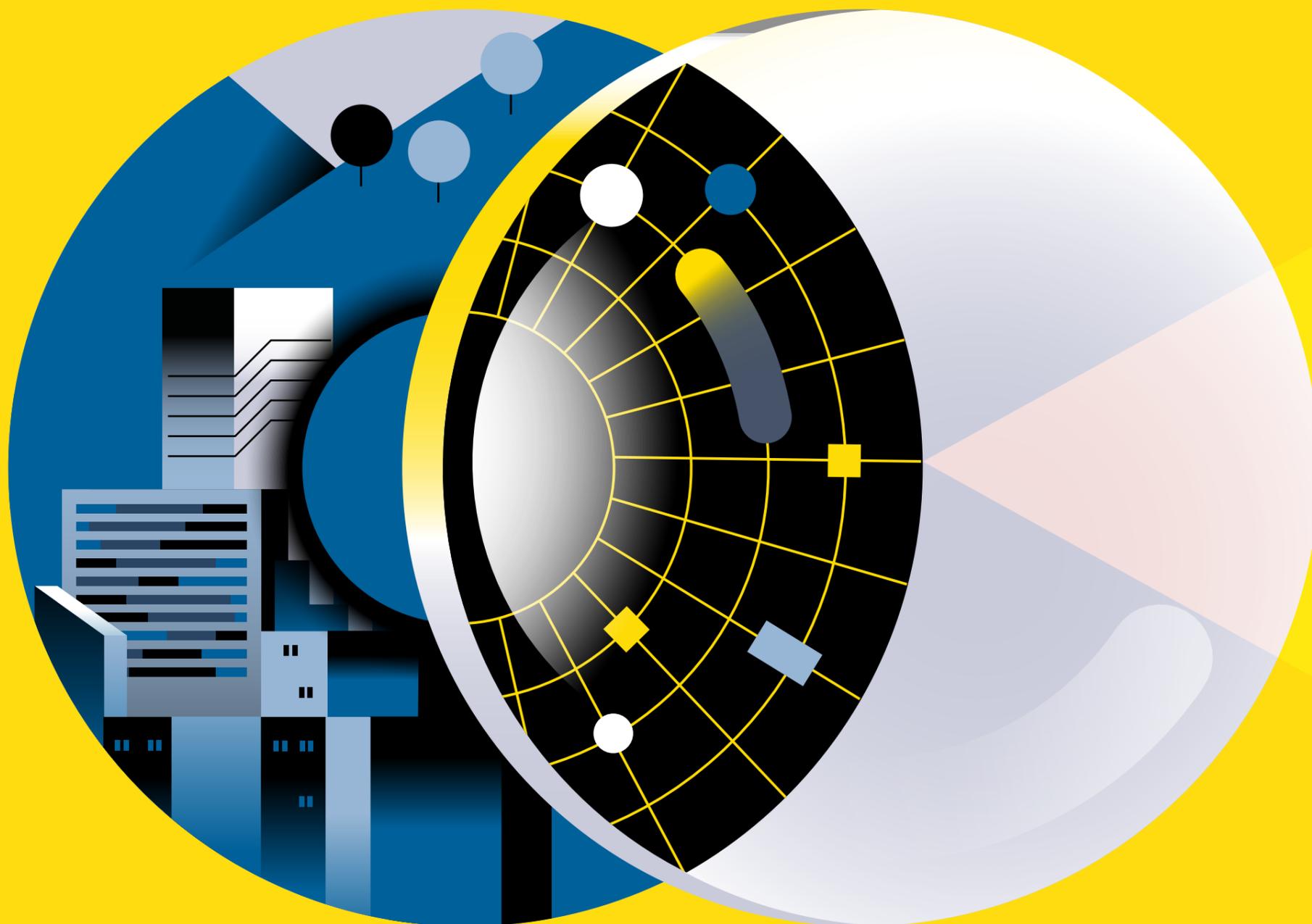


# Discovering exponential hope: Finnish deep tech startups



**Introduction to finding  
exponential growth  
from Finnish deep  
technology startups.**

Antti Vasara  
CEO, VTT

**beyond the obvious**

**“Businesses and societies are faced with yet another technological transformation. This time it will change our economy and our lives in an even more profound way than digitalisation has done over the last few decades. In the 2020s, a science-based technological transformation will accelerate quickly, moving beyond bits to the level of atoms and molecules.”**

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# The deep tech transformation will enable sustainable business growth

We are faced with yet another technological transformation. This time, it will start from growth companies that take advantage of tremendous scientific breakthroughs, creating entirely new ways to produce materials, treat diseases and steer industrial processes. They will not only advance the existing solutions but replace them altogether, while simultaneously solving the biggest problems of our time. This paper is a guidebook to Finnish deep technology startup expertise. It explains what deep technology is about, and how companies can join the transformation.

We are living through pivotal moments. Businesses and society are faced with yet another technological transformation. This time it will change our economy and our lives in an even more profound way than digitalisation did over the last few decades. This transformation is based on scientific breakthroughs, and it is powered by companies making use of them. The transformation is driven by accelerating global challenges: the need to tackle climate change, safeguard resources and maintain people's health create a huge demand for new, world-changing solutions.

I call this next wave of transition a *deep tech transformation*.

In the 2020 VTT vision paper titled *Discovering exponential hope*, I proposed that Finland invests in new, revolutionary areas of technology that can solve global challenges and generate radical leaps in productivity and sustainability. In this publication, I will continue to map out the same path of exponential hope.

However, my focus will now be on the rapidly emerging form of business that I believe to be at the heart of the radical innovation and renewal that companies currently need: **deep tech, or deep technology startups**.

The definition of the term deep tech, or deep technology, varies in international discussion. In this

text, it refers to growth companies whose business is based on recent breakthroughs in science and technology, and which offer unique and disruptive solutions to global problems. They not only improve the existing solutions but create completely new, revolutionary ones. Unlike digital startups, deep technology usually involves concrete physical technologies or products. Deep tech growth companies thus produce not only bits, but both bits and atoms.

Deep tech solutions include such innovations as creating totally new materials – all the way from the atomic level – or guiding personal health through genetic technologies and data.

Having such innovations commercialised will bring forth an entirely new group of companies leading the economy, some being the developers of such innovations and others their early adapters. However, the transformation offers new opportunities in almost every sector from food production to the construction industry and from healthcare to the processing industry.

My message to companies is this: seize the opportunities of deep tech – right now. The early adapters of new technologies and innovations will win the competition and may find a path to rapid, sustainable growth. Thanks to deep technology, existing products or processes can be made exponentially faster and smarter – and, above all, *sustainably*.

After all, we are also faced with the imperative shift towards a sustainable economy and lifestyle. The Intergovernmental Panel on Climate Change (IPCC) has set a strict timetable for transforming the way humankind lives its everyday life. Global carbon emissions must be halved by the end of this decade and brought down to zero within a few decades if we want to avoid the most catastrophic consequences of the climate crisis. At the same time, we need to stop biodiversity loss, ensure that there are enough global resources for the growing population, and offer people a good and healthy life under increasingly unstable conditions.

Every sector and company must quickly detach themselves from the materials, business models, and structures of the fossil-based world. The current forms of business destroying nature and the environment can no longer exist in 20 years' time. We must make a rapid change and act on every front.

We cannot overcome major sustainability challenges by making incremental improvements in old

technologies and business models. Instead, we need to bring new and surprising solutions from the world of science which have the potential to replace today's unsustainable systems and transform our everyday lives. These are exactly the kinds of innovations deep tech startups are developing. I therefore believe that **cooperation with these growth companies will provide other companies with the necessary tools for a radical, rapid, and sustainable change**.

Scaling the production of deep technology by bringing a new plant protein to people's plates or building a commercially operating quantum computer is not easy. A deep technology startup often needs research laboratories, factories, expensive equipment and new technology in the early stages, meaning that deep tech's leap from laboratory to factory production often takes tens of millions of euros. Therefore, a deep technology growth company usually needs to be supported by a network of other companies, financiers and research institutes.

**“Health, resource sufficiency, food, carbon neutrality... All answers to major global problems already exist in science. Now, someone will need to scale them up and introduce them to the market. We believe that deep tech growth companies are the fastest way to get them into the market.”**

– Inka Mero

*Founder and Managing Partner of Voima Ventures  
deep tech venture capital fund*

**“If your company is interested in ensuring its own viability and competitiveness, you should be interested in deep tech start-ups. Otherwise, you will not have a part in defining your future playing field. Of course, you can always choose to copy others and be reactive, but usually being a pioneer gives you an advantage. Don’t be disrupted, be a disruptor.”**

**– Lotta Partanen**  
*Manager Incubation and Acceleration,  
science startup incubator VTT LaunchPad*

Nevertheless, the investment can pay for itself in immeasurable ways if a new solution is introduced throughout the world, if it helps the partner company become the winner in the transition in its own field, or if it helps keep our environment viable.

At the same time, making a shift from bits to atoms means that deep technology may revolutionise the way we live our physical everyday life. Applications and software alone cannot solve the sustainability problems associated with our material consumption or the challenges in our healthcare systems. They require concrete new technologies.

For example, BioNTech, which developed a coronavirus vaccine based on the new mRNA technology, is a deep tech startup. To get its product into the world market, it collaborated with the pharmaceuticals giant Pfizer. This cooperation between the growth company and the global pharma giant

made it possible to rapidly scale up the innovation to global use.

As the example of BioNTech–Pfizer vaccine shows, the radical innovations needed for solving global challenges are usually not created in the R&D departments of major corporations, but in deep tech startups.

The example also shows that scaling new solutions to a global level at a rapid speed often requires cooperation between deep tech startups and large global companies. I believe that, in the 2020s, this kind of cooperation will play a crucial role both in how we respond to the climate and ecological crises and in generating new economic

growth, employment and well-being. The time is finally right because consumers, workers, investors and societies as a whole need – and practically demand – radical change.

Growth companies can develop radical technologies quickly, and global corporations can help take these technologies to people’s everyday lives rapidly. For the corporations this means that by seizing

the deep tech innovations and expertise, they can earn a share of tremendously rapid sustainable growth. However, by instead choosing to opt-out of the accelerating development of deep technology, they may become sidelined faster than they realise.



# The map of inevitable transformation: Guidebook to Finnish deep tech startup scene

Finland is known for its digital startup field. However, not many have a view into the tremendous scientific and technological innovations that are being developed by Finnish deep tech startups and how these innovations could revolutionise various industrial sectors. That is why I try to bring Finnish deep tech startup expertise to the attention of global companies and the media, funders, and research partners.

Next, I will present a map of what I consider to be the most important **breakthrough areas in Finnish deep technology**, and a few examples of growth companies operating in each of them. This is not a full story of what is happening in the Finnish deep technology scene, but a map of our areas of expertise that, in my opinion, have the greatest **potential for impact on the world and for businesses**.

Keeping impact on my mind, I have examined the field of Finnish deep tech startups applying two key criteria: **inevitable transformation** and **the unfair northern competitive advantage**.

1. The **inevitable transformation** refers to the depth and impact of the scientific breakthroughs currently being introduced. New methods of making materials, starting from the level of atoms, may revolutionise how all materials are manufactured. New means of producing data may change the way we foresee future. New medicines and healthcare

innovations may revolutionise the way people and societies take care of their health. As the innovations are of a deep and fundamental nature, it also means that their areas of application cover almost all industrial sectors. Therefore, the growth potential of the competence areas presented here is exponential.

2. The **unfair Northern competitive advantage** refers to the unique Finnish deep expertise built over time. Deep technology is an extremely difficult area of operation that requires expertise in various fields, ranging from basic research to commercialisation, accumulated over a long period of time. In the areas I have selected, Finland has accumulated unique competence that makes world-class breakthroughs possible. In addition, Finland's areas of competence are linked to the research expertise and startups in other Nordic nations and the Baltic countries. Measured by various indicators, this New Nordics area is one of the world's leading deep tech regions.

The three special fields of deep technology in which Finnish expertise can enable sustainable transformations are:

## 1. New materials

Advanced materials science, synthetic biology and virtual materials design provide solutions to the world's resource scarcity and the creation of a carbon-neutral society.

## 2. Nanoelectronics

Micro- and nanoelectronics, sensors and probes, optics and photonics, and quantum technology can enable high-performance digital systems and a quantum leap in data processing.

## 3. Health technology

New health technologies, medicine, biosciences, and diagnostics may enable sustainable well-being for societies and a good life for people even during the upcoming transformation.



**“Finland is experiencing a third wave of entrepreneurship. The first one emerged in the aftermath of Nokia, the second one was generated by the rise of digital startups and the game industry. In the third wave, our successful startup entrepreneurs unite with strong Finnish research expertise and science-based innovations, launching growing Finnish technology startups to global success.”**

– Sami Lampinen  
Managing Director, Partner at Inventure

# 1

## New materials enable carbon-neutral material cycles

### Why is the sector disruptive?

When it comes to the questions of life and death for the humanity, materials science lies at the very heart of the matter. How can we continue ensuring that we have enough resources for all mankind? How do we replace fossil raw materials at an extremely fast pace with renewable, carbon-neutral and recyclable alternatives? How can we make the production of food, goods, and raw materials genuinely sustainable?

We must seek answers to these dilemmas from new ways by which materials are designed and produced.

The impact of materials science on technological development and people's everyday lives has already been revolutionary.

**Omkaram Nalamasu**, Chief Technology Officer of the materials engineering company Applied Materials, has calculated that if a modern smartphone had been made in the 1980s, its manufacturing would have cost USD 110 million, and the process would have required 200 times more energy than it does today. The phone would also have been 14 metres high. Today, billions of people have an affordable smartphone in their pockets because materials science has made it possible to shrink technologies and reduce their prices.

In the same way, new advances in materials science may soon make sustainably produced food, textiles or building materials, among others, available to everyone.

Today's companies know how to manufacture their products extremely efficiently, but few know how to do it sustainably. Therefore, every sector that produces something from raw materials – from food to clothing or from industrial equipment to ships – should be interested in new materials

science solutions and research institutes developing such solutions, and in deep technology startups. They offer new kinds of revolutionary ways of producing materials and enable a sustainable circular economy. Food, materials, energy... everything can soon be made in a carbon-neutral or even carbon-negative manner and within the limits of nature's carrying capacity.

### What kind of revolutionary breakthroughs are being introduced right now?

Several simultaneous breakthroughs have taken place in the development of materials.

Firstly, materials technology has broken into a level where new materials are developed starting from molecular and atomic level.

The modern synthetic biology can read the DNA of any living organism and is also capable of creating molecules never seen in nature before, as DNA can also be made in test tubes outside cells. By modifying DNA, it is possible to make a micro-organism produce desired materials, chemicals, polymers, proteins, or foodstuffs.

Similarly, advanced materials science makes it possible to process the nano-level structures of lignocellulosic fibres of wood and to use them for developing, for example, renewable and recyclable alternatives to plastics.

New sustainable bio-based materials are inspired by nature and imitate the natural cycles. They are often reusable, recyclable and biodegradable and do not generate waste.

The second breakthrough is related to the new techniques offered by digitalisation, which can be

**Does the effectiveness of materials design affect your value chain?**

**Would you like to halve the time needed for the materials development cycle?**

**Are you seeking new sustainable and recyclable materials solutions?**

used to exponentially accelerate materials development. Thanks to virtual materials development and artificial intelligence, materials are no longer developed slowly through trial and error. Instead, they can be designed and modelled atom by atom to meet the final needs.

Virtual materials design may even halve the materials development cycle and generate a real leap in productivity. Artificial intelligence can also be applied to efficient materials optimisation, without major additional costs. In the future, materials development may even be based on real-time research, in which materials development and manufacturing

can be robotised. This enables exponentially faster and more sustainable materials development.

Efficient and sustainable materials design is critical for the future of companies, as the world is effectively running low on many raw materials, such as metals needed for the electrification of society.

The ethical problems associated with the production of materials are also increasing, as their production is not fair to people, or it destroys the environment.

We need new solutions that enable recyclability and the use of materials without putting unethical burden on the environment and communities. The new materials technology offers sustainable solutions to these challenges that can bear ethical scrutiny.

### Why does Finnish deep tech have an unfair competitive advantage?

The Finnish materials expertise and innovations have been among the best in the world for a long time. Finland's long history in forest, chemical, and processing industries has created unique expertise in Finland in such fields as cellulose-based biomaterials and alternative materials.

In Finland, we have been making innovations related to new materials and efficient cycling of materials for more than 20 years.

Successful examples include novel recyclable and ecological textile fibres; biodegradable cellulose-based innovations to replace plastics; and more eco-friendly concrete, which can cut a major part of construction industry emissions. Some of our deep tech startups are already collaborating with the world's largest global companies in fields such as fashion, cosmetics, and construction.

## Startup examples: New materials



Image: Solar Foods

### Solar Foods makes food from thin air

Solar Foods has developed a revolutionary way to produce protein from the carbon dioxide captured from the air. The invention represents a novel food production method that does not involve any fields or animals. The company rewarded by NASA is now building its first commercial-scale production plant in Finland.

How can the growing world population be fed without needing to clear more land for agriculture? The Finnish deep tech startup Solar Foods offers a revolutionary solution to this challenge: it has invented a unique method to produce a completely new protein – Solein – directly from air-captured carbon dioxide.

The company uses electricity to capture atmospheric carbon dioxide and produces nutritious, protein-rich microbial mass from the carbon. The closed fermentation process used slightly resembles wine production. If solar or wind power is used, the protein production process can be completely emissions free.

This scalable technology can solve global challenges associated with food production, population growth and the environmental impacts of agriculture. Almost all raw materials for making the protein are captured from the air, so no arable land or farmed animals are needed. According to Solar Foods, Solein can potentially reduce emissions by up to 99% compared to meat production and by 80% compared to traditional plant proteins.

Solein can be produced in harsh and dry conditions, even in space – hence NASA's interest – without having to cut down any trees. Contrary to conventional agriculture, there is no need to use pesticides, and the production will not generate any runoffs into water systems, or release greenhouse gas emissions. In November 2021, Solar Foods won the American space agency NASA's Deep Space Food Challenge.

Solar Foods has initiated the authorisation process of a novel food regarding Solein in the European Union and the United States. The company has already started the construction of its first commercial-scale production plant in Vantaa. The plant known as Factory 01 will enter production in 2023. It aims to produce up to 100 tonnes of Solein per year, equalling the protein content of approximately 5 million meals. Solar Foods has already acquired a total of EUR 41 million in funding. The company aims to become the world's leading manufacturer of carbon-neutral protein.

Solar Foods was established in 2017 based on a research project carried out by VTT and the LUT University.



Image: Spinnova

### Spinnova spins sustainable textiles out of wood and waste

Imitating the way spiders make their webs, the fibre technology company Spinnova created a technology for producing new sustainable clothing textiles from food waste and cellulose fibres. Currently, the revolutionary startup already partners with the global fashion giants Adidas, H&M and The North Face.

Could new textile fibre be produced by imitating a natural process, the way spider spins its web? This insight was the starting point of the story of deep tech startup Spinnova. The company, founded by Finnish researchers Janne Poranen and Juha Salmela in 2015, has developed a method resembling the way spiders weave their web that can turn wood cellulose or leather, textile, and food waste into new sustainable textile fibre.

With Spinnova's technology, the long fibres found in pulp or waste can be arranged in such a way that the fibre suspension flows evenly through a small nozzle without the fibres sticking to each other. In the process, the fibres are spun into a thin and durable yarn without the need to use any complex chemical methods. The resulting material is fully natural, recyclable and decomposes rapidly.

According to the company, producing the fibre requires 99% less water and produces 65% less CO<sub>2</sub> emissions compared to cotton production. The disrupting technology can therefore offer solu-

tions to sustainability challenges in the fashion and textile industry, i.e., recycling of materials, curbing emissions, and reducing water consumption.

Experimental collections have already been created using Spinnova's fibre, and the company has found partners in the world's largest fashion brands such as the sports garment giant Adidas, the fashion chain H&M, and the outdoor clothing brand The North Face. Spinnova listed on Nasdaq Helsinki in June 2021 with an initial public offering of EUR 115 million. The demand from world-class brands has rapidly increased the company's value and enables the production to be scaled up. According to Spinnova, the fibre it makes from wood and waste streams will be widely available to textile industry partners in 2023.

The company is currently building a commercial-scale plant with the Brazilian pulp company Suzano in Jyväskylä, where its pilot plant and research centre are already located. For operating the plant, Spinnova and Suzano set up a new 50/50 joint venture.

# 2

## Nanoelectronics enables data to be collected and processed on a scale and at a rate never seen before

### Why is the sector disruptive?

In the future, the development of nanoelectronics may enable, for example, the use of data as a basis for modelling, foreseeing and steering human health or the Earth's natural resources.

Current information and communication technologies are based on microelectronics, which have made it possible to reduce the size and price of smart devices and to disseminate them increasingly wider.

Examples of such consumer technologies include smartphones, computers and new intelligent features in cars and homes.

In the industrial sector, this kind of intelligence enables running entire factories or ports based on data, as minuscule sensors and probes can collect increasingly accurate data for boosting operational efficiency.

Today, as the world electrifies, electronics are everywhere. They are technologies upon which other technologies are built, i.e. platform technologies.

Now, these platform technologies are taking a leap from one level to the next, to an even smaller scale: from microelectronics to nanoelectronics, from the scale of parts per million to a scale of parts per billion.

When technologies are being developed at this extremely small and precise nano level, entirely new natural phenomena are at work. In the nanoscale world, we can discuss interactions between individual atoms, or even subatomic, or quantum level, phenomena.

The future breakthroughs in nanoelectronics may enable making smart sensors and probes or sensory surfaces increasingly smaller and cheaper,

**Would your company benefit from more efficient data processing?**

**Are you making efforts to bring intelligence to the technologies you use or as part of your production chain?**

**Have you ever wondered about what kind of changes breakthroughs in nanoelectronics might bring to your own field?**

which would make it possible to disseminate them anywhere. The accuracy at which the functions of the human body, cars, industrial processes, or the globe in its entirety can be sensed, foreseen, and measured is increasing.

In addition, as the computing capacity of computers may grow exponentially because of quantum technology, the enormous amounts of data pro-

duced by sensors can be used more rapidly and in better ways than before.

Therefore, the development of electronics may enable us to collect and process data at a rate that allows us to model, anticipate and steer increasingly complex operational entities, from the human body to the planet's resources.

### What revolutionary breakthroughs are being introduced right now?

The development of nanotechnologies has continued for a long time, and some of the solutions are already in commercial use. But this will be the decade when nanotechnology innovations will really break out of laboratories, making their way to a wide variety of uses across industrial sectors and by humans.

Material innovations reaching the nano level will bring intelligence to completely new areas, allowing plastics, glass, or textiles to be used as smart, sensory surfaces.

In addition, nano-structured materials expand the range of sensory observation, enabling, for example, much more extensive measuring of the frequencies of light than before. Accurate infrared or hyperspectral cameras can be used for seeing in the dark or for analysing the composition of different surfaces with extreme precision – be it the human skin, the chemical composition of food or the state of the Earth's forests.

In other words, there is an extremely wide variety of applications for new nanoelectronics, from the clothing and automotive industries to healthcare and space technologies.

### Why does Finnish deep tech have an unfair competitive advantage?

Finland has been a pioneer in microelectronics since the 1970s. Finland has made ground-breaking achievements in the fields of new micro-electromechanical systems (MEMS), photonics and quantum components and other special components.

In 1974, Finnish scientists developed atomic layer deposition (ALD). The method is used for building thin films one atomic layer at a time, which enables the operation of all modern microprocessors.

The biggest commercial breakthrough generated by the Finnish R&D was the Nokia mobile phone. Nokia was also once a deep tech growth company based on research development, which then evolved into a global mobile phone giant. Partly as legacy of Nokia, Finland became a location for state-of-the-art research and expertise in microelectronics and nanoelectronics.

Today, Finland is one of the world leaders in fields such as space technology, photonics, quantum technology, and radio and micro-electromechanical systems (MEMS) and nanomaterials, such as atomic layer deposition (ALD) technology. In these areas, there are deep tech startups emerging in Finland with the potential to scale into global technology suppliers.

## Startup examples: Nanoelectronics



Image: ICEYE

### ICEYE satellites provide the capacity to see events around the world in near real time

ICEYE, which produces small synthetic-aperture radar (SAR) satellites, offers near real-time images of any location on Earth regardless of the time of day or weather conditions. The data can be used, for example, to map storm and flood damage or to prevent piracy and illegal fishing.

New satellite technologies offer amazing capabilities to observe the entire world in real time. ICEYE, which has its origins in Aalto University's 2012 Aalto Ventures programme, develops small SAR satellites that bring a new level of accuracy and speed to monitoring events on the planet.

The satellites transmit radar images of the Earth from space in near real time. The data collected can be used to map flood damage caused by hurricanes and storms, to monitor the status of wildfires, or to see where pirates and illegal fishers move.

As the climate and ecological crisis turns the planet into an increasingly unstable place, the capacity to monitor or even foresee the development of crisis situations is becoming progressively beneficial.

ICEYE's biggest customers include large insurance companies and public agencies and organisations that need information quickly on how natural disasters or major accidents devel-

op. Some of ICEYE's satellite data is also distributed free of charge for the use of the research community through the EU's Copernicus programme.

ICEYE's microsattellites use exceedingly small and sophisticated technology, bringing their weight down to less than 100 kg, while conventional satellites typically weigh thousands of kilos.

ICEYE's advantage is that it can manufacture and build its small satellites faster than its larger competitors. The company has already launched 14 satellites since 2018 and now operates the world's largest constellation of SAR satellites. It also aims continuously to increase the number of satellites in its constellation.

In terms of funding, ICEYE represents the cream of Finnish deep tech startups: it has accumulated more than EUR 152 million in funding from venture capital investors.



Image: IQM

### IQM builds functional quantum computers

IQM builds the world's leading quantum computers and is one of the fastest growing companies in the global quantum technology sector. The aim is to get quantum computers into practical use and to harness them to building a better future.

In this decade, the world's data processing industry is about to take a major quantum leap and the Finnish IQM is one of the pioneers in building quantum computers.

The company provides on-site quantum technologies for world-leading research laboratories and high-performance computing centres (HPC), which are used by various data-intensive industries, such as the automotive, pharmaceutical, and technology industries and large research organisations.

According to IQM's estimate, three out of four super-efficient data processing centres in the world will introduce experimental quantum technology by 2023. Most of them will build new on-site quantum infrastructure in the data centres, and to meet this demand commercial startups with expertise in quantum technology, such as IQM, are needed.

IQM was established in 2018 and has grown into a company that employs 130 people between Finland and Germany. Currently, IQM is building a 50-qubit quantum computer in Espoo, Finland and developing quantum processors for commercial applications as well as corresponding algorithms for them in Germany.

In 2021, the company announced that it will establish a new unit in Bilbao, Spain, where it aims to develop quantum technology and software for the financial sector, and an office in Paris to serve the French market with a focus on air, space, and cybersecurity industries. The company has collected over EUR 71 million in funding from private and public investors.

# 3

## Health technology breakthroughs enable anticipation of health hazards and targeted treatments for diseases

### Why is the sector disruptive?

In the next decade, we must save not only the planet's ecosystems, but also humanity's health. There is still a lot of work to be done in solving challenges such as ageing populations, chronic diseases, increasing obesity, antibiotic resistance, and potential new pandemics. We should foster our own health, and the healthcare system should work in a more effective and humane way to ensure that there is enough healthcare capacity to give every patient the care they need.

Some of the problems related to equal access to care are systemic and cannot be solved by technology alone. Political means are also needed.

At the same time, it is possible to maintain health and treat illnesses more effectively by combining new medicine and diagnostics. The COVID-19 tests and vaccines are a good example of this: solutions were found in record time because entirely new kind of research and development work was conducted on a wide front and with sufficiently large funding.

The development of genetics and personal diagnostics will soon provide people with better opportunities to steer their own healthcare and manage the associated risks. It will also enable the development of better targeted treatments for different illnesses.

### What revolutionary breakthroughs are being introduced right now?

A radical drop in the cost and increase in the efficiency of genome sequencing will make it possible to

base the diagnosis and treatment of illnesses increasingly on the patient's personal genetic information. DNA sequencing is used as a basis for developing, for example, unprecedentedly cost-effective, accurate and rapid molecular diagnostics or more targeted treatments for severe illnesses than before.

The use of extensive patient data and artificial intelligence help physicians make better decisions and provide the treatments most likely to be effective.

Today, diagnostics and pharmaceutical development are carried out with innovative technologies that are radically faster than before, using such methods as DNA sequencing, bioinformatics, nanotechnology, and pharmaceutical particle technology.

### Why does Finnish deep tech have an unfair competitive advantage?

According to Business Finland, Finland is one of the world's three leading health technology economies, and digital health is Finland's biggest field of high-tech exports.

Our strength in health technology is built upon robust expertise in ICT and mobile technology, which also combine Finnish material innovations, optics, and photonics. The best Finnish deep tech startups combine these different areas of expertise with the development of new diagnostics. Finland is one of the first countries in the world to have created a national digital patient database that combines the data from both public and private healthcare. The opportunities to utilise extensive databases promote the development of new innovative solutions.

In addition, Finland has a long tradition of world-class medical research, and we are among the best in the world in many areas, ranging from cell and molecular biology to biochemistry, and from cancer and tumour biology to neuroscience and genetics. We also have extraordinarily strong, long-term diagnostic expertise which has already generated growing business through ground-breaking molecular diagnostics solutions.

**What kind of opportunities will emerge in the growing export market for health technologies, for example in digital services?**

**Can personal diagnostics help prevent pandemics?**

**How will drug development speed up with technological breakthroughs?**

### What combines our areas of expertise?

The factors combining the breakthrough areas of Finnish deep technology are small in size and the disruptive nature ensuing from it.

Research is now breaking into molecular and atomic levels, to the nanoscale and picoscale.

We are about to understand how the basic pillars of life and the universe work: how molecules and atoms – or even subatomic particles operating under them – behave.

It gives us new capabilities to control the organisation of these basic pillars, such as the way atoms and molecules organise themselves into different materials and raw materials, or how the genes in our DNA steer health within the human body.

The minute scale also allows nano-sized electronics to spread everywhere. Sensors and probes can sense the world to a wider extent, and the data gathered provides us with smarter and more sustainable opportunities to steer and predict how systems operate.

These are precisely the kind of fundamental new skills that we will need for making the huge shift of rapidly transforming our entire lives into sustainable lifestyles.

These skills are generated by science and developed into practical applications by deep tech growth companies. Large companies are needed for industrial scaling and introducing the applications to all our operations worldwide.

Together, we can build completely new, sustainable businesses and lifestyles for all of us.

## Startup examples: Health technology



Image: Nanoform

### Nanoform modifies medicinal substances into effective drugs

The pharmaceutical deep tech company Nanoform has developed a method for breaking down pharmaceutical molecules into nanosized particles. Their innovative technology may significantly increase the bioavailability of medicines. The aim is to help the global pharmaceutical industry double the annual volume of new medicines.

The story of Nanoform began when professors Jouko Yliruusi and Edward Hæggström first combined their expertise in pharmaceutical technology and physics. Their cross-disciplinary cooperation led to a breakthrough in 2012: Yliruusi and Hæggström developed a completely new kind of nanoparticle technology which may revolutionise global drug development.

The technology patented by Nanoform is called Controlled Expansion of Supercritical Solutions (CESS). It allows the molecules of active ingredients in drugs to be produced into minuscule nanoparticles.

This method, called nanoforming, is extremely useful in pharmaceutical development, as nanoformed drug molecules have more effective surface and higher solubility in the human body. This will make the drugs more effective.

According to Nanoform, up to 75% of new drug molecules developed in the pharmaceutical industry are poorly soluble. In their ordinary form,

they would not produce the desired effect in the human body, but nanoforming may make the pharmaceutical molecules more effective.

In other words, the new nanotechnology may help release the hidden potential in an increasing number of new drug molecules. According to the company, its nanoforming process is effective on most small molecules at the probability of 80–90%.

Nanoform's vision is to help the pharmaceutical industry double the number of new drugs that advance to clinical patient trials and thus increase the number of new drugs entering the market.

Nanoform was listed on the stock exchange in 2020 and has since made major investments in the construction of production lines and product development. It has raised more than EUR 140 million in funding and is already partnering with several international pharmaceutical companies.



Image: Unsplash

### Desentum develops allergy vaccines

There are a billion people suffering from allergies worldwide. Desentum uses biotechnology techniques to develop a new revolutionary immunotherapeutic product: an allergy vaccine that could significantly speed up and enhance the efficiency of desensitisation.

Allergies are one of the most common chronic conditions in the world. In Europe alone, more than 150 million people suffer from allergic congestion, and the number of allergy sufferers in the world is estimated to have passed one billion.

Allergy symptoms can be alleviated with medication, but currently there is only one therapy that addresses the cause of allergies: desensitisation, or allergen immunotherapy. However, it is a slow treatment process that lasts for years and is inconvenient for the patient. In addition, there is a risk that desensitisation causes anaphylaxis, or a severe allergic reaction, in the patient.

Desentum has set out to solve the challenges in the present allergy therapies by developing a completely new type of immunotherapeutic product: an allergy vaccine. The technology, using biotechnology techniques, modifies allergens to reduce their ability to cause symptoms.

In other words, the effectiveness is based on retraining a person's own immune system so that

the body begins to tolerate allergens. Compared to normal desensitisation, an allergy vaccine could be used to significantly speed up and improve the efficiency of the therapy in a safe manner.

If successful, Desentum's solution could bring about a fundamental change to how allergies are treated: a transition from the current medication to alleviate the symptoms to treating the actual cause of the condition.

Currently, the company is developing vaccines for treating birch, hay, and peanut allergies.

At the end of 2021, Desentum reported promising results in the first clinical trial of the birch allergy vaccine: when administered as a series of five doses, the vaccine was found to be safe and well tolerated. The markers measured indicated that the vaccine produced the desired immune response.

Desentum has received funding from the highly competitive EU's Horizon 2020 programme amounting to around EUR 2 million for the first clinical trial and business development.

# Companies, it is time to take a more strategic approach to the emerging deep tech startups!

So, what should companies do next?

## 1. Create a systematic strategy for making use of deep tech startups

Monitoring technological innovations should be on the agenda of all corporate management groups and strategy units. Even if your own field has been developing steadily and calmly so far, it may soon be revolutionised by technology. This has already happened in many fields that have been following the same logic in their operations for decades, such as the media, taxis, and communications.

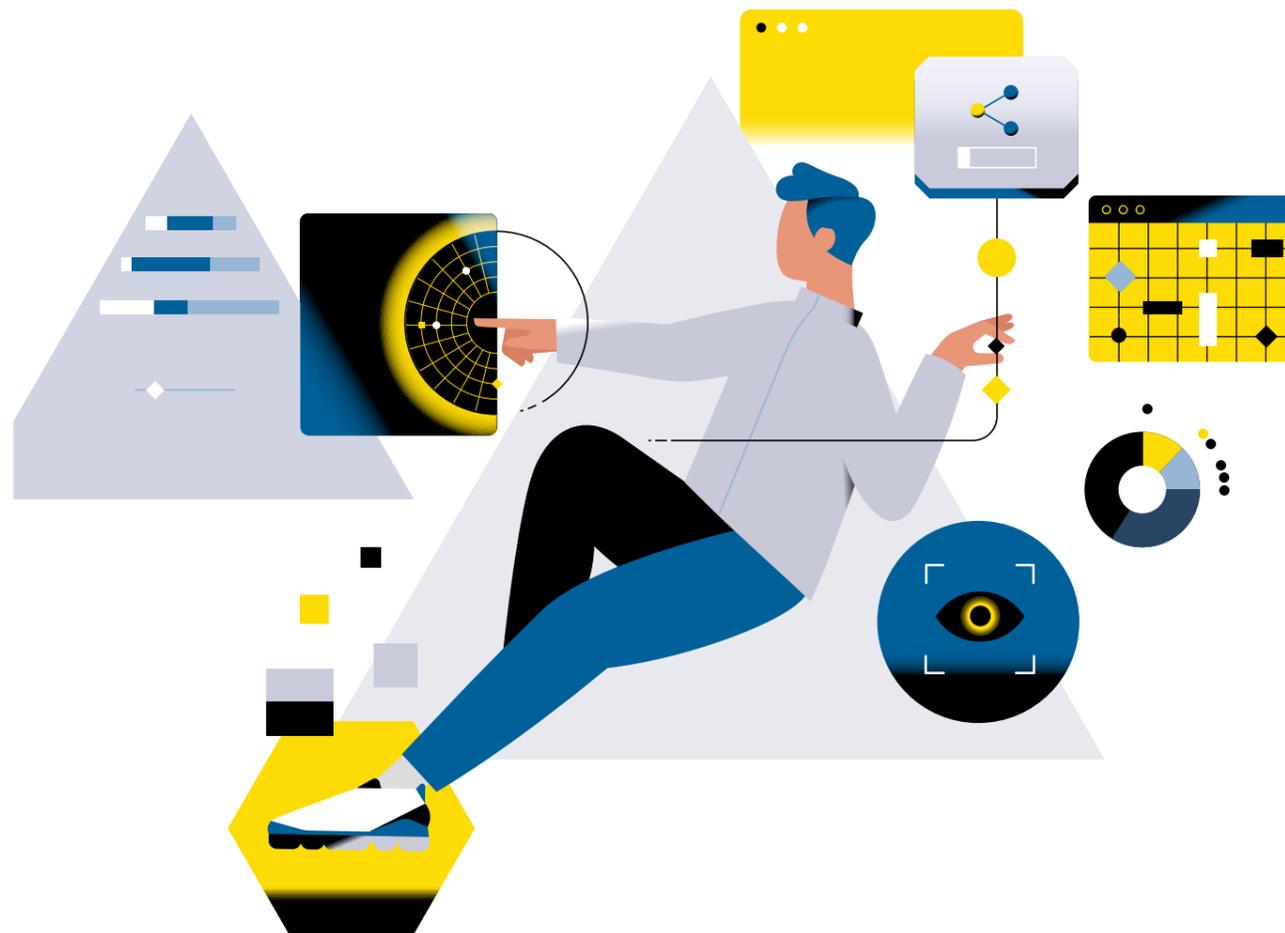
Companies should also invest in their own technological competence, since creating deep partnerships with deep tech startups and research institutes also requires that they have some understanding of the subject.

When hunting for radical innovations, one must take risks and break traditional operating models. One cannot know for certain which deep technology innovation will eventually scale into a global revolution. Therefore, an extensive portfolio is better than seeking a single Holy Grail. However, you do not need to take the risks on your own, and co-

**“The existing companies should be bolder. The world’s most innovative companies, Apple, Meta, and Alphabet, are constantly buying smaller startups, and with them, entrepreneurial people and radical innovations. Industrial companies should also have a clear strategy for innovation: more bold company acquisitions and more transformative, deeper partnerships with research institutes and technology startups.”**

– Timo Ahopelto

*Founding partner of the venture capital firm Lifeline Ventures*



operation may also mean participation in research projects and building of new ecosystems.

## 2. Make a trip to the northern treasure chest of deep technologies

Why search for startup partners from Finland in particular?

Over the several decades, special expertise and excellent networks have accumulated into Finland and on a wider scale into the Nordic and the Baltic countries. In the areas described, the small size of the market is a strength: experts with in-depth knowledge from different fields operate in the same circles without hierarchies and exchange ideas quite directly across sectors and competence areas. The region has a feel of its own.

VTT is an excellent example of this tradition. Many of the deep tech startups have been built upon the expertise from VTT or they are linked to our research activities in other ways. VTT often plays an active role in ecosystem projects with large companies, research projects, and deep tech startups. In addition to VTT, other ways to gain access to the Finnish deep technology scene include universities, Business Finland, and venture capital funds.

I warmly recommend that as international operators you get acquainted with what we have to offer and the way we think in this region. We at VTT are happy to help you!

**“My message to companies is this: seize the opportunities of deep tech – right now. The early adopters of new technologies and innovations will win the competition and may find a path to rapid, sustainable growth.”**

### **Acknowledgements**

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**Antti Vasara**  
CEO, VTT

VTT's President and CEO Antti Vasara has decades of experience in leading Finnish technology companies such as Nokia and Tieto. He holds a Doctor of Technology (Technical Physics) degree from Helsinki University of Technology.

# APPENDIX: Finnish deep tech startups from our areas of expertise

Name	Business idea/ innovation	Which challenge is addressed/ why is it <i>revolutionary</i>	Which innovative technologies are used	Turnover/ financial data *
<b>Materials innovations and materials science:</b>				
<b>Solar Foods</b>	Makes food from the air by turning carbon dioxide into microbial mass using electricity. Solein protein developed by Solar Foods can be used as food.	Addresses challenges of global food production: A completely new type of food, which is natural, can be made to taste like anything, and, unlike other foods, does not require farming or animals.	Food technology	Turnover EUR 0 Result EUR -1.1 million
<b>Spinnova</b>	Turns wood fibres and leather, textile, and food waste into yarn.	Produces material that does not harm the environment and is fully recyclable for the needs of textile industry. Minimises water consumption, harmful chemicals, and carbon emissions.	Materials technology, textile technology	Turnover EUR 254,000 Result EUR -5.6 million
<b>Infinited Fiber</b>	Makes new Infinna textile fibre from textile waste.	Waste that would otherwise end up in landfills can now be converted into new fibres, which also reduces the need for virgin textile fibres consuming natural resources.	Materials technology, carbamate technology	Turnover EUR 0.9 million Result EUR -1 million
<b>eniferBio</b>	Produces high-protein ingredient for fish feed from biorefinery side streams.	The protein supports more sustainable food production as it can be used as replacement for soy, a commonly used fish feed component with ecological challenges associated with its production.	Protein technology, bioprocess technology	Turnover EUR 7,000 Result EUR -66,000
<b>Carbo Culture</b>	Produces biochar from agricultural side streams.	Biochar binds carbon dioxide into the soil and enriches the soil. The climate-enhancing product is made of crop waste, which has become a problem in agriculture.	Bioprocess technology	Turnover EUR 9,000 Result EUR -237,000
<b>Sulapac</b>	Develops fully biodegradable material to replace plastic by combining biomaterials and wood fibre.	Biodegradable packaging is a more ecological alternative to conventional plastic packaging that produces huge amounts of plastic waste and microplastics.	Biomaterials technology	Turnover EUR 1.1 million Result EUR -3.9 million
<b>Betolar</b>	Provides low carbon concrete production with the Geoprime® solution. This method can be used to convert industrial waste and side streams into low-carbon building materials - "cement-free eco-concrete".	Cement in concrete emits more carbon dioxide than air transport, the Geoprime® solution replaces cement by utilising industrial waste and side streams.	Materials technology	Turnover EUR 25,000 Result EUR -585,000
<b>Origin by Ocean</b>	Collects and refines marine biomass, such as blue-green algae and bladderwrack, and turns them into sustainable raw materials.	Removes harmful algae from the seas and oceans and converts it into ingredients that can be used in the food, beverage, cosmetics, and pharmaceutical industries, etc.	Algae refining technology	N/A
<b>Paptic</b>	Bags and packaging materials made of paper that work like plastic.	A completely new type of biodegradable packaging material, with the combined benefits of paper, textiles, and plastics in an environmentally friendly and recyclable form.	Materials technology	Turnover EUR 1.3 million Result EUR -2.2 million
<b>Woodly</b>	Produces a new kind of plastic with wood cellulose as its main feedstock. The plastic is carbon-neutral and recyclable.	Thanks to the renewable feedstock, Woodly is a carbon-neutral material, and it can help reduce the use of fossil raw materials.	Materials technology	Turnover EUR 32,000 Result EUR -623,000

\* Figures from 2020 unless stated

Name	Business idea/ innovation	Which challenge is addressed/ why is it revolutionary	Which innovative technologies are used	Turnover/ financial data *
<b>Micro- and nanoelectronics, sensors &amp; probes, optics &amp; photonics</b>				
<b>Dispelix</b>	Develops waveguide displays for eyeglasses used in Augmented Reality (AR) applications.	Lightweight and high-quality waveguides can be mass produced more cost-effectively than ever before.	Nanophotonics (parallel computing, algorithm)	Turnover EUR 1.2 million Result EUR -6.7 million
<b>TactoTek</b>	TactoTek is the leading provider of Injection Molded Structural Electronics (IMSE) solutions that integrate printed circuitry and electronic components into 3D injection molded plastics.	IMSE is the greener choice: it uses 50-70% less plastics and produces up-to 35% less greenhouse emissions compared to traditional manufacturing technologies.	Injection Molded Structural Electronics (IMSE™)	Turnover EUR 1,55 million Result EUR -8.1 million
<b>Elfys</b>	Develops black-silicon UV photodiodes with an exceptionally high efficiency for the needs of the processing industry.	The sensors significantly improve the performance of any device using photodetectors, including health monitoring devices such as smart clocks and rings.	MEMS-nanotechnology, ALD technology	Turnover EUR 169,000 Result EUR -325,000
<b>Kuva Space</b>	Provides satellite services, which produce daily data of the Earth's bioresources.	Kuva Space's special camera technology enables the construction of cost-effective small-scale satellite constellations. Satellite data of forests and fields helps prevent biodiversity loss and optimise land use.	Nanosatellite technology, hyperspectral imaging, AI-based analytics	Turnover EUR 532,000 Result EUR -149,000
<b>Canatu</b>	Manufactures formable and stretchable thin films and touch sensors for companies making consumer electronics and automotives.	Canatu solutions improve the user interfaces of 3D touch surfaces and make them easier to design. The Carbon NanoBud® material provides seamless contact when integrated with plastic, glass or textile.	Nanomaterials technology Patented Carbon NanoBud® material and roll-to-roll Direct Dry Printing® process	Turnover EUR 1.5 million Result EUR -6.8 million
<b>Emberion</b>	Emberion develops photonics and uses it to produce electronics that disrupt infrared and thermal imaging technologies.	Emberion's infrared cameras extend the wavelength range beyond visible light and offer imaging solutions at a significantly affordable cost.	Photonics, nanomaterials technology	Turnover EUR 62,000 (2019) Result EUR -2.2 million (2020)
<b>Minima Processor</b>	The company offers smart processor technology solutions that achieve significant energy efficiency.	The number of electronic devices in the world is proliferating rapidly. At best, Minima's technology reduces the power consumption of digital computing equipment to a fraction of the current level.	Energy efficiency technology	Turnover EUR 224,000 Result EUR -0.9 million
<b>ICEYE</b>	Manufactures radar imaging satellites and sells satellite-based data.	The data provided by the company's SAR satellites can be used, for example, in the maritime industry to monitor port traffic and in the oil industry to detect leaks.	Space technology, satellite technology	Turnover: EUR 6.8 million Result: EUR -21.11 million
<b>IQM</b>	Is building a quantum computer.	Quantum computers enable taking an unprecedented leap in computing power and solving problems that have previously been impossible to process.	Quantum technology	Turnover EUR 75,000 Result EUR -5.2 million
<b>Oura</b>	Company specialised in health and well-being technology, develops a smart ring for health monitoring. The Oura ring and mobile application measure and analyse the quality of sleep, physical recovery and daily activity of their users.	Oura provides guidance for improving the quality of sleep. The aim is to maintain health and well-being in a comprehensive manner and to find a balance between daily periods of stress and rest. Several universities, research institutes, sleep clinics and companies use data collected by Oura.	Wearable technology	Turnover EUR 26,7 million Result EUR -2.0 million (2019)
<b>Picosun</b>	Manufactures and develops equipment for manufacturing ALD thin films that can be used for depositing layers even in the nanometre scale and development of the solutions.	ALD films are a prerequisite modern electronics and semiconductors. New uses for ALD technologies are found all the time, in health technology, for example. The market is expected to grow significantly over the next few years.	ALD technology, or atomic layer deposition	Turnover EUR 34.2 million Result EUR 200,000
<b>Beneq</b>	Manufactures coating equipment based on atomic layer deposition (ALD) and durable and transparent electroluminescent displays; the products are targeted for the semiconductor industry and the automotive industry. The technology is used for making thin films in nanometre scale.	The state-of-the-art technology will be used, for example, in the future 5G and IoT systems, and in the automotive industry.	ALD technology, or atomic layer deposition, nanotechnology	Turnover EUR 29.4 million Result EUR -3.4 million

\* Figures from 2020 unless stated

Name	Business idea/ innovation	Which challenge is addressed/ why is it <i>revolutionary</i>	Which innovative technologies are used	Turnover/ financial data *
<b>Health technology, medicine, biosciences, diagnostics</b>				
<b>Mobidiag</b>	Develops diagnostics for infectious diseases, such as PCR tests for COVID-19.	The company's unique Novodiag test platform enables tests that are faster and easier to use than conventional methods, and that cost-effectively scale to both large test volumes and smaller needs.	Molecular diagnostics Nucleic acid amplification, biochemistry, gene chip technology, bioinformatics, software, optics, fluidics	Turnover EUR 31.4 million Result EUR -5.2 million
<b>TILT Bio-therapeutics</b>	A pharmaceutical development company that develops new treatments for cancer tumours, oncolytic immunotherapy.	TILT technology can be used to improve the efficiency of immune checkpoint inhibitors and to help increasing numbers of cancer patients heal by means of immunotherapy.	Biotechnology	Turnover EUR -0.1 million Result EUR -1.5 million
<b>Nanoform</b>	A pharmaceutical company that enables a significant increase in the number of drugs progressing to clinical trials and entering the market.	The patented and scalable technology makes it possible to break down drug molecules into smaller parts, which facilitates clinical testing of medicines.	Nanotechnology, pharmaceutical particle technology, patented CESS technology	Turnover EUR 687,000 Result EUR -19.5 million
<b>Genomill Health</b>	A precision diagnostics company that develops molecular diagnostic tests.	The patented Geno1® sample preparation technology enables more cost-effective, accurate and faster molecular diagnostics.	Molecular biology, robotics, DNA sequencing, artificial intelligence	Turnover N/A Result EUR -285,000
<b>Desentum</b>	Develops allergy vaccines to shorten the desensitisation process from years to a few months.	A unique solution to the problems of conventional desensitisation therapy – slowness, inconvenience and adverse effects. With the help of the Desentum vaccine, the body's reaction causing allergic symptoms is transformed into a protective immune response within 3–6 months.	Biotechnology	Turnover N/A Result EUR -1.3 million
<b>StemSight</b>	Developing new treatments for corneal blindness using human stem cells.	Producing replacement tissues for the cornea from human induced pluripotent stem cells (iPS-cells) has the potential to cure previously untreatable patients and to alleviate global corneal tissue shortage.	Biotechnology, genetics and cell and tissue technology	N/A
<b>Blueprint Genetics</b>	Uses genetic testing to generate genetic knowledge to support clinicians in diagnosing rare, hereditary diseases.	With the help of its ground-breaking sequencing method, provides quick answers in a cost-effective and comprehensive manner.	Health technology, genetic diagnostics	Turnover EUR 16.1 million Result EUR -8.3 million
<b>Adamant Health</b>	Develops and provides measurement and analysis service for measuring the symptoms of and the efficacy of treatment on Parkinson's disease and other movement disorders.	By combining patient data and deep understanding of algorithms, the company supports neurologists in the planning of treatment and medication for Parkinson's disease and frees the patient from keeping a treatment diary. The solution helps pharmaceutical suppliers develop better drugs and alleviate the patients' symptoms.	Health technology	N/A
<b>Finnadvance</b>	Develops organ-on-chip platforms for the purposes of research and pharmaceutical development.	The benefits of chip technology include speed, adaptability, and ethical values, as it can be used to replace pharmaceutical research carried out through animal testing. Microfluidic assay systems can narrow the gap between the results obtained through test tube analysis and testing on living organisms.	Microtechnology, 3D biology, chip technology	Turnover EUR 1,000 Result EUR -116,000 (2019)
<b>Firstbeat</b>	Develops heart rate variability analysis to help improve physical performance and well-being. The analysis is used to produce personal information on stress level, recovery and the effects of physical activity.	The data provided by analysis is used, for example, by well-being at work services and as a coaching tool in top-level sports.	Health technology	Turnover EUR 8.6 million Result EUR -0.5 million

\* Figures from 2020 unless stated

VTT is a visionary research, development and innovation partner. We tackle global challenges and turn them into opportunities for sustainable growth. We help society to develop and business to grow using technological innovations – we think beyond the obvious. We have 80 years of experience in cutting edge research and science-based results. VTT is at the sweet spot where innovation and business come together.