have the ability to kill microbes and prevent their growth. Tests were carried out within the project to determine the difference in the amounts of microbes between ordinary curtains and curtain fabrics treated with tree bark tannin. The studies showed that tannins in resin and tree barks are promising antimicrobial compounds.

“The tannin coating reduced the total number of bacteria in the curtains by an impressive 60%. Further testing also showed that the effectiveness can be enhanced by lightly moistening the tannin coating, which improves the contact between the bacteria and the tannins,” explains **Matti Virkkunen**, Senior Scientist at VTT.

Also tested in the project was the functionality of dirt-resistant and easier-to-clean coatings on surface materials used in hospitals. Measurements showed that the hygiene levels on the coated areas were 32% higher than on the uncoated control surfaces.

6/7 GREAT CHALLENGES: Superior digital systems

Unleashing superior performance and sustainability in digital systems

Challenge

Digital systems are at the core of all organisations and digitalisation has the potential to make most sectors more competitive and efficient.

Digitalisation boosts internal efficiency, makes use of new technologies in products and services, and helps to develop innovations to solve the major challenges faced by industries.

Digitalisation requires that processes are re-designed by integrating ICT (such as 5G, big data, artificial intelligence, and sensors), robotics production, and service environments. To ensure their competitive advantage, companies must invest in digitalisation, if possible, before their competitors do so. Major improvements require reassessment of business operating models and value creation in the business ecosystem.

Activities and strengths of VTT

With the cross-disciplinary expertise possessed by VTT, challenges arising from digitalisation can be identified and customers can be provided with digitalisation solutions tailored to their needs. Using VTT's equipment and methods, organisations can determine how new technologies can be applied in their operations.

Tools based on AI maturity and robotics process automation help to identify how organisations can benefit from these technologies. The Future Radar process can be used in the development of radical innovations and it also provides a road map for the digitalisation journey.

Our aim is to create new technology-based growth companies in Finland and provide existing companies with a competitive basis for the future. These enterprises will utilise the innovations promoted by VTT to create competitive export products and the conditions for a profitable business ecosystem. We create business openings based on technologies in the micro-sector, nanosector, quantum field, photonics, printed intelligence, and by digitalising traditional industries. We leverage environmentally friendly materials in electronics products and reduce e-waste.



Artificial intelligence is making automated driving safer.

Case

Automation makes driving safer

Vehicles already have many automation-enabled functions such as lane marking detection. However, they do not function reliably in poor weather. Broad-based international cooperation has been launched to tackle the challenge.

The aim is to create an AI-supported environmental observation system for cars, which enables driving in poor weather conditions. To reduce the impact of weather conditions on the sensors, efforts are being made to use data to modify the operation of the sensors. The result is a system that operates effectively in different lighting and weather conditions.

AI-SEE is an international research project coordinated by Mercedes Benz AG. Finnish

actors are strongly represented in the project. In addition to VTT, such partners as Unieke (a software company developing autonomous driving technology), Meluta (a specialist in signal processing), and Patria are also involved in the project.

AI-SEE was launched in June of 2021, and it will run for three years. The 21 partners involved comprise research institutes, car manufacturers, and software companies. The purpose of the project is to develop AI-based algorithms for processing sensor data. The sensor data helps to create a better situational picture for the vehicle.

7/7 GREAT CHALLENGES: Synthetic biology

Matching nature's engineering skills through synthetic biology and bioinspired production

Challenge

VTT is a top expert in synthetic biology and the development of cell factories. We use scientific breakthroughs to model DNA and to create unprecedented biological organisms. In this way, we can revolutionise food production and create new biobased materials outperforming fossil-based alternatives. We provide technological solutions for producing chemicals from biobased raw materials and by-products.

Biotechnology is suited to meeting the needs of the biocircular economy, as microbes can feed on waste streams and synthesise the desired products from them. We can use cell factories to deliver products for bioreactors. This also saves arable land and forest resources.

Activities and strengths of VTT

VTT is a top expert in synthetic biology and the development of cell factories. We use scientific breakthroughs achieved in recent decades that can be used to model DNA and create unprecedented biological organisms. We are on track to revolutionise food production and create new biobased materials outperforming fossil-based alternatives. We also provide technological solutions to produce chemicals from biobased raw materials and by-products.

Utilizing AI, VTT develops modified microbes and plant cells, commonly called cell factories, which can produce chemicals, polymers, proteins, materials, and food. This approach significantly speeds up the development of biotechnological solutions.

VTT CellularFood service provides food sector actors with expert assistance and research platforms for developing new food solutions, using moulds that efficiently produce proteins, yeasts that are highly resistant to processing conditions, and even bacteria that get their energy from hydrogen. We use cell factories to produce substitutes for oil-based plastics and chemicals as well as medically important molecules such as antibodies. We also are developing new food production methods that conserve both livestock and arable land.



Achieving impact resistance with a new innovation.

Case

Super-strong material for dental crowns from wood fibre

Incredible but true: more durable dental crowns can be produced from birch cellulose than from ceramics. This was discovered in a VTT development project in 2021. Working in a laboratory, a VTT research team developed a new nanocomposite from birch cellulose and protein and produced dental implant crowns from it in collaboration with Nanyang Technological University.

The new material is stronger, tougher, and substantially lighter than the technical ceramics used in dental crowns. In addition to dental applications, it could also be used in other impact-resistant implants, sports equipment, body

armour, exoskeletons for aircraft, or surface coatings for windscreens.

The research team was inspired by mantis shrimps, which are among the deadliest creatures on earth. They can deliver a stronger blow than any other living creature relative to their size. To create a similar structure, the research team constructed a new composite from cellulose nanocrystals and from two genetically modified proteins. The new nanocomposite was used to build dental implant crowns with a structure like that of human teeth. For future applications, better scalability and processing conditions are required.

Successful year of customer relationships

We help our customers to develop products and services that generate global impact and can be utilised to solve the most serious problems of the world.

Our customers are taking a long-term view beyond COVID-19.

VTT continued to achieve good results for our customers in 2021. VTT and its customers launched a large number of joint research and development projects to tackle the major problems facing the world.

We had a total of 1,160 customers during the year, a total of 3,244 projects were under way with them.

At the core of the discussions that we conduct with our customers is responsibility. In 2021, many of these discussions led to concrete actions and new strategic projects, in which the aim is to develop sustainable products and services of the future. Our customers take a broader and increasingly ambitious approach to responsibility and they are looking at the world beyond COVID-19. The aim is to make business operations sustainable in the long-term.

This creates exponential hope: companies and organisations are determined to solve the most serious problems facing the world and expect the development of sustainable innovations to enhance their own competitiveness. We use science and research to help our customers develop products and services that can generate global impact.

Customer sales increased despite COVID-19

Our customer sales increased 10% in 2021, which is an exceptionally good result. We should be satisfied with our growth, especially as it has continued throughout the COVID-19 crisis and the economic uncertainty that the pandemic has created. It shows that VTT has successfully provided companies with relevant research, development, and innovational partnerships that can build sustainable business operations of the future in uncertain conditions.

We have even managed to make new openings and strategic cooperations by relying on remote connections. Measured by net turnover, the proportion of foreign customer relationships have also risen slightly. In numerical terms, we still have more

Total number of customers

1,160

Share of domestic customers of VTT's net turnover

55%

Share of foreign customers of VTT's net turnover

45%

VTT's net promoter score (NPS)*

69

Project delivery met agreed objectives* (on a scale of 1 to 5)

4.3

How easy it was to work with VTT, rate seen by customers (CES)* (on a scale of 1 to 5)

4.5

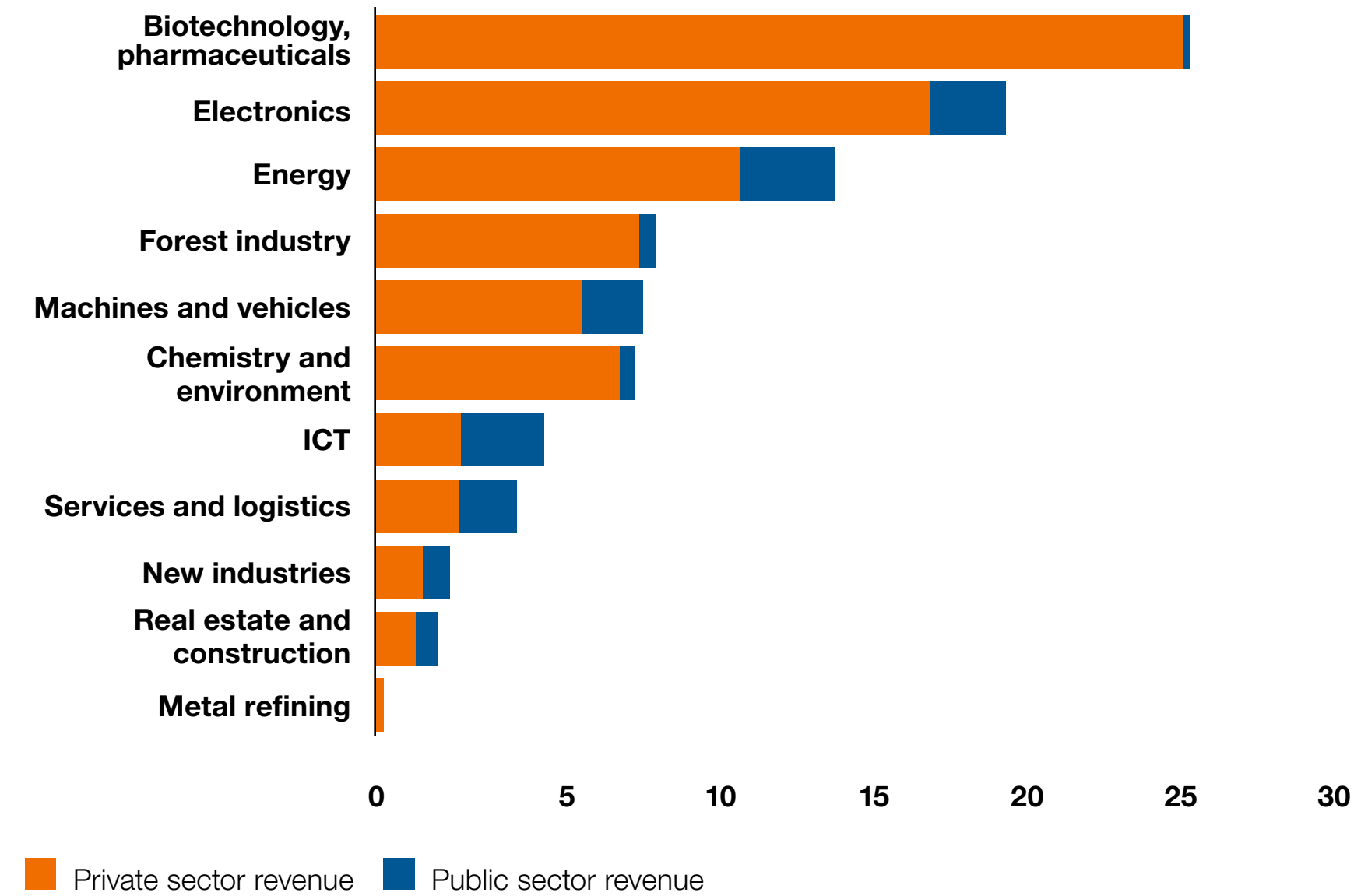
*The figure is based on a customer feedback survey carried out after projects. NPS = Net Promoter Score. CES = Customer Effort Score.



domestic customers because the threshold for cooperation with a familiar Finnish partner is lower.

Our net promoter score (NPS) is at an extremely high level. It shows that in our customers' view, cooperation with VTT brings them added value. We measure NPS after the conclusion of each project by means of a customer feedback survey and, later, with a more extensive customer impact survey carried out one or two years after the end of the project. The response rate in the customer feedback surveys is high and the NPS based on them was 69 for the whole of 2021.

Customer solutions sales revenue* (%)



*Parent company, classification according to VTT's customer segments.

Research and innovation work carried out with our customers is part of the efforts to solve the major problems facing the world.

Commercialisation of technologies and IPR protection

VTT significantly strengthened the offerings of new business opportunities to its customers: IPR worth EUR 1.9 million was invested in growth companies as contribution in kind, and 65 priority patent applications were filed. Commercial revenue from intellectual property rights (EUR 2.8 million) remained at previous year's levels.

VTT invested EUR 1.9 million in IPR as contribution in kind.

A strong IPR portfolio is a good source of future innovations. VTT invested in the protection of new technologies by filing a total of 65 priority patent applications even though the number of invention disclosures (166) was lower than in 2020. VTT owns about 430 patent families and during 2021 a total of EUR 2.17 million was invested towards them. With strong IPR (intellectual property rights) offerings, VTT can provide its customers with new opportunities for success.

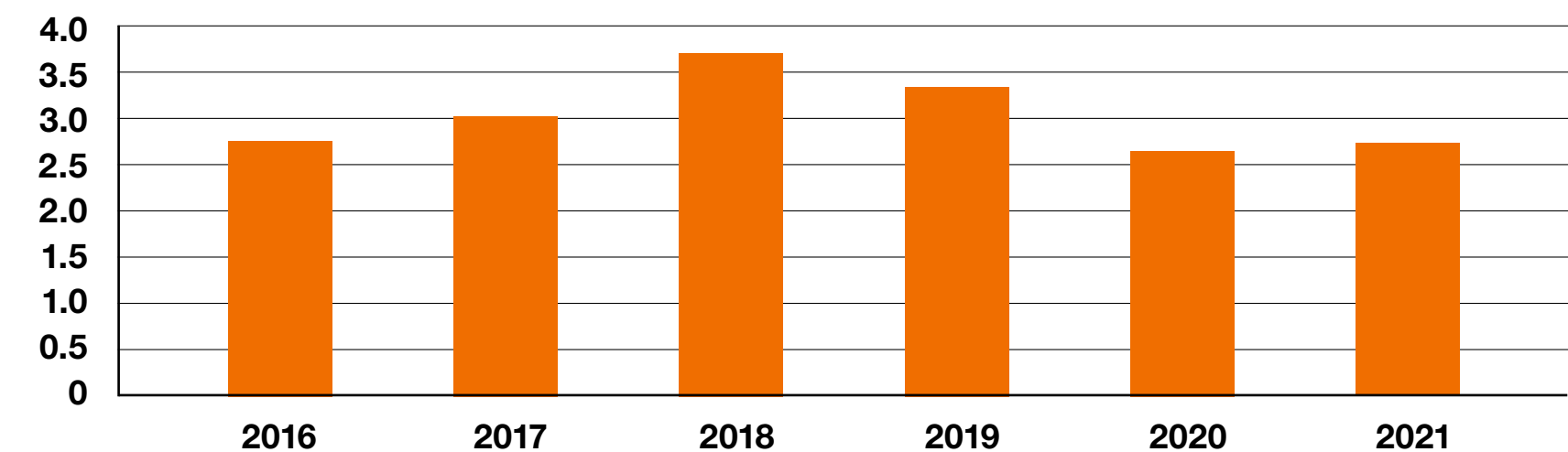
Our IPR is creating new business for our customers

Despite the difficult world situation, our IPR revenue remained at previous year's levels (EUR 2.8 million). Most of the revenue was generated by health technology, process simulation software, spectroscopy, optics, and biotechnology. VTT invested a record EUR 1.9 million in IPR in five growth companies. Additionally VTT's IPR is used as a solid basis for research projects. Through this, it creates important impact and value for our customers.

Clear criteria and an open portfolio boost the value and use of IPR

In 2021, VTT made the practices of IPR protection criteria more effective to enhance IPR value creation from commercial, technological, and protection perspectives. There is extensive cooperation between our research areas, sales organisation, and IPR team so that we can enhance the utilisation of our IPR. The collaboration is based on VTT's multidisciplinary expertise. All VTTers were provided with access to IPR offerings of our research areas. This will boost the use of our IPR in research and make it easier to offer it to our customers.

VTT's IPR revenue, MEUR



2.8

EUR million in IPR revenue

65

priority patent applications

~430

patent families in the patent portfolio

Cooperation and networked activities have an increasingly important role in research

VTT is an active and internationally recognised network actor, and VTT's impact extends over wide areas of society through its customers and partners.

Innovation ecosystem projects are important operating models for networks.

VTT is Finland's largest research institute and one of the most important in Europe. Our activities have a significant impact on society. Network expertise in research and development work lies at the core of our activities. Solutions are created by combining expertise with others. As a neutral state-owned actor, VTT always seeks the best solutions for all parties.

Cooperation and networked activities are assuming an increasingly important role in research. Interdisciplinary approach and activities combining different sectors are becoming more common. The key role played by networks is reflected in our strategy and in our organisation.

We cooperate with a variety of Finnish partners, such as companies, universities, research funders, ministries, industry associations, and local and regional government. We contribute to the formulation of joint views in issues requiring research and technology expertise that are important at national and European levels. For example, VTT is a member of the Tulanet consortium, which can be described as the common voice of research institutes in matters concerning the development of research policy and research systems. We also take part in the activities of many other networks, too, such as Finn-ARMA (which brings together research support and administration experts), and the Inklusiiv network (which promotes diversity and inclusion).

We are helping to make Finland more competitive

We actively cooperate with companies in projects that promote sustainable competitiveness and create new business opportunities. According to the results of our customer impact survey, our overall customer satisfaction score has risen and nearly all parties involved in VTT-coordinated projects feel that targets are met.



According to our customers, VTT often helps companies to access international networks. Most of the respondents are of the view that VTT has helped them to improve their competence level and made their product development processes more efficient.

Many key parts of Finland's national innovation infrastructure are based on VTT's research infrastructure and development platforms, which are also networked at EU level. Companies can also take part in the shared use of infrastructures and in this way create new export products and services.

VTT's pilot infrastructure has been used in a joined project in partnership with Finnfoam and Brightplus in which we have been developing a technology to produce bioplastic from soy industry by-products. A decision to construct a pilot plant in anticipation of the actual production start was made in 2021.

Innovation ecosystem projects are important operating models for broad-based networks, and VTT plays an important role as an actor coordinating and promoting them. With its ecosystems, VTT aims to boost dual transition (sustainable development and digitalisation). Built in 2021, Finland's first quantum computer is an example of our ecosystem at work.

We also play an active role in decision-making and promote the role of the research sector internationally.

Start-ups actively innovating food systems are also an important focus. As part of our ecosystem work, we have constructed tools to support the success of start-ups. The EIT Food Helsinki HUB accelerator programme is the most important of these projects. Coordinated by VTT, University of Helsinki and several companies, the project entered into its second year in 2021. To be accepted in the programme, a team had to present a business model supporting sustainable development and producing innovations for the food system.

Cities are at the core of transport transformation, for there is a huge potential for smart and sustainable solutions in this area. One solution is to introduce data-based transport and mobility services as they help to achieve the transition towards public transport and shared transport services. Test-based development and ecosystems promoting cooperation between companies and the public sector are seen as important tools, and over the past few years VTT has strengthened its expertise in Living Lab testing involving user groups. 2021 also saw the launch of the Tampere Urban Rail Mobility Services (TURMS) development environment. With the City of Tampere and the SmartRail business ecosystem, a developer of light rail solutions, VTT concluded the first agreement on the implementation and funding plan for a world-class urban traffic market and test environment.

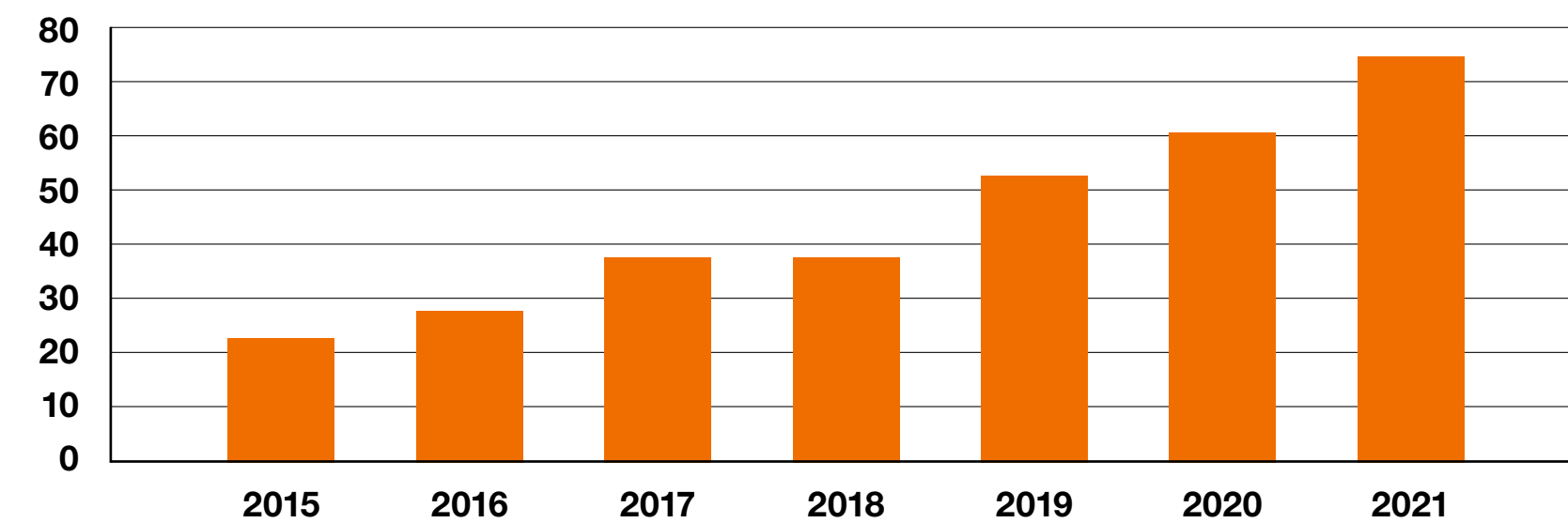
VTT is internationally networked

VTT has joined many European and international innovation communities. We also play an active role in decision-making and promote the role of the research sector as a member of international organisations and by cooperating with the European Commission.

We are actively involved in the work of European public-private partnership technology communities and in four innovation clusters of EIT (European Institute of Innovation and Technology). We play an active research and innovation policy role as a member of EARTO (European Association of Research and Technology Organisations). Antti Vasara, VTT's President & CEO, serves as President of EARTO. At the start of 2021, VTT joined the Global Compact corporate sustainability initiative of the UN. Jussi Manninen, also from VTT, started as a board member of its Finnish network.

One of VTT's ongoing tasks is to support Finland's competitiveness in a sustainable manner, as long-term European cooperation has a major effect on our international visibility and financial performance as well as the impact of our work. Almost all funding for VTT's public international research activities comes from European sources. Despite tough competition, VTT has maintained its position as a key European

Share of Open Access articles (%)



actor, and it remains the largest single recipient of EU research funding in Finland.

The research and innovation framework programmes of the EU are the most important form of public funding for European research and development work. However, VTT also takes part in other EU programmes. In 2021, we played an active role in the development of Horizon Europe, EU's research and innovation framework programme for the period 2021–2027, and the Green Deal digital and industrial strategy of the EU.

Most of our publications are universally accessible

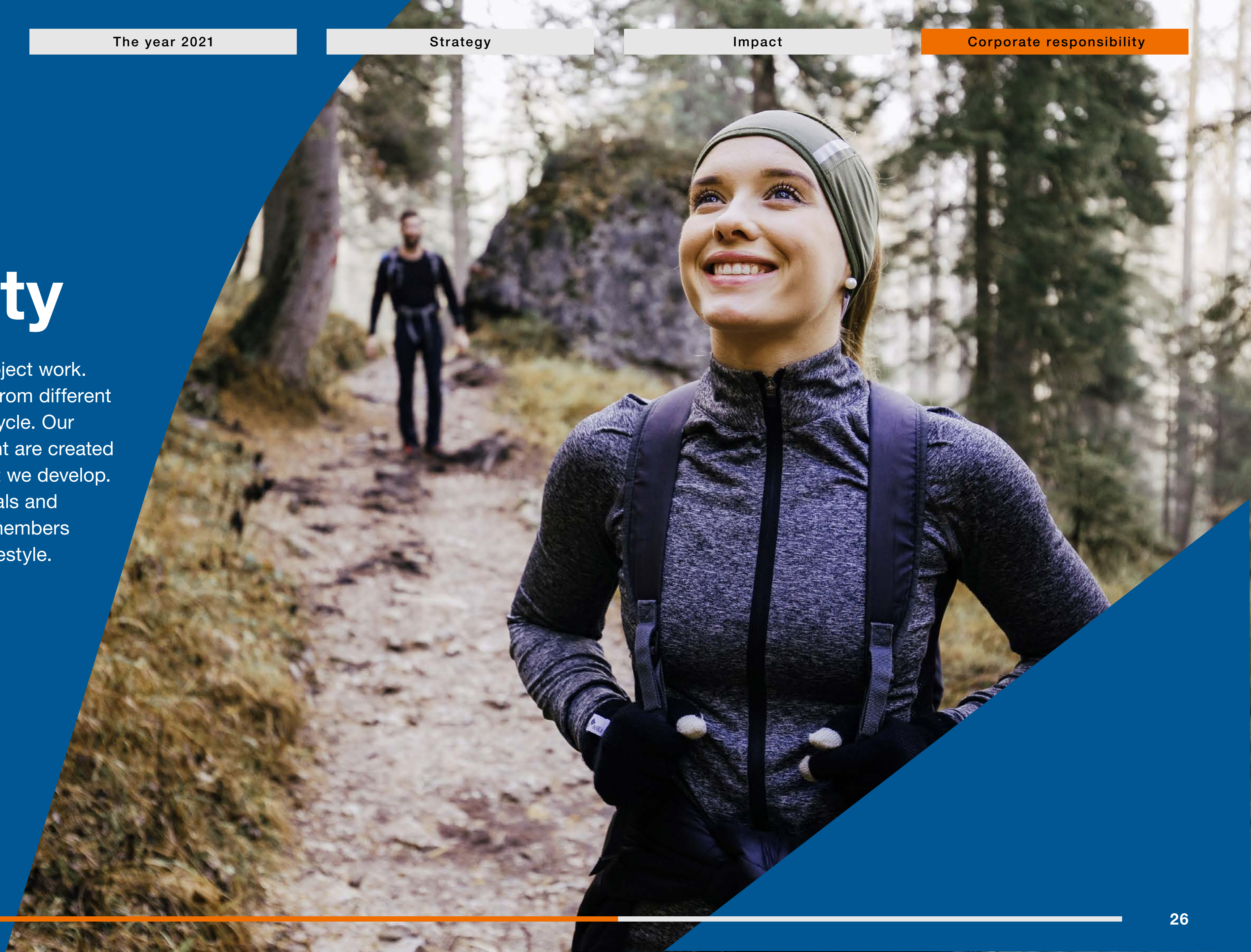
VTT carries out research to find solutions to global challenges, which are discussed in scientific articles and other publications across the world. In 2021, the number of peer-reviewed scientific articles totalled about 540, which was slightly higher than in the previous year. One third of these articles were published in international top journals. We also published conference presentations, books, and articles in trade journals.

Open science and open access make top science universally available. About 75% of all scientific articles published by VTT in 2021 was universally accessible. 2020, in which the figure was 60%. Even though the proportion of universally accessible publications is growing each year, researchers still need older, subscription-based publications: only about one in four of the scientific articles downloaded by VTTers for their own use are freely accessible without paywalls.

The VTT [Research Information Portal](#) contains the details of more than 60,000 publications produced by VTTers. Using a variety of different search criteria, you can find the experts, their areas of expertise and cooperation networks in the system by topic and by theme. All open access publications can be directly read within the system.

Corporate responsibility

Responsibility is at the core of our daily project work. For this reason, we examine responsibility from different perspectives at all stages of a project life cycle. Our most significant impacts on the environment are created through the solutions and technologies that we develop. We want to take care of our top professionals and promote the mental wellbeing of our staff members and encourage them to pursue an active lifestyle.



Working together with our customers to achieve sustainable impact

Corporate responsibility has always been at the core of VTT's activities and our focus here is on the contents of our research and the solutions that we develop. We have also decided to integrate sustainability into our activities more systematically, and it plays a key role in VTT's strategy presented in early 2021.

VTT joined the UN Global Compact initiative on corporate sustainability in early 2021.

Sustainability at the core of VTT's strategy

Sustainability is at the core of our ongoing strategy that was first presented in January 2021. VTT is a research institute and in accordance with this, our core mission is to develop sustainable solutions and technologies for our customers and society at large. VTT's research agenda and research inputs are steered by global challenges and its challenge frame. During 2021, we analysed the match between the priorities set out in the challenge frame and the Sustainable Development Goals (SDGs) of the UN. We identified five key SDGs that are the most relevant to research at VTT and in early 2022, we start to collect data on the match between our project base and SDGs.



Corporate responsibility priorities and sustainability programme

At the start of 2021, we introduced [the priorities to promote sustainability](#) in our work. They have been defined based on a materiality analysis carried out in cooperation with our stakeholders. As an instrument to implement the strategy, we launched the Sustainability@VTT development initiative to coordinate the development of responsible practices at VTT and to make them part of our daily work. During 2021, the key contents of the project included:



1. Compiling the sustainability programme
2. Preparing VTT's carbon-neutrality plan
3. Developing VTT's sustainability indicators (sustainability index and carbon handprint)
4. Incorporating the operating models ensuring sustainability into VTT's project work
5. Identifying VTT's own expert networks and activating them around sustainability work

[VTT's sustainability programme](#) is built around promoting corporate responsibility. In 2021, we defined targets, indicators, and future actions for each of the priorities. They provide the framework for our sustainability programme, which was presented at the end of the year.

Sustainability in research projects

Sustainability plays a central role in our daily project work. For this reason, it is essential to examine responsibility from different perspectives at all stages of a project life cycle. During 2021, we updated sustainability criteria and guidelines for such areas such as the project preparatory stage, the project launch stage, and the final

project evaluation. We developed an operating model and tools for project categorisation and follow-up in accordance with the SDGs. The work will continue in 2022 with process development in the responsibility and trade compliance verifications of our partners and customers.

Focusing on the sustainability of supply chains

Sustainability of supply chains has a major impact on corporate responsibility at VTT because our procurement volumes are substantial. Our key principles for sustainable procurement are set out in [VTT's Supplier Code of Conduct](#) published in 2021. During 2022, we will continue our work to develop sustainability criteria for procurement and to improve the quality of the responsibility data on purchases and suppliers.

Sustainable foundation

We observe the Finnish Corporate Governance Code with certain exceptions, which are described in our own [Corporate Governance document](#). We are responsible with our tax policy, and we report on our tax footprint in a transparent manner as part of our financial statements. We updated our export control instructions in 2021. We observe the Responsible Conduct of Research (RCR) guidelines of the Finnish National Board on Research Integrity. VTT is a member of the FIBS corporate responsibility network.

In 2021, we signed the UN Global Compact initiative on corporate sustainability and joined its Finnish network. At the end of the year, VTT completed the certification of its occupational safety system in accordance with the ISO 45001 standard. The focus in the updated Code of Conduct, to be introduced in early 2022, is on corporate responsibility as a cross-cutting theme in our business operations.

Thriving professionals

As VTTers are at the core of our activities, we take good care of them. We give high priority to safety and in accordance with our occupational safety programme, a good safety level is the minimum requirement in all our activities.

Our safety objective is to ensure that all VTTers come to work healthy and leave work healthy.

1. VTT offers meaningful work that factors in the capabilities, resources, and weaknesses of individuals (physical, psychological and social stress).
2. VTT provides a healthy and safe working environment.

3. Taking risks, deviating from safe procedures and ignoring instructions are forbidden.

We are a member of the Zero Accidents Forum. For us, the Zero Accident policy is not just about injuries but also about the following:

- Zero occupational diseases
- Zero tolerance for bullying
- Zero sick days resulting from work
- Zero unaddressed incidents of violence and harassment
- Zero burnouts
- Zero managers and employees who are unfamiliar with occupational safety issues

Anyone working in VTT's premises must have valid occupational health and safety certification. In the spirit of our common workplace safety practices, the policy applies to both VTT employees and anyone representing our partners. The requirement applies to all work, except for work in offices and at computer terminals.

Calculated using the method of the Finnish Workers' Compensation Center, the accident frequency in the parent company stood at 0.76 per million hours worked.

Physical impacts, slips, falls, and chemicals were the most common causes of injuries and accidents requiring first aid. VTT also registered one work-related accident in remote work: a portable computer fell on a staff member's toes. VTT did not register any serious workplace injuries among its own personnel during 2021.

Our KPI for the seriousness of workplace injury in the parent company was 9.0 sick days per accident.

Our 'monthly safety observation' procedure boosts awareness of safety issues. A significant observation or several observations of the same issue are considered in the procedure. The individual reporting the featured incident receives a small prize. Safety observations were made on issues such as the use of personal protective equipment, emergency preparedness, storing of chemicals, marking of containers, gas detectors, and lithium-ion batteries.

At VTT, safety is integrated into everyday activities and provides a sustainable basis for responsible operations. We want to take care of our personnel and stakeholders. The ISO 45001 certificate granted to VTT in December 2021 shows that we have successfully achieved this goal.

Only 0.76 workplace injuries in the VTT parent company/million hours worked.

VTT's sustainability program

Thriving experts

We treasure the wellbeing, diversity and fair treatment of our brilliant minds.

Strategic choice:

Always build the world's most meaningful place to work

Empowered customers

We help our customers to unleash superior performance and productivity that lead to sustainable growth.

Strategic choice:

Always create impact together with a customer

Resilient society

We solve the world's biggest challenges through innovations, research and co-operation.

Strategic choice:

Always aim for impact

Sustainable Foundation

We are an all-round sustainable company from an environmental, societal, and financial point of view. Impeccable ethical practices – impartiality, reliability, integrity and responsibility – form a solid basis for our business. All our operations are continuously developed to reduce our environmental footprint and enhance our handprint.

Strategic choice:

Always drive sustainable business

Strategic choice: Always lead for excellence

VTT stakeholder interaction

VTT is engaged in a continuous dialogue with its key stakeholders. Customers, personnel, financiers, owners and the research community are our most important stakeholders. In addition to engaging in direct communication and discussions with our stakeholders, we also collect information about their views in surveys and interviews, such as customer satisfaction, customer impact and personnel satisfaction surveys, by taking part in the Reputation&Trust survey and by collecting feedback on ownership steering.

Stakeholder group	Customers	Owner	Financiers	Personnel	Research community
Expectations	<ul style="list-style-type: none"> VTT helps its customers to boost their own expertise and capabilities. VTT supports the identification and evaluation of new opportunities and accelerates research and product development. Excellent customer service and smooth, flexible, operating methods in projects. Working with VTT helps customers to establish networks in research and innovation ecosystems. 	<ul style="list-style-type: none"> Being a state-owned company operating in the administrative branch of the Ministry of Economic Affairs and Employment, VTT has corporate social responsibility as its fundamental value. Owners expect VTT to be a pioneer in the transition to a carbon-neutral circular economy, use of digitalisation, and responsibility. Responsibility must be a consideration when we set our remuneration criteria. VTT focuses its services on the strategic priority areas of the Finnish economy, strengthening national and international partnerships between the private and public sector and internationally attractive innovation clusters, and making Finland more appealing to foreign experts and investments. 	<ul style="list-style-type: none"> A mission-oriented approach and identifying the opportunities arising from global challenges are now at the core of institutional and government activities. With its policies, budgeting and research and development programmes, the European Union is at the forefront of mission-based and sustainability-based thinking, and this is strongly reflected in the funding criteria. Inclusive and competent Finland – a socially, economically and ecologically sustainable society’, the programme of Finland’s current government, is also phenomenon-based. This is reflected in the expectations and requirements of domestic providers of funding. Financiers expect VTT to act in a responsible and ethical manner in matters concerning research content and in its own operations. 	<ul style="list-style-type: none"> Interesting work content Meaningful work Competitive salary and other benefits Good working conditions, good leadership and good balance between work and leisure Fair and just treatment 	<ul style="list-style-type: none"> Research cooperation in which the expertise and capabilities of the parties involved complement each other in an innovative manner Cooperation in the use and development of research infrastructure Research cooperation in innovation ecosystems and research projects Promotion of open science
VTT’s response	<ul style="list-style-type: none"> Customer satisfaction with our projects remained high (NPS 69). According to our customer impact survey, 49% of the projects carried out in cooperation with VTT helped customers to integrate into international networks. 	<ul style="list-style-type: none"> VTT promoted sustainable development and well-being in Finland by channelling research to the societal, systemic and technological challenges in which it could generate the maximum impact and solve some of the most wicked problems of our time. Coordinated or implemented by VTT, a number of studies and research projects were under way under the auspices of the Prime Minister’s Office. The projects improved the quality and impact of national decision-making by strengthening the knowledge base of the preparation and decision-making in policy matters concerning society at large and implementation of the decisions. VTT participated in the flagship programmes of materials bioeconomy, the Finnish Center for Artificial Intelligence and photonics research and innovation funded by the Academy of Finland, and in the Centre of Excellence in Quantum Technology. VTT plays a key role in a number of knowledge and innovation ecosystems that develop special sectoral expertise for Finland and create economic growth for them. 	<ul style="list-style-type: none"> VTT has already updated its challenge-oriented strategy. VTT’s research agenda is guided by the challenge frame, our new operating framework. We respond to systemic and technological challenges, explore new challenges and support society in the challenges it faces. Our updated strategy brings experts together to deal with key challenges to produce effective solutions to the climate crisis, resource sufficiency, industrial renewal, safety and security and wellbeing. VTT’s challenge frame is also in line with the UN’s Sustainable Development Goals. 	<ul style="list-style-type: none"> Continuous investment in fair and coaching-oriented leadership. Coaching programmes for a coaching leadership style and emotionally intelligent leadership intended for line managers. Staff members’ wishes for the development of work and competence and their wellbeing are highlighted in goal and development discussions. The Navigator personnel survey provides an opportunity to hear staff members’ views on their expectations and to what extent they have been realised. The results published at the end of 2021 were excellent. In addition to VTT’s reputation, interesting tasks are highlighted as the key factors strengthening commitment in the personnel survey. Investing in comprehensive physical and mental wellbeing and creating an extensive wellbeing programme help our staff members to cope at work and achieve the right balance between work and leisure time. With its remuneration policy, VTT aims to ensure a fair, transparent and competitive approach to remuneration. 	<ul style="list-style-type: none"> Joint research projects Research collaboration with the international research community and organisations Joint scientific publications Visiting researchers and professors Partnership cooperation Participation in international research seminars

Achieving results and generating wellbeing with good leadership

We work hard to ensure the excellence and wellbeing of our personnel. We promoted mental wellbeing and an active and healthy lifestyle. We were ranked among the top ten employers by natural science and engineering professionals.

VTT is an encouraging and inspiring workplace community for top talent.

VTT is an expert organisation in which continuous learning and development of expertise are key priorities. Excellence in the selected areas lies at the core of our success.

Continuous development of leadership

The Tunto2 – Tunnetoimijuus (emotional agency) programme was our largest development package in 2021. We took part in research and development projects that support our strategic approach and enhance the emotionally intelligent leadership skills of our leaders and line managers. About 180 VTT leaders and line managers took part in the training. We also developed high-quality leadership practices by continuing coaching & feedback training. Virtual coaching for experts continued and was made more extensively available.

With the organisational changes introduced in spring 2021, we enhanced the skills of units' leadership teams to promote excellent leadership and teamwork.

Manager Toolbox was used to provide new line managers with induction into everyday leadership practices and 174 managers took part in the training provided in its modules.

Onboarding and new skills

Newcomers will only become committed VTTers if they are provided with proper onboarding. Because of COVID-19, onboarding involved numerous challenges. Despite this, we warmly welcomed new personnel to VTT even though we were unable to do it face to face. Onboarding also promotes networking and familiarises newcomers with VTT's corporate culture. All eight Discover VTT onboarding events were carried out virtually and they were attended by 178 new VTTers.



Project management coaching was increasingly provided as multiform studies based on the hybrid model. Mentoring remained an important development tool. A total of 97 persons took part in our internal and external mentoring programmes.

We tested a range of different tools supporting digital learning. They included the LinkedIn Learning platform and the Bookboon e-library.

At the end of the year, we again carried out the Navigator personnel survey, and as before, the response rate was high (87%). Overall results were excellent; both our organisational culture score and our promoter score were higher than in the previous survey. Detailed survey results and measures to be taken on their basis will be discussed in early 2022.

Mental wellbeing and active lifestyle

In wellbeing, the focus was on mental wellbeing and active and healthy lifestyle. We provided our personnel with a comprehensive package of wellbeing services and tools as well as campaigns and lectures covering a range of different themes. The work was launched with online coaching with a focus on mental wellbeing, physical exercise, and diet.

The teams could choose between three different team workshops promoting wellbeing. The themes were: self-management and time management, building an effective hybrid team, and exercise and tips to support healthy minds and bodies. We provided VTTers with lectures on occupational psychology, and peer groups supporting wellbeing were set up for line managers.

We updated the Wellbeing Champion network, which was itself established in 2020. It arranged events enhancing wellbeing and promoted the use of wellbeing tools.

In recognition of its support for mental wellbeing, VTT received the [Hyvän mielen työpaikka](#) (“Workplace with a good feeling”) recognition granted by the association Mieli ry for the second time.

Health of middle-aged people and psychological factors affecting the last years of working life were some of the new themes discussed in expert lectures.

The impact of dietary habits on wellbeing was covered in a training package arranged in cooperation with a nutritional therapist of the occupational health care services. It comprised five nutritional information sessions and discussions with individual staff members.

There was more emphasis on ergonomics as remote work continued. An occupational physiotherapist held information events for staff members working remotely

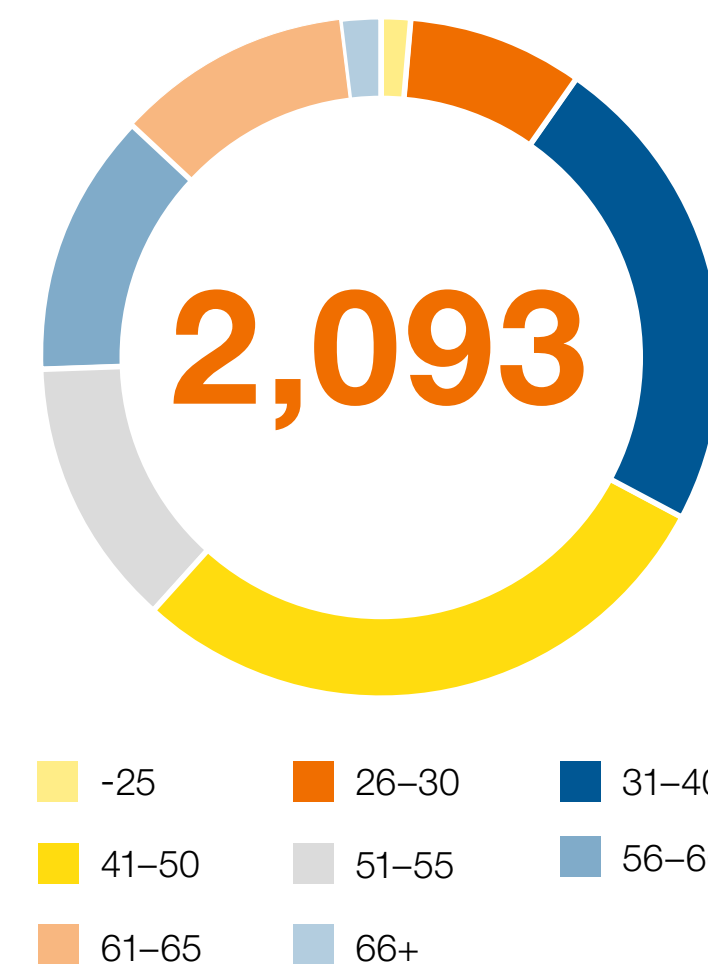
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different nationalities

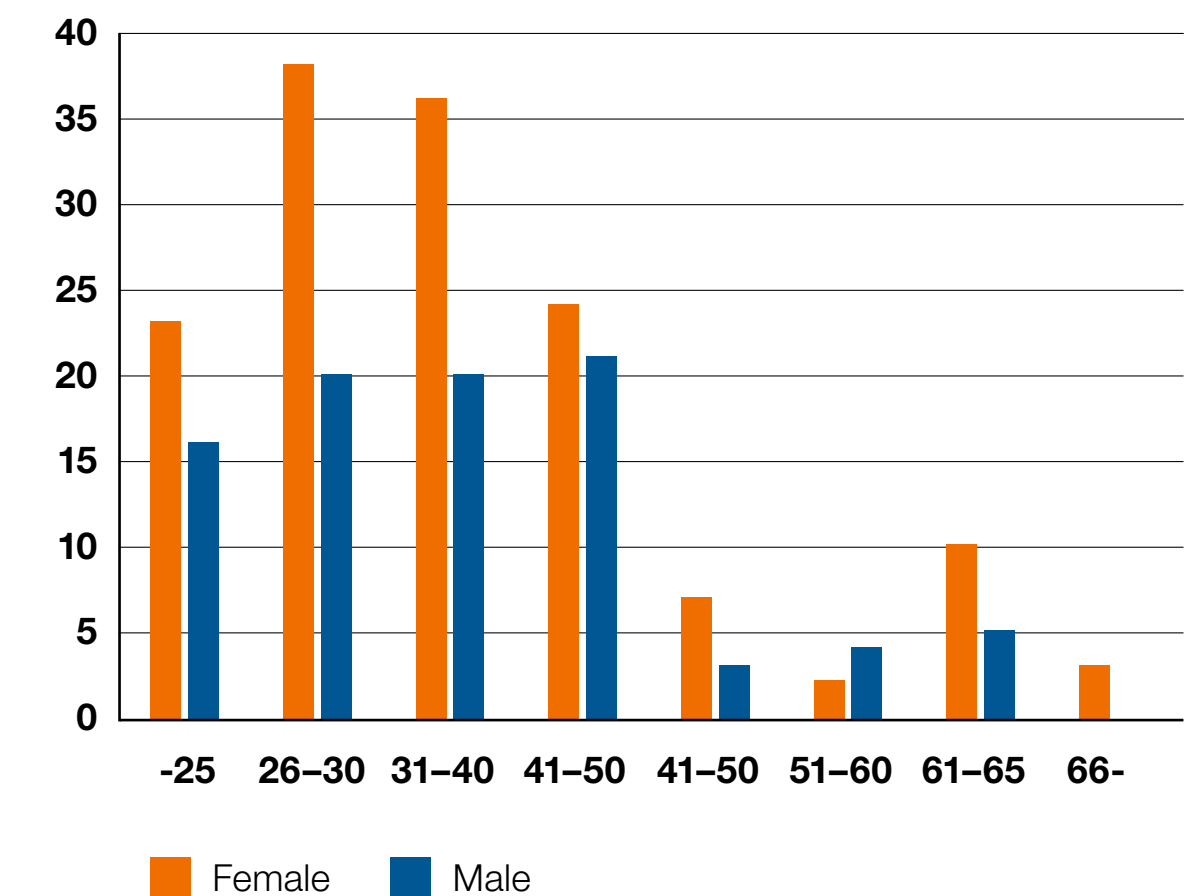
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serious occupational accidents

Employees by age



New employee hires by age groups and gender



and those working in the office, and we reminded VTTers of ergonomic instructions and the need for breaks. We also introduced a new break exercise programme.

Gyms in different localities were available to VTTers in accordance with COVID-19 restrictions. A total of 1,739 VTTers used the sports and cultural services provided by Smartum, and 60% of the benefits were used for sports services.

In the autumn, we offered flu vaccinations for personnel and they were taken by 1,191 VTTers.

Further improvement in employer image

Our employer image is based on our employer promise: join us in building a brighter future. VTT is an encouraging and inspiring workplace community for top talent. We focus on wellbeing.

According to the survey among engineering professionals carried out by T-Media in early 2021, VTT's reputation and employer image have improved considerably since the last survey conducted in 2017. In 2021, VTT received an overall score of 3.81 (on a scale of 1 to 5). In 2017, the overall score was 3.58. Overall reputation was assessed in eight areas: workplace, responsibility, administration, finances, products and services, management, interaction, and renewal. VTT improved its score in all sectors and was ranked 'good' or above in each of them. We did best in responsibility (4.20).

In the employer image survey carried out by Universum among students in the spring, we were ranked 13th amongst natural science students and 20th among engineering students. In the professional survey carried out in autumn, VTT was ranked seventh by both engineering and natural science professionals.

We launched the new VTT Summer of Changemakers summer job programme in January 2021. The recruiting campaign that was carried out in connection with the programme was a success, and achieved broad visibility on different channels. The number of summer job applicants increased by 148% compared to the previous year's campaign. We employed 65 summer trainees in different parts of the organisation through the campaign.

Rewarding

Rewarding at VTT comprises financial rewards, wellbeing at work, corporate culture, and the development of expertise. Rewarding helps us to implement our strategy and to achieve our goals. Most of the financial rewards are granted as recognitional rewards in which the focus is on promoting excellence and boosting impact.



VTT received the Hyvän mielen työpaikka (“Workplace with a good feeling) recognition granted by Mieli ry for the second time.

In 2021, a total of 373 VTTers received recognition awards. The Customer Excellence award encouraging teams to achieve excellence in customer work is also an important form of reward. In 2021, we also introduced a flexible system of small-scale employee recognition, in which staff members can receive immaterial gifts.

The Leadership Excellence Reward is intended for VTT management, and its criteria comprise company-level, business area-level, and personal targets.

Health and safety given priority during COVID-19

VTT's coordination group continued its work during the coronavirus pandemic. In addition to senior management representatives, the group also comprised members from all parts of the organisation, and it usually met on a weekly basis. The instructions were updated, and VTTers were provided with information through different channels regularly. The main aim was to ensure the health and safety of all staff members.

Almost all VTTers worked remotely for most of 2021. Special measures were taken to ensure the continuation of experimental work in the research facilities. As the pandemic continued, we introduced further measures to support both physical and mental wellbeing and work capacity. Line managers were also provided with regular training.

Close cooperation with occupational health care continued and we urged staff members to take COVID-19 tests provided by occupational health care already when mild symptoms appear. The infection rate remained low during 2021.

Towards carbon neutral VTT

Environmental responsibility lies at the core of sustainability. Our most significant impacts on the environment are created through the solutions and technologies that we develop. We also take care of the direct environmental impacts of our own actions and take active measures to reduce them.

Renewable electricity verified with a guarantee of origin reduced our greenhouse gas emissions.

VTT's environmental policy sets the framework for our environmental approach:

1. We create sustainable solutions to major societal challenges in our research projects.
2. We support our customers in the development of environmentally friendly innovations.
3. We encourage our staff to make sustainable choices.
4. We comply with the statutory requirements and other binding obligations that apply to our operations.
5. We continuously improve our management system to enhance environmental performance.

We have developed a carbon handprint indicator to assess the positive environmental impacts of our research work

VTT's carbon handprint is created in our research and customer projects. It shows how our work helps to reduce greenhouse gas emissions in our customer organisations and in society at large. Throughout 2021, we worked to develop a method and an indicator to assess our carbon handprint. Identifying the projects that have positive climate impacts is used as the main source data for the carbon handprint. Of the identified projects, we select the subgroup for which more detailed carbon handprint analyses will be carried out. The overall assessment of VTT's carbon handprint is based on these analyses.

From 2022 onwards, we will apply the assessment of the carbon handprint in practice. We are also planning to expand the impact assessment to other areas of sustainability.

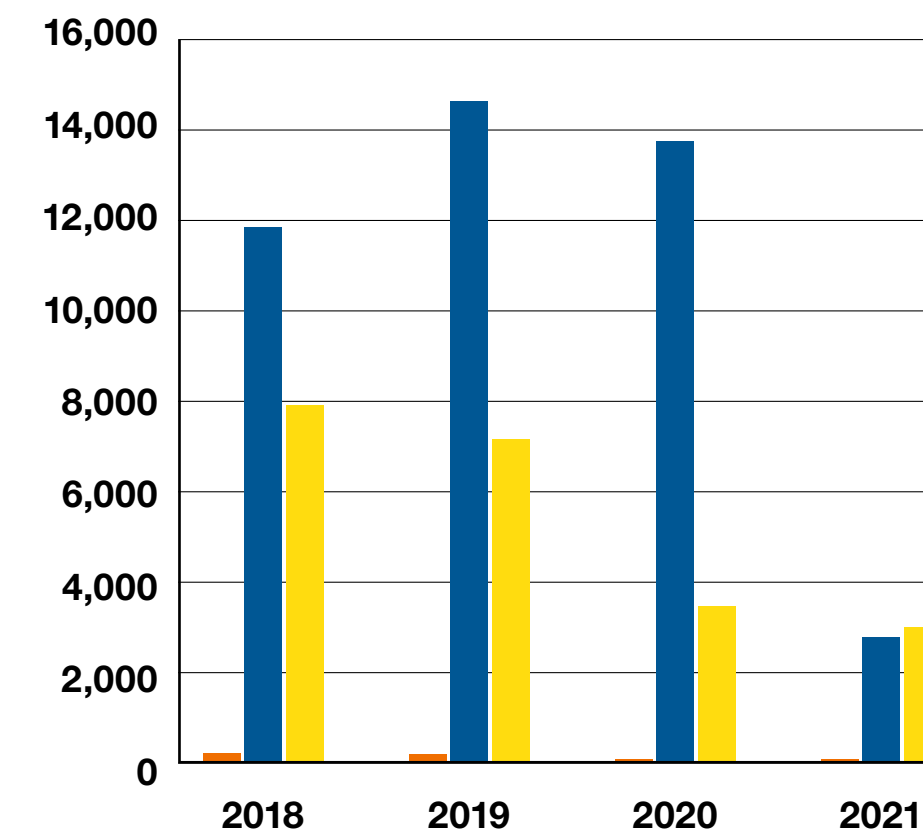
VTT's target is to be carbon neutral by year

2030

The amount of renewable energy granted a certificate of origin

93%

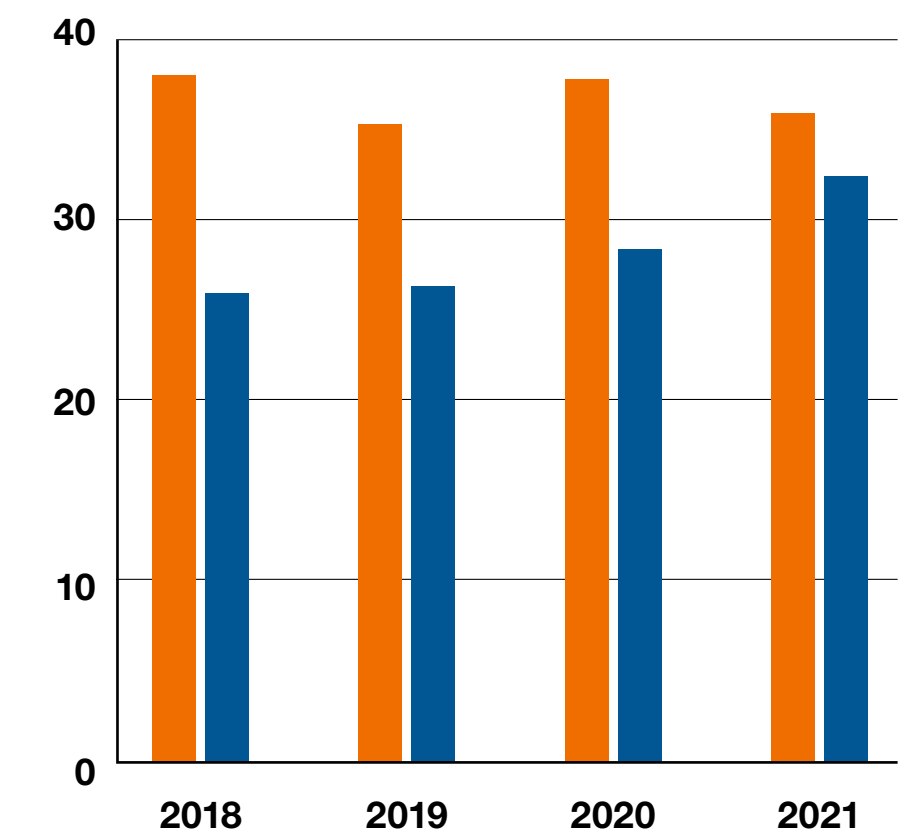
VTT's estimated GHG emissions (as tonnes of CO₂ eq)*



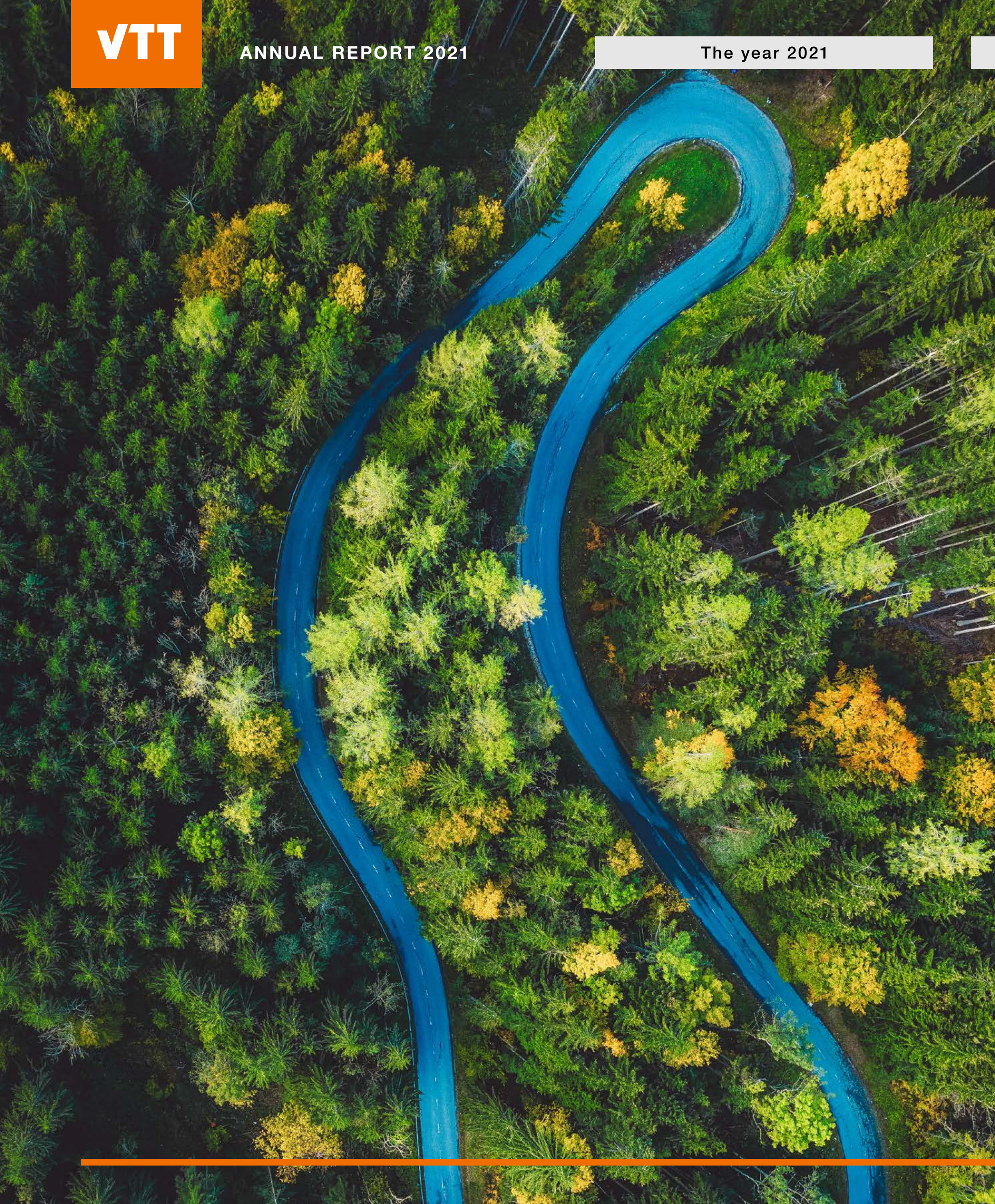
- Scope 1 Direct emissions
- Scope 2 Energy indirect emissions
- Scope 3 Other indirect emissions

*Reporting was conducted according to the main principles of ISO 14064-1 and the GHG Protocol.

Consumption of electricity and heat, GWh



- Electricity
- Heat



Towards carbon neutral VTT

Our strategic goal is to achieve carbon neutrality by the year 2030. In 2021, we continued to develop VTT's carbon footprint calculation and related life cycle-based assessment model. Using the model as a basis, we defined the path towards a carbon neutral VTT (the areas where reductions in our carbon dioxide emissions will be achieved next).

In January 2021, we changed over to renewable electricity verified with a guarantee of origin, which significantly reduced our annual fossil greenhouse gas emissions. The reduction in air travel caused by COVID-19 also kept estimated indirect emissions at fairly low levels, compared with previous years.

In 2022, we will continue to focus on the environmental impacts of travel by applying our new travel policy emphasising sustainability. We will improve the assessment of upstream emissions impacts in a joint effort with suppliers of goods and services and examine whether we could change over to carbon-neutral district heating in all our facilities.

We have an impact on environmental matters at the level of society

We also provide other parties with expert assistance in environmental matters. It is important that there is a solid knowledge base for decision-making and public debate. Our researchers took part in 19 Finnish parliamentary committee hearings on energy and environmental issues as invited experts or by submitting written statements. VTT also contributes to environmental protection as a member of the Climate Leadership Coalition. We also signed the UN Global Compact initiative on corporate sustainability in early 2021, joined its Finnish network, and took part in the Climate Ambition Accelerator programme.

Environmental management at VTT

An executive vice president nominated by the VTT Executive Leadership Team, is responsible for the overall development of environmental management at VTT. The head of each research area is responsible for meeting the environmental obligations applying to its work. As members of the QEHS (quality, environment, health, safety/security) team, our own quality, environmental and sustainability experts work to ensure that environmental matters in our organisation are properly coordinated and that VTT complies with the standards ISO 9001 and ISO 140001. The distinctive features of our operations, in particular the extent and nature of experimental research, impact the way environmental matters can be best considered in different parts of the organisation.

Assessment of the positive impacts of VTT's project activities is making progress.

GRI index

Standard	Indicator	Reported fully ● partly ◐ not included ○	Link or explanation
102 (GRI 2016)	Organisational profile	●	AR = Annual Report 2021 , CoC = Code of Conduct , MA = Management approach annex
102-1	Name of the organisation	●	Key facts of VTT
102-2	Activities, brands, products and services	●	Research results, AR 7, 14–20 Key facts of VTT
102-3	Location of headquarters	●	Key facts of VTT
102-4	Location of operations	●	Key facts of VTT
102-5	Ownership and legal form	●	CoC 4
102-6	Markets served	●	AR 22
102-7	Scale of the organisation	●	AR 6, 8, 21–22
102-8	Information of employees and other workers	●	Total number of employees by contract type and gender
102-9	Supply chain	◐	MA VTT uses Hansel's services in procurement. Responsibility Supplier Code of Conduct .
102-10	Significant changes to the organization and its supply chain	●	No significant changes in the organization and no change the scope of the GRI-report.
102-11	Precautionary Principle or approach	●	The State owned bodies are following the precautionary approach although it is not any more explicitly mentioned.
102-12	External initiatives	●	CoC 4 AR 27–28, 30 VTT sustainability webpage
102-13	Membership of associations	●	Because of corporatization VTT has joined to Palta ry.
102-14	Statement from senior decision-maker	●	AR 4
102-16	Values, principles, standards, and norms of behavior	●	CoC
102-17	Ethics and integrity	●	VTT has ethics committee, compliance officer and ethics contact network to support organization in any ethics related questions and solve any concerns. VTT also participates and complies to rules of Finnish national board on research integrity TENK.

Standard	Indicator	Reported			Link or explanation
		fully ●	partly ◐	not included ○	
102-18	Governance structure		●		Tax footprint, management and control annex VTT's Corporate Governance The administration code of Finnish listed companies VTT's Board has audit and remuneration committees.
102-40	List of stakeholder groups		●		AR 30
102-41	Collective bargaining agreements		●		Essentially 100%, only top management is outside collective bargaining agreements.
102-42	Identifying and selecting stakeholders		●		AR 30
102-43	Approach to stakeholder engagement		●		MA AR 30
102-44	Key topics and concerns raised		●		AR 30 Materiality matrix of stakeholders' priorities
102-45	Entities included in the consolidated financial statements		●		Annual Report 2021
102-46	Defining report content and topic Boundaries		●		MA Government ownership steering requires government-owned companies to submit reports in a specific format. Ownership policy Materiality matrix of stakeholders' priorities
102-47	List of material topics		●		201-1, 201-4, 203-1, 207-1, 301-1, 302-1, 303-5, 305-1, 305-2, 305-3, 305-5, 306-3, 307-1, 401-1, 403-2, 403-3, 403-4, 403-5, 403-6, 403-7, 403-9, 404-1, 405-1, 406-1, 408-1, 409-1, 415-1, 416-1
102-48	Restatements of information		●		No major changes.
102-49	Changes in reporting		●		No major changes.
102-50	Reporting period		●		Calendar year 2021
102-51	Date of most recent report		●		13th April 2022
102-52	Reporting cycle		●		Annually, typically on March/April
102-53	Contact point for questions regarding the report		●		kirjaamo@vtt.fi
102-54	Claims of reporting in accordance with the GRI Standards		◐		This material references partly to Global Reporting Initiative GRI Standard 2016/2018/2019/2020. The scope is 'Core'-option, however not all criteria are met. Those have been marked in this table as ◐.
102-55	GRI content index		●		This table
102-56	External assurance		○		The report has not been externally confirmed.

Standard	Indicator	Reported fully ● partly ◐ not included ○	Link or explanation
200 (GRI 2016, except 207 (GRI 2019))	Management approach		MA
201-1	Direct economic value generated and distributed	●	AR 6, 8
201-4	Financial assistance received from government	●	AR 8
203-1	Infrastructure investments and services supported	●	Annual Report 2021
207-1	Approach to tax	●	Tax footprint, management and control annex
300 (GRI 2016, except 303 (GRI 2018) and 306 (GRI 2020))	Management approach		MA
301-1	Materials used by weight or volume	◐	Amount of printings Consumption of paper reams
302-1	Energy consumption within the organization	◐	Consumption of electricity Consumption of heat
303-5	Water consumption	●	Consumption of water
305-1	Direct GHG emissions	◐	Total GHG emissions
305-2	Indirect GHG emissions from energy	◐	GHG emissions according to sources
305-3	Other indirect GHG emissions	◐	GHG emissions according to sources
305-5	Reduction of GHG emissions	●	In January 2021, we changed over to renewable electricity verified with a guarantee of origin, which significantly reduced our Scope 2 indirect GHG emissions. In previous years, purchased electricity was the single biggest contributor to our total (Scope 1-3) GHG emissions .
306-3	Waste generated	●	Amount of waste Hazardous waste to Ekokem by road (ADR) No hazardous waste exported nor imported. No hazardous waste treated. No hazardous waste shipped internationally.
307-1	Non-compliance with environmental laws and regulations	●	No compliance breaches has been identified.

Standard	Indicator	Reported fully ● partly ◐ not included ○	Link or explanation
400 (GRI 2016, except 403 (GRI 2018))	Management approach		MA
401-1	New employee hires and employee turnover	◐	New employee hires by age group and gender (Region is Finland for all hires)
403-1	Occupational health and safety management system	●	MA Whole VTT Group personnel (with the exception of VTT SenseWay Oy personnel) are within OHS management system.
403-2	Hazard identification, risk assessment, and incident investigation	●	MA
403-3	Occupational health services	●	MA VTT provides more comprehensive health services than required in legislation.
403-4	Worker participation, consultation, and communication on occupational health and safety	●	MA
403-5	Worker training on occupational health and safety	●	MA
403-6	Promotion of worker health	●	MA AR 31–33
403-7	Prevention and mitigation of occupational health and safety impacts directly linked by business relationships	●	MA
403-9	Work-related injuries	●	Frequency and gravity of accidents
404-1	Average hours of training per year per employee	◐	Training expenses and days (Education and training costs)
405-1	Diversity of governance bodies and employees	◐	Age structure and gender distribution Share of men and women In VTT's Board there are two women and five men.
406-1	Incidents of discrimination and corrective actions taken	●	No discrimination cases identified.
408-1	Operations and suppliers at significant risk for incidents of child labor	◐	MA Coc 10
409-1	Operations and suppliers at significant risk for incidents of forced or compulsory labor	●	MA Coc 10
415-1	Political contributions	●	No contributions has been rendered
416-1	Assessment of the health and safety impacts of product and service categories	◐	Research concerning health technology and foodstuff, AR 15, 16, 18

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