



VTT's research and innovation **visions in 2020**

Tomorrow's challenges for mankind are today's opportunities

Today, mankind faces perhaps its greatest ever challenges. Through globalisation, life on our planet is becoming more and more challenging, both politically and economically, as a result of population growth and ageing, climate change, the dwindling of raw materials and their unbalanced geographical distribution, all combined with economic uncertainty.

Simply acknowledging problems is not enough. Political decision-makers must also seek ways to resolve these challenges. The unilateral construction of politico-commercial barriers and economic isolation complicate the search for political solutions. The EU has been successful at creating operating models that allow measures geared towards balancing the economy within the internal market. These operating models are now being put to the test.

In future, technology will increase in importance along with the economy. The effects of global challenges should not prevent technology being a path to new solutions for alleviating or even eliminating the problems described above. Both within the EU and in a broader context, Finland has been able to turn several global challenges to her advantage. Combined with an industry keen to invest in new technology, our high level of expertise and education produces results. However, technology should not be an end in itself, but a means to an end. No challenges means no development.

If handled properly and combined with new knowledge, I am confident that major global challenges can generate innovation benefiting the Finnish national economy, the EU market and, in the long term, the entire global economy. It is said that innovation springs up quickly when necessity dictates the rules. The challenges of globalisation place us in a situation in which we must actively seek solutions geared towards sustainable development.

This publication and VTT's road maps present by way of science and technology a number of efficient policies that through innovation can help to resolve the challenges affecting all mankind. These solution models will benefit our country, the EU and, ultimately, individual consumers. I would like to encourage science and technology experts to be bold in the face of challenges, and thereby contribute to the creation of a better future for Finland and her business life.

Jyri Häkämies
Minister of Economic Affairs



Contents

- 2** Tomorrow's challenges for mankind are today's opportunities
- 3** Big global challenges need strong performers in the European innovation ecosystem
- 5** VTT R&I Vision 2020
- 5** Bioeconomy
- 8** Low carbon energy
- 10** People's wellbeing
- 12** Resource efficient industries
- 14** Clean Globe
- 16** Digital world

VTT Technical Research Centre of Finland is the biggest multi-technological applied research organisation in Northern Europe. VTT has a turnover of EUR 290 million and 3,100 employees.

VTT focuses on technologies of the future

• Applied materials • Energy • Bio- and chemical processes • Information and communication technologies • Industrial systems management • Microtechnologies and electronics • Services and the built environment



Cleantech Finland® is a gateway to the top Finnish cleantech companies. Cleantech Finland gives clients, partners, investors and other stakeholders all over the world easy access to the best cleantech expertise. VTT is a member of Cleantech Finland.



Big global challenges need strong performers in the European innovation ecosystem

VTT like other European Research and Technology Organizations (RTOs), has been making a major contribution to innovation excellence, economic competitiveness and social progress across Europe for more than 60 years. As noted, this contribution often goes unnoticed as some kind of 'forgotten sector'. However, the total economic impact of RTOs has been estimated at up to €40 billion annually and at over €100 billion when taking account of longer-term spill-over effects.

RTOs bring together a rare and long-established array of capabilities and activities from basic and applied research to advanced engineering, design and development, measurements, tests and prototype production, and industrial exploitation through contract research, licensing and spin-outs. They use these capabilities to serve both public and private clients, including a very large number of SMEs. Every year, their research resources and technology commercialization expertise help well over 100,000 companies, from SMEs to multinationals, to go beyond their internal technological limits to produce world-beating innovations.

RTOs have a long tradition of helping governments tackle major social, technical and scientific challenges of the day, and RTO-enabled innovations are therefore found everywhere – improving the health and wellbeing of citizens and the quality of lives and environments. >>

The unique funding model of RTOs, their trans-disciplinary skills and practical problem-solving approach predestine them for a key role in the new European policy focus on tackling 'grand challenges' such as climate change, better food and health for all, integrated and efficient urban environments and transport systems, security of energy supply and optimal use of scarce natural resources.

As a representative of technology, I have the courage to state that science and technology policy and innovation policy aim, first of all, to improve the competitiveness of business life, i.e. industry and the service sector, by developing and applying new technology. This is regarded as benefiting positive development of important economic and social goals such as growth, employment and wellbeing of the whole society. On the other hand, it is good to remember that technology is only a means. Significant moral and ethical viewpoints are connected to its use.



Lately the term 'knowledge triangle' has turned up in science-political language in the European Commission. 'Knowledge triangle' describes the interaction between teaching, research activity and innovation activity.

I would like to emphasize the interaction between different actors, i.e. the tripartition of universities, research institutions and business life. It should be noted that the majority of innovations is based on existing knowledge without any direct contribution from scientific research. Of course research that creates new knowledge can be a source of innovation, but the roles of research and teaching are emphasized in the cultivation, development and renewal of knowledge capital.

Nowadays, multidisciplinary activities are emphasized, maybe sometimes at the expense of profundity; however, innovations are borne on the interface of different sciences, technologies and competences. But how do we get the top experts to discuss together and in an unprejudiced way the development steps that would be important for society? How far can academia go on this road?

The science world has an important role in turning the on-going difficult economic situation and getting the EU into take-off. Innovation activities are seen as a central factor for the future. We must remember though, that no grouping has a monopoly on innovation activity. Innovation activity must be part of the whole society – it must be part of the culture.

Erkki KM Leppävuori
President & CEO

VTT R&I Vision 2020



Welcome to take a preview of the future

Today's waste will be tomorrow's valuable raw material. Production around the globe will strive to reach zero waste policies that are already a reality in the majority of Finnish factories. Water will be reused with great

efficiency, energy production will be smart and the sustainable growth of our economy will have a strong foundation in bioeconomical production. The world will be digital. Our lives will be valued and the wellbeing of every person of every age will be a matter we as a society take great pride in.

Our world is facing grand societal challenges. Far reaching effects touch the lives of us all, both today and in decades to come. There is a growing demand for clean energy, water, the sustainable use of raw materials, secured food production and an improved quality of life for us all.

Climate change mitigation calls for replacing fossil based raw materials with renewables, overall energy efficiency and low carbon energy production. With all these requirements, economical growth is a necessity; yet tomorrow's economy must be based on sustainability. Both these prerequisites for a better future can be achieved with technology development that enables the sustainable use of resources and cost effective businesses.

VTT's research and innovation strategy 2020 is driven to create value from sustainability. It addresses societal challenges in six areas of research and technology development with great prospects of new business: bioeconomy, low carbon and smart energy,



people's wellbeing, resource efficient industries, a clean globe and the digital world.

There are high hopes of these six impact areas solving a range of environmental, social, and economic challenges that we will be facing in upcoming years. Together these six show great promise of increasing our quality of life, advancing sustainable economic growth and creating a clean world.

Progress inevitably involves the downfall of old ways. New solutions to improve health and wellbeing and to enhance productivity with sustainable use of raw materials are likely to disrupt many existing business models, even economic structures. Thus it is imperative to be a forerunner, on the first wave of forward looking research and business. Only this way can we not only prepare for the future but also make the most of it.

Anne-Christine Ritschkoff
Executive Vice President, Strategic Research

Bioeconomy

What is bioeconomy?

In short, bioeconomy is an economy based on the sustainable manufacture of different products from renewable biobased resources, as well as exploitation of biological phenomena in processing of non-biological raw materials. Bioeconomy thus combines traditional processing and engineering technologies with emerging technologies to generate business opportunities, welfare and economical growth.

Views and foresights of bioeconomy

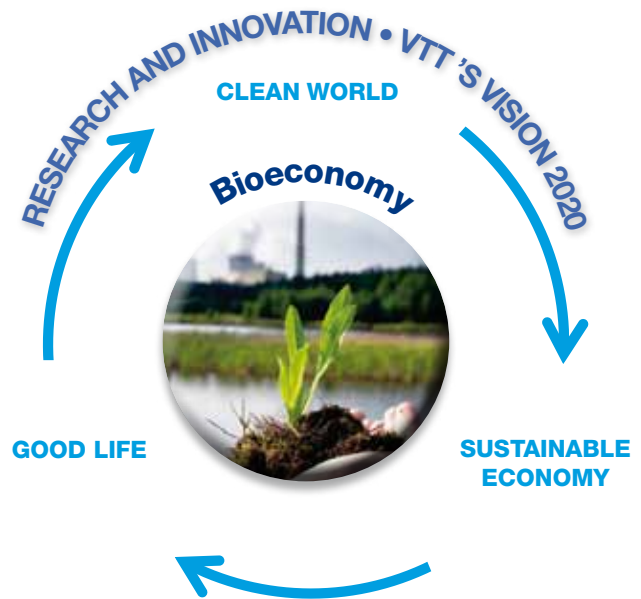
Bioeconomy is the future. Several industrial sectors will clearly benefit from bioeconomy and it is expected to have considerable impact on society.

Trends driving towards bioeconomy are environmental, societal and economical. Climate change will result in changes in agriculture and forestry. New crops and plant varieties will grow in northern Europe. Increasing environmental consciousness means more and more are willing to pay for sustainable products. The depletion of fossil raw materials is a global problem that is advancing bioeconomy everywhere.

Bioeconomy is a mark of our time and increased economic consciousness. Although bioeconomy serves a greater purpose to increase sustainability, efficient business is still the foundation upon which all bioeconomy production is built.

Bioeconomy and VTT

Sustainable processes which can convert biomass to a multitude of different products are at the heart of bioeconomy. Key enabling technologies include biotechnology, chemistry, process technology, automation and manufacturing technology. In the field of bioeconomy, VTT has an important role in



producing research and insight that glues industrial value chains together, to achieve best practices and competitive results.

VTT's multidisciplinary offering in bioeconomy combines vital enabling technologies for a large range of production competences. Industries that are in an especially promising position to prosper from bioeconomy include pulp & paper, food, energy, chemical and materials production.

VTT is a key player especially in developing bioeconomy processes and products, with research ultimately leading to new business in biorefinery products, biotechnical products and bio-enabled products. As a provider of bioeconomy related research for partners all over the world VTT also has an active bioeconomy spin off policy - creating new stakeholders to the value-chain is highly important to us.

In years to come, VTT expects bioeconomy to be an essential part of the whole economic system, when goods and services are produced with the winning combination of different sustainable technologies and renewable raw materials.

Bioeconomy is a mark of our time



Low carbon energy

Views and foresights of low carbon and smart energy solutions

The changes we are facing today will be far-reaching. The use of solar, wind and biomass based energy will grow significantly and a sharp increase is predicted for wind power generation. In the very near future, low carbon energy production and transport solutions will increase significantly with new low carbon solutions to existing power plant assets as will efficient energy use initiatives in industry. We will see more smart buildings, even smart cities.

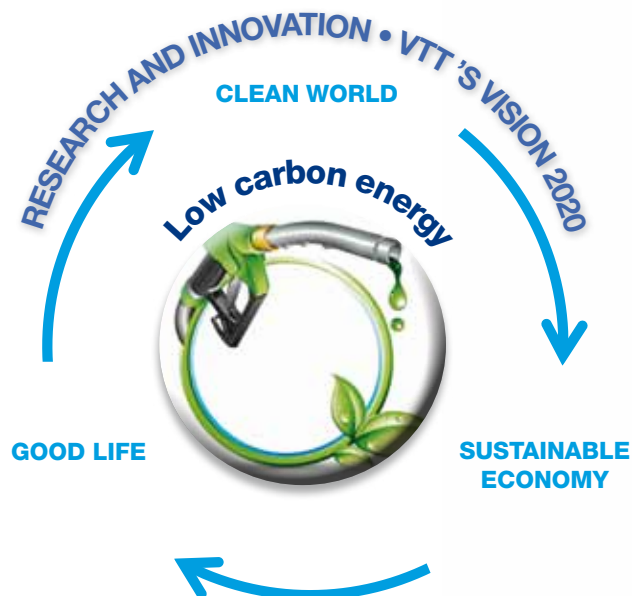
When all these advances are coupled with the smart integration of production, use, and consumer choice, we have every opportunity for achieving world class efficient use of energy and meeting or even surpassing mutual targets.

Unprecedented investments are expected in low carbon and smart energy solutions world wide. Finnish solutions for greenhouse gas reduction and competitive economy have vast opportunities in the global market, especially in the field of low carbon and smart energy technology and services, where massive growth is predicted in upcoming years.

Low carbon and smart energy solutions and VTT

VTT's low carbon and smart energy related research spans numerous different fields, including solar energy, nuclear safety, bioenergy chains and concept solutions, wind power production and fuel cell solutions, as well as waste-to-energy technologies.

VTT develops technologies, systems and business models to combine well-being and low carbon society for the year 2050. VTT identifies low carbon



pathways for local and business area driven solutions. Furthermore VTT generates low carbon solutions with scenario assessment and global energy system modelling. Our multi-disciplinary approach is combining expertise in energy systems, energy production, and energy use in all sectors of society and gives us competitive edge.

VTT offers support for policy makers and companies by energy system modelling and scenario work in order to find cost efficient measures and implementation plans to fulfil the new energy and climate targets. VTT's leading edge low carbon and smart energy technology enables new solutions with first of its kind demonstration in Finland to catalyse introduction of new energy technology to market. VTT's multidisciplinary expertise is crucial for these success stories.

We need to re-think the way we work, move, live and consume. The challenge is to make the change without sacrificing quality of life and well-being. New technologies will be needed for virtually every aspect of our daily lives. Low carbon and smart energy solutions may limit global warming and enable 50-80% green house gas reduction globally.



**Massive
growth for
smart
energy
solutions**

People's wellbeing

Views and foresights of people's wellbeing

The need to reinvent healthcare has become obvious in the course of the past 10 – 15 years, when several drivers have emerged that interactively push for a systemic change in health services.

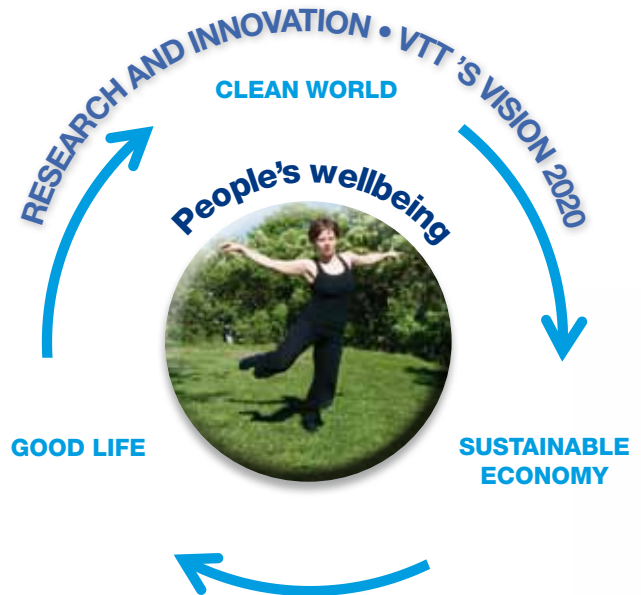
On the demand side societies are greying, our lifestyles are projected to lead towards a huge increase in chronic conditions and we are better informed of what medicine or nutrition can do. On the supply side biology based medicine has improved our understanding of diseases, their diagnostics and therapies.

The role of patients has changed fundamentally from passive objects of care to proactive partners and co-producers of their health and care, while ICT enables the integration of data and best practices, the virtualisation of certain health services and resources, and access to services anytime anywhere.

People's wellbeing and VTT

In Europe, we currently spend close to 80 % of our health budgets on the direct and indirect care of chronic diseases, although we know that chronic diseases can to a large extent be prevented and managed. VTT has three multidisciplinary research frontiers in the realm of wellbeing that all aspire to change our concept of healthcare in years to come: active and healthy ageing, lifestyle management and personalised medicine and nutrition.

The evolution of the health care field is inspiring great hopes of wellbeing reaching completely new



levels within our lifetime. Functional nutrition, early diagnostics, motivational tools, remote health monitoring and active and responsive housing are but a few examples of areas with substantial future impact for both business and society. Wellbeing is a core area of future growth with substantial potential for a large array of new business.

VTT's research both directly and through additional business innovation strives to dramatically improve the quality of life. VTT is taking a leading role in generating a platform of combinatory technologies and services to ensure wellbeing at all ages. VTT's work on wellbeing focuses on creating concrete solutions, tools and devices through advanced research.

Within a few decades we will have dramatically different services and tools to enable and support good life. Although population ageing is a central driver of wellbeing related business opportunities, new business innovations are expected to be life changing for people across all age groups.

A better life and wellbeing for all



Resource efficient industries

Views and foresights of resource efficient industry

Resource-efficiency is a paradigm change ongoing in the material and energy basis of sustainable society and economic growth. Global shortages in critical materials have strategic and economic implications. Parallel approaches are requested towards substitute solutions and eco-efficient economy: In the short term we need to improve materials efficiency and in the medium term to adopt green growth business models.

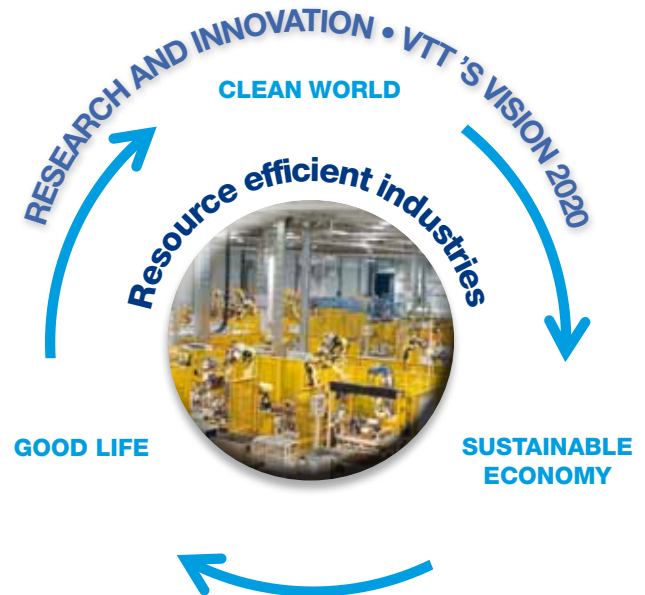
The ongoing energy shift is also all-encompassing and affects every line of business. Both research and business strive for eco-innovations to deal with the paradigm change and to achieve higher raw material yield, reduced energy usage, reduced CO2 emission, higher product quality, improved safety and increased plant security.

Novel innovation patterns are challenging traditional research and development models. The end users are increasingly part of the design process. The manufacturing industry has a chief role in resource efficiency both as a user of resources and as a provider of solutions.

Resource efficiency and VTT

As a rule, the eco-innovations driving resource-efficiency are closely connected both to public decision making regarding regulation, and strategic decision making on a company level. A lean and agile innovation policy system is a prerequisite to future success.

In order to harness the full potential of cost savings and new business creation that resource-efficiency



holds, we must ensure that innovations are rapidly brought to the market.

VTT research covers the full scope of resource efficiency from the development of new business models and value chains to the simulation based production, product and material design.

Market oriented, flexible and resilient value chains and networks are developed via open engineering and operation platforms and can be monitored by novel indicators on energy use and eco-efficiency. Virtual methods and tools are developed for open environment aware engineering systems. Control and automation at all levels of value chains is an obvious way to find solutions for process and manufacturing industry aspiring to achieve resource efficiency.

Resource efficiency will be the corner stone of competitiveness in all industries. When we think of the near future, most everyone acknowledges what awaits around the corner - materials and energy shall be saved, recycled and reused to a much greater extent than they are today. We are looking forward to cost efficiency, new competitive edge and cleaner production.

Resource efficient industry paves the way to progress



Clean globe

Creating a clean globe is a joint project. It involves every line of business and society at large. All material resources are relevant to clean globe related research. Currently, focusing on incorporating a zero-waste policy is the most critical driver towards a cleaner planet.

Views and foresights of clean globe

A heightened awareness of climate change all over the world has paved the way for research and new business opportunities related to central challenges regarding a clean globe, such as lowering emissions, the sustainable use of materials and water efficiency. Life-cycle considerations are receiving increasing attention in product development, as are the overall ecological, social and economical aspects of production.

Rising living standards combined with the new global division of labour have created considerable business opportunities in both preventing a decline in ecologically sustainable living and in cleaning our globe.

Another key driver is urbanisation, which is advancing at an alarming pace. New solutions relating to urban air quality and water use will become a fast growing line of business with great potential within the near future.

Clean globe and VTT

VTT focuses on four technological areas in order to create a cleaner globe through new business: purification, recovery & reuse, efficiency and information management.

In practise this translates to a wide range of progress: VTT creates technologies for emission mitigation and research is finding ways to make



products from CO₂. Smart water reuse concepts, the valorisation of water impurities and water efficient industrial processes show great promise, having already had a considerable impact on production sustainability in water-intensive industries - with far reaching effects promising to ultimately have a role in easing global water shortage. Groundbreaking work done by VTT's experts has also enabled the ecoefficient exploitation of minerals and production, which is both emission efficient and produces zero waste.

We are moving towards a clean globe with green solutions for water and waste. VTT is leading this effort on many fronts.

Your waste is valuable raw material for someone else. You need not look too far in the future to imagine a world with no waste. Recycling, reusing, smart production, water purification and zero-waste policies are changing the way we produce and consume - ultimately the way we all live our lives.



VTT aspires to create a clean globe



Digital world

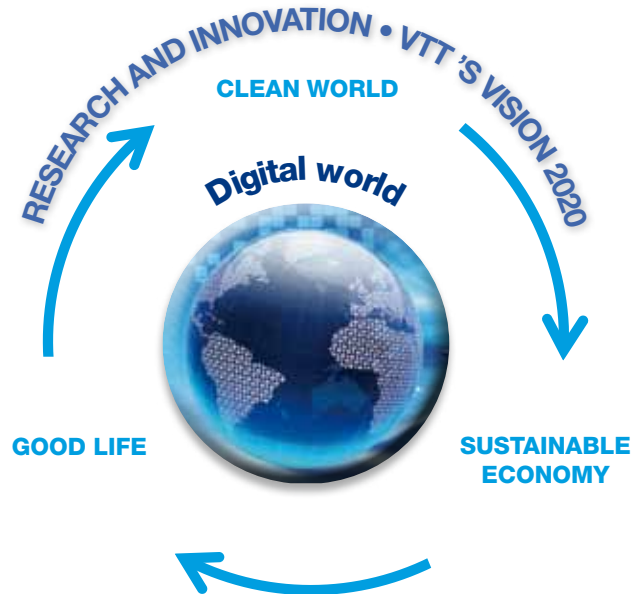
Views and foresights of Digital world

Soon, all information will be digitised. Digital information can be used in other instances and for other purposes than the original. It can be controllably replicated into service mash-ups, creating a wide range of new business and incentives for open use of public and private data. We have coined this trend as the emancipation of data.

Hand in hand with digital convergence, sensors and printed intelligence are gaining momentum as key building blocks of ubiquitous computing. Sensors, embedded into our surroundings and everyday objects, are essential for making objects and spaces smart. Printed intelligence is a way to produce sensors, solar panels, user interfaces and other components at cost unimaginable with other production mechanisms.

There are three main goals towards which the ICT sector is heading: smart, sustainable and inclusive growth.

- 1) Smart growth is characterised by ICT enabled innovations, which substitute raw material and energy intensive consumption of the past with digital and immaterial growth.
- 2) Sustainable growth uses ICT as an instrument. We can meet the challenges of climate change and scarce resources by involving the latest ICT solutions to manufacturing, logistics and consumption. ICT can provide the citizens with the tools and incentives for reclaiming responsibility of their actions.
- 3) Inclusive growth invites everybody to enjoy the social benefits of the digital world. The threat of digital divide can be avoided by ensuring general computer literacy. Finland can take a pioneer role



in this aspect thanks to good education system, homogenous and small population and citizens positive attitudes towards ICT.

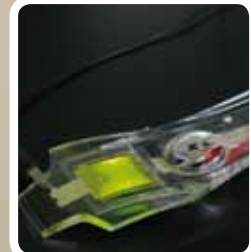
VTT and Digital world

Digital convergence is changing the way we live as citizens of the new knowledge based society and how we do business in the new digital economy. VTT offers leading edge ICT and electronics technology enablers which will boost competitiveness of businesses across all industries.

VTT is at the heart of digital research in a country that has proven its outstanding ICT skills time and again. New, knowledge-based business is evolving fast and VTT aims at creating new business ecosystems by providing efficient, inclusive, and trustworthy solutions for industrial competitiveness and societal grand challenges.

ICT is the nervous system of society: it is the primary instigator for 80% of innovations and 40% of current productivity improvement. ICT Digital convergence is the source of disruption in every business.

Upcoming in a digital world: the emancipation of data





VTT TECHNICAL RESEARCH CENTRE OF FINLAND
Vuorimiehentie 5
P.O. Box 1000, FI-02044 VTT, Finland
Tel. +358 20 722 111
Fax +358 20 722 7001
E-mail: firstname.lastname@vtt.fi

Customer service:

info@vtt.fi

Tel. +358 20 722 7070

Fax. +358 20 722 7001

Opening hours 8.00 - 16.00, GMT +2

VTT's offices in Finland: Espoo, Oulu, Tampere, Jyväskylä, Rajamäki, Turku, Kuopio, Lappeenranta, Kajaani and Raahе. VTT also has regional representatives promoting VTT's contacts with businesses in their areas.

VTT's offices abroad: Bay Area and Berkeley (California, USA), Shanghai (China), Tokyo (Japan), St. Petersburg (Russia), Seoul (South Korea), Brussels (Belgium) and São Paulo (Brazil).

More information on VTT activities and research as well as the webversion of this review on our website: www.vtt.fi.

VTT Review as well as other printed information material can be ordered from:

VTT/Communications

Liisa Linnama

Tel. +358 20 722 6849, liisa.linnama@vtt.fi

Graphic design: Sari Halme, VTT

Photos:

Pia Inberg, Tekes, VTT, iStockphoto, Finnish Government / Ministry of Employment and the Economy

This review is printed on Galerie Art Silk printing paper, which has been granted the environmental emblem of the Nordic countries.

Edita Prima Oy, December 2011





VTT Technical Research Centre of Finland is the largest multitechnological applied research organisation in Northern Europe. VTT provides high-end technology solutions and innovation services.

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

Through its international scientific and technology network, VTT can produce information, upgrade technology knowledge, create business intelligence and value added to its stakeholders. VTT is a not-for-profit research organisation.



VTT TECHNICAL RESEARCH CENTRE OF FINLAND

Vuorimiehentie 5, Espoo
P.O.Box 1000, FI-02044 VTT, Finland
Tel. +358 20 722 111, Fax +358 20 722 7001
www.vtt.fi