



# VTT Review 2017





The VTT Review 2017 consists of reports in PDF format and complementary online content:

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# VTT 2017, key performance indicators and financial statement



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# Key performance indicators 2017

Net turnover and  
other operating income\*

**258 M€**

Invention disclosures received

**237**

45 priority patent applications\*\*

Patent families\*\*

**364**

Patents or patent applications\*

**1,324**

751 patents granted,  
573 pending patent applications\*\*

Publications

**1,345**

In VTT's own publication  
series 61\*\*

International scientific  
articles\*\*

**610**

Personnel 31.12.2017\*

**2,368**

Doctors and licentiates\*

**27%**

University-level degree\*

**80%**

\*VTT Group

\*\*Parent company

## President & CEO's review

The year 2017 was a positive one for VTT in many respects. For years now, we have been working persistently to build VTT into a more customer-oriented and relevant partner for business life and society. We seek to understand the needs of companies and society better and to create business opportunities together, even in the face of great challenges. Last year, we consequently witnessed improvements in customer feedback, trust in VTT and our attractiveness as an employer. For this, we are proud and thankful.

It is also noteworthy that, once again, we were one of the most successful applicants in the EU's Horizon 2020 framework programme and received significant support for our scientific research, with which we are seeking to respond to global challenges, such as climate change, resource sufficiency and safety and security, renew Finland's industries and improve lives in every respect.

The year involved some challenges as well. The grants budget of Tekes (now Business Finland) has decreased dramatically in the past few years. VTT has traditionally been one of the largest implementers of Tekes projects, and the drastic drop in funding has been clearly reflected in our operations. We believe that we will be able to make up for the decrease in Finnish innovation funding by being more active in other types of operations. In the long term, however, we are concerned for the future of Finland's innovation system. The seamless cooperation between companies, research institutes and universities has been one of the "secret weapons" for ensuring Finland's international competitiveness. For years, Tekes played a significant role as a funder of these innovation ecosystems and technology platforms, and a Finnish replacement has not been found to date. I hope that a solution will present itself in the future.

We also invested more in the development and well-being of our personnel in 2017. We are competing for the best experts with business life and the academic world. On the one hand, our work requires a high degree of academic merit, in addition to which we need to be able to operate according to the laws and management methods of the private sector. We are committed to the training and occupational well-being of our personnel. In recognition of our work for increasing the well-being and activeness of our personnel, VTT received the Finnish Olympic Committee's "Most Active Workplace in Finland" award at the Urheilugaala sports gala in January 2018.

I would like to extend my heartfelt thanks to all VTT employees, our customers and our partners for the past year. It is a great joy to build a brighter future with you.

President & CEO  
Antti Vasara





# Strategy 2016 - 2020

## Vision

A brighter future is created through science-based innovations.

## Mission

VTT helps customers and society to grow and renew through applied research.

## VTT strategy: we make an impact through scientific and technological excellence

Challenge-driven way of working and excellence in science and technology are at the core of VTT's strategy.

VTT aims at understanding customers and society's needs and opportunities by working in a challenge-driven way. VTT co-develops impactful solutions to match these needs. In this way we help customers to succeed and promote sustainable growth and wellbeing in the society.

Scientific and technological excellence in all our work is the basis for VTT's impact. To further develop our competencies and identify new growth opportunities, we work with demanding customers and challenges around the world.

People at VTT make us unique. Wellbeing and competence development ensure that VTT people succeed in their work for customers. Built on our knowledge, partnerships, unique research infrastructure and IPR, we collaboratively develop timely and commercially competitive innovations.

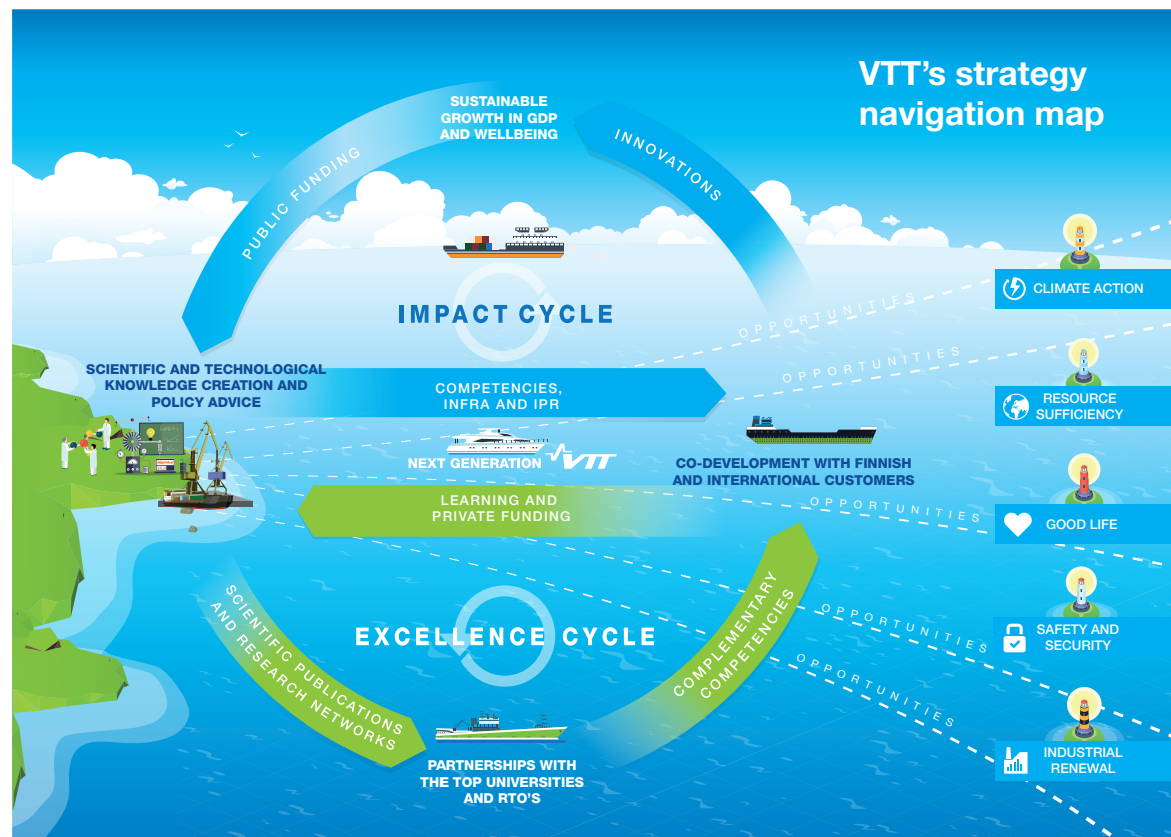
VTT achieves world class research and development by focusing its research on the following societal challenges and growth opportunities for Finland. We call these VTT Lighthouses:

- **Climate action**
- **Resource sufficiency**
- **Good life**
- **Safety and security**
- **Industrial renewal**

## How we work at VTT?

Our impact and excellence in science and technology are concretised in eight strategic choices that rise from market trends and customer needs. They describe how and on what grounds we make choices at VTT.





## IMPACT FROM VTT

- 1 We work in a challenge-driven way to create solutions to the current and future needs of our customers and society.
- 2 We formulate our research agenda based on future market growth opportunities (lighthouses).
- 3 We co-develop with customers according to differentiated service models matching their needs.
- 4 We proactively bring different customers and partners together around ambitious innovation initiatives.

## EXCELLENCE FROM VTT

- 5 We want to learn and improve. That's why we continuously evaluate the impact of our work.
- 6 We always improve our way to lead people and substance to ensure excellence and continuous competence development.
- 7 We work with leading international customers and partners to further develop our competencies and identify new growth opportunities.
- 8 We invest in excellence through funding from multiple public and private sources.

# Organisation and Leadership Team

## 1.3.2018



# Business areas

We work in close cooperation with domestic and global customers and partners. We create diverse ecosystems and bring different operators, capabilities and competencies in the value chain together in order to achieve common goals.



## Knowledge-intensive products and services

The digital revolution of society provides an opportunity to create growth stemming from new innovations, business models and their combinations.

Utilising the changes brought by digitalisation, particularly in the manufacturing industry and health care sector, will require visionaries and new technological solutions. Indeed, our research focuses on disruptive technologies linked to digitalisation: sensors, data communications, information security, data analytics, digital platforms and safe autonomous systems.

We have unique research facilities and pilot environments available for our scientific work. From successful pilot projects, we have built the PrintoCent and 5GTN innovation ecosystems, making use of printed functionalities and the 5G test network, and a nano and micro electronics business ecosystem that leverages the micro and nano technology research centre Micronova. The pilot environments are also open to our customers and partners for the quick and cost-effective development and demonstration of new and innovative products, services and solutions.

## Solutions for natural resources and the environment

The transition to a sustainable economy requires society and companies to be able to increase the value production of material flows, extend the life spans of products and materials and replace fossil-based raw materials with renewable alternatives.

The nascent bio and circular economies need sustainable, value-adding products, resource-efficient technologies and efficient process management. Our areas of expertise include industrial biotechnology and innovative food solutions, biomass processes and products, along with sustainable energy solutions and chemical technology. By combining these key areas of expertise with our VTT-wide expertise in digitalisation and manufacturing technologies, we can help the process industry renew itself.

We have demonstrated experience in the development of new processes and product concepts from ideas, through the laboratory phase and into industrial pilot production. Our versatile pilot facilities, modelling expertise, techno-economic assessments and environmental impact assessments help accelerate the R&D process.

## Smart industry and energy systems

Our goal is to create a new competitive edge by developing smart solutions for industrial and energy systems. Wide-ranging changes in industry, energy production and the energy system are a particular focus of our research.

The business area works closely with the industry, with innovation ecosystems in fields such as autonomic systems, intelligent industry, energy and transport as essential aspects of this cooperation. The constantly increasing importance of digitalisation plays a major role in all of the research conducted by the business area. The challenge-driven parallel development of technology and business models is at the heart of our R&D.

Our research activities emphasise the development of low-carbon and intelligent solutions for the production, transfer and distribution of energy as well as for consumers; solutions related to intelligent transport and an intelligent built environment; solutions and networks for the circular and minerals economies; security of supply and design and simulation methods that support the renewal of the manufacturing industry; along with dispersed production solutions and the supporting new manufacturing and automation solutions.

# VTT subsidiaries

## VTT Ventures Ltd

VTT's spin-offs are early-stage, technology-intensive growth companies. Technological and commercial innovation, team competencies and international potential are the key criteria when selecting target companies.

VTT Ventures' mission is to develop commercialisation-ready prototypes from the most promising technologies. Its activities are one of the keys to creating a flow of projects with investment potential.

VTT Ventures Ltd works in close collaboration with other actors in the innovation network. Its investments in portfolio companies are market-based and follow the same principles as venture capital investors.

In Finland and internationally, VTT Ventures has an extensive partner network with private equity investors. In 2017, VTT Ventures made investments worth a total of EUR 2.6 million, with 20 companies in the portfolio at the end of the year. In 2017, these companies attracted around EUR 27 million in new capital. The financial year was profitable for VTT Ventures.

## VTT Memsfab Ltd

VTT Memsfab Ltd operates as part of Micronova's manufacturing services in the 'Knowledge-intensive products and services' business area.

The company is engaged in the contract manufacture of micro and nano-electronics components and materials.

Production activities began in early 2011. The final product is typically a silicon disk which has been further processed and characterised in line with the customer's specifications, and contains sensors and detectors or the related parts.

Future growth is primarily expected to come from optical components.

## VTT Expert Services Ltd

Together with its subsidiary, Labtium Ltd, VTT Expert Services Ltd is one of the leading providers of testing, inspection and analysis services in Finland. The companies' service offering also includes expert assessments and analyses, along with calibration services. The majority of these services have been accredited by Finland's national accreditation service, FINAS. Our accreditations cover over 1,300 standards. Labtium and VTT Expert Services Ltd have the necessary notifications to act as a Notified Body. In addition, VTT Expert Services Ltd is a certified product approval body.

VTT Expert Services Ltd is a market-based, independent, third-party testing, inspection and certification organisation, while Labtium Ltd offers chemical analysis services.



Customer assignments are executed fairly, impartially and confidentially. Independence is ensured, while taking account of personal, financial, organisational and operational aspects on a project-by-project basis.

Diverse services help customers respond to the challenges posed by rapidly changing markets. The services provided by VTT Expert Services Ltd support the product development, launch and maintenance of the products of its customers over their whole life spans. The company offers a wide variety of services for different sectors, with a focus on construction and real estate management services. Comprehensive testing opportunities enable the production of reliable data to support modelling, assessments and decision-making. For its part, Labtium Ltd produces data for its customers' production processes and quality control, particularly through the methods of geological, fuel and environmental analysis. Demand for the two companies' services arises from regulations as well as deficiencies and development needs in production and products. The services are also needed in production process management.

The need and demand for the services of these companies has increased steadily. In order to fulfil customer needs, we have expanded our service offering and developed their customer communications and methods for executing assignments. The positive development of the Finnish economy has supported the organic growth of the companies. Many of the services are sectoral, and special expertise is required in order to provide them. The demand for various certification and testing services has been growing slightly, and the companies have responded to new demand by developing and expanding their accreditations, with the objective of providing the most comprehensive services possible for their customers.



At the end of the period, VTT Expert Services Ltd's accreditation services comprised testing, inspection, calibration and certification activities covering 33 accreditations, and 9 authorisations as a Notified Body. The company's quality management system has been certified according to standards ISO 9001 and ISO 14001. Nearly all of the testing and analysis functions of Labtium Ltd have been accredited.

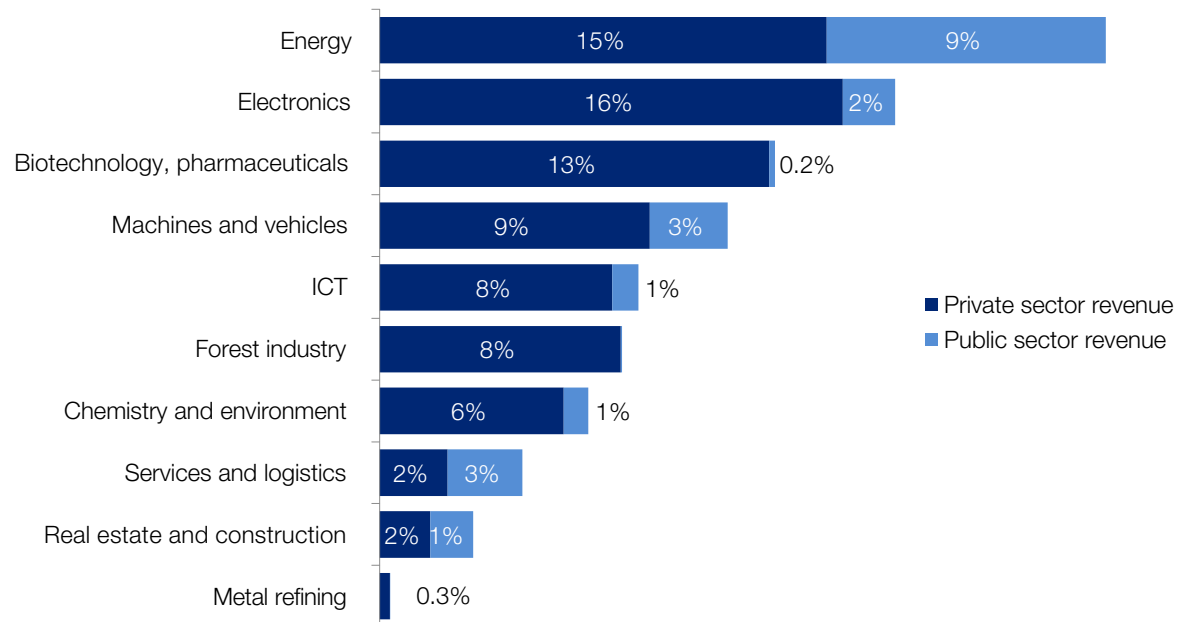
VTT agreed on the sale of VTT Expert Services Ltd and Labtium Oy to Eurofins Scientific Group on 15 December 2017. The transaction is subject to the approval of the FCCA and is expected to be closed in the second quarter of 2018.

# Customers



\*Parent company

VTT's sales revenue from commercial activities\*



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

# Personnel

## Development of a shared culture and way of working

The commitment of personnel and implementation of strategy are key issues for VTT. Launched in the summer of 2017, the VTT Experience programme brings new and long-serving VTT employees together to discuss matters of shared importance. A total of five VTT Experience days were held, with a total attendance of 130 employees, and the feedback was excellent.

The VTT Compass personnel survey was carried out in December 2017, with a response rate of 76.5%. The results and development measures will be discussed in the spring of 2018 with the help of workplace community games.

## We invest in the development of management and leadership

Excellent leadership and managerial work help VTT to succeed even better. The VTT Transformers coaching programme for managers was launched in the spring and the first LEAP manager coaching course in the autumn. The two coaching programmes will be attended by a total of 185 persons. Two training days for managers were held in the autumn on the theme of account management; more than 240 managers attended the training. Managers also received training in the active care model.



Personnel\*

2,368

Doctors and licentiates\*

27%

University level degree\*

80%

\*VTT Group 31.12.2017



## **Well-being at work is an important success factor for VTT**

VTT's well-being target for 2017 was to highlight a more diverse selection of alternatives and methods for improving the occupational well-being of individuals and groups. To this end, well-being workshops with various themes were organised for all VTT personnel. These were supplemented with a variety of events: the Heart Week tour, Dream Exercise Day, Step Competition and national exercise day "One Hundred Movements for Finland".

VTT organised two human resource coaching groups in 2017 for preventing coping issues and arranged a mindfulness training course that attracted 140 participants.

We also supported our personnel with Academy of Brain online courses and a pilot project for obtaining help for various crises at an earlier stage.

In 2017, VTT's actions for promoting well-being and activeness were recognised with the Finnish Olympic Committee's "Most Active Workplace in Finland" award, presented at the Urheilugaala sports gala held in January 2018.

## **Personnel development by a range of means**

VTT's success is based on continuous learning and the development of excellence by all staff. In 2017, the focus areas of development included on-the-job learning, project coaching and development programmes related to the execution of the strategy. VTT also launched an internal mentoring programme and development discussions were renewed to support the implementation of the strategy.

## **Good employer image the key to attracting talent**

In order to improve VTT's employer image and recruitment communications, we carried out an internal employer image survey and selected themes for supporting communications based on the results. In the employer attractiveness survey conducted by Universum, we achieved rank 6 among technical and natural sciences professionals and rank 8 among students. Awareness of VTT was increased through a summer job campaign, student events, recruitment fairs and social media communications.

## **Rewarding is an important part of a good employee experience**

The development of VTT's overall reward criteria and processes continued in 2017, with the objectives of increasing impact and excellence. Recognition rewards, used to reward personnel for excellent performance, were adopted as the principal short-term incentive.

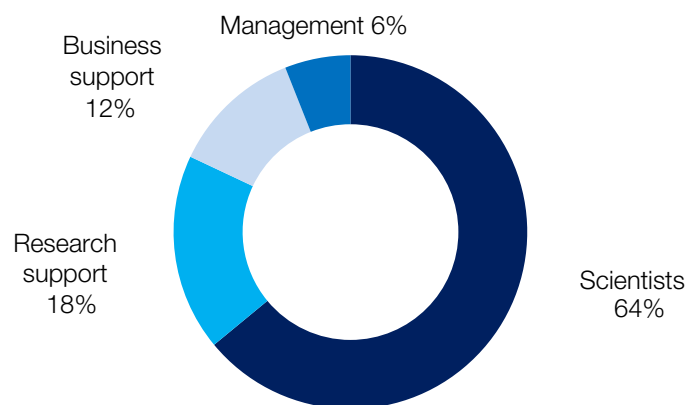
Other forms of reward included promoting occupational well-being, the diverse development of competencies and flexible working hour arrangements.

## Personnel 2017

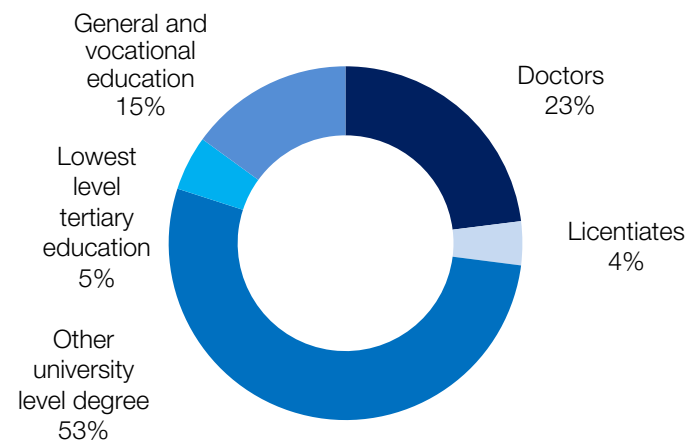
VTT Technical Research Centre Ltd had an average of 2,109 employees during the financial year. Around 1,947 person years were worked during the same period.

VTT Technical Research Centre of Finland Ltd						
	VTT Group			Parent company		
31.12.2017	2017	2016	2015	2017	2016	2015
The average number of employees	<b>2,398</b>	2,439	2,532	<b>2,109</b>	2,159	2,252
- Management 31.12.	<b>144</b>	132	145	<b>121</b>	110	123
- Scientists 31.12.	<b>1,513</b>	1,577	1,609	<b>1,387</b>	1,454	1,487
- Research support 31.12.	<b>385</b>	387	384	<b>253</b>	253	258
- Trainees 31.12.	<b>42</b>	36	45	<b>42</b>	36	45
- Business support 31.12.	<b>284</b>	282	287	<b>278</b>	275	279
Fixed-term contracts 31.12.	<b>184</b>	182	166	<b>170</b>	175	155
Part-time contracts 31.12.	<b>244</b>	238	205	<b>214</b>	211	182
Male 31.12.	<b>1,459</b>	1,483	1,521	<b>1,271</b>	1,300	1,351
Female 31.12.	<b>909</b>	931	949	<b>810</b>	828	841
Personnel costs (1 000 €)	<b>145,748</b>	152,298	155,880	<b>130,415</b>	136,986	140,858

Personnel structure\*



Education of personnel\*



\*VTT Group

# Financial statements

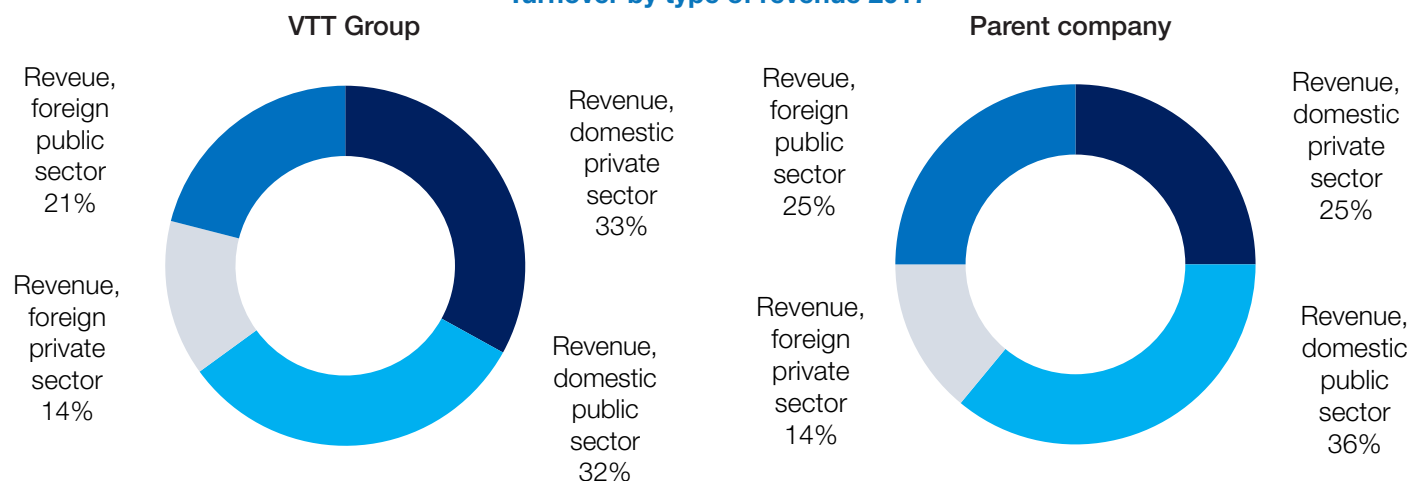
## Key figures 2017

VTT Technical Research Centre of Finland Ltd						
	VTT Group			Parent company		
	2017	2016	2015	2017	2016	2015
Net turnover (1 000 €)	<b>180,219</b>	188,378	184,538	<b>153,183</b>	162,572	157,915
Other operating income (1 000 €)	<b>77,345</b>	80,875	87,357	<b>82,372</b>	86,430	92,577
Government grant	<b>73,154</b>	77,235	85,384	<b>73,154</b>	77,235	85,384
Other	<b>4,191</b>	3,640	1,973	<b>9,218</b>	9,195	7,193
Operating profit before special items (1 000 €) (operative, unaudited)	<b>-2,245*</b>			<b>-2,883*</b>		
Operating profit (1 000 €)	<b>-17,536*</b>	-244	3,333	<b>-18,175*</b>	1,442	2,729
Operating profit (%)	<b>-9,7%</b>	-0,1%	1,8%	<b>-11,9%</b>	0,9%	1,7%
Return on equity (%)	<b>-11,7%</b>	-1,1%	2,6%	<b>-13,9%</b>	1,0%	2,1%
Equity ratio (%)	<b>59,6%</b>	67,3%	65,5%	<b>58,3%</b>	66,9%	65,2%

VTT Technical Research Centre of Finland Ltd's net turnover consisted of 61% public sector revenue and of 39% private sector revenue. The domestic revenue accounted for 61% and foreign revenue for 39% of the net turnover. Of the foreign revenue 75% came from Europe, 15% from North and South America, 10% from Asia and 1% from elsewhere.

\* Operating loss for the financial year 2017 includes 15.3 million euros special item costs due to decommissioning of FIR1 research reactor and restoration of old hotcell premises. The sum includes also estimated future costs. Until 2016 the state of Finland has financed these costs. During 2017 VTT did not receive a positive funding decision on its application for additional funding for the updated total costs of decommissioning. Estimated total costs have increased due to external expert opinion on total costs and due to increased uncertainty on the disposal site. VTT continues the negotiations with the State on the funding for these costs.

### Turnover by type of revenue 2017



# Reforms begin to bear fruit

It has been three years since VTT's legal structure changed from a government agency into a limited liability company and VTT Ltd was born. A key reason in doing this was to enable faster renewal of VTT, allowing it to be quick and agile in responding to changes in customer needs. The goal was to have greater impact and create renewal and growth in Finland. VTT became a limited liability company in order to change from a public-sector approach to modern business and customer driven management practices. Now is a good time to look back on our achievements.

- The incorporation clarified the responsibilities and roles of VTT's Board of Directors, CEO and Leadership Team. This laid the foundation for starting the renewal in VTT.
- The new company structure enabled VTT to seek a President & CEO with expertise in the Finnish and international research and business sectors. Antti Vasara, DSc (Tech.), took up the post two and a half years ago. Under Antti's leadership, VTT has renewed its Leadership Team, streamlined its objectives, improved management practices and made them more transparent.





- VTT's strategy was renewed together with the employees and is now more customer driven and more focused on scientific expertise. The rapid renewal of our organisation and practices has drawn attention within and outside VTT. In most cases the changes have generated fresh excitement among people when they have seen the positive results.
- We have turned the decline in customer financed business operations around, i.e. we now have growing numbers of joint development projects with companies. Our changes in personnel and operating methods are achieving clear results.
- Our Horizon 2020 research funding and the programme's acceptance rate of VTT projects have grown. VTT, which has long been one of Europe's most successful EU funding applicants, has further improved its reputation in the EU, where it is even more highly regarded than in Finland.

In other words, the renewal process is bearing fruit. However, our work in improving VTT has just begun.

The next key goals are ramping up R&D&I activities and increasing our Finnish private and public-sector funding. On behalf of the Board of Directors, I would like to thank our customers and all VTT employees for their help and support in our aims to build agile VTT. I wish you many inspiring moments in the days ahead.

Aaro Cantell  
Chairman of the Board, VTT

**VTT Board**

						
<b>Aaro Cantell</b> Chairman, Normet Oy M.Sc. (Tech.)	<b>Matti Hietanen</b> CEO Terrafame Group Oy M.L., M.Sc. (Econ.)	<b>Kari Knuutila</b> CTO Outotec Oyj D.Sc. (Tech.)	<b>Harri Leiviskä</b> CFO Suunto Oy MBA (CU), M.Sc. (Econ.)	<b>Petra Lundström</b> VP, Nuclear Development Fortum Power and Heat Oyj M.Sc. (Tech.)	<b>Tuija Pulkkinen</b> VP, Prof., Research and innovation services Aalto University	<b>Kaija Pehu- Lehtonen</b> SVP, Business Development Metsä Fibre Oy M.Sc. (Tech.)

# Impact of VTT 2017



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IPR protection and commercialisation

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# Impact evaluation

The impact of research has a key position in VTT's new strategy. As part of the implementation of the strategy in 2017, VTT developed its organisational evaluation culture and created an evaluation model corresponding to the strategy. The evaluation model includes new key performance indicators (KPI), whose purpose is to make VTT's impact and excellence visible at the level of the whole organisation.

According to the evaluation model, VTT's impact can be boiled down to four dimensions: benefit to society, benefit to customers, excellence of operations and balanced finances. Each target dimension is represented by three indicator baskets in the model. Figure 1 presents VTT's new evaluation model in a concise fashion.

According to the evaluation model, the key objective guiding our operations is social impact. To this end, we will create conditions for the sustainable growth of society and the renewal of Finland's industries by developing new products, services and technologies in cooperation with our partners. These products, services and technologies will support the creation of new markets and renewal of Finland's industries and secure social well-being and sustainable development.

Long-term social impact is built on customer impact. To ensure this, we help our customers succeed and grow by developing their competencies, contributing to the achievement of their targets and assisting them with international networking. We also make active efforts to create new customer relationships and partnership networks.

The impact generated by VTT in society and for its customers is based on the excellence of our operations. We are an agile, pioneering organisation that promotes innovation through high-quality scientific and applied research. These goals are supported through continuous learning and development of VTT's organisation and through excellent leadership.

The excellence and impact of operations require VTT's finances to be in balance. In this regard, our objective is to ensure long-term financial equilibrium by managing our turnover, productivity and order books, along with the efficient use of resources.

One KPI has been selected to represent each indicator basket, giving 12 KPIs for the entire organisation. The improvement of our impact requires the organisation-wide implementation of management and learning practices that support the evaluation model. Different indicators are given different weightings in different parts of the organisation. In other words, the targets for each part of the organisation are set in line with VTT-level targets. The KPIs used at each level of operations will be specified over the course of 2018.



# VTT creates growth

Share of survey respondents who felt that this benefit was generated in their VTT project:

**88%**

reported that their **knowledge base and expertise improved**

**69%**

believed that a VTT project **contributed positively towards the opening up of new business opportunities**

**68%**

told that the project **contributed positively to identifying new opportunities**

**66%**

told that their VTT project **speeded up or otherwise improved research and development work**

**58%**

reported that their **competitiveness improved**

**51%**

thought that their VTT project **promoted international networking**

**45%**

said that the VTT project **promoted their marketing**

**40%**

confirmed that **a new or improved process was created**

**26%**

reported that **a whole new technology was adopted**

**14%**

reported that **a new business concept or a new earnings model was created**

Source: VTT customer survey 2017, Feelback Group (international customers)



# IPR protection and commercialisation

IPR commercialisation progressed well in 2017. We received EUR 3.0 million in IPR revenue from the licensing and sales of intellectual property rights and software. IPR income broke the previous record for the fourth year running and grew by 8% from 2016 (EUR 2.8 million).

As in the previous year, the most significant licence income was obtained from process simulation software, health technology and optics and spectroscopy. Approximately 46% of IPR revenue was obtained from software licensing (2016: 47%).

In 2017, we received 237 invention disclosures (2016: 229). A total of 45 priority patent applications were filed in 2017 (2016: 52), of which 41 were filed with the Finnish Patent and Registration Office.

At the end of 2017, VTT held 364 inventions protected by patents or patent applications (2016: 365). The total number of patents and patent applications was over 1,300.

The total value of VTT's IPR investments was EUR 1.7 million (2016: EUR 1.9 million).



Patent families\*

**364**

Patents or patent applications

**1,324**

751 patents granted,  
573 pending patent applications\*\*

Received invention disclosures

**237**

45 priority patent  
applications\*

IPR investments\*

**1.7 M€**

IPR revenue\*

**3 M€**

\*Parent company



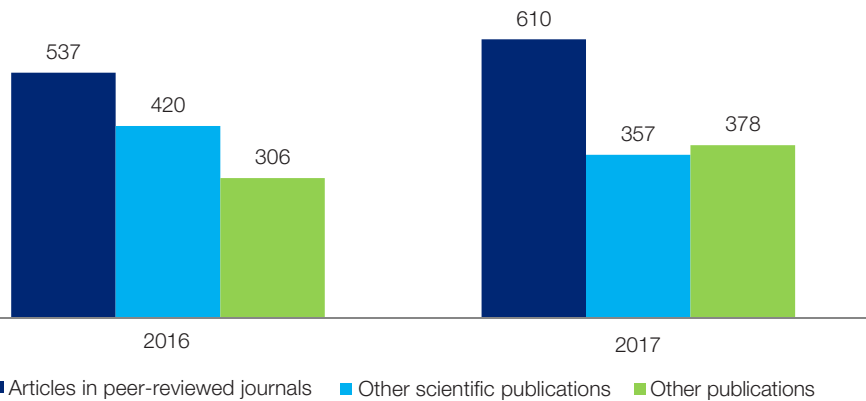
# Food economy 4.0

VTT's vision of an era of smart consumer-centric food production

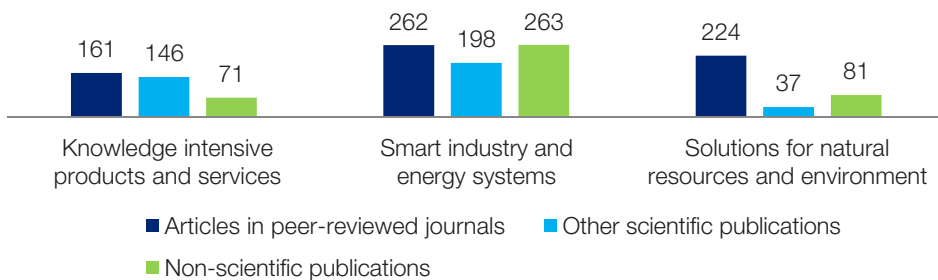
## Publications

VTT employees publish research results in foreign and domestic science journals, in professional periodicals and publication series, as books, conference presentations or patents, and in the VTT publication series.

Publications 2016 - 2017\*



Publications by business areas 2017\*



\* Parent company

Publications\*

1,345

International scientific articles\*

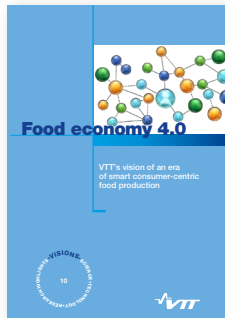
610

61

in VTT's own publication series\*

\*Parent company

## Examples of publications in VTT series 2017



**Food economy 4.0**  
VTT's vision of an era of smart consumer-centric food production  
Kaisa Poutanen, Emilia Nordlund, Jaakko Paasi, Kaisa Vehmas & Maria Åkerman

VTT Visions 10



**Barents 2050 – Impacts, opportunities, and risks of climate change and climate change mitigation**  
Tommi Ekholm, Tomi J. Lindroos, Laura Sokka, Kati Koponen & Tiina Koljonen

VTT Technology 316



**Quality in open data based digital service ecosystem**  
Dissertation  
Anne Immonen

VTT Science 159



**Towards a new era in manufacturing**  
Final report of VTT's For Industry spearhead programme  
Jaakko Paasi (Ed.)

VTT Technology 288



**Model of circular business ecosystem for textiles**  
Paula Fontell & Pirjo Heikkilä

VTT Technology 313



**Actigraphy in evaluation and follow up of physical functioning of older adults**  
Dissertation  
Juho Merilähti

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**Opportunities of big data analytics in supply market intelligence to reinforce supply management**  
Salla Paajanen & Anna Aminoff

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**FinnFusion Yearbook 2016**  
Markus Airila (Ed.)

VTT Science 157



**Flexible pigment-cellulose nanofibril composites for printed electronics applications**  
Dissertation  
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All publications: [www.vttresearch.com/publications](http://www.vttresearch.com/publications)

# R&D infrastructure

VTT's unique R&D infrastructure enables the development chain from basic research and process development up to prototyping and pilot manufacturing. Our research facilities are an essential part of the Finnish research infrastructure.

## Examples of our R&D infrastructure



### **Bioruukki**

The largest bioeconomy pilot and research facility in the Nordic countries.



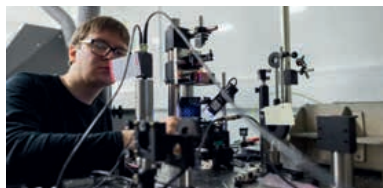
### **Biotechnology and food research piloting environment**

offers unique facilities for the development and customisation of bio and food industry technologies.



### **Micronova**

World-class cleanroom facility, fully equipped for the fabrication of silicon, glass and thin film-based microsystems.



### **VTT MIKES Metrology**

is the National Metrology Institute of Finland and performs high-level metrological research and develops measuring applications in partnership with industry.



### **Engine and vehicle laboratory**

enables research on passenger cars as well as heavy-duty vehicles up to 60 metric tons to develop energy efficiency, emissions reduction and use of 2nd generation biofuels.



### **PrintoCent**

World's first pilot factory for printed intelligence industrialisation.



### **ROViR**

Remote Operations and Virtual Reality Centre for the development of remote operations and virtual reality technology in industry.



### **A pilot-scale research environment for fibre processes**

enables the development of novel products and supports the renewal of the pulp and paper industry.



### **Centre for Nuclear Safety**

for nuclear technology safety research.

# Domestic and international cooperation

VTT engages in research cooperation with three main objectives: to increase innovation-driven investment in Finland, reshape industrial and commercial business activities and create value added and jobs in Finland. Domestic and international cooperation gives VTT a prospect to promote solutions to grand challenges of the society. Availability of publicly funded research and innovation programmes is indispensable for VTT to be able to collaborate effectively with industry, academia and other key stakeholders in innovation ecosystems. From VTT's perspective, ideal operational environment can be achieved by alignment of innovation policies at national and EU level.



## Domestic cooperation

When collaborating with various stakeholders in Finland (companies, universities, research institutes, funding agencies, associations, ministries, municipalities and regional governments) VTT is contributing to open dialogue and formation of joint vision in the society. VTT welcomes the national foresight activities taking place in Finland, aiming at shared understanding, not only at national level but also in the global context.

VTT in the Academy of Finland's Centres of Excellence	VTT's national development platforms
<ul style="list-style-type: none"> <li>• CoE in Atomic Layer Deposition (ALD) (2012 - 2017)</li> <li>• CoE in Low Temperature Quantum Phenomena and Devices (2012 - 2017)</li> <li>• CoE in Molecular Engineering of Biosynthetic Hybrid Materials (2014 - 2019)</li> <li>• CoE in Quantum Technology (2018 - 2025)</li> </ul>	<ul style="list-style-type: none"> <li>• Bioruukki – Research and pilot environment for the bioeconomy</li> <li>• SMACC – Smart Machines and Manufacturing Competence Centre</li> <li>• PrintoCent – Innovation centre for printed electronics</li> <li>• 5G test network</li> <li>• Micronova – Cleanroom for silicon-based micro systems</li> <li>• MIKES – National metrological institute</li> <li>• VTT Centre for Nuclear Safety</li> </ul>

VTT is part of the Team Finland Network providing businesses with a smooth service for internationalisation. In addition to project collaboration with industry and academia, VTT also participates in the Finnish Centres of Excellence funded by Academy of Finland. VTT works in close collaboration with industry and highlights the renewal of industrial value chains and sustainable competitiveness in Finland and Europe. To achieve these objectives, VTT is making a major contribution to the development activities of regional innovation ecosystems and networking between local centres of expertise. VTT's national partnerships include joint research and technology infrastructures, extensively networked at European level, such as Bioruukki, SMACC, Printo-Cent, 5G Test Network Finland, Micronova, MIKES and VTT Centre for Nuclear Safety.

### European cooperation

VTT is linked well to innovation initiatives at EU level. EU's Research and Innovation Programme Horizon 2020 (2013-2020) is important for implementation of the EU 2020 Strategy, addressing employment, research and innovation, climate action, energy, education and prevention of poverty. VTT's EU activities also mean that Finnish companies and other stakeholders get access to European networks and industrial value chains. Broad networks, positive visibility and constructive contribution in EU projects can have a significant springboard when taking forward Finnish innovation. EU project funding is highly competitive and VTT needs to understand the big picture: active follow-up of EU research and innovation policy, proactive participation in new collaboration and partnership structures and continuous long-term collaboration with various stakeholders. VTT's EU project portfolio contains numerous programmes and funding instruments, calling for profound competence in funding rules and legal arrangements.

VTT's key European research alliances	VTT in PPP initiatives (H2020 programme)
<ul style="list-style-type: none"> <li>• EARTO - Eurooppalaisten tutkimusorganisaatioiden edunvalvontajärjestö</li> <li>• EERA - Eurooppalainen energiatutkimusallianssi</li> <li>• EIT Digital - Euroopan teknologia- ja innovaatioinstituutti</li> <li>• EIT Raw Materials - Euroopan teknologia- ja innovaatioinstituutti</li> <li>• EIT4Food - Euroopan teknologia- ja innovaatioinstituutti</li> <li>• NUGENIA - Eurooppalaisen ydinvoimateollisuuden ja tutkimuslaitosten tutkimusyhteisö</li> </ul>	<p><b>Contractual PPPs</b></p> <ul style="list-style-type: none"> <li>• Photonics</li> <li>• 5G</li> <li>• Big Data</li> <li>• Cyber Security</li> <li>• Robotics</li> <li>• FoF (Factory of the Future)</li> <li>• SPIRE (Sustainable Process Industry and Resource Efficiency)</li> <li>• EeB (Energy Efficient Building)</li> </ul> <p><b>Joint Technology Initiatives/Joint Undertakings</b></p> <ul style="list-style-type: none"> <li>• Electronic Components and Systems ECSEL</li> <li>• Biobased Industries BBI</li> <li>• Fuel Cells and Hydrogen FCH</li> </ul>

VTT is active in several initiatives, such as ETPs (European Technology Platforms), and PPPs (Public Private Partnerships). VTT is also involved in three Knowledge and Innovation Communities (KICs) of the European Institute of Innovation and Technology (EIT Digital, EIT RawMaterials, EIT4Food) as well as in EERA, European Energy Research Alliance which is the crucial research network for implementing EU Member States' SET-Plan (Strategic Energy Technology Plan).

EU project collaborations are carried out by consortia, i.e. projects have several partners from several member States. VTT is known for excellent support services for project management. In spite of extreme competition, VTT has maintained its position as a major player

in Europe and Finland's largest recipient of EU research funding 17% of all H2020 funding to Finland is received by VTT (Commission statistics 10/2017). 25% of H2020 funding to Finland in collaborative projects is received by VTT. In FP7, VTT share was 22,5% of all FP7 funding to Finland.

Over the past years VTT has actively contributed to assessments and priority-setting processes for European research and innovation policies and programmes. This has been on the grounds of the national mandate of VTT and VTT's long-term capability to act in various research networks and innovation communities. Participation in EARTO (European Association of Research and Technology Organisations) has given VTT a strong

position in policy dialogue with European Institutions, examining issues in a broad, innovation policy context across traditional administrative boundaries.

H2020 has links with regional and industrial policies and related programmes (smart specialisation strategies, investment programme, defence research programme). Understanding multitude of policy sectors as well as legal/financial framework are sine qua non in this complex environment. Especially in view of the next MFF and Framework Programme, VTT is carefully following the development. Preconditions for VTT to stay competitive in the EU funding landscape are challenged with national resources decreasing for applied research. It is important that there are no cuts in the FP9 budget and that relative share for mono-beneficiary funding would not grow at the expense of collaborative funding. VTT's participation in EU research an innovation collaboration is founded on solid ecosystem approach, fostering continuous interaction between research communities and companies. From VTT's perspective, ideal operational environment can be achieved by alignment of innovation policies at national and EU level. In future, public programmes should be planned in such a way that SMEs benefitting from those programmes have a smooth access to the competences hosted by research and technology organisations.

### VTT in the world

In a globalised world, developing solid knowledge base requires world-class players and broad-minded collaboration across disciplines. We believe that a brighter future is created through science-based innovations, and responsible research and innovation. VTT's public mandate and broad technology portfolio have created the basis for participation in international cooperation and our broad networks means our partners get access to the best knowledge worldwide.

Through the Team Finland network VTT also engages in information exchange with diplomatic and foreign services, takes part in official government and trade missions, and gives expert support to the work of Intergovernmental Panel on Climate Change IPCC, inter alia.

VTT's EU-level networks and research partnerships in Finland have given VTT a strong position. While VTT's international public research activities mostly involve European cooperation, VTT is partner in projects sponsored by the EU in third countries. There is continuous dialogue between VTT and research organisations in third countries and VTT carries out contract work for customers in selected global innovation environments.







IMPACT



# Examples of research results 2017



## Climate action – Clean energy for the future

Close to 200 countries have committed to the Paris climate agreement aiming to keep global warming below 2 °C. Rapid transformation of all the sectors that are emitting greenhouse gases is needed. Finland has also set ambitious targets to increase the use of renewable energy to over 50% of the final energy consumption by 2030.

Billions of mechanical devices, buildings, vehicles and industrial processes need to be changed, retrofitted or renovated to improve energy efficiency and to decrease emissions. The emergence of integrated consumers and producers, called prosumers, will recreate energy markets.

Innovations for producing low-carbon energy from versatile sources are required more urgently than ever.

VTT fosters novel technologies and digitalisation as opportunities to support a systemic energy transformation.

**#ClimateActionVTT**





## The climate change plan points the way to a sustainable, low-carbon society

The impact evaluation of the medium-term climate change policy plan (KAISU) required by the Climate Change Act reviewed the impact of the climate change policy on Finland's greenhouse gas emissions, energy system, economy, environment and health. KAISU clarifies and complements the actions for reducing greenhouse gas emissions in the non-ETS or effort sharing sector, specified in the Energy and Climate Strategy published in 2016.

Based on the impact evaluations in KAISU, the greatest potential for reducing greenhouse gas emissions lies in the transport sector but, on the other hand, the reduction of transport emissions and the ensuing costs and environmental impact also involves the greatest uncertainties. Additional emission reductions can be achieved in particular by reduc-

ing the use of mineral oils for heating buildings and in machinery fuel. Even though the emissions-reduction actions involve costs, the evaluation of economic impact shows that the measures specified in KAISU will only have a negligible impact on the growth of Finland's GNP.

The Sustainable Energy and Climate Policy and the Role of Renewables in Finland (KEIJU) research project analysed energy and climate policy from a broad perspective, particularly from the impact perspective. The project produced a comprehensive report of Finland's opportunities to cost-efficiently and consistently meet the energy and climate targets set for 2030 by the Government Programme, Climate Change Act and European Union.

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## Making Helsinki a pioneer in intelligent energy solutions

Globally, cities produce 70% of greenhouse gas emissions. Together with its residents and companies, Helsinki is taking significant steps to make the city carbon neutral. The objective is supported by the mySMARTLife project, which involves testing an emission-free, electronic robot bus and encouraging the housing companies in Merihaka to renovate in an energy-efficient manner.

The mySMARTLife project is part of the EU's Horizon 2020 programme for testing new solutions to curb climate change in cities. The pilots implemented within the scope of the project will achieve energy savings of 10–20% and expedite the market launch of the best solutions. The solutions tested in Helsinki can be used in other cities in Finland and abroad.

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## Small SMR reactors are suitable for district heat generation

VTT has studied the suitability of small modular nuclear reactors for industrial processes and district heat generation. The small modular reactor (SMR) was modelled as part of the projected district heating network of a model Finnish city in the 2030s. According to the results, the modelled reactor type could be included in the production mix of the district heating network. The ROI period was estimated at 10–20 years, depending on the realisation of costs.

In Finland, nuclear power is only used for electricity generation, but other countries use it for applications such as district heating, desalination of sea water and the generation of industrial process heat. The vapour produced by high-temperature SMR concepts could be used for applications such as the production of nitrogen. Several types of modular reactors that are significantly smaller than traditional nuclear power plants are currently under development around the world. The estimated benefits of the new small modular reactors include shorter construction times, standardised plant types and suitability for smaller systems and industrial integrations.

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## Resource sufficiency – Prosperity from resource wisdom

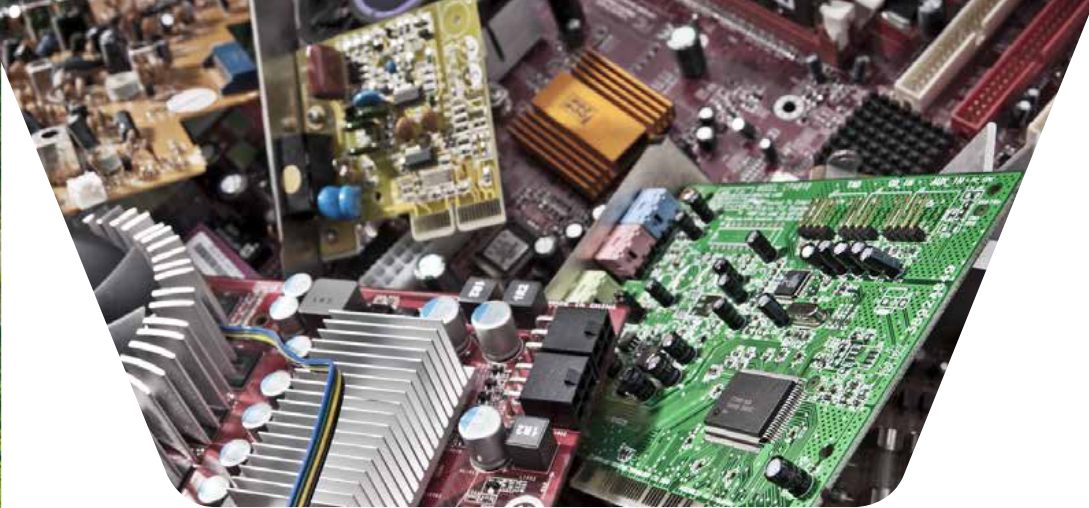
Social changes, urbanisation, increasing wealth and consumerism have led to a rapid exploitation of natural resources in excess of the capacity of the earth.

VTT recognises the need for sustainable, resource-efficient solutions, such as renewable raw materials and a circular economy. The challenges can be solved by resource wisdom. Tapping into unutilised reserves and closing the loops will open new economic potential.

Industries will benefit from renewable and unconventional raw materials, such as forest biomass CO<sub>2</sub>. Design will enable the high performance of consumables produced according to demand. Non-conventionally produced food will help feed the growing population while conserving water and the environment.

**#ResourceSufficiencyVTT**





## Integrated technologies to recover metal and plastic from electronic waste

VTT has developed a new electronic waste recycling concept that combines a range of technologies and reduces waste. One of the technologies included in the concept is gasification, which is used to recover not only metals and rare-earth elements from the waste but also organic components that can be used to produce energy or products, such as plastic and chemicals. VTT has brought together a group of Finnish partners to promote material-efficient production.

Vast amounts of valuable raw materials are lost through recycling and processing: As much as half of all materials can end up in landfill. Products are becoming increasingly complex, which is why traditional mechanical recycling processes are no longer enough.

Traditional recycling focuses on recovering base metals and precious metals, such as gold, leaving other valuable resources, and especially hydrocarbon-containing organic matter, unutilised.

VTT has developed a recycling concept based on integrated technologies, which can be used to increase the efficiency of material recovery and reduce the use of virgin minerals and fossil resources. In addition to the mechanical sorting of waste, the range of techniques includes gasification, which is a thermal conversion process for separating not only metals but also organic materials that can then be used to produce energy or products, such as plastic and chemicals.

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## Protein produced with electricity to alleviate world hunger

A batch of single-cell protein has been produced by using electricity and carbon dioxide in a joint study by the Lappeenranta University of Technology (LUT) and VTT. Protein produced in this way can be further developed for use as food and animal feed. The method releases food production from restrictions related to the environment. The protein can be produced anywhere renewable energy, such as solar energy, is available.

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## Valuable products from carbon dioxide

The utilisation of carbon dioxide could be a major driver for economic growth in Europe. A total of 43 leading industrial and research organisations have joined the CO2 Value Europe association, established on 30 November 2017, to accelerate the conversion of carbon dioxide into valuable products. VTT is one of the founding members of the association.

The mission of the CO2 Value Europe association is to develop and market sustainable industrial solutions for converting carbon dioxide into valuable products, thus decreasing carbon dioxide emissions and expanding the raw materials base.

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## Fabric made from VTT's recycled fibre feels half way between cotton and viscose

The method developed at VTT involves dissolving worn and discarded cotton and using it as a raw material for new fibre. The first product models demonstrate that recycled fibre can be transformed into a yarn and pleasant fabric. Based on a carbamate dissolution process, the technology has been used to produce the first batch of recycled fibre in a pilot facility. The fabric made from the recycled fibre met the researcher's expectations: it is smooth with a subdued matt finish and drapes nicely.

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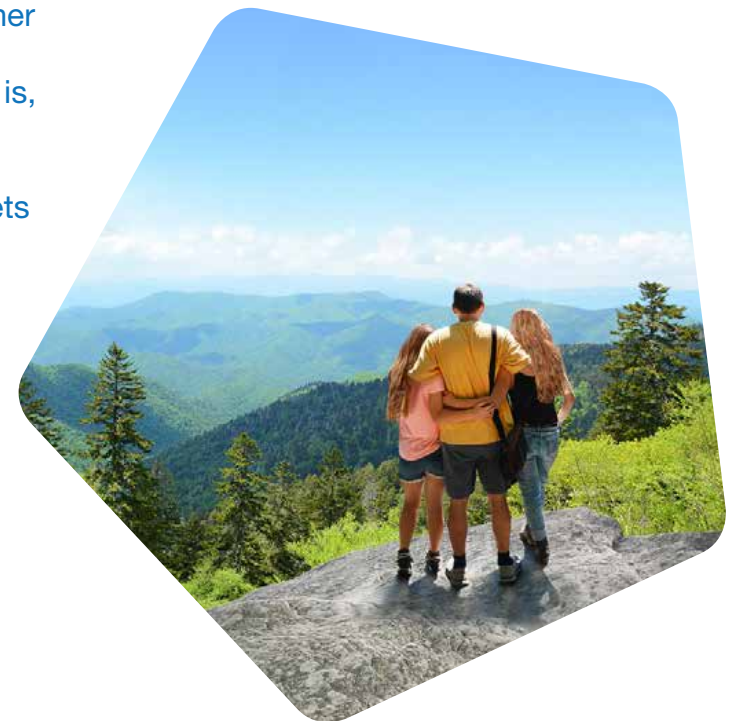
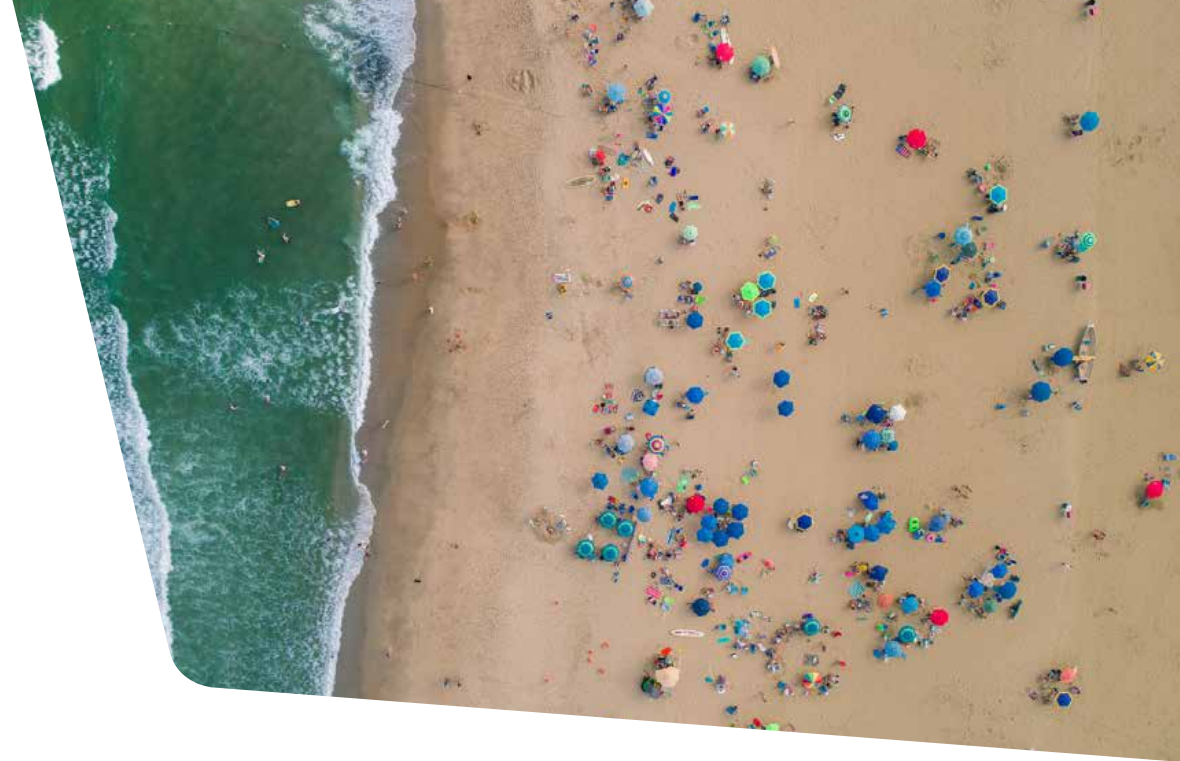
## Good life – Improved quality of life, work, health and well-being

Everyday life is being affected by major global changes. Growing health care costs together with aging populations require a paradigm shift for the prevention of non-communicable diseases and a new kind of participatory health care system. The disruption of work, that is, robotisation outside of factories is making many current jobs obsolete.

The overload of the human-technology relationship, manifesting itself clearly in the gadgets we use in our work and free time, is increasing stress when it should make life easier. Urbanisation and strained infrastructures create pressures on the design of our living environment.

Finland has the ability to answer these challenges thanks to its well-educated population, high level of trust in society and large number of growth-oriented companies. VTT develops new technology, service concepts and business models for the benefit of the individual in the society of the future.

**#GoodLifeVTT**





## Finnish mobile device for detecting arrhythmia soon available for consumers

The VTT spin-off, VitalSignum, is making a small mobile device – which detects arrhythmia by measuring the patient's ECG – available to consumers.

The device has been tested, with good results, on heart patients for three years at the University Hospital of Turku and now also within the Hospital District of Helsinki and Uusimaa. Top athletes suffering from heart problems and many other private individuals have also tested the innovation.

### Effortlessly portable

This highly portable device precisely measures the patient's ECG and heart rate variability (HRV). Medical device approval will be sought next, after which the device will be suitable for preoperative and postoperative monitoring of cardiac patients at home, since the data is automatically transferred from a cell phone to nursing staff via a cloud service.

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## Artificial intelligence reveals cardiac patients' risk of complications

Artificial intelligence can detect the risks posed to cardiac patients and prevent complications caused by heart disease at an early stage. The application improves patient safety, while creating savings in growing healthcare expenditure.

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## New measuring improves indoor air quality while cutting energy cost by up to 50%

A healthy, comfortable and productivity-enhancing indoor climate can only be created by making sure ventilation accurately responds to the needs of the people occupying the space. Current ventilation systems, based simply on estimated average occupancy, are not capable of adapting to changes in the use of indoor spaces. For example, the air in a conference room or a classroom quickly becomes stale if more than the predetermined number of people are present – or the ventilation may work at full speed even if the room is empty, wasting energy and money.

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## VTT's roadmap guides Finland into the ranks of AI winners – this is how our country will thrive

Now is the time to take stock of the situation and determine the areas in which Finland is strong and Finnish companies and society have the best opportunities for utilising the AI revolution. We must also prepare for social effects at the workplace and in the distribution of income. In its report, VTT presents a selection of proposed measures for guiding our land safely through the digital revolution and lifting us into the ranks of the winners.

[READ MORE»](#)

## Safety and security – Resiliency in turbulent world

In our turbulent world, unexpected complex and cascading failures can lead to catastrophic effects. The trends behind opportunities are increasing the exposure of societies to natural and man-made threats. Ensuring the safety and security of people, government, companies and infrastructures in all conditions has strong implications on technological development, business continuity and resilience models. The safety and security of the society of tomorrow demands means and tools to detect, prevent and recover from incidents.

VTT envisages and develops technologies and systemic models for comprehensive safety and security. All systems should be flexible and self-adaptive with inherent safety and security features. Designing, developing and testing complex systems enables the secure use of the full potential of innovations in the digital society.

Solutions that counter threats enable trouble-free lives and business.

**#SafetySecurityVTT**







Photo:  
Domenico  
Tedone, Thales-  
Alenia Space,  
Italy

## Augmented reality increases maintenance reliability at a space station

VTT participates in the development of new AR tools for the European Space Agency (ESA). An international project led by VTT developed a new augmented reality (AR) tool for the ESA. In the future, it is envisaged that astronauts will be able to use this tool to perform maintenance tasks and real-time equipment monitoring in the demanding conditions of space. The first practical tests carried out at ESA's European Astronaut Centre produced excellent results.

The two-year EdcAR project (Engineering data in cross platform AR) led by VTT developed a solution to the challenges involved in maintenance and the provision of work instructions, which have been an issue for more than a decade. Since maintenance and other work tasks in space are critical, they must be carried out without errors and at the right time. Preparing for these requires in-depth practising, which involves coordinating the activities of various experts. Since astronauts' time is extremely valuable, their tasks and maintenance instructions must be unambiguous.

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## Finland's first 5G development environment opens to businesses

Finland's first 5G test network 5GTN expands in Oulu. 5G development environment of VTT, the University of Oulu and the Centria Polytechnic will be used especially for vertical business use. There is already a large number of Finnish companies with whom 5G technology has been developed and will be tested in several application areas.

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## VTT's autonomous cars take to public roads and start communicating with each other

Marilyn, the first automated car to be granted a road traffic testing permit in Finland, and its spouse Martti have taken things to a new level together and started exchanging information with each other and their driving environment. The automated cars developed by VTT can hear, see and sense, and Finnish intelligence hums in their brains. They are able to follow a pre-programmed route and avoid collisions with sudden obstacles without input from the driver. The cars currently require the lane markings or sides of the road to be visible. This is, however, only the first step; by 2020, the cars will be driving in more demanding conditions on roads covered in gravel and snow.

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## Block chain technology for ensuring the reliability of welfare applications and services

In a Government research and study programme, VTT studied the benefits of block chain technology in improving the efficiency of social and health care services. VTT proposed the promotion of a welfare ecosystem based on block chains with a concrete pilot project. In the project, reliability and welfare funds would create the foundation for placing anticipatory health care and welfare maintenance at the centre of the social and health care service system.

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## Industrial renewal – Innovations empowering industry

Renewing the design, manufacturing and service businesses will create new opportunities for industries in high-cost economies. The economic growth and employment of Finland are highly dependent on the success of the export industry. It is essential for Finland's industrial sector to be one of the leading players in implementing future digital solutions and business models.

Tomorrow's smart products and services are created in new industrial ecosystems supported by a globally connected platform economy. Opportunities will emerge from collaboration, service subscriptions and use of data. The growing share of services and novel business models based on big data strengthens the competitive advantage of Finnish industries.

Robotisation, flexible automation and artificial intelligence offer opportunities for enhanced production. Smart specialisation and digitalisation supports the competitiveness of production industries. A high dependence on resources (energy, materials, water) can be overcome by applying solutions of the circular economy.

Finland, with its high innovation capabilities and skilled work force, is ready to be a frontrunner in next-generation manufacturing and service businesses.

**#IndustrialRenewalVTT**





## Competitiveness from digitalisation: VTT and Hydroline to develop new service business from hydraulic cylinders

VTT and Hydroline Oy have joined forces to develop networked, intelligent next-generation hydraulic cylinders. The project enables a transition from a product-centric business model to a new service-based business model to boost competitiveness.

Digitalisation is propelling product development in the manufacturing industry forward at speed. This allows new product and service concepts to be developed faster and more and more profitably.

Finland's leading hydraulic cylinder manufacturer Hydroline and VTT have joined forces to turn the company's products into services. Hydraulic cylinders are used extensively in heavy machinery and industrial applications thanks to their excellent power density, reliability and user-friendliness.

The aim of the new four-year Tekes-funded project launched in the spring is to build a digital platform for the company to use in life-cycle management and in-service maintenance. Digitalisation enables new business development and shifting the focus from products to selling services.

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## Digitalisation will revolutionise the textile industry: individual clothes quickly and on demand

In the near future, digitalisation will usher in significant changes in the textile, clothing and fashion industries thanks to innovations such as 3D modelling, intelligent clothing, robotics and product customisation. VTT is studying the solutions offered by new digital technologies, which will significantly accelerate the rotation speed of product ranges, shorten product development times, decrease production costs and promote sustainable choices.

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## Modular drop-in fuel technology to boost bio-share of oil refineries

EU-funded project COMSYN aims to develop a production concept for competitive bio-based fuels by means of a compact gasification and synthesis process. The target reduction of the biofuel production cost is up to 35% compared to alternative routes, which translates to less than 0.80 €/l production cost for diesel. The production concept is based on the distributed primary conversion of various kind of biomass residues to intermediate liquid products at small-to-medium scale (10-50 kt/a Fischer-Tropsch products, 30–150 MW biomass) units located close to biomass resources. The Fischer-Tropsch products will be upgraded to fuels in existing central oil refineries, also bringing the benefits of economy of scale for the overall process.

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## In the future, products are manufactured decentralized – towards a digital factory

VTT, Tampere University of Technology (TUT) and Tampere University of Applied Sciences (TAMK) set up a demonstration of a digital factory. In this demo, different robots located in various facilities of the organisations involved are monitored and controlled remotely from one place.

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# Corporate responsibility report 2017



## **Table of contents**

Sustainability in our operations

VTT promotes responsible operations

# Sustainable development as a key part of what we do

We take account of the principles of sustainable development in research and development and in our internal operations. We apply the GRI guidelines to our reporting on corporate responsibility. In this review, we describe our social responsibility through examples. The selected GRI indicator table is published on our website (more information is available on VTT's corporate responsibility page).

## Social responsibility

VTT's research focus areas – climate action, resource sufficiency, good life, safety and security and industrial renewal – seek sustainable solutions to major social challenges. When drawing up our research agenda, we look at the issues from the outside, taking a challenge-oriented approach. This continuous process is steered by outside signals instead of our existing competencies. The challenges and future growth opportunities of our customers have a pronounced impact on our research agenda and competence development. According to studies, the utilisation rate of our research results is extremely high, which means that VTT has a highly important impact in promoting sustainable development. Our research results and experts are also widely called upon as a basis for public decision-making on the journey to a society founded on sustainable development.

VTT is a member of the FIBS corporate responsibility network.

## Responsibility for our own personnel

To this end, well-being workshops with various themes were organised for all VTT personnel. These were supplemented with a variety of events: the Heart Week tour, Dream Exercise Day, Step Competition and national exercise day "One Hundred Movements for Finland". VTT organised two human resource coaching groups in 140 for preventing coping issues and arranged a mindfulness training course that attracted 140 participants.

We also supported our personnel with Academy of Brain online courses and a pilot project for obtaining help for various crises at an earlier stage. VTT's actions for promoting well-being and activeness were recognised with the Finnish Olympic Committee's "Most Active Workplace in Finland" award, presented at the Urheilugaala sports gala held in January 2018.

Systematic competence development and training, and work-based learning, form a key element of our responsibility for our own employees.

### Accident frequency

# 0.96

per million working hours

Calculated using the method of the Workers' Compensation Centre, the Group-wide accident frequency was lower than ever at 0.96 per million working hours. The corresponding figure for the parent company was 0.82. The most common causes for accidents were bumping into an object, slipping and falling, and chemicals. There were no serious occupational accidents in the Group, and the severity indicator was 8.6 days of absence/accident (10 in the parent company).



The 2015–2017 three-year plan's projects for 2017, with the objective of developing environmental and occupational health and safety, were implemented according to plan. The themes were occupational health and safety culture and its development, strengthening the QEHS capabilities of the management chain, the common workplace, and cleanliness and order. One of these projects was the Hoksaa, huomaa, reagoi (Notice, observe, react) campaign implemented in cooperation with the occupational health care provider and accident insurer. The campaign included lectures, information and reminders of VTT's practices. A particular technical focus area was the measurement of air volumes in fume cupboards in order to ensure their reliable operation.

## Responsibility for the environment

VTT Technical Research Centre of Finland Ltd has ISO9001 and ISO 14001 quality management systems in place, certified by DNV GL Business Assurance Finland Oy Ab.

We updated our environmental principles, targets and indicators. The new principles are:

- 1) improving the eco-efficiency of our operations
- 2) communicating openly about our environmental policy
- 3) producing new and significant environmental innovations
- 4) producing expert information to support decision-making by companies and society.

VTT scientists took part in eleven parliamentary committee hearings on the subjects of energy and the environment, either as invited experts or by submitting a written statement.

There was a gap year in spot checks required by the Energy Efficiency Act. Electricity consumption remained nearly unchanged (+0.7%) from the previous year. VTT undertook to reduce its climate emissions and joined the Climate Partners network. From its EU emissions trading quota, VTT bought and cancelled a quantity of emission allowances equivalent to the CO<sub>2</sub> emissions (59 tonnes) of VTT's car fleet in 2016. The CO<sub>2</sub> emissions of VTT's leasing fleet decreased further, to 109 g/km. The use of private cars declined by 11%. The number of flights continued to decline in line with the target, with a reduction of 2% in comparison to 2016.

Use of purchased office paper once again took a downturn (-15%). The share of ecological products used amounted to 27% and printing volumes decreased by 17%. VTT does not operate in ground water areas, but in Espoo it does operate close to the Laajalahti Natura Nature Reserve.

In the monitoring of the oil spill related to the metro construction site in Otaniemi, the sampling frequency of water collected into the pump wells was reduced to twice per year. The levels of detrimental elements in the water have been very low, and a further reduction in the sampling frequency to once per year has been proposed.

The share of  
ecological products used

27%





# VTT promotes responsible operations





## VTT's innovation activities include the promotion of responsible water use

The Aalto University, Natural Resources Institute Finland (Luke), Ministry of Agriculture and Forestry, Ministry of the Environment, VTT and WWF have drawn up a water responsibility commitment as part of Society's Commitment to Sustainable Development as drawn up by the Government. VTT undertakes to promote the responsible use of water in its operations by developing innovative solutions that support industrial competitiveness and social welfare and promote the efficient and environmentally friendly use of water.

Even though the state of Finland's water reserves and their management is on a sound basis for the most part, Finnish companies operate and subcontract

in areas suffering from a variety of water-related problems. Global challenges such as the scarcity and pollution of water pose significant risks to the operations of companies, but they also play a key role in the resolution of these challenges.

The water stewardship commitment challenges Finnish companies and organisations to identify water-related risks in their procurement and value chains, ensure the water responsibility of their offices and procurement chains through risk analyses, and to develop sustainable water use and management practices together with their stakeholders.

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## The climate change plan points the way to a sustainable, low-carbon society

The impact evaluation of the medium-term climate change policy plan (KAISU) required by the Climate Change Act reviewed the impact of the climate change policy on Finland's greenhouse gas emissions, energy system, economy, environment and health. KAISU clarifies and complements the actions for reducing greenhouse gas emissions in the non-ETS or effort sharing sector, specified in the Energy and Climate Strategy published in 2016.

Based on the impact evaluations in KAISU, the greatest potential for reducing greenhouse gas emissions lies in the transport sector but, on the other hand, the reduction of transport emissions and the ensuing costs and environmental impact also involves the greatest uncertainties. Additional emission reductions can be achieved in particular by reducing the use of mineral oils for heating buildings and in machinery fuel.

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## Significant project underway to utilise Finnish discarded textiles

The industrial utilisation of discarded textiles requires that an extensive sorting and collection network is established for the different fibres – from cotton to polyester and viscose. Companies that wish to become involved in developing a business from circular economy must also be found. In the Telaketju project developing circular economy for textiles, VTT Technical Research Centre of Finland coordinates a project component that received EUR 2.3 million of funding from Tekes.

The purpose of the Telaketju project is to establish an ecosystem formed by companies and other actors that would raise the circular economy for textiles to a whole different level in Finland and develop it into a profitable business.

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## A new method for producing plant-based drinking bottles from FDCA

VTT has developed an environmentally sound and economical method for producing furan dicarboxylic acid (FDCA) from plant sugars for the production of drinking bottles, paints and industrial resins, for example. This technology enables production of plant-based products.

The main production material of drinking bottles is still oil-based PET although there has been news on alternatives based on renewable materials during the last few years. VTT's new method provides a new route for the packaging and beverage industries to expand the use of renewable materials in their production.

VTT has patented the method for producing furan dicarboxylic acid (FDCA), the monomer for PEF polymers, from sugar or sugar waste. Thanks to the solid acid catalyst and biobased solvent with short reaction time, the method provides a considerable reduction of toxic waste compared to traditional methods.

The method can be scaled-up to industrial purposes without substantial investments, and it has already raised a lot of interest in industry.

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## ITERAMS project reinventing the role of water and waste in mining

The ITERAMS project "Integrated Mineral Technologies for More Sustainable Raw Material Supply" funded by the European Union Horizon 2020 programme is reinventing water and waste in mining. The new methods developed in the project will offer the EU the potential to be in the forefront with regard to minimal waste, minimal energy and minimal water consumption in the mining sector.

Mining has been and is still a significant user of land space and water. One of the major environmental issues in processing the ore to concentrates is the waste stream, which can reach over 90% of the total mass.

The ITERAMS project targets significantly reducing water consumption by circulating process waters and reducing the amount of tailings waste through valorisation of the mineral matrix. Water circulation reduces water consumption at mine sites and the need to dispose of large quantities of wastewater in surrounding areas. To achieve this, the project focuses on the complete isolation of process waters from the adjacent water systems.

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## A total of 33 companies joining forces with VTT to develop new generation sustainable forest products

Together with a large industrial consortium, VTT has launched a EUR 4.5 million project to speed up the development of fibre-based products as alternatives to oil-based materials like plastics. The project, funded partly by the European Regional Development Fund ERD, has brought together 33 companies, ranging from small to large, global companies.

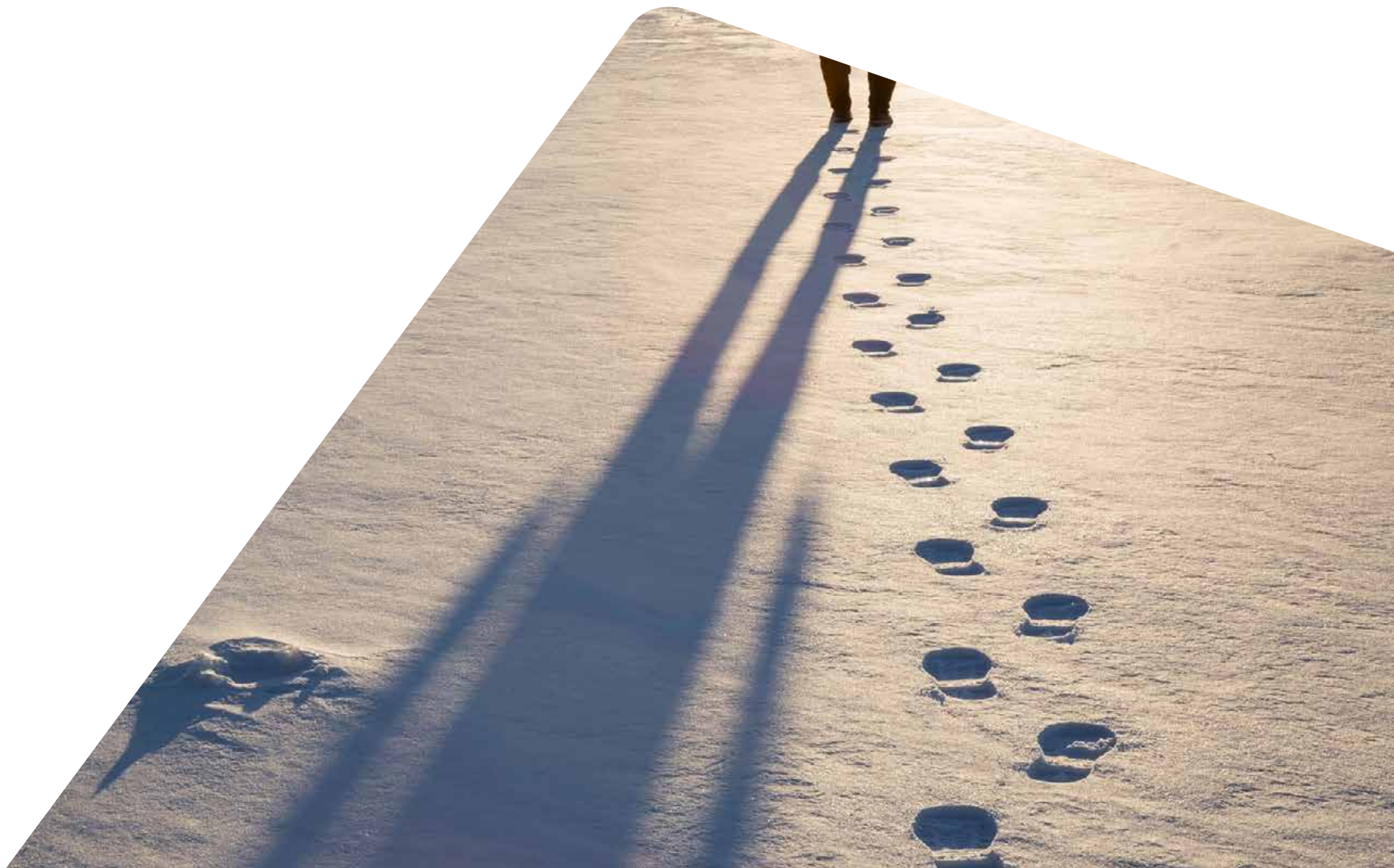
The Future Fibre Products project coordinated by VTT will transform laboratory-scale results into pilot-scale demonstrations for products and processes with a low carbon footprint. It will also explore how the current paper and board production infrastructure can be utilised in the field of new packaging solutions, non-woven materials, porous insulation materials, or even as replacements for EPS-based materials.

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# Tax footprint, management and control 2017



## Tax footprint

A company's tax footprint describes the amount of tax revenue it generates for society, and how tax is paid between different countries. VTT reports taxes paid, and entered in the accounts, as part of its tax footprint. Transparent reporting of its tax footprint forms a key part of VTT's corporate responsibility activities. In each case, VTT complies with local legislation on the payment, collection, book-entry and reporting of taxes.

High quality and timely management of tax returns and other statutory obligations form a key part of VTT's management of its tax and related affairs. VTT's tax footprint summary covers those taxes and tax-like charges which VTT has a statutory obligation to pay or collect.

At the end of the fiscal year, VTT Group consisted of four wholly-owned subsidiaries in addition to the parent company: VTT Expert Services Ltd, VTT Memsfab Ltd, VTT Ventures Ltd and VTT International Ltd. In addition, VTT Expert Services Ltd owns Labtium Ltd. The operations of VTT Brasil LTDA ended in 2016, and the run-down of the company was concluded in early 2017. At the end of the period, VTT Ventures Ltd owned 23 associated and other companies (so-called spin-offs). VTT Ventures Ltd's associated companies are not included in VTT Group's tax footprint reporting. VTT has no subsidiaries in low-tax countries.

Like other limited liability companies, the parent company and its subsidiaries are subject to income tax and value added tax on the basis of the Act on the Taxation of Business Income and the Value Added Tax Act.

In accordance with the act on VTT's incorporation (Act on the limited liability company called VTT Technical Research Centre of Finland Ltd (761/2014)) the Finnish state shall compensate VTT for costs associated with

VAT paid on activities other than those incurred through purchases and office rental related to business activities pursued on a commercial basis as defined in Section 1, paragraph 1, clause 1 of the Value Added Tax Act (1501/1993). The compensation is adjusted annually on the basis of the most recent accumulation of value added tax for the Company.

The parent company did not generate any taxable income. The parent company has confirmed losses, as well as statutory reserves entered in its opening balance sheet; statutory reserves used to pay realised

costs do not constitute taxable income in this respect. These statutory reserves have not been recognised as deferred tax assets in the parent company's financial statements. However, deferred tax assets have been taken into account in the consolidated financial statements in accordance with the prudence principle, by recording EUR 1.3 million in deferred tax assets. The Group's subsidiaries also have confirmed losses subject to taxation, for which EUR 0.2 million in deferred tax assets were recognised in the consolidated financial statement.

	VTT Group		Parent company		Subsidiaries	
	2017	2016	2017	2016	2017	2016
<b>Taxes paid</b>						
Income taxes	0.0	0.0	0.0	0.0	0.0	0.0
Property taxes	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
<b>Recognised taxes</b>						
Payroll taxes	31.5	34.3	28.5	31.1	3.0	3.1
Social security contributions	1.3	2.7	1.2	2.4	0.1	0.4
Value-added taxes	13.2	11.0	9.9	7.8	3.4	3.2
Asset transfer taxes	0.0	0.0	0.0	0.0	0.0	0.0
Other taxes	0.0	0.0	0.0	0.0	0.0	0.0
	46.1	48.0	39.5	41.3	6.5	6.7
<b>Grand total</b>	<b>46.1</b>	48.0	<b>39.5</b>	41.3	<b>6.5</b>	6.7
% share	100%	100%	86%	86%	14%	14%

Table 1. Relevant taxes and charges by category in 2017.

The relevant taxes and charges are listed by tax category in Table 1. The Group's parent company is reported separately and the subsidiaries as a whole. The Group's effective income tax rate in 2017 was 0.0%. Most taxes were paid in Finland.

In the 2017 financial year, the Group's parent company received EUR 87.3 million (EUR 91.8 million) in government grant. A total of EUR 4.5 million (EUR 6.0 million) of government grant was carried over from the previous year, increasing the total amount of government grant available to EUR 91.9 million (EUR 93.3 million). VTT used EUR 91.8 million (EUR 93.3 million) of the government grant.

As part of the government grant, the parent company received VAT compensation from the Ministry of Economic Affairs and Employment for costs associated with VAT paid on activities other than those incurred through purchases and office rental related to business activities pursued on a commercial basis. EUR 18.7 million of VAT compensation was used during the financial year (EUR 16.0 million). In addition, the parent company received EUR 3.7 million in investment grants (EUR 5.7 million), of which EUR 2.5 million consisted of government investment grants (EUR 1.0 million).

The tax reporting of VTT Group is audited by VTT's auditor, Authorized Public Accountants KPMG Oy Ab, to the extent that such reporting is included in VTT's financial statements.

## Governance and control system

VTT complies with the corporate governance principles defined by the Board of Directors. In all decision-making and governance, the company complies with Finnish laws and regulations and the Articles of Association.

The tasks of VTT's and its subsidiaries' various bodies are governed by the laws of Finland. VTT complies with the corporate governance principles defined by the Board of Directors, which are based on the Finnish Companies Act.

VTT is committed to the Finnish Corporate Governance Code. The company has deviated from the Corporate Governance Code (2015) as follows: Recommendation 3 – Not all members of the Board participated in the Annual General Meeting of 21 April 2017.

Recommendations 18a and 18b on a Nomination Committee - Given the scope and number of issues to be prepared in relation to recommendations 18a and 18b, a Nomination Committee is not considered necessary. The Board of Directors is responsible for the tasks in question.

Recommendation 23 - Remuneration and shareholding of the Board of Directors. This recommendation states that Board and committee remuneration can be paid in full or in part in company shares and that shareholding by Board members promotes good governance. VTT is a wholly state-owned limited liability company, the ownership of which is fully held by the State. For this reason, VTT does not pay Board and committee remuneration in shares.

The Corporate Governance Code can be found at: <http://cgfinland.fi/files/2015/10/hallinnointikoodi2015fin-web1.pdf>.

VTT and its subsidiaries form a group in accordance with the Companies Act. VTT prepares its consolidated financial statements, the parent company's financial statements and its annual report in accordance with the Finnish Accounting Act and regulations, and the Finnish Limited Liability Companies Act.

## Internal control

Internal control and risk management aims to ensure the identification, assessment and monitoring of risks affecting the company's business activities. All planning and reporting procedures are used as tools for internal control and risk management.

The control environment is based on the values defined in the strategy, and on defined and monitored processes and guidelines. Performance targets, from which personal targets are derived and agreed in development discussions, are set in VTT's interactive strategic and annual planning.

The Code of Conduct document was approved by the Board, and a mandatory online training course for all employees was launched in support of its implementation. Two business areas held research ethics seminars, and one had organised an equivalent seminar earlier. Two internal reports were received through the whistleblowing channel, and the investigation of one of them is still ongoing. The Ethical Committee made five statements on issues related to research ethics.

## Audit

The company's auditor must be an auditing body approved by the Central Chamber of Commerce. The auditor's term expires at the close of the subsequent Annual General Meeting. On 21 April 2017, the Annual General Meeting decided that Authorized Public Accountants KPMG Oy Ab (Business ID: 1805485-9) shall act as the company's auditor with

APA Jorma Nurkkala as the principal responsible auditor. A more detailed description of the activities of the Board, internal control and risk management is available on our website ([www.vttresearch.com/vttreview2017](http://www.vttresearch.com/vttreview2017)).







# Salary and remuneration report 2017



At VTT, rewarding is a key management tool deployed in support of the organisation's strategy and the achievement of its goals. The key elements of salaries and rewards are an incentivising and fair basic salary, a reward system that supports the implementation of the strategy, and a wide range of employee benefits.

The monetary remuneration methods employed in 2017 included the basic salary, recognition rewards and employee benefits. Other reward types included excellent training and development opportunities, flexible work and working hour arrangements, and an inspiring work environment that supports occupational well-being.

The VTT Board approves the reward principles and budget on an annual basis.

### Benefits, remunerations and rewarding

In addition to the President & CEO, the VTT Leadership Team includes seven members and a personnel representative.

The President & CEO or other managers do not have any out-of-the-ordinary (a telephone benefit) benefits or option rights. In accordance with the policy of the state owner, VTT has a supplementary pension system in place for compensating for the pension reduction caused by the corporatisation, as personnel were moved from under the State Pension Act to the Employees Pensions Act. Members of the Leadership Team are not covered by this system, however.

In 2017, the monthly salary of President & CEO Antti Vasara was EUR 18,500. His total salary includes the monthly salary and all fringe benefits (telephone benefit). Thus, the monetary salary equals the monthly salary minus the fringe benefits enjoyed by the President & CEO at the time. A holiday bonus is paid in addition to the monthly salary. The retirement age of the President & CEO is 65, and there are no pension arrange-

ments in excess of the statutory level in place for him. The President & CEO has a three-month period of notice in case of resignation. In the event of dismissal by the company, the period of notice is six months.

The employment contract of the President & CEO does not include any special severance pay clauses.

The salaries and rewarding of the President & CEO and Leadership Team are decided by the Board. The table below presents the salaries and other remunerations paid to the Group Leadership Team, President & CEO included, in 2017, along with other rewards for 2017 paid in 2018. The total salary includes fringe benefits and holiday bonuses.

	Total salary	Rewards	Total
President & CEO	235,306	16,650	251,956
Rest of the Leadership Team*	985,362	22,560	1,007,922
<b>Total</b>	<b>1,220,668</b>	<b>39,210</b>	<b>1,259,878</b>

The total salary includes fringe benefits and holiday bonuses.

\*Several changes were made to the Leadership Team in 2017. The calculations include the salaries of the persons for the duration of their membership in the Leadership Team.

### Attendance fees of Board members in 2017

	Monthly reward	Monthly reward, total	Attendance fee	Attendance fee, total	Total attendance fee of the Remuneration and Audit Committee	Total
Cantell Aaro, pj.	1,500	18,000	500	5,000	500	23,500
Hietanen Matti	850	10,200	500	5,500	3,000	18,700
Knuutila Kari-Hannu	700	8,400	500	5,000	2,500	15,900
Leiviskä Harri	850	10,200	500	5,500	2,500	18,200
Lundström Petra	700	8,400	500	5,500	500	14,400
Pauli Anneli	700	2,800	500	1,500		4,300
Pehu-Lehtonen Kaija	700	8,200	500	5,500	2,500	16,200
Pulkkinen Tuija	700	5,600	500	3,000		8,600
<b>Total</b>		<b>71,800</b>		<b>36,500</b>	<b>11,500</b>	<b>119,800</b>

Anneli Pauli, Board member until 04/2017, and Tuija Pulkkinen from 05/2017.



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