



# VTT Review 2012



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## Mission

VTT produces research services that enhance the international competitiveness of companies, society and other customers at the most important stages of their innovation process, and thereby creates the prerequisites for growth, employment and well-being.

## Core values

- Together for the client
- One step ahead
- Passion for innovation
- Support and respect to the core

# President & CEO's review



Developments during 2012 were somewhat contradictory in terms of VTT's research and innovation activities. The volume of major projects linked to extending VTT's expertise and networking with companies and other research bodies exceeded our expectations. The most important sources of this joint-funded work – Tekes, the EU, and the corporate sector – helped secure our success, and VTT has retained its place as a major R&D player in the EU.

The confidential work that we carry out with our corporate partners plays a central role in consolidating the influence that VTT has. Economically turbulent times often have a conflicting impact on companies' willingness to prioritise development work, however. Some companies see the need to secure their future competitiveness as important even in an economic downturn, while many others, perhaps understandably, implement cuts that have a negative impact on innovation work.

The value of Finland's Strategic Centres for Science, Technology and Innovation (SHOKs) for Finland's innovation policy was reviewed this winter. Inspired by an initiative from the business world, these centres were created to promote long-term technological development and corporate competitiveness in Finland. Deciding what they would focus on was deliberately left up to the corporate sector. The R&D intensity of the projects that they have coordinated has proved less ambitious than originally hoped for, however. As a major player, VTT's aim here is to play a more active role in helping SHOKs make a greater impact in the future.

Extending the range of products on offer from Finland's export sector and enhancing productivity is fundamental to improving Finland's competitiveness. VTT has played – and will continue to play – a central role here. More and more is being expected of innovation by society today in terms of truly sustainable solutions. Innovation alone, however, cannot secure the competitiveness of Finnish business. The public sector also needs to invest intelligently in developing Finland's innovation environment in these challenging times.

The need to restructure state research organizations has also been highlighted recently – and not for the first time. Major organisational and funding-related changes are now on the agenda. VTT is committed to being constructive in respect of all changes aimed at improving the potential that innovation has to offer. Securing future expertise that benefits the business community is essential. Close cooperation between the business and innovation world has a central role to play here. In a small country like Finland, we need to realise that investing too heavily in purely basic research will not generate the improved competitiveness that we need.

In what proved a difficult year, financially speaking, the good progress we made in achieving our scientific and customer benefit targets was very positive. I would particularly like to thank our customers, our partners, and of course all our personnel for the contribution they made here.

Erkki KM Leppävuori  
President & CEO



# BUSINESS FROM TECHNOLOGY

**VTT** Technical Research Centre of Finland is a customer-oriented, multitechnological applied research organization that provides leading-edge technology solutions and innovation services. By creating new and improved products, services, processes, and business concepts – and producing research data for the authorities and public decision-makers – we enhance the competitiveness and competence of our customers and contribute to the sustainability of society, employment, and people's wellbeing.

We have identified six areas of research and technology where we can help solve a range of present and upcoming environmental, social, and economic challenges. These six impact areas – bioeconomy, low carbon and smart energy, people's wellbeing, resource-efficient industries, a clean globe, and the digital world – offer our customers a number of exciting prospects for new business and growth.

VTT's services range from forecasting future technological and business developments through strategic technology development, solutions development and testing, to commercialization. We also help our customers improve their competitive edge by offering them off-the-shelf, VTT-patented IP. Our testing, inspection, and certification services add the all-important final touch by ensuring the viability of new products and services for their intended use.

Our extensive partner networks, together with our participation in EU and other international projects and our commitment to including customers in development work from an early stage, mean that we can transform new technologies into practical solutions very effectively.

According to our most recent customer survey in 2012, our customers reach their goals well when co-operating with VTT: 70% confirmed that new or improved products, services or processes were created and 53% of respondents had introduced a totally new technology as a result of a VTT project.

VTT is the biggest multitechnological contract research organization in Northern Europe. VTT provides high-end technology solutions and innovation services.

From our wide knowledge base, we can combine different technologies, create new innovations and a wide range of world class technologies and applied research services, thus improving our clients' competitiveness and competence.

Through our international scientific and technology networks, we can produce information, upgrade technology knowledge, and create business intelligence and value added for our stakeholders.

## VTT Group organization

Erkki KM Leppävuori, President & CEO

### Business Development

Petri Kalliokoski, Senior Vice President, Strategy and Business Development  
Howard Rupprecht, Vice President, New Business Development

### Business Solutions

Jouko Suokas, Executive Vice President

#### *Vice Presidents:*

Biotechnology, pharmaceutical and food industries: Hannu Lampola  
Chemical industry and environment: Tuomas Mustonen  
Electronics: Juha Palve  
Energy: Rauno Rintamaa  
Forest industry: Timo Pekkarinen  
ICT: Juha Palve  
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Real estate and construction: Harri Airaksinen  
Services and logistics: Harri Airaksinen  
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Value networks: Tiina Nakari-Setälä

### Research and Development

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#### *Vice Presidents:*

Bio and Process technology: Anu Kaukovirta-Norja  
Energy and Pulp&Paper: Satu Helynen  
ICT: Jussi Paakkari  
Industrial Systems: Risto Kuivanen  
Materials and Built Environment: Eva Häkkä-Rönholm  
Microtechnologies and Sensors: Arto Maaninen  
R&D operations development: Jussi Tuovinen

### Strategic Research

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Bio- and Chemical Processes: Johanna Buchert  
Energy: Kai Sipilä  
Industrial Systems Management: Rauno Heinonen  
Information and Communication Technologies: Tatu Koljonen  
Microtechnologies and Electronics: Harri Kopola  
Services and the Built Environment: Matti Kokkala  
EU Affairs: Leena Sarvaranta

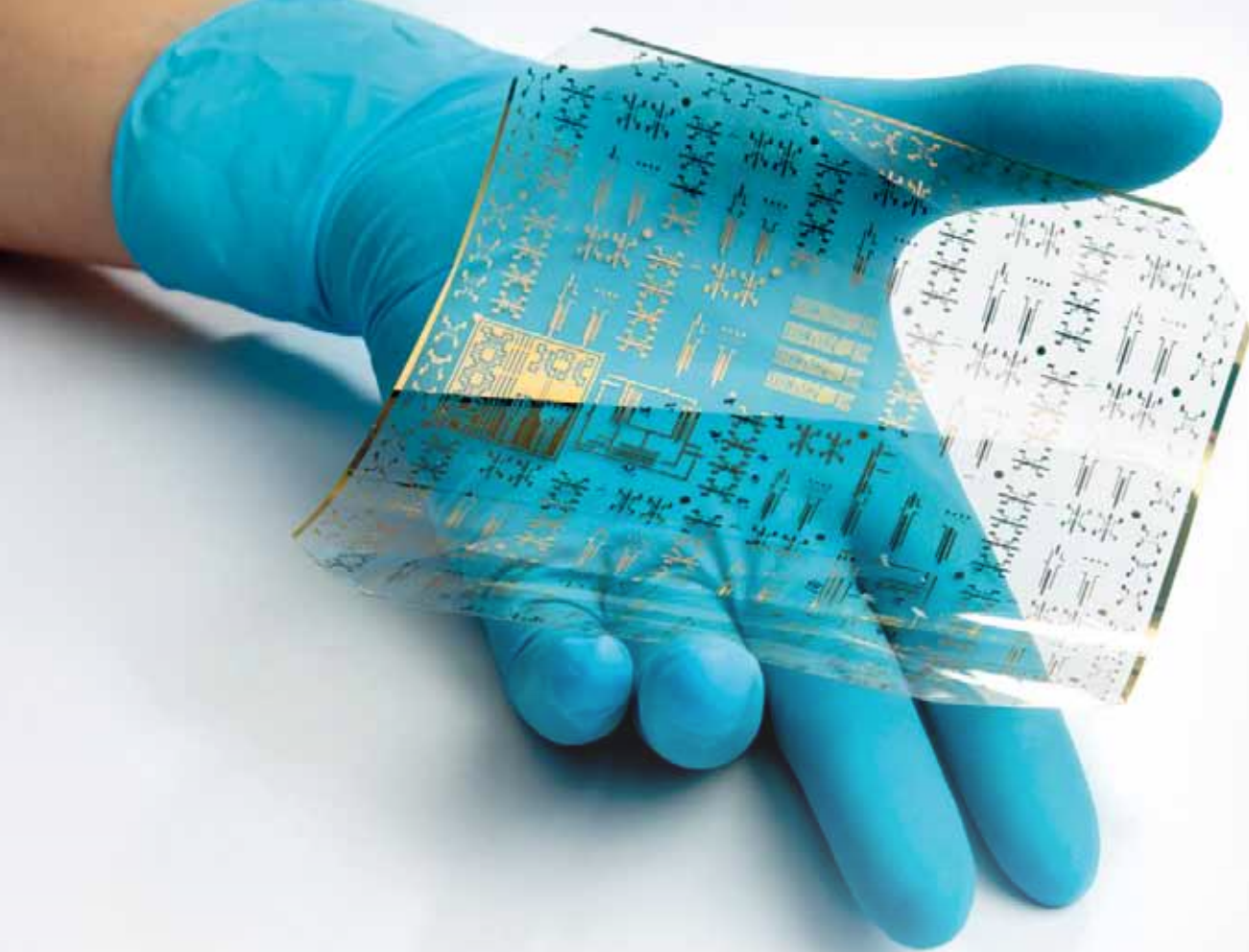
### Group Services

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Timo Nurminiemi, Senior VP, Finance  
Seppo Viinikainen, Executive VP, Group Services  
Riitta Tolvanen, Senior VP, Human Resources  
Markus Ekman, Senior VP, Information Management  
Jukka Forsström, Senior VP, Risk Management  
Matti Karhunen, Senior VP, Legal and Governance

### VTT companies

VTT Expert Services Ltd, Laura Apilo, CEO  
VTT Ventures Ltd, Antti Sinisalo, CEO  
VTT International Ltd, Petri Kalliokoski, CEO  
VTT Memsfab Ltd, Hannu Kattelus, CEO

The research examples presented in this review represent only a small fraction of VTT's activities, although they do provide some idea of the many and varied ways in which VTT's know-how influences technical development in Finland.



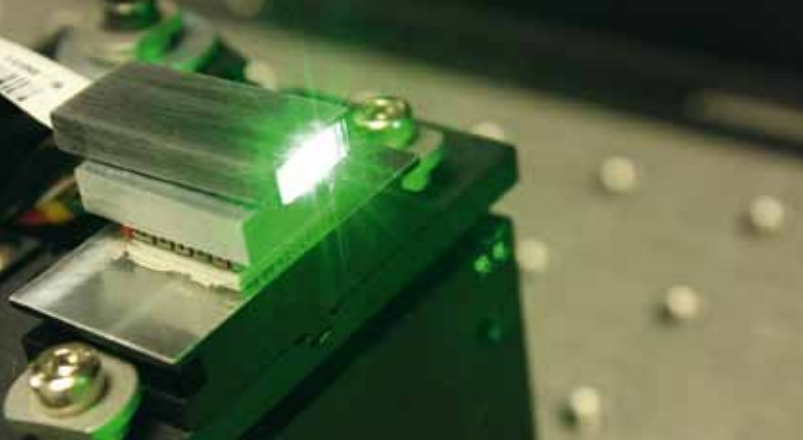
# ICT, ELECTRONICS

- Despite global economic difficulties, the value of the global electronics market was estimated to exceed USD 1,000 billion, with exceptional growth in the smartphone, tablet and LED TV markets
- The growth in smartphone sales in 2012 was estimated at 45%, while the total sales of mobile phones would only increase by 1.4%, which equals 1.7 billion phones
- The nationwide mobile broadband is used at home by 37% of Finnish Internet users, an increase of 11 percentage units from the previous year
- The PC market was estimated to drop for the first time in ten years by 1.2%, to 349 million PCs.

## **Laser projection technology for smartphones**

Mobile phones currently on the market are capable of showing high quality images and video, but the phones' small size sets insurmountable limits on screen size, and thus the viewing experience. EpiCrystals Oy, VTT and the Aalto University are developing a better laser light source for projectors that can be integrated into mobile phones, which will enable accurate and efficient projection of, for example, photographs and movies on any surface.

Small-size laser projectors of 1–2 cubic centimetres can be integrated into many types of electronic appliances, such as digital or video cameras, palm PDAs and mobile phones. Integrated micro projectors could, in practice, project images the size of an A3 sheet of paper on a wall.



Small-size laser projectors can be integrated into many types of electronic appliances, such as digital or video cameras, palm PDAs and mobile phones.

The challenge is to develop a small, energy-efficient and luminous three-colour (RGB) light source, whose manufacturing costs can be kept low, for use in the projectors. Solutions are being sought in a project combining Finnish know-how, with participants EpiCrystals Oy, VTT and Aalto University.

The project is a combination of multi-technological know-how, from materials manufacturing and the accurate assembly of laser chips all the way to production line design. The project has moved on from the brainstorming and design stage to the building of prototypes, and the first results have been very promising.

Mobile phones equipped with laser light sources could be within the ordinary consumer's reach in a few years' time. EpiCrystals Oy aims straight for the global market with its products, and it is the company's goal to be the technology and market leader in laser light sources for micro projectors by 2015.

The laser modules will be assembled in Asia, but the research and development will remain in Finland. The joint project has received funding from the Finnish Funding Agency for Technology and Innovation Tekes, among others.

#### Further information

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### Integrating ubiquitous computing into our everyday lives

**The next ICT revolution will have a profound impact on our lives and the economy. Ubiquitous computing and the Internet of Things are experiencing remarkable growth. The effects are apparent in housing, transport, health care, and retail, as well as the security and energy industries. VTT has been developing ubiquitous computing applications in the OPENS (Open Smart Spaces) programme.**

Ubiquitous computing (ubi) and the Internet of Things (IoT) will revolutionize technology and business. Information

technology and electronics are becoming entwined with our everyday lives in industry, the service sector, transport, logistics, health care, housing, education, and leisure time, almost without our noticing it.

The changes are already apparent to consumers in the energy sector, for example: remotely readable meters are rapidly becoming more common, enabling developments such as new pricing models that encourage the reduction of carbon dioxide emissions. The remote control of machines and devices is experiencing substantial growth and spreading to smaller and smaller appliances. Smart buildings use building automation to control their own functions to an ever greater extent, and remote health care applications are increasing apace with the ageing of the population.

VTT has been developing ubiquitous computing applications and basic technology in the OPENS programme. The programme's achievements include the implementation of the interoperability platform Smart M3, which enables various appliances and objects in the home or office to "converse", understand each other, and share information. This interoperability platform, created for devices produced by different manufacturers for a variety of purposes, is based on so-called semantic technology, which defines a common "language" for devices and applications. The interoperability of devices promotes energy saving, comfort, and safety at home and at work. The solution was developed together with VTT, industrial partners and universities in various national and European projects.

One way to make appliances and services feel "smart" for the user is to make them situationally aware. Situation and location awareness has already been put into practice in mobile communications devices and other appliances. VTT has brought a new dimension to awareness with the solutions it has developed to enable additional recognition of the user's activities – is the user sitting, walking, or running – and his or her method of travel – is the user travelling by train, bus, car, or bicycle. In this way the user can be offered the most appropriate services for the situation.

One example of interaction technology between man and machine is mixed and augmented reality, an area in which VTT has achieved globally significant results. Such applications include motion sensing input devices and 3D cameras for games and practical applications. Mixed and augmented reality as an interface for mobile phones, for example, is just breaking into the market and entering consumer consciousness.

By next year, IoT technology and application business will be worth EUR 300 billion, with an annual growth rate of 30 per cent. VTT is determined to help its customers reap their share of this growth. Research in the field is continuing strongly, with a particular focus on the Internet of Things.

VTT is developing uID (universal Identification) technology with its Japanese partner, the University of Tokyo. This technology enables the identification and tracking of individual products, components, and food products. With uID, information on origin, manufacture, and history can be attached in the digital world to the most commonplace items over their entire life cycle. A timber plank, for example, can be tagged with information on which forest the timber was cut from, where it was sawn, how many times it has been painted, and with what paints.

#### Further information

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### Efficient use of the radio spectrum

**Current spectrum occupancy can be improved with the help of cognitive radio system (CRS) technology. New CRS technology can be used to achieve more efficient spectrum sharing between wireless systems. A thesis completed at VTT has created a general approach for obtaining knowledge of spectrum availability and improving spectrum occupancy. The results can be exploited especially in the development of future mobile communications systems.**

The number of wireless communication devices and data rates is growing, leading to increased spectrum demand to which it will be difficult to respond on account of limited spectrum availability. In particular, the spectrum demand of mobile communication systems is expected to increase significantly. Cognitive radio system (CRS) capabilities boost spectrum sharing between various systems by using temporarily and locally free spectrum resources without harmful interference to primary systems. In this way CRS techniques

enable more effective use of spectrum resources through the deployment of frequency bands with low occupancy.

The thesis studied the methods of obtaining and exploiting knowledge of spectrum availability for CSRs. The thesis presents new information on the influence of spatial dimension on spectrum occupancy measurements, showing that spectrum occupancy can vary significantly depending on the measurement location. Several methods for obtaining knowledge of spectrum availability for CRS, including control channels, databases and spectrum sensing techniques, were studied in the thesis. The results of the study present a general framework for obtaining knowledge of spectrum availability. The study proposes a novel band-specific approach, where the selection of the method is determined separately for each frequency band based on the deployment characteristics and regulatory requirements of the specific band.

The general approach for obtaining knowledge of spectrum availability developed in the thesis can be applied to wireless systems operating in different frequency bands. The results and principles of the thesis work can be exploited in the development of future mobile communication systems by incorporating cognitive radio technology in response to growing data rate demand.

VTT has also developed a trial environment for cognitive radio systems and networks for testing cognitive decision-making techniques. The trial environment includes functions for information gathering, decision-making and the implementation of decisions, and each function can be modified to suit various purposes.

VTT is actively involved in promoting spectrum sharing in international CRS-related regulatory activities. Together with industry and the Finnish Communications Regulatory Agency FICORA, VTT has provided several contributions to the spectrum activities of the International Telecommunication Union ITU, and is currently acting as the Chairman of the CRS group of one of the Radiocommunication Sector's working parties, ITU-R WP5A.

#### Further information

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### Introducing printed electronics into mass-produced articles

**The idea behind printed intelligence lies in manufacturing large quantities of functional electronics at sufficiently low cost and at such a high speed that they can be added to mass-produced articles.**





The world's first ever business and production environment for printed electronics is being piloted at VTT's facilities in Oulu as part of the PrintoCent programme.

The world's first ever business and production environment for printed electronics is being piloted at VTT's facilities in Oulu as part of the PrintoCent programme. The new industrial-scale roll-to-roll printing line enables fast and efficient manufacture of mass-produced printed electronics for commercial production. VTT's PrintoCent facility makes use of various printing processes, such as flexographic and rotogravure printing, reverse gravure printing, screen printing and hot press printing. The technology also enables the production of printed light-emitting foils and solar cells as well as the incorporation of microfluidics and holograms into printed products. Possible applications for printed electronics and intelligence technology include in-home diagnostics, dispersed energy production, electronic products, intelligent packaging and intelligent environments.

Roll-to-roll assembly combines functionalities created using printing technology – which are flexible and have a unique form factor – with robust and industrially mature silicon-based components and other electronic components, to create a functional end product.

In addition to cutting-edge technological know-how, PrintoCent offers a unique development environment for businesses of all sizes. The Oulu-based custom-built technical facility enables industrial pilot manufacturing at an extremely low risk. There is no need for start-up businesses that wish to make use of the technology to invest in their own production environment. Although some customers are major international industrial enterprises, the facility also creates a substantial number of new manufacturing and design jobs in production and service companies in Finland. The objective is for Finland to take one per cent of the global industry, which market forecast companies have estimated at EUR 250 billion, over the next 20 years, which would create 10,000 jobs in export roles in Finland.

PrintoCent is a contractual community set up by VTT Technical Research Centre of Finland, the University of

Oulu, Oulu University of Applied Sciences and Business Oulu. PrintoCent is based on research that VTT began towards the end of the 1990s, which has now grown into a community of more than 100 person-years of work annually. The PrintoCent community was launched in 2009, and it has already led to the creation of around a dozen new businesses. The total volume of PrintoCent's project portfolio was EUR 15 million between 2009 and 2012, with businesses investing EUR 2 million.

One of the businesses using VTT's printed electronics technology is a spin-off called TactoTek Oy, which develops durable and formable optical touch panels. They can be used in consumer electronics, such as mobile telephones and tablet computers as well as in industrial applications. Touch panels will also become increasingly common in other uses, ranging from coffeemakers to toys and excavators.

#### Further information

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# FOREST, ENERGY, CHEMISTRY, ENVIRONMENT

• In 2011, global coal production grew more than 6%, the production of nuclear energy reduced by 9% in the OECD countries, and renewable energy production grew by 8% • The turnover of the renewable energy sector in Finland in 2011 was EUR 905 million, and the share of renewable energy sources of total energy consumption was 33% – of which 80% was wood-based • The global value of chemicals production has reached USD 4,100 billion, and the market value of green chemistry is some USD 100 billion • The chemical industry is now the leading Finnish export, with its share of all export at 25%.

## **Cost-efficient bio-oil production for heating**

VTT has collaborated with energy company Fortum, technology specialist Metso and forestry firm UPM to develop a solution for co-generating electricity and heat in parallel with bio-oil production within a single power plant in a cost-efficient and sustainable manner. The new production method of connecting bio-oil production to a fluidized bed boiler will be introduced at Fortum's Joensuu CHP (combined heat and power) plant in Finland in about one year's time.

Bio-oil has been seen as one of the future replacements for fossil fuels. However, the extensive commercial use of bio-oil in heat production requires a cost-efficient bio-oil production

An industrial-scale foam forming environment will be integrated to the SUORA facilities at VTT.



process. Using a method developed on the basis of VTT's patented innovations for combining two technologies, pyrolysis and combustion, bio-oil production costs can be significantly reduced. As a result, bio-oil production volumes can be expected to increase significantly in the coming decades.

Linking the rapid pyrolysis process to a fluidized bed boiler of a conventional power plant brings several advantages. This type of bio-oil production method is cheaper than using a separate pyrolysis process. Connecting bio-oil production to a power plant is very energy-efficient, as the energy derived from pyrolysis by-products can be fed into the boiler. This is a major improvement, because by-products can contain as much as 40% of the energy of the original biomass. It also allows the effective exploitation of the heat flows and loads of the power plant and pyrolysis process within the plant, not to mention the lower investment and operating costs of an integrated plant compared to having two separate production facilities.

Bio-oil use has significant positive environmental impacts. Carbon dioxide emissions can be reduced by 70–90% by replacing fossil fuels in heat production with bio-oil. It will also significantly reduce sulphur dioxide emissions. The goal of the next phase of the development work is to refine bio-oil into higher-value products.

The commercial implementation of the new production method that connects bio-oil production to a fluidized bed boiler, i.e. the integrated pyrolysis process, will take place at Fortum's Joensuu CHP plant in about one year's time. The Joensuu plant produces approximately 50,000 tons of bio-oil a year, enough energy to cover the annual district heating needs of some 24,000 average-sized flats.

VTT is also involved in European standardization work to support the innovation's entry into the market. There are currently some 200 CHP plants in Europe and North America that have the potential to implement the integrated bio-oil production process. The use of the innovation would generate more than 10,000 jobs within the forest and logistics sectors, for example.

Taking the development project all the way to its industrial implementation phase is a good example of successful collaboration between the public and private sector. The project has been part of Tekes' BioRefine programme.

VTT was awarded the EARTO Innovation Prize 2012 for developing a new bio-oil production method last December. EARTO is the European Association of Research and Technology Organisations.

#### Further information

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### Foam forming offers new properties to packaging

**Foam forming can be used for marked expansion of the selection of natural fibre-based, recyclable and lighter products, and the achievement of substantial savings in production costs. The world's first industrial-scale foam forming research environment will be constructed for VTT to support the product development of companies.**

With foam forming technology, it is possible to improve the properties of existing packaging, paper and board products, and the manufacture of different types of highly porous, light-weight and smooth products, such as hygiene products, insulators and filters. It may also be the solution for printed intelligence and electronics and microcellulose applications. The foundation for the development of this technology has been laid by Forestcluster's programmes EffTech and EffNet.

Foam forming technology requires significantly less water than conventional paper and board manufacturing. Pulp contains large amounts of air, providing better opportunities for influencing the properties of the end-product. Foam forming technology also reduces energy consumption, while saving on raw materials.



The new gasification power plant constructed by Lahti Energy Ltd uses combustible energy waste collected from industry and households.

The KOTVA project involves transferring foam forming technology to VTT's SUORA research environment in Jyväskylä. SUORA is VTT's pilot-scale research environment for fibre processes, developed in close collaboration with the member companies of Forestcluster. The environment is smaller in scale and its functions more easily modifiable than the piloting equipment used in the industrial sector. This allows for development solutions to be generated rapidly and cost-effectively, often already at the idea stage.

The two-year KOTVA project, with a budget of two million euros, supports the Forestcluster's national research strategy. The Forestcluster's goal is to double the Finnish forest sector's turnover by 2030. Half the turnover is expected to come from new fibre-based products not yet in production.

VTT bears the main responsibility for the development of foam forming technology. Also involved in the project are UPM, Stora Enso, Metsä Board, Kemira, Omya, Wetend Technologies, and Vision Systems, as well as the cities of Jyväskylä, Äänekoski and Jämsä, and the University of Jyväskylä.

#### Further information

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#### Eco-friendly energy from solid recovered fuel

**The world's first power plant to produce energy from solid recovered fuel (SRF) was opened in Finland in spring 2012. The contractors were Lahti Energy Ltd and Metso Corporation. The power plant's operations are based on gasification and gas cleaning technology, developed by VTT, which help turn combustible waste into electricity and heat, with a considerably higher efficiency rate than conventional waste treatment methods.**

Lahti Energy has been exploiting and developing gasification technology in the treatment of energy waste for

nearly 20 years. The first gasification reactor was introduced in 1998, and the gases it produced were directed to a boiler for co-combustion with coal. Fuel for the new gasification power plant constructed by Lahti Energy Ltd is combustible energy waste collected from industry and households in the Southern Finland region and processed into SRF by fuel suppliers in their own facilities. The power plant exploits the gasification and gas cleaning technologies developed by VTT. Using a novel operating model and technique affects the SRF emissions in such a way that the purity of the gas enables combustion at a higher temperature with a higher efficiency rate.

The new technological concept introduced at the Kymijärvi II power plant is related to the gasification and gas cleaning of solid recovered fuel. SRF that includes plastic, board, paper, wood and other combustible waste materials contains compounds that are harmful both to the environment and to the technical structures of the power plant. In the new power plant, the first step in separating harmful impurities from SRF is the gasification of the solid material. Gasified harmful impurities are returned to solid state by cooling the gas from 900 degrees to 400 degrees. Once the impurities have turned into ash, they are removed through a filtering process. The end-product is clean eco gas, comparable to natural gas. The eco gas is directed to a conventional boiler, where it can be burned at high temperatures for the purpose of using it in the efficient production of electricity and district heat.

The Sustainable Development Forum of Finnish Energy Industries selected Kymijärvi II as the Climate Action of the Year 2011. Kymijärvi II reduces deferred CO<sub>2</sub> emissions by 410,000 tonnes a year on estimate, in comparison to producing the same amount of electricity by using coal. Introducing the new gasification power plant also reduces the use of Lahti Energy's existing coal-fired power plant, and the CO<sub>2</sub> emissions it produces, by 230,000 tonnes a year.

#### Further information

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## **Emissions measurement know-how to India**

**VTT assists Indian operators in improving their skills in emission measurement. Reliable measurement plays a key role in identifying and reducing emissions.**

Currently only a few Indian institutions own automatic measuring devices that record the volume and type of emissions around the clock. For the most part, emission measurement is performed using single-spot measurement that requires special skills and precision. The cooperation project's Indian partners, the Central Pollution Control Board (CPCB), an agency governed by the Indian Ministry of the Environment, and the units of its sub-organization, the State Pollution Control Board (SPCB), take advantage of VTT's decades of experience in the development of skills and improvement of the level of measurement.

The project consists of Indian specialists' education and training visits to VTT in Finland and various Finnish companies to introduce the latest technology in the field, as well as the workshops held by VTT in India. The project disseminates practical emission measurement know-how and promotes technology export.

The project is implemented using the Ministry for Foreign Affairs' ICI instrument. The Institutional Cooperation Instrument (ICI) was established by the Ministry for Foreign Affairs to finance the participation of Finnish government agencies in international development cooperation. The objective is to strengthen the skills and know-how of government actors, such as ministries and institutions, in the developing countries.

### **Further information**

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## **Low carbon visions for Finland**

**The EU has set a goal for 2050 of reducing its greenhouse gas emissions by 80% from the level of 1990. According to VTT's study, the goal is challenging, but within Finland's reach if cleantech solutions are adopted at an accelerated pace in energy production, industry, housing and transport.**

VTT's specialists have assessed Finland's chances of achieving the EU's 80% greenhouse gas emission reduction targets. In the research project Low Carbon Finland 2050, approximately 50 specialists from various areas of competence within VTT came together to formulate three alternative future scenarios for Finland to become a low-carbon society by 2050.

In the Tonni scenario, Finland's industrial structure and production volumes, as well as urban form, remain relatively unchanged. The growth of production volumes in energy-intensive industry is linear, and GHG emission reductions are achieved with the help of fairly mature technology.

In the Inno scenario, technological development is progressing strongly; welfare is based on the commercialization and export of new products and services. Population is increasingly concentrated in a few centres, offering a promising environment for the introduction of intelligent and energy-efficient transport and housing solutions, for example.

In the Onni scenario, industrial production moves more in the direction of small-scale industry. The number of local, small-scale service enterprises increases while the production volumes of traditional, energy-intensive industry diminish.

By 2050, the proportion of renewable energy could be as high as 60% of the energy end-use, in which case Finland would pay 5 billion euros less for imported fuels. Making a cost-effective transition to a low-carbon economy requires a diverse structure for energy production that covers renewable energy sources, nuclear power and fossil fuels, all of which will have their role to play in the future. In addition, energy efficiency must be significantly improved in transport, buildings and industry.

Of Finland's electricity production, 85–100% could be based on carbon-free energy production in 2050, assuming that Finland's energy production structure is versatile and new CCS (carbon capture and storage) technology solutions are extensively deployed in the use of fossil fuels and biomass.

If significant improvements are made to the energy- and resource-efficiency of industry, including measures such as increasing the use of recovered materials, and industry also adopts CCS technology, then 80% of the energy used by industry can be carbon-neutral in 2050.

A 70–80% level of carbon-neutral energy in transport is possible by 2050. There is great demand for biofuels in low-carbon transport; these could account for up to 40% of the total energy consumed by the transport sector.

In buildings, 85–95% of final energy consumption could be carbon-free in 2050. Locally, buildings could even produce energy. The potential for improving the energy-efficiency of buildings is already great with modern technology, but sufficiently rapid implementation poses a challenge.

### **Further information**

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# BIOTECHNOLOGY, FOOD, PHARMACEUTICALS

- The global biotechnology market value reached nearly USD 282 billion in 2011, with a growth of around 8% • The value of the biotechnology market is estimated to grow by more than 60% by 2016 • The combined market value of the pharmaceutical and health care sectors is more than 67% of the total value of the biotechnology market • In 2011, biotechnology companies boosted their R&D investments by roughly 9%.

## **Food industry's co-streams used as raw material for new products**

New uses are being developed for the substantial co-streams of fish and oil plant processing. VTT coordinates the European Commission's APROPOS project. The project's researchers are creating methods of ecologically, effectively and economically reusing protein- and oil-rich co-streams suitable for food, as dietary supplements, foods and skin care products, for example.

Co-streams from the food industry are excellent sources of proteins and healthy oils for use in foods and cosmetics. However, at the moment these co-streams are mainly used as fish and animal feed, for energy, or end up as waste.

Coordinated by VTT, the APROPOS (Added value from high protein and high oil containing industrial co-streams)



For the past ten years, researchers at VTT have been studying drug mechanisms of action and developing new drug molecules and biomarkers for diagnostic applications.

project seeks to enrich several co-stream components at once. The project results especially promote the competitiveness of the SME sector and benefit regional production units located near primary production. There is global demand for a waste-free biorefinery for processing natural products that improve human well-being, and that supports sustainable development.

According to FAOSTAT statistics, the global catch of fish is about 90 million tonnes each year, of which Europe's share is around 13 million tonnes. Less than half is used as human food. Annual production of oil plants, such as the oil palm, soy, olive, sunflower and turnip rape, is around 60 million tonnes, of which 25 tonnes come from Europe. In oil plant production, an even greater portion remains unused as foodstuffs for humans compared to the catch of fish.

It has been estimated that the world population will reach 9 billion people by 2030, with the need for food

growing by 50 per cent. From the sustainable development perspective, utilising high-quality co-streams from fisheries, agriculture and the food industry is a better solution than expanding agriculture and the number of farmed animals.

In addition to VTT, the research partners in the European Commission's APROPOS project are the Polytechnic University of Catalonia, Scandinavia's largest independent research organization SINTEF from Norway, the Lithuanian Aleksandras Stulginskis University, the Manitoba Agri-Health Research Network from Canada, the India-based Energy Research Institute, and the University of Nairobi, Kenya.

The project also involves developing eco-efficient biomechanical processing technologies and end-product applications suitable for small enterprises. SMEs from various countries contribute by evaluating the applicability of these technologies to their business operations.

#### Further information

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#### New information on compounds that inhibit breast cancer progression

Researchers at VTT, in collaboration with the University of Turku, Indiana University and two Turku-based companies, Biotie Therapies and Pharmatest Services, have discovered new information concerning the development of breast cancer bone metastases. Heparin-like compounds can potentially be used to prevent breast cancer from spreading to bones. The mechanisms of breast cancer progression have also been studied in various dissertations.

Using the RNA interference screening of breast cancer cells, researchers at VTT discovered an enzyme that modifies heparin sulphate glycosaminoglycans, HS6ST2, an





VTT has cooperated with LUMENE Oy to develop a cell culture technology that allows the stem cell extract derived from Finnish cloudberry to be used in skin care products.

important regulator of breast cancer cell-bone interactions. Heparin, commonly used as an anticoagulant, also inhibited this regulatory mechanism.

Experiments in a mouse model of breast cancer metastasis indicated that heparin-like compounds decreased breast cancer cell growth in bone and the resulting bone destruction. One such heparin-like compound has been developed by Biotie Therapies. It is not as effective an anticoagulant as heparin, making it more applicable as a cancer therapeutic agent.

In her dissertation, researcher Laura Lehtinen aimed to identify novel regulators of tumour progression in breast cancer and study their role in breast cancer cells. The study provided important insight into the processes influencing breast cancer progression and found regulating genes that are potential drug targets for blocking breast cancer cell migration and invasion.

For the past ten years, drug development researchers at VTT have been studying drug mechanisms of action and developing new drug molecules and biomarkers for diagnostic applications, with special focus on breast and prostate cancers.

#### Further information

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#### Stem cell technology used in skin care products

VTT has cooperated with LUMENE Oy to develop a cell culture technology that allows the stem cell extract derived from Finnish cloudberry to be used in skin care products. This technology is unique worldwide, and was developed exclusively for LUMENE Oy by VTT.

The cloudberry stem cell culture technology represents the cutting-edge of biotechnology. VTT was responsible for the development of the raw material, which LUMENE Oy further developed into an application suitable for use in the cosmetics industry. The company was also in charge of the research of the safety and efficiency of raw material.

The production of cloudberry stem cell extract is based on cutting-edge plant cell culture technology. In practice, the first step is to make an incision in the berry plant to initiate the formation of callus cells that cover the plant wound.

Callus cells protect and repair the plant's surface wounds. These cells are then collected and grown in laboratory conditions. The final step is to freeze-dry the stem cells.

Cloudberry stem cell extract contains more than ten times the amount of potent natural anti-oxidants, flavanols, found in fresh cloudberry. Anti-oxidants help protect the skin against external factors causing premature ageing. In addition, the extract provides UV-protection and advances skin's collagen formation, helping maintain its elasticity.

LUMENE's skin care product line that utilizes the cell culture of arctic berries is the first commercial one of its kind in the world. LUMENE Oy has a patent pending concerning the texture and effectiveness of the products. Cooperation with VTT continues in new projects.

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# MACHINES, VEHICLES, METAL

- In total, 5.8 million hybrid electric vehicles were sold worldwide by October 2012
- The value of the global industrial automation market was estimated to reach USD 200 billion by 2015 – with a growth of nearly 10% in the US and China
- In 2012, the world's largest steel producer, China, increased its production volume to more than 716 million tonnes.

## **Increasing the accuracy of ship design**

The starting point of ship design is ensuring the operating safety of ships in all types of wave conditions. Using a calculation method developed at VTT allows more accurate prediction of wave-induced loads in ship hull design.

The design bases of ships include effective and functional space planning and structural solutions suitable for the ship's mission, with the starting point of ensuring the operating safety of ships in all types of wave conditions.

It is important to have a clear and accurate understanding of wave loads, ship motion and ship structure stresses right from the early stages of the design process. The most significant factor in hull strength analysis is determining the worst possible wave that the ship may encounter during its operating life.



A test bus assembled on Kabus Oy's bus chassis in the eBus project will accelerate the development of electro-technical components.

In his dissertation, Senior Scientist at VTT Timo Kukkanen studied wave loads for ships. Kukkanen developed a calculation method that can be applied to modern ship types, thus providing support for ship hull design.

The calculation method and model ship tests were employed for analysing nonlinear effects of wave loads and ship's motion impossible to assess through conventional methods. Numerical and experimental investigations revealed that the loads were greater and more significant than suggested by the predictions generated through simple solutions traditionally utilised in ship hull design.

The new calculation method is based on a time domain solution applicable for carrying out model tests in regular and irregular head waves at specific speeds and heading angles.

The newly developed time domain calculation method has already been applied in the design and construction of the cruise ship Oasis of the Seas at STX Finland's shipyard in Turku, for example.

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#### Pioneering commercial vehicle technology

**VTT has expanded its research environment to allow the development of future electric vehicles and mobile machinery, battery systems and components. VTT's vehicle laboratory is also suited to testing and developing heavy vehicles. A test bus assembled on Kabus Oy's bus chassis in the eBus project, will accelerate the development of electro-technical components.**

VTT's new research environment for vehicles provides an opportunity to develop electric vehicles and their powertrain as an entity, including electric motors, electronics and batteries. Integration of testing into VTT's powertrain modelling competence will speed up the design of new vehicles.

VTT's research projects combine, for example, expertise related to materials technology, electrotechnology, electric machines and vehicles.

The power supply unit mounted in the vehicle laboratory is capable of both simulating the battery system of a heavy electric vehicle under vehicle testing conditions, and performing full-scale battery charge-discharge cycles. The renewed battery laboratory's operations are divided into R&D of battery cells, battery modules and large ready-to-use battery systems.

The performance of energy storage systems suited to electric vehicles can be measured in a repeatable manner under controlled circumstances, such as extreme cold of -70 degrees Celsius.

Testing of battery cells and battery systems in various modes of operation and under conditions corresponding to actual use will help develop safer and more efficient products. In addition to the development of vehicles and machinery, VTT's research environment supports the electro-technical component industry, which has several plants throughout Finland.

The operations of the laboratory provide excellent support for new Finnish networking projects, such as the ECV project entity for the development of electric commercial vehicles. The extent of this networking project implemented under Tekes' EVE programme and coordinated by VTT is some 10 million euros. Taking part in the ECV project, in addition to VTT, are 25 to 30 research organizations and companies, including Aalto University, Tekes, Ministry of Transport and Communications, Metropolia, Lappeenranta University of Technology, Rovaniemi University of Applied Sciences, Veolia Transport, Normet, Rocla, Fortum, Kabus, Vacon, European Batteries, Helsinki Region Transport (HSL) and the City of Espoo. The partners have international goals: the project is aiming for international business activity, and also seeks admission to various EU projects to network with European R&D projects.

Industrial components can now be tested and developed in their actual user environment with the help of the electric test bus created under the eBus project. The eBus test bus was designed by VTT and Aalto University, and assembled on Kabus Oy's bus chassis by Helsinki Metropolia University of Applied Sciences. With the help of the research environment and test bed, component manufacturers can test and demonstrate their batteries and component products and compare them with those available on the market.

#### Further information

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#### Cooperative traffic safety information

**VTT, Mobisoft Oy and the Finnish Meteorological Institute, with their partners, have developed a co-operative communication system for sharing real-time traffic information to drivers on weather, slippery road conditions and traffic disruptions. The system is aimed at preventing serious traffic accidents, and the components are expected to enter to the market in the next few years.**

According to prior studies, the risk of having an accident on a snowy or icy road surface is more than four times higher than in normal road weather conditions. Together with the partners, VTT have participated in the international WiSafe-Car project to develop solutions for vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication that assists driver to adapt to challenging road weather conditions, thus helping to improve traffic safety.

Vehicles can use this new system to communicate their own observations concerning traffic, road conditions and the weather to the core platform. This information is

available to other vehicles as analysed data including the weather reports, for example. The system also warns the driver of an immediate threat of accident arising from slippery road conditions.

Cooperative mobility aided by communication and data sharing services between vehicles and infrastructure is the next big intelligent transportation leap during 2014–2030. In particular Europe, the United States and Japan are focusing on developing cooperative mobility services. The in-vehicle information systems developed by the Finnish organizations innovative due to its comprehensive approach and the solution for providing the driver with real-time weather and road condition information.

The project has included pilots on dedicated short-range communications (DSRC) technology, as defined by the IEEE 802.11p standard, and the continuous air interface long and medium range (CALM) communication technology that uses mobile phone networks. This project is probably the first pilot in Finland to exploit both these data exchange technologies in traffic environment.

VTT's role in the project was to develop a cooperative, situation aware vehicular network and sensor technology for road and traffic monitoring applications. Mobisoft Oy acted as project coordinator, while developing in-vehicle applications and data communication solutions required by these applications, which were linked to Sunit Oy's in-vehicle computers. The Finnish Meteorological Institute developed a route-specific weather service for the system, and is involved in designing the ICT architecture for vehicle-to-vehicle (V2V) communication. Taipale Telematics Oy involved assessing and developing measurement methods and the possibilities of linking them to in-vehicle computer units. Infotripla Oy fused data derived from various sources into real-time traffic and travel information conveyed to



VTT, Mobisoft Oy and the Finnish Meteorological Institute have developed a communication system for conveying real-time information to drivers on weather, road conditions and traffic disruptions.



New driver advisory system reduces fuel consumption and speeding, while helping the driver to maintain schedule.

vehicles using an Intelligent Transport Services (ITS) system. The members of the WiSafeCar project were nine business and research organizations from Finland, Luxembourg and South Korea. The Finnish financing partner for this project implemented under the Eureka-CELTIC programme was Tekes, the Finnish Funding Agency for Technology and Innovation.

The commercial use of the project results has been initiated in the field of transport services. Further results will follow to the markets over the next two years. The cooperation team will continue disseminating the project results under the CoMoSeF (Co-operative Mobility Services of the Future) Celtic-Plus project. One of the objectives is to reduce prices of the developed in-vehicle systems, thus lowering the threshold for their deployment.

#### Further information

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### Driver advisory system for buses saves energy

**The Jokeri bus route, operated in the Helsinki metropolitan area, was used for piloting a real-time driver advisory system that adapts to timetables and routes, developed by VTT. The results have shown that the driver advisory system reduces fuel consumption and speeding, while helping the driver to maintain schedule.**

The development work for the driver advisory system was carried out in the RASTU and HDENIQ projects, which studied the energy consumption of heavy duty vehicles and aimed to develop an advisory system that helps save energy, improve safety and make the timetable more accurate. Rapid acceleration and low top speeds are the key to reaching these goals when driving in the city, which involves a lot of stops. The driver advisory system monitors the

vehicle's motion and location and compares the data to the timetable and route instructions.

The driver advisory system has been field-tested in 15 buses of the Nobina Group on the Jokeri route. The advisory system is linked to the Jokeri route's timetable and route instructions. The system informs the driver when the speed is appropriate or if he or she is driving too fast, and advises the driver to accelerate or decelerate, according to the situation. During peak times, vehicles should run within five minutes of each other, but this is a major challenge for the drivers on the Jokeri route. The driver advisory system can be used for better control of the distances between vehicles, thus preventing congestion on the bus routes. However, this requires that all drivers use the driver advisory system and follow the instructions provided.

Use of the driver advisory system on the Jokeri route reduced fuel consumption by 4.5% on average. The system reduced speeding by less than 10 km/h over the limit by roughly 60%, and speeding by more than 10 km/h over the limit by around 80%, while higher speeds were practically eliminated. The driver advisory system also helps the driver maintain schedule.

Vehicles driven in the city are an ideal target for the driver advisory system, but the system is also suitable for use in traffic that follows a specific timetable, such as express buses and cargo transport. An automatic detection system that warns drivers about icy road surfaces, developed by VTT, can also be linked to the system.

In addition to VTT, the participants in driver advisory system research include Nobina Finland, Helsinki Region Transport, Jyväskylän Liikenne (Koiviston Auto Corporation), AC-Sähköautot Oy, and several other bus operators and equipment manufacturers.

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# REAL ESTATE, CONSTRUCTION, SERVICES, LOGISTICS

- In 2011, the value of construction investments in Finland totalled 66% of all investments, and the construction industry's share of export was 8%
- In Finland, 24% of the end consumption of energy is used to heat buildings, with an additional 8% used by the construction industry
- The logistics costs of the Finnish industry and commercial sector exceeded EUR 33 billion in 2011, while the average logistics costs of all companies were approximately 12% of company turnover
- Approximately one quarter of the exports of EU countries comprises services, while the corresponding share in the US is 30%.

## **Augmented reality to support building design**

Electronic tools for community planning and building design have developed dramatically over the past few years. VTT has developed the world's first augmented reality (AR) applications for community planning and building design. VTT's AR technology has enabled the placement of office and residential buildings in their target environment already at the planning stage, and review of the overall concept on-site, for example, on a smartphone display.

Among other uses, VTT's AR application can be employed to experience in advance what the view from a balcony of a building will be like once construction is completed.

Combining technology originally developed for entertainment apps with positioning software has created new areas of application that include community planning, building design and interior design.

The practical applications developed by VTT are the first of their kind in the world, and have caused a considerable stir both at home and abroad. Examples of a recent Finnish application are the virtual presentations of the Kämp Tower building for Jätkäsaari, Helsinki, and the hotel construction project for Billnäs Ironworks. The presentations were also utilized in planning hearings. In both cases the VTT-developed technology was used to place a sketch of the building in its natural environment. The same images could be examined on site by using, among other means, a smartphone camera display.

The new virtualization technology brings broadened perspectives not only to the work of architects and planners but also to the full range of community planning and related decision-making. With the help of AR technology, the overall concept can take shape at the proper scale and far more realistically than with the 3D imagery and modelling achieved by using traditional design software. Although principally a design tool, augmented reality is also a tool for communication, one that can be used to disseminate a more realistic picture of construction projects in support of resident feedback and decision-making.

Apart from its benefit to design and planning professionals, VTT's AR technology also offers advantages for interior designers belonging to the average household, who can use it to completely redesign and furnish their living room, for example. This software application has been developed by VividWorks Oy, and is already in use for example on the website of Vepsäläinen Oy, a Finnish furniture chain.

Potential new areas of use include property maintenance and repair services, while the technology is also awakening interest among construction companies and software houses in the field of design. For example, the technology enables a "see-through" application for mapping the position of HVAC systems behind walls and panels. In this way, any changes can be observed by comparing the prevailing on-site situation with information that has been recorded previously.

#### Further information

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### New models for organizing services for the elderly

**Finland has the fastest ageing population in Europe. More and more, the challenge lies in guaranteeing safe services of high quality for the elderly in a cost-efficient manner. VTT and TTS, together with companies and municipalities, are conducting a joint development project to solve this problem with a novel operating model and versatile use of technology.**

The TupaTurva project (The Future Home – Integrated Safety Services for the Senior-aged) aims to improve the cost-efficiency and quality of the services for the elderly by using the existing resources in a novel way and renewing the service procurement process. New product and service concepts will help make the planning of services for the elderly more comprehensive. In addition, cooperation between private and public sector actors will be tightened and the municipalities' competencies in the procurement of technology solutions enhanced.

The TupaTurva project aims to improve the cost-efficiency and quality of the services for the elderly by using the existing resources in a novel way and renewing the service procurement process.





VTT's energy-self-sufficient test apartment produces energy for living and motoring.

From the perspective of the services for the elderly, living at home is the more economical solution compared to institutional care. What is more, most elderly people prefer to stay at home. Technological solutions already aid in ensuring safe and independent living at home for elderly people, but the municipalities lack the competencies necessary for the procurement of comprehensive service packages and cost-efficient use of technology.

In the TupaTurva project, more close-knit cooperation is created between private sector service providers and the municipalities, thus allowing the municipalities to combine the products and services provided by various companies into extensive service packages and solutions, each suited for a specific purpose. If the municipalities were already to assess the benefits and costs of services for the elderly at the procurement phase, with a long-term approach that covers service lifecycle, savings could be achieved in the organization of the services. For this purpose, the Tupa-Turva project is preparing a special cost-benefit-analysis model to support decision-making.

The new operating model will open new business opportunities for companies and service providers, because the new service solutions developed in the municipal projects will also be conceptualised for export. The model will pay special attention to the operational reliability and risk management of systems throughout their lifecycle, and the opportunities provided by new PPP models.

VTT and TTS are currently developing a novel operating model in collaboration with four municipalities. One of the partners, Tampere, aims to develop its services for the elderly offered in the rural regions of the city and on the service campus located in Härmälä. A new multi-provider model allows companies and the City of Tampere to bring into use new methods of cooperation. Local companies have the opportunity to achieve synergy for the production of services, and Tampere for the procurement process.

#### Further information

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#### Building-specific energy production

**VTT has a research environment that is connected to the electricity distribution network, and produces the energy required for living and motoring with its own solar and wind power systems. An energy-self-sufficient test apartment is used to research and develop building-specific energy production solutions.**

VTT's energy-self-sufficient test apartment comprises a renewable energy production unit, a wind power plant, solar panels, an electric car, electricity storages and an eco-friendly living space, graphical displays, and a database solution for the monitoring of energy consumption. The test apartment is used as accommodation for visiting scientists, and is located within VTT's offices in Oulu.

The apartment is equipped with normal, energy-saving household appliances and other equipment. Lighting is optimised, based on a low-voltage network using 24 VDC. The resident can influence the energy consumption through his or her choices. The wind power plant and solar panels produce the electric energy required for living and using the electric car. Living in VTT's test apartment without using an external energy source is possible for approximately two days.

VTT collects data on the apartment's consumption and production, and the choices made by the residents, in its database. Consumption data is stored in the database at one-minute intervals.

Distributed generation is one of the means to improve the reliability of energy production, for example, in preparation for long power outages. In the future, consumers will be able to monitor and control their electricity consumption for living and transport, and will even have the possibility of



The city can play its part in influencing the building of a sustainable community by establishing eco-efficiency as a guideline from the very beginning.

selling electricity to an electricity distribution company. This is made possible by the development of intelligent electricity networks, improving the efficiency, flexibility and dynamism of outdated electricity distribution systems. It could be possible in the future to place local power plants in office buildings, commercial buildings and residential buildings.

#### Further information

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### Enhancing the energy and eco-efficiency of residential buildings

**Ecologically sustainable building and energy-efficiency are key goals in today's construction and housing sectors. VTT has developed new methods for the measurement of eco-efficiency and operating models, for example, to support the eco-renovation of homes.**

The Hiukkavaara project in Oulu, Finland, was implemented under Tekes' 'Sustainable Community 2007–2012' programme, and studied the concept and creation of a sustainable community. The project is an example of how the city can play its part in influencing the building of a sustainable community by establishing eco-efficiency as a guideline from the very beginning.

The results derived in Hiukkavaara showed that in addition to conventional building products, ecologically sustainable construction requires new technology and its applications, the use of which requires skills and attitude adjustment. Traditional earning and operating models of the construction business must be questioned. Comprehensive

optimization must be used in development instead of partial processes, and the focus must be shifted from relationships between companies to entire ecosystems.

Land-use planning of Hiukkavaara has successfully taken account of light traffic and public transport. Despite this residential area being dominated by one- and two-family houses, its eco-efficiency corresponds with that of newly built neighbourhoods within the Helsinki metropolitan area, filled with blocks of flats. The project results are presented in the publication 'Turning the construction of a sustainable community into a business project'. It provides brief introductions to the theoretical background of the social, ecological and economic dimensions of sustainable development and descriptions of evaluation methods, two of which have been tested in the project.

Eco-efficiency can be markedly enhanced through energy renovations of buildings. If all the 1.1 million single-family houses in Finland were to be renovated to meet the energy-efficiency levels of a newly built single-family house, the savings in nationwide consumption of heating energy would total 11.8 terawatt hours (TWh), of which 4.3 TWh could be derived from single-family houses with electric heating. This is equivalent to the annual electricity production of four mid-sized coal-fired power plants.

VTT has been involved in the Success Families and One Stop Shop projects for creating new energy renovation concepts and services designed for single-family houses, based on the one-stop-shop principle. Different renovation options can be better made available to consumers by offering comprehensive service models. These may include, for example, a building condition survey or inspection, an energy performance certificate, equipment and system



installations, financial services, maintenance and repair services, energy monitoring, and energy consumption analysis.

The means to boost and support the use of energy renovation services include, for example, building regulations that require measures to increase energy-efficiency or energy audits in connection with the renovation work, and linking the awarding of financial assistance for the renovation to these measures.

Research results concerning energy renovation are presented in the publication 'Energy renovation services for single-family houses. Generalisation and challenges of the one-stop-shop service model'.

#### Further information

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### Envisioning a safe and secure transport system

**VTT, the Finnish Transport Agency and the Finnish Transport Safety Agency Trafi have envisaged a long-term vision of what a safe and secure transport system in Finland will be like in 2100. The vision is aimed at initiating more extensive discussion on the direction and means suited for the long-term development of the Finnish transport system.**

Global warming, urbanization, safety issues, the ageing of the population and the digitalisation of the operating environment will impose certain conditions for any future transport system. Long-term foresight is one method of responding to these types of challenges, and the vision is intended to act as a tool for the strategic planning of transport.

According to the future vision 'Safe and secure transport system 2100', the most important modes of transport are railway and light traffic, backed up by roads in sparsely developed areas. Air transport is focused on travelling to distant destinations, while seafaring focuses on intercontinental cargo transport. The future vision's transport system is service-oriented and all currently motor-driven modes of

transport have been made electric and automated. Passenger and cargo transport systems and the related infrastructures and services function seamlessly as part of urban and IT infrastructures, among others.

In the vision, the Finnish society and transport system are built on two basic premises. The first premise is the transition to carbon neutral and sustainable energy production, and incorporating electricity-intensive concepts into transport and the society as a whole. The second premise is the introduction of automation and intelligent applications to transport equipment and infrastructure, especially as instruments for ensuring the safety and secure of transport.

Harmful environmental impacts arising from the transport system are minimal, because the modes of transport are emission-free. In addition, a sustainable and effective approach based on life cycle thinking is implemented in electricity production and the use of materials. Electricity production is carbon neutral; renewable energy sources and nuclear power are primarily used. The transport system's greatest challenges are system malfunctions and failures in the automation systems and intelligent applications.

The vision comprises descriptions of five theme areas: the social environment, energy system, transport system, technologies and services related to the transport system, and transport and the environment. Safety and security are the key priorities of each theme area.

The vision utilized a previously developed foresight method that enables the examination of the future technological prospects of transport, and the future trends of mobility and transport as part of a more extensive social environment. The method highlights the inclusion of transport system experts and actors, and the vision's starting points and outlines were drafted by expert workshops. In addition to traffic safety, the combination of methods developed at VTT can also be utilized in the creation of system visions or clusters of visions from other perspectives.

#### Further information

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VTT has envisaged one possible long-term vision of what a safe and secure transport system in Finland could look like in 2100.





# BUSINESS RESEARCH, COMMERCIALIZATION

## **Improved service through networking**

**Kemppi Oy, Barona and VTT have developed a new innovative business concept for the joint use of Kemppi and its partner company Barona in the leasing of skilled welders and welding technology. The package solution combines technology and services, while promoting the transition from providing services to the provision of solutions.**

Rapid changes in the market require flexibility and efficient production activity. VTT is involved in a project in which Kemppi enhances its competence and operations and seeks new business models and solutions to better serve its customers. As a company that offers welding equipment

and services, Kemppi is transforming from a traditional equipment manufacturer into an industrial service and solution provider. The collaboration has generated, for example, HumanWeld leasing services, combining technology and services.

HumanWeld is a joint service of the welding expert Kemppi and workforce leasing expert Barona for leasing skilled welders and welding technology to companies, thus adding flexibility to the customer's production capacity. Coordinated by VTT, a networking-based business model and operational processes and systems for implementing and measuring the concept were developed collaboratively.

A package solution is less complicated and more economic for the customer compared to the use of separate

workforce leasing and equipment rental services. Without any investment risks, the customer gains flexible access to trained employees and the technology required to perform effective welding work.

The concept also provides an excellent opportunity to monitor and develop the quality of work and customer focus of operations. The efficiency of the customer's welding processes will be improved continuously on the basis of acquired experience. Any needs, of which even the customer may not be aware, will be carefully examined via observing and filming the welder at work, for example.

#### Further information

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**Creating business from VTT technology**  
**VTT's spin off companies raised record high new capital in 2012. Two examples of VTT's spin-offs are TactoTek Oy, a company that combines touch screen technology and printed electronics, and MediSapiens Oy, which provides software tools for processing Big Data for pharmaceutical applications.**

Spin-offs managed by VTT Ventures Ltd raised approximately EUR 5.9 million of new capital in 2012, almost twice as much as the year before. The previous record was from 2010 (ca. EUR 4.3 million). Some of the investments were allocated for two years. VTT Ventures' share of the new capital was roughly 30%. In addition, the companies received 5.3 M€ Tekes funding.

The majority of the new investments came from Finnish venture capital funds. The highest single investments were raised by Zora Biosciences Oy and Tactotek Oy. In 2012, VTT invested in two new companies: Desentum Oy, which

develops next generation allergy vaccines, and LightTherm Ltd, an LED technology development company. At present, the spin-off portfolio of VTT Ventures includes 19 companies.

TactoTek combines familiar FTIR technology with VTT's printed electronics manufacturing method for the design and manufacture of touch panels for consumer electronics, such as mobile phones and tablets. The current value of the touch panel market is some eight billion dollars, and considerable growth is to be expected in the coming years.

A manufacturing technique developed at VTT enables the making of curved FTIR-based touch panels that can be integrated seamlessly into larger equipment parts, providing new integration opportunities and cost savings for equipment manufacturers. The functionality of the panels equals that of rival technologies.

MediSapiens Oy is a science-centric company based on strong research expertise in the fields of bioinformatics and oncogenomics. The company provides big-data-based software tools and an online genomics database for assisting cancer researchers in gaining insight into genomics, cancer clinics in selecting the best possible cancer therapy for each patient, and pharmaceutical companies in the discovery of next-generation personalised medicine. Bayer HealthCare Pharmaceuticals recently chose the software solution developed by MediSapiens, OncoGenomics Online, for their cancer-related Big Data processing needs.

The mission of VTT Ventures Ltd is to focus on extracting value from VTT technology in developing VTT-based high-tech companies with international growth potential. VTT Ventures provides the entrepreneurs with professional business development support together with its public and private innovation partners.

#### Further information

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TactoTek combines familiar FTIR technology with VTT's printed electronics manufacturing method for the design and manufacture of touch panels for consumer electronics.



# BREAKTHROUGHS FOR TOMORROW'S CHALLENGES

## **Targeting competitive industry and people's wellbeing**

VTT has responded to the challenges facing Finland and its industrial development for over 70 years by helping develop new solutions for the needs of the time. Today's challenges are, however, increasingly global. VTT's Research and Innovation Vision 2020 acts as a springboard for directing spearhead and innovation programmes in areas where VTT has the potential to have a significant impact on society, business, and people's everyday lives.

Continuously improving industrial competitiveness, reinventing business, creating new value chains, and improving agility are central to VTT's programmes. Efficient solutions are needed to meet the challenge of the world's declining natural resources, alongside recycling to minimise the generation of waste. Low-carbon and energy-efficient technologies are essential for sustainable development and for ensuring that future generations can enjoy a clean world and access to the natural resources they will need. New solutions combining and exploiting multiple technologies will

help promote people's wellbeing at every stage of their lives. In addition to scientific excellence, this calls for extensive cooperation throughout the innovation system and with clients looking for new solutions.

### Generating new exports through bioeconomy

Reinventing industries and value chains, and combining technology in new and innovative ways are essential to developing the current economic structure towards bioeconomy. The Industrial Biomaterials spearhead programme, which ended in 2012, raised the use of biomass as a raw material to a new level. The forest industry gained additional competitive edge through new bio-based products and new types of value chains. Completely new ways of manufacturing and processing mouldable web products were developed, for example, and transparent nanocellulose film produced for the first time, opening up a completely new application field. All these products were also commercialized successfully. In addition, the programme produced a competitive bio-based composite that rivals traditional chipboard and is already being used by furniture manufacturers.

Bio-based fibres were also developed for the textile industry. The programme has thus generated an extensive technological foundation for the future of bioeconomy.

Economic aspects, people's wellbeing, and resource efficiency lie at the heart of the Bioeconomy Transformation spearhead programme, which was launched at the beginning of 2013. In this programme the emphasis will shift from developing bio-based products to developing new technology-driven value chains and new businesses. Bioeconomy relies on new technologies that blur the boundaries of traditional industries, and VTT is taking an active role in promoting the related business revolution.

*"The Bioeconomy Transformation spearhead programme is aimed at creating and commercializing technological solutions to foster a strong and more versatile bioeconomy sector. We want to sow the seeds for new growth companies and completely rethink the production structures behind the industries that processes biomass."*

*Jussi Manninen, Programme Manager*

### Promoting a leap in productivity for industry and the economy

The eEngineering spearhead programme that ended in 2012 focused on developing and commercializing digital product process solutions that halve the time needed for designing and starting production in the technology



### Impact through holistic technology solutions

- Clean living environment
- Decreasing oil dependency
- Strong and versatile exports
- Efficient and eco-friendly use of materials

industry. Thanks to a new approach to product development and the ability to evaluate different design possibilities from various disciplines with the help of virtual simulation and analysis tools, the result is significantly improved productivity. One of the most important achievements of the programme was the release of the Simantics open modelling and simulation platform. The Simantics platform enables the communication between programs that model and simulate different phenomena within the same context and the combination and co-use of modelling, simulation, design management, and life cycle information.

The Open Smart Spaces spearhead programme that ended in 2012 produced a range of commercial solutions for uniting physical and virtual worlds. VTT and its partners operated at the cutting edge of technology and business driven by the development of ubiquitous technologies, such as context-aware devices, augmented reality, and service and device interoperability.

The same challenges and threats that are driving us towards bioeconomy make it necessary to increase productivity. The biggest expectations here are linked to information and communication technologies as enablers for leveraging the co-use of information and interoperability. The Productivity Leap with Internet of Things spearhead programme, launched in 2013, will tackle these challenges and build on the results of earlier spearhead programmes.

*"The next technology disruption, and the productivity leap that it will enable, will take place in the internet of things. By introducing sensors in our physical surroundings and connecting them to a virtual environment, it will be possible, for example, to provide better lighting experience for users while using 50% less energy. Similarly, it will be possible to minimise the downtime of heavy machinery through the use of predictive and performance-based maintenance."*

*Heikki Ailisto, Programme Manager*

### **A cleaner world through sustainable waste management and smart mobility**

The Green Solutions for Water and Waste spearhead programme is focused on developing efficient solutions for water and waste management capable of responding to tomorrow's challenges. Clean water will be in increasingly short supply in the future and there will be growing international demand for technologies and competences that tackle this challenge. Numerous industries will also need solutions that improve the resource efficiency and cost-



effectiveness, for example, by developing the way in which waste is utilised. The programme is focusing on energy-efficient membrane technologies, separating valuable metals from waste and side streams, and monitoring tools.

The spearhead programme Smart Mobility Integrated with Low-carbon Energy, for its part, is concentrating on the development of a functional, cost-efficient, and sustainable transport system. The programme will help create new business for the Finnish transport related sector and solutions for increasing exports. This will be achieved by combining research on socio-technological change, low-carbon fuels, energy-efficient vehicles, and ICT-based services. The programme will also support public decision-making on future transport solutions.

*"A more systematic approach is needed in the transport sector to achieve the challenging goals in terms of service quality, efficiency, and sustainability. We need to shift from trying to optimise subparts of the system to understanding and optimising the system as a whole."*

*Nils-Olof Nylund, Programme Manager*

### **Further information**

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# VTT's strategic research portfolio

## Bioeconomy transformation

- Sustainable use and refining of bio-based raw materials
- Industrial biotechnology and green chemistry
- Process and manufacturing technologies
- Bioeconomy business ecosystems

## Digital world

- High-performance microsystems and sensing solutions
- Printed intelligence
- Scalable digital service economy
- Internet of Things (IoT)

## Low-carbon economy

- Energy efficient solutions for industry, built environment, and transport
- Renewable energy sources
- Nuclear energy: safety and waste management
- Energy systems and modelling

## Resource efficient production systems

- Eco-efficient machines
- Resource efficient processes
- Simulation based design
- Global production and services

## Clean environment

- Clean environment
- Clean water cycles on demand
- Industrial ecology and life cycle design
- Waste refineries, material recovery, and recycling
- Substitute material solutions

## Health and wellbeing solutions

- System biology and diagnostics
- Food products and health
- ICT for health
- User-driven spaces and environments

## Horizontal research:

Business and Services – Innovation methods and policies –  
Safety and security – User and customer understanding

## VTT's spearhead and innovation programmes that have ended in 2012

### Spearhead programmes

- Industrial Biomaterials
- Open Smart Spaces
- eEngineering

### Innovation programmes

- Nutritech – Health and Wellbeing through Eating
- Technologies for Health
- Fuel Cells
- TransEco – Energy Efficiency and New Fuels for Transport
- InTrans – Intelligent Transport
- Cognitive Communications

## VTT's spearhead and innovation programmes in 2013

### Spearhead programmes

- Green Solutions for Water and Waste
- Bioeconomy Transformation
- Productivity Leap with Internet of Things (IoT)
- Smart Mobility Integrated with Low Carbon Energy

### Innovation programmes

- Intelligent Energy Grids
- High Performance Microsystems
- Multiscale Design
- Arctic and Cold Climate Solutions
- Cognitive Communications for Critical Infrastructures
- Personalised Health and Wellbeing
- Human Driven Design – “Design for Life”
- Safe and Sustainable Nuclear Energy
- Sensing Solutions



# SUSTAINABILITY AND RESPONSIBILITY

**At VTT we take account of the principles of sustainable development both in our research and service operations and in our internal operations. We are developing our corporate responsibility reporting in line with the GRI G3 guidelines. This review illustrates our actions relating to corporate social responsibility by means of examples, and our chosen GRI indicators are published on the VTT website.**

VTT's Research and Innovation Vision 2020 responds to the grand challenges facing society and contains the objectives of a clean world, a sustainable economy and a good life. VTT's research investment in environmental technologies, bioeconomy, resource-efficient industry, low-carbon energy, human well-being and digitalisation, produces novel solutions. VTT's new programme portfolio includes three spear-

head programmes – Green Solutions for Water and Waste, Bioeconomy Transformation and Smart Mobility Integrated with Low Carbon Energy – that focus specifically on the challenges of sustainable development. Furthermore, VTT's research activity creates a strong knowledge base for public decision-making on the journey to a society founded on sustainable development.

## **Responsibility for our own personnel**

The 2012 personnel survey indicates slight improvement. The index indicating overall satisfaction rose slightly to 3.40 (2011: 3.36); the response rate was 75.4 per cent. The strengths highlighted by previous surveys have been preserved, notably the co-operation with line managers that has since shown further improvement. In practice this can be seen as line managers giving more time and feedback to



their employees. The personnel feel that the effectiveness of development discussions has improved. Weakened areas clearly relate to questions of work management, workload and coping with work. Working time management was statistically the only significant weakness in the entire survey.

The frequency of accidents, as calculated by the method developed by the Zero Accident Forum, was lower than ever before: VTT had 1.54 and VTT Group just 1.36 work-related accidents per one million working hours. VTT recorded one major accident at work, which resulted in 41 lost days of work. This is why the accident severity rate came to 10 days of absence per accident.

In 2011, occupational safety and health authorities issued VTT with a fixed-term action plan concerning cuts to credit balances on personnel's working-hour accounts. VTT has agreed on the course of corrective action.

Occupational health and safety inspectors visited VTT's Tampere offices for the first time. According to the occupational health and safety authorities' VALMERI employee satisfaction survey, working conditions in both of VTT's Tampere offices were better than in benchmark workplaces overall. VTT was given orders to take corrective action on account of artificial resin compounds produced and safe usage of machine tools. These issues have been rectified.

VTT began to provide occupational health and safety card training to managerial staff – approximately 120 managers attended training courses. VTT inspected all pressure equipment subject to official inspections and formulated a process for managing pressure equipment issues. Attention was also given to risk assessments of machinery and equipment. Actions relating to these continue in 2013.

### Environmental issues

VTT has had Green Office certification since 2009. Our offices (Turku, Oulu and headquarters in Espoo) were audited for the second time in 2012, and the auditors concluded that almost all aspects of environmental friendliness are well taken care of at VTT. Use of renewable forms of energy, monitoring water consumption and actions to conserve water were satisfactory. Measuring office electricity consumption separately is a challenge.

VTT operates at more than forty addresses. Total electricity consumption amounted to 39.0 GWh. Consumption decreased for the second year in a row, by more than 700 MWh from the previous year. This figure includes electricity consumed by both premises and research activity. Domestic flights rose back to the level of 2010, to 3.2 mil-



lion kilometres. Flights amounted to a total of 37.5 million kilometres, generating just over 3,700 tonnes of carbon dioxide emissions, almost 100 tonnes more than the year before. VTT's internationalization strategy has resulted in a higher volume of international travel and a higher frequency of this kind of travel. The adoption of conferencing technology and video conferencing has helped to stop the increase in domestic travel, although the volume of domestic travel tickets sold no longer decreased as planned. The number of kilometres driven for work-related purposes for which employees were reimbursed was similar to the previous year's figure. The number of kilometres driven in VTT's own vehicles dropped by almost 30,000 kilometres.

The volume of paper bought dropped by 12.3 per cent from the previous year and amounted to 4.5 reams per person. Printing volumes decreased from the previous year's figure by almost one million (8.7%). The growing trend in colour printing was turned around.

The outstanding act for promoting the environment in 2012 was awarded to new specialist refrigeration equipment at Tietotie 2 (e.g. -50 °C). Modernizing the equipment decreases energy consumption considerably and complies with the energy efficiency plan that we produced in 2012.

The oil leak detected in connection with the Otaniemi metro construction site in 2011 was fixed immediately and the situation has remained stable. Techniques and a time-scale for soil remediation have been discussed with various parties. Remediation measures are due to begin in 2013.

GRI table 2012 at website: [www.vtt.fi/files/vtt\\_gri\\_table\\_2012.pdf](http://www.vtt.fi/files/vtt_gri_table_2012.pdf)

### Further information

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# INTERNATIONAL AND DOMESTIC COOPERATION

VTT is responding to global societal challenges through its Research and Innovation Vision 2020 and by networking Finnish and European actors in the global context. Strong innovation partnerships are essential for developing the energy-efficient economy of the future.

## **Extending European research cooperation to global innovation**

VTT had 541 (2011: 506) internationally publicly funded research projects under way in 2012, of which 361 (2011:322) were EU projects. Projects included in the EU's Seventh Framework Programme (FP7) numbered 289. VTT is particularly active within the ICT, Nanotechnology, Materials and New Production Technology, Energy, Biotechnology, and Transport Programmes.

VTT's contribution to the targets and content of Horizon 2020 is channelled through its membership of Finland's national EU20 Group, the work it does through numerous other channels and networks, and its involvement in developing key European partnerships. VTT's strong position in a number of European strategic research alliances is very useful here. The experience built up by working through new cooperation models is important in developing innovations systems in Finland and across the EU. A good example is the EIT ICT Labs, where VTT is a core partner in the Helsinki node and part of a worldwide innovation cluster. While the majority of VTT's internationally publicly funded research is European-driven, VTT's goal is to extend its reach and develop links with key global innovation environments.

### Implementing strategy through the international office network

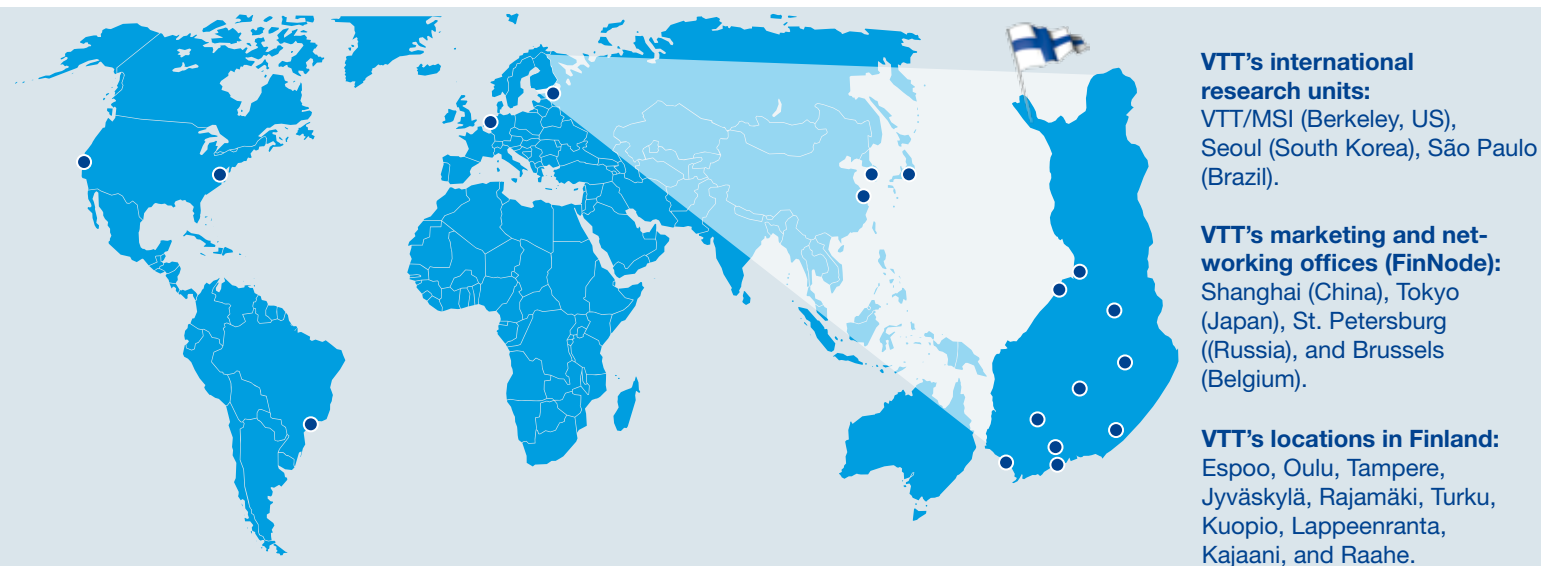
VTT has continued its strategy of internationalization in selected focus areas: industrial biotechnology, renewing forest industry and energy, in addition to ICT and electronics. VTT had a total of eight locations outside Finland in 2012, of which three are research units at which VTT carries out active research and innovation work, and five are contact points for networking and marketing purposes. A feasibility study on establishing a presence in Singapore was carried out in 2012.

VTT's research units in Brazil, South Korea, and Berkeley in the US are managed by VTT International Ltd. The unit in Brazil concentrates on research in biomass utilization, water know-how, and research linked to the forest industry. During 2012, its activities mainly concentrated in the Center of Water Efficiency Excellence also known as SWEET – a joint initiative between VTT and Kemira – and projects with forest industry companies. In addition, a significant joint industry-university research project in bioethanol, PAISS, was prepared for.

The focus of VTT's research unit in South Korea is primarily on ICT and electronics research in collaboration with local universities and research institutes. The VTT/MSI Molecular Sciences unit in Berkeley concentrates on basic and applied research in industrial biotechnology and draws extensively on the expertise of local universities and other partners.

Four of VTT's five contact points are part of the joint FinNode network – created to promote the internationalization of Finnish research and innovation. These offices are located in the US, Japan, China, and Russia.

VTT's office in Washington is primarily devoted to marketing know-how in the environmental and electronics fields to major companies. The office has played an important part in strengthening cooperation with local universities and research institutes. In Japan, the emphasis is on coopera-





### VTT in European alliances and expert groups

- AERTOs – Horizontal partnerships between research institutes
- EERA – The European Energy Research Association
- EIT ICT Labs
- ETSON – European Technical Safety Organizations Network
- HTA – Heterogenous Technology Alliance
- JIIP – Joint Institute for Innovation Policy
- KET – Key Enabling Technologies High Level Group (EU Commission)
- NULIFE/NUGENIA – Nuclear Generation II and III Association



### VTT in Finnish research alliances

- BETA – Bioenergy Technology Alliance
- Industrial Biotechnology Cluster Finland
- FIMM – Institute for Molecular Medicine Finland
- FSA – The Finnish Service Alliance
- PrintoCent – Innovation Centre of Printed Electronics and Optical Measurement Technology
- Finnish Centre for Nanocellulosic Technologies
- SWEET – Center of Water Efficiency Excellence



### VTT's participation in Academy of Finland Centers of Excellence (CoE)

- Finnish CoE in Atomic Layer Deposition (ALD) (2012–2017), VTT as a participant
- Finnish CoE in Low Temperature Quantum Phenomena and Devices (2012–2017), VTT as a participant
- Finnish CoE in Molecular Systems Immunology and Physiology Research (2012–2017), coordinated by VTT
- White Biotechnology - Green Chemistry Research (2008–2013), coordinated by VTT

tion in the ICT field with local research institutes and universities; while in Shanghai, China, the primary focus is on the manufacturing industry, the energy sector, and serving Finnish companies operating in China. The St. Petersburg office in Russia concentrates on the transport and logistics sector and nanoelectronics. The VTT office in Brussels (at EARTO) was used on a full-time basis in autumn 2012 for managing general EU affairs. The main purpose was to contribute to the development of the Horizon 2020 programme and to foster contacts with EU institutions and other key partner organizations.

### Intensifying innovation collaboration within Finland

VTT has strengthened its strategic partnerships with universities in Finland through research linked to its strategic focus areas, joint research infrastructures, and joint professorships. Particular emphasis is being given to utilizing and commercializing the results of joint research. This work has helped clarify the mutually beneficial roles of Finland's universities and VTT, and create mutually complementary bodies of expertise, such as the new Finnish Institute of Innovation and Technology (FIT) concept.

The PrintoCent Innovation Centre of Printed Electronics and Optical Measurement Technology – based in Oulu and founded together with the University of Oulu, the Oulu University of Applied Sciences, and Business Oulu – was extended with the commissioning of the world's first pilot factory for printed intelligence industrialization. PrintoCent has an extensive network in Europe, and has participated in creating a total of 14 start-up companies within Finland since 2010. Cooperation with the Lappeenranta University of Technology's Centre for Separation Technology was intensified through establishing a new research group focusing on separation technology in Lappeenranta.

VTT participates in all of Finland's six Strategic Centres for Science, Technology and Innovation (SHOK), in defining research scopes and in structuring and implementing their programmes. VTT is also extensively involved in various national research and technology programmes, including around 30 funded by Tekes and the Academy of Finland. A new joint five-year research and innovation programme was launched in 2012 by the Finnish Forest Research Institute and VTT: ForestEnergy 2020. VTT also leads the Finnish Research Programme on Nuclear Power Plant Safety, SAFIR2014, and coordinates the Finnish Research Programme on Nuclear Waste Management, KYT2014.

In addition, VTT actively participates in four of the Academy of Finland's Centres of Excellence. Other research alliances with industrial and scientific partners are continuously ongoing.

### New concepts for regional innovation work and SMEs

VTT's regional activities focus on participating in regional research partnerships and project-based development work. VTT has 10 locations around Finland and works closely with local universities, research institutes, and universities of applied sciences. Strong local networking has continued. VTT's network of local representatives was extended to the Kokkola area in 2012 and now covers 15 localities across the country. Together with these local representatives events promoting VTT's activities and seeking cooperation opportunities with local companies were organized.

VTT plays an important role in offering small and medium-sized companies access to international contacts and opportunities for participating in international projects, such as the EU's Research for SME scheme, to which a total of

approx. 40 applications were submitted in 2012. A new concept for approaching SMEs was developed, focusing especially on growth and high-tech companies. In addition, a new website for SMEs was launched. The ConceptStore model for software companies and the SME2RUS concept for subcontractors of the Russian vehicle manufacturing industry were also introduced. Cooperation in the field of bioeconomy is being developed with SMEs in the Seinäjoki region, which has a strong food processing cluster. It will support the creation of new value chains between biotech and engineering companies. One aim is to create new growth companies.

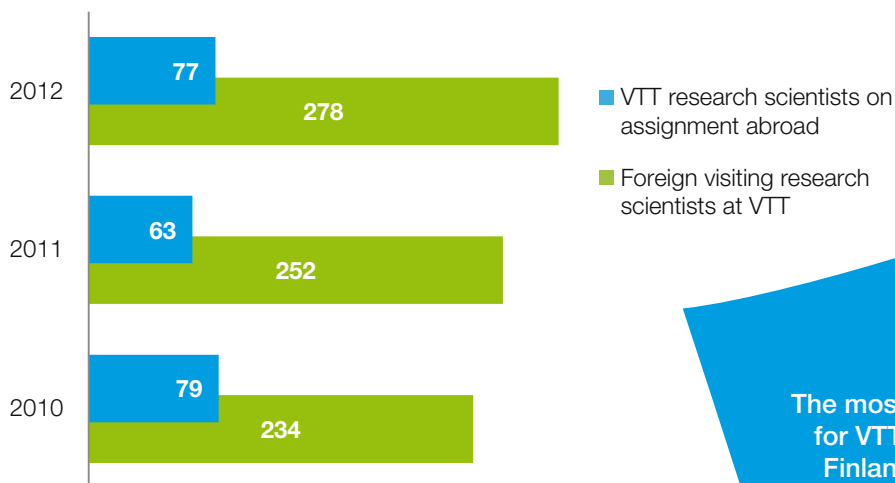
### Further information

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### International mobility



6.1% of VTT personnel in 2012 were from outside Finland and 48% of its visiting research fellows (not employed by VTT). A total of 172 staff from outside Finland, representing 51 different nationalities, worked at VTT as of the end of the year; Germans and Chinese were the largest individual groups of non-Finns.

The most important countries for VTT personnel outside Finland in 2012 were the US, Japan, and France.

# Impact, prizes

## Impact of VTT's projects

Share of survey respondents who had this benefit as their goal in their VTT project and felt that the benefit was generated in the project:

- 95% thought that a VTT project had promoted networking.
- 91% said that a VTT project had promoted their marketing.
- 90% reported that their knowledge base and expertise had improved.
- 82% believed that a VTT project had speeded up or otherwise improved research and development work.
- 73% believed that a VTT project had contributed positively towards the opening up of new business opportunities.
- 73% reported that their competitiveness had improved.
- 70% confirmed that new products, services or processes were created.
- 54% said that a new business concept or a new earnings model was created.
- 53% reported that a whole new technology was adopted.

Taloustutkimus Oy, VTT customer survey, 2012

## Significant prizes and accomplishments

- VTT President & CEO Erkki KM Leppävuori has been invited for a second time to participate in Key Enabling Technologies' (KET's) high level expert group, made up of highly qualified specialists in European research and industry and set up by the European Commission. In 2010–2011, the group prepared the strategic measures by which means the European Union is able to strengthen its industrial competitiveness and create permanent jobs in Europe.
- VTT was awarded the European Association of Research and Technology Organisations (EARTO) Innovation Prize for developing a new bio-oil production method together with Fortum, Metso and UPM, which enables cost-effective and sustainable cogeneration of electricity and heating energy and bio-oil in the same power plant.
- Head of VTT's Knowledge Solutions Kirsi Tuominen has been appointed vice-chair of the WorldWideScience Alliance. The aim of the Alliance's WorldWideScience portal

is to make public scientific information from around the world available to the general public free of charge.

- Research Professor Merja Penttilä was rewarded by Wihuri Foundation for International Prizes with EUR 150,000 for her achievements in the field of industrial biotechnology.
- VTT's Principal Scientist Jari Ahola has been appointed as Head of Unit for Intelligence at the European Institute of Innovation and Technology (EIT).
- Key Account Manager Jyri Nieminen was given the VTT Communications Award in recognition for his active communications efforts and for increasing VTT's know-how in professional and news media.
- The Central Organisation for Motor Traffic awarded the Finnish Medal of Merit of Motor Transport to Research Professor Nils-Olof Nylund for his long and meritorious career promoting the development of road transport and achievements in the field of Finnish motor transport.
- A team of researchers from VTT and Åbo Akademi University received the Jasper Mardon Award 2012 for their paper on the effects of certain polymers on wet web behaviour at the TAPPI PaperCon conference in New Orleans.
- VTT President & CEO Erkki KM Leppävuori was appointed as the Chairman of the European Energy Research Alliance (EERA) on 12 June 2012.
- The Finnish Academy of Technology gave its 2012 Engineering Expert Prize to Senior Research Technician Seppo Vasarainen in recognition of his meritorious research into the development of building energy technology and HVAC. The prize is aimed at recognizing the role of mechanics and other technical assistants in research and development work.
- The Sustainable Development Forum selected Kymijärvi II as the Climate Action of the Year. Lahti Energy's new plant is presumably the first gasification power plant in the world to use only solid recovered fuel to produce electricity and health. VTT has played an important role in developing the plant's technology.
- Research Professor Kenneth Holmberg was chosen as the recipient of the 2012 VTT Award. The award was given in special recognition of the development of VTT's customer-orientated operating models.

# VTT has an important role to play in renewing Finnish companies



VTT's key task is to improve the competitiveness of Finnish companies. Maintaining a high level of scientific research and technological expertise in selected fields is one of the organisation's main responsibilities, and VTT receives a significant amount of funding from the state budget for this purpose.

The most important role of VTT, however, lies in making this technical know-how available to companies and with that help strengthen their competitiveness. Giving companies access to the science and technology that they need represents VTT's core task.

Finland's future continues to be dependent on Finnish industry. Many areas of industry today are experiencing a major transformation, however. While this process is often primarily seen as a threat, it also represents a significant opportunity. Manufacturing in the metal and engineering sector is moving to lower-cost countries closer to customers, and Finland-based operations need to be revamped to remain competitive. Developments at Nokia have had a major impact on the ICT sector, and new ways of leveraging ICT expertise in other areas is the subject of growing attention as a result. The energy sector is also faced with a major transformation as it adapts to the need to develop different types of renewable alternatives and ways of meeting tougher energy efficiency targets. The forest industry has been under extensive pressure to change and adapt for some time. The growing interest in Finland's metal resources and activity in the field is generating new opportunities for mining companies and technology companies serving the sector, as well as for the entire cleantech field.

Finland continues to have many very successful companies in the above and other fields. They possess competitive strengths that could be used to create successful and fast-growing international business much more effectively than what happens today. Companies like this need to continuously look for new opportunities and boldly seize the most promising ones. VTT's job, for its part, is to identify the companies with the most potential here in Finland and do

everything it can, with its technological know-how, to support and help them to develop and reinvent their business and generate new success. Finland and Finnish companies have the potential to be world leading pioneers in many fast changing industries.

VTT has an important role to play as a technology partner for companies in Finland. VTT's very existence is one key reason for companies to operate in Finland. To succeed here, VTT not only needs technological expertise, but also the ability to work closely with its customers in the business world. VTT needs to find out what companies need how VTT can help them, and VTT needs to develop its know-how and its own technology projects in line with what the business world expects of its technology partners, both today and in the future.

VTT has an excellent reputation at home and abroad. To maintain its good reputation VTT must itself continuously renew itself and launch bold new initiatives where needed. Being agile and moving boldly forward is the best way to renew oneself and stay competitive in today's world, whether you are a private company or a public organisation such as VTT.

Aaro Cantell,  
Chairman of the Board

## VTT's Board

Chairman: Aaro Cantell, CEO, Normet Group  
Vice chairman: Pekka Lindroos, Commercial Counsellor,  
The Ministry of Employment and the Economy

### Members:

Kirsimarja Blomqvist, Professor, Vice-Rector Lappeenranta  
University of Technology  
Kjell Forsén, President & CEO, Vaisala Oyj  
Petra Lundström, Vice President, Solar Business  
Development, Fortum Oyj  
Kaija Pehu-Lehtonen, Senior Vice President, Business  
development, Metsä Fibre Oy  
Riitta Varpe, Director General, Palvelualojen työnantajat  
PALTA ry

Erkki KM Leppävuori, President & CEO, VTT  
Iiro Auterinen, Principal Scientist, VTT (Staff representative)

# VTT in figures

## Internal income statement

	1.1. - 31.12.		Change %
	2012 (M€)	2011 (M€)	
<b>REVENUE</b>	<b>292.3</b>	<b>286.5</b>	<b>2</b>
<b>Turnover</b>	<b>286.4</b>	<b>278.5</b>	<b>3</b>
External revenue	192.5	192.6	0
Revenue, domestic private sector	58.2	62.9	-7
Revenue, domestic public sector	83.1	79.5	5
Revenue from Tekes	57.5	55.4	4
Other revenues, domestic public sector	25.7	24.1	6
Revenue, foreign private sector	16.9	15.9	6
Revenue, foreign public sector	34.3	34.4	0
Revenue from EU	29.8	30.8	-3
Other revenues, foreign public sector	4.4	3.6	23
Basic government funding	94.0	86.5	9
Turnover adjustment items	-0.2	-0.6	-73
<b>Other operating income</b>	<b>5.9</b>	<b>8.1</b>	<b>-27</b>
<b>EXPENSES</b>	<b>291.6</b>	<b>279.4</b>	<b>4</b>
Personnel expenses	162.5	160.2	1
Materials and consumables	16.7	15.7	6
Rents	29.5	27.8	6
Purchases of services	48.6	45.9	6
Other expenses	15.3	14.1	9
Depreciation	15.6	14.5	7
Financial expenses and revenues	3.1	0.8	275
Extraordinary expenses and revenues	0.2	0.3	-44
<b>RESULT</b>	<b>0.6</b>	<b>7.1</b>	

## VTT Group

- Turnover 316 M€

## VTT

### Financial information

- Turnover 286 M€
- External revenue 192 M€ (67% of turnover)
- Basic government funding 94 M€ (33% of turnover)
- Revenue from abroad 51 M€ (18% of turnover)

### Personnel

- Personnel 2,834
- University degree: 81%
- Doctors and licentiates: 26%
- 77 persons on assignment abroad
- 286 foreign visiting persons at VTT

### Customers

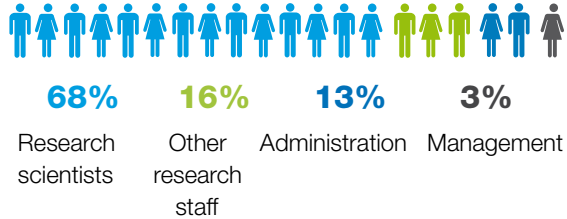
- 1,510 customers
- 865 domestic companies
- 385 foreign companies
- 260 public organizations in Finland and abroad

### Results

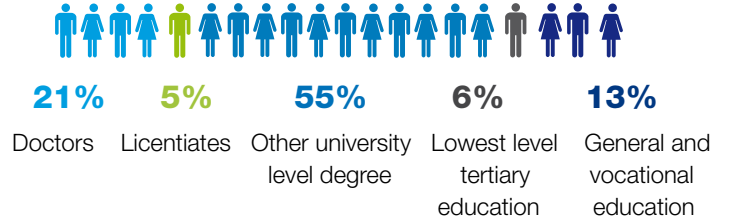
- Notifications of inventions 269 and software notifications 25
- 1,290 patents and patent applications in VTT's patent portfolio
- Publications 1,611, of which scientific articles 605 (38%)



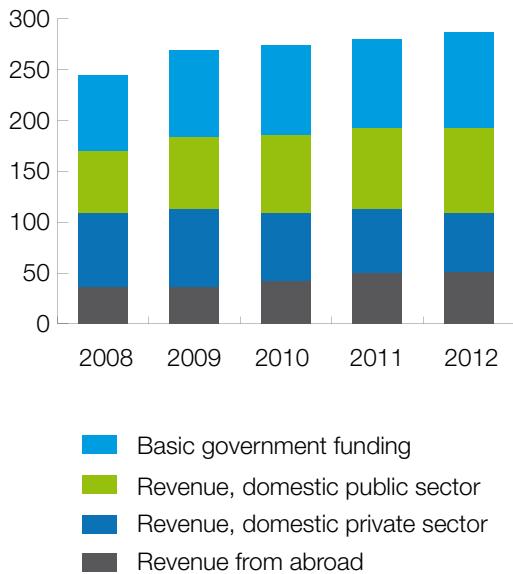
### Personnel strength and structure



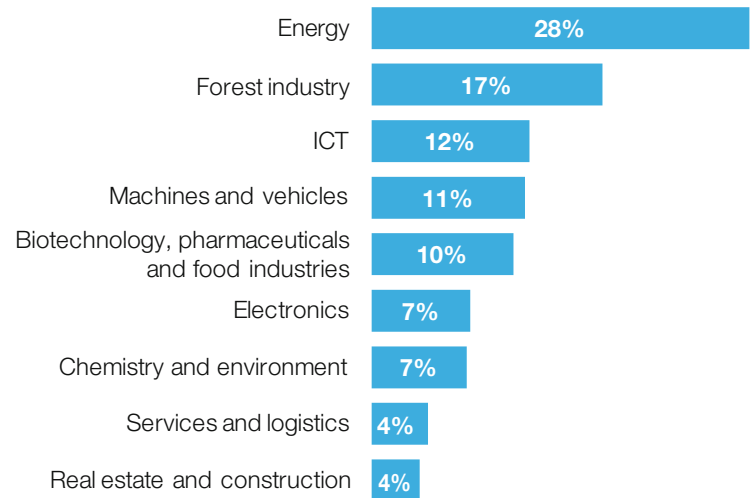
### Education of personnel



### Turnover, M€

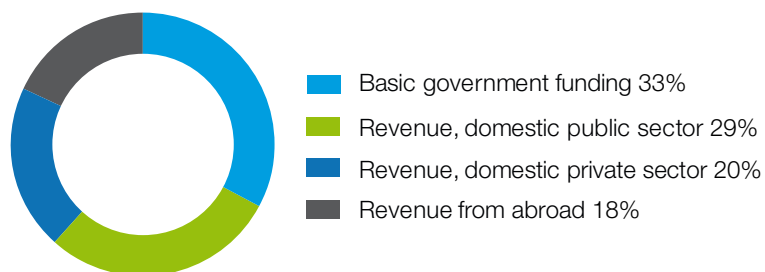


### Revenue from commercial activities in the domestic private sector (\*)



\*) Classification according to VTT's customer segments.

### Turnover by type of revenue



More information on VTT activities and research:  
[www.vtt.fi](http://www.vtt.fi).

Webversion of VTT Review: [www.vtt.fi/vtt2012](http://www.vtt.fi/vtt2012)

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