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# Regional Innovation Monitor Plus 2016

## Regional Innovation Report

## West Finland (Advanced materials and nanotechnology)

**To the European Commission**

**Internal Market, Industry, Entrepreneurship and SMEs Directorate-General**

**Directorate F – Innovation and Advanced Manufacturing**

technopolis |group|

# Regional Innovation Monitor Plus 2016

Regional Innovation Report
West Finland (Advanced materials and nanotechnology)

technopolis |group| in cooperation with

Anniina Heinikangas

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# *PREFACE*

In the context of the growth and investment package set out in the Investment Plan of the European Commission, the Regional Innovation Monitor Plus (RIM Plus) provides a unique platform for sharing knowledge and know-how on major innovation and industrial policy trends in in some 200 regions across EU20 Member States.

Launched in 2010, the Regional Innovation Monitor aimed at supporting sharing of intelligence on innovation policies across EU regions. Building upon the experience gained and results obtained during the period 2010-2012, the RIM Plus 2013-2014 provided practical guidance to regions on how to use the collected information, via a network of regional experts. Since 2014, the RIM Plus has introduced a thematic focus on advanced manufacturing.

The RIM Plus 2015-2016 evolved from a general monitoring of innovation policies towards establishing a more thematic focus in selected areas in order to contribute to improving the competitiveness of European regions.

Particularly, the RIM Plus aims through its activities and in close cooperation with the regional stakeholders and other relevant initiatives to:

- Contribute to the development of new and open spaces of collaboration and exchange on advanced manufacturing, each with a clearly defined thematic focus.
- Play an enabling role in providing evidence-based information on specific themes and bring in outside perspective from other regions.
- Map out regional practices in support of advanced manufacturing and relevant pilot/demo projects and work towards involving the relevant stakeholders.
- Provide an easy access and comparative overview of regional innovation policies and relevant actions in the field of advanced manufacturing.
- Share the lessons learned with the European Commission services to feed into the preparation of future programmes.

The main aim of 30 regional reports is to provide a description and analysis of developments in the area advanced manufacturing with a clearly defined thematic focus and regional innovation policy, taking into account the specific context of the region as well as general trends. All regional innovation reports are produced in a standardised way using a common methodological and conceptual framework, in order to allow for horizontal analysis, with a view to preparing the Final EU Regional Innovation Monitor Plus report.

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*Further information:*

https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor

# Executive Summary

### *1. Advanced Manufacturing: Advanced materials and nanotechnology*

West Finland (Länsi-Suomi, FI19) consists of five (sub-)regions: Central Finland, South Ostrobothnia, Ostrobothnia, Satakunta and Tampere region. West Finland is an area of significant traditional industrial production in Finland. One challenge relates to the production structure, which emphasises capital goods and is reasonably vulnerable to international economic trends. The sustained deterioration in the economic cycle has inevitably reduced the RDI investments in West Finland.

Nanotechnology as a cross-cutting technology can be used to produce innovations in materials, products, equipment and processes, which lead to increasingly high added value. With regard to new materials, nanotechnology can be utilised in the improvement of the properties of existing materials and in the production of new kinds of material compounds, among other things.

- **Challenge 1: Declining private and public RDI expenditure**

Owing to the prevailing economic situation, the industrial manufacturing sectors in West Finland have suffered problems. The prolonged recession has inevitably affected the level of private-sector RDI investments. On a national level, investments targeted at research, product development and innovation have returned to the level preceding the financial crisis, but the situation in West Finland is more difficult than the average. The weakest situation is in regions that are weighted towards the electronics industry and its subcontractors, where recovery from the structural change caused by Nokia is still incomplete.

Public funding resources can no longer revive the situation. Financial reserves have contracted in structural funds allocated to West Finland, in national Tekes funding and in basic funding for institutes of higher education. Connected to the challenges in the funding of new materials and nanotechnology is the fact that nanotechnology is no longer very visible in the agenda of public innovation policy programme development. The reduction in national public funding reserves is increasing the tendency to seek out international funding.

- **Challenge 2: The commercialisation of top-level research and business activity**

The generation of business from science is a common challenge for all research institutes and universities. West Finland has good examples of the commercialisation of top-level research in the field of nanotechnology, the creation of wholly new industrial sectors based on it and of spin-offs, but the above-mentioned reduction in RDI funding is challenging research institutes to improve their commercialisation activities.

Establishing a company is seen as considerably easier than accelerating its growth after start-up. A critical stage is when the basic vital functions of a nanotechnology company have been established, and the micro or small business should then enter into international competition. This means either a need for aggressive expansion or selling the idea to another larger company, for example. West Finnish nanotechnology start-ups have found buyers reasonably well. Natural growth sought on international markets as an independent company has been more difficult to achieve.

- **Challenge 3: Fragmentation of skills and equipment resources**

Innovation work in the fields of nanotechnology requires plenty of time and an expensive equipment infrastructure applicable to special needs. The progress of technology within the sector requires regular investments in equipment, which are not necessarily profitable or even possible to make in a decentralised manner in a small country. There are two solution models to this challenge: the centralisation of top-level

skills or networked connection nationally and internationally. Bearing in mind scarce research and development resources, both proposals are current topics for discussion.

### *2. Regional Innovation Performance Trends, Governance and Instruments*

In a comparison of European innovation, West Finland still performs well, but several significant indicators have deteriorated in recent years. The field of Finnish innovation and competitiveness faces significant challenges, and there is no strong global economic growth on the horizon, which might improve the situation in itself. The key challenges identified in innovation performance are an increase in unemployment among university graduates, the threat of RDI stagnation resulting from the prolonged economic downturn and the development of new operating models such as open innovation platforms required for structural change.

Innovation activity is based on the application of high-level expertise produced with the help of tertiary education. Problems with the innovation system are reflected in unemployment amongst university graduates. The danger is that skilled young people will leave not only the region but also the country. Present operating models have been unable to create new jobs in growing sectors at the same speed as they have been lost from traditional professions. New effective development tools are expected of innovation policy. In view of the weak economic prospects, the will to develop and take risks of both the private and public sectors is on the decline, and distributable resources available to RDI activity are continuing to contract. New operating models are also needed to increase hope in the future.

### *3. Future Actions and Opportunities*

*With regard to the new materials and nanotechnology*

New expertise is particularly produced in the region's areas of top scientific research, whose future potential is important for the advanced manufacturing. The utilisation of nanoscale technologies is producing vast potential for the modernisation of existing industry both globally and in Finland and West Finland, which is home to well-established and internationally-renowned research institutes as well as spin-offs that have sprung from them.

- **Cross-disciplinary application of different fields of research**

Nanotechnology is an example of a cross-cutting key enabling technology (KET), whose fields of application are almost limitless. West Finland's traditional manufacturing sectors include the rubber and plastics industry, chemicals, food and the manufacture of electrical equipment. They have succeeded in increasing their turnover even during the most recent recession. The potential to utilise new technologies rests, on the one hand, in the abilities of these basic industries to modernise and, on the other hand, on completely new fields of application, whose success cannot be fully predicted. Nanotechnology offers completely new development potential to both the traditional manufacturing and the rising cross-disciplinary industries. Innovation expectations are high when two top-level fields meet.

The basic problem of innovation policy is that innovation is a somewhat unpredictable added value that cannot necessarily be promoted through focus points precisely defined for funding programmes. Flexibility provided for the areas in funding allocation, multidisciplinarity and platform based solutions can help in this. Dialogue between regional triple-helix actors is important to see each other's needs and clarify messages to be shared with other networks.

- **International networking**

International networking is often more fruitful than trying to achieve a domestic critical mass. In high-technology fields, international networking is usually a basic prerequisite, as RDI clusters are globally relatively few, the supply of top-class experts limited and market potential is basically international. International cooperation also increases opportunities for the shared use of expensive equipment infrastructure.

Networking also increases international investors' and financiers' awareness of local operations.

- **Increasing business potential through opening up**

Innovation-targeted advanced manufacturing requires opening up organisation-centred activity externally towards networks and agile operating models. In practice, this means increasing scientific research and cooperation with the private sector and deepening networks between developers locally, nationally and internationally.

Different subcontractor chains are a fundamental part of traditional industrial manufacturing. The introduction of advanced manufacturing and new technologies affects the roles of subcontractors and thereby the entire industrial value chains. Rather than 'subcontractors', business partnerships based on new technologies could be better described as, say, partner suppliers or network suppliers.

In Finland, a noteworthy paradigm shift to platform-based mechanisms has been discernible. Open innovation platforms are based on shared creation by teams from multiple backgrounds, controlled interactive models and a culture of experimentation.

*With regard to innovation policy*

The innovation policy of the regions is changing. As a result of the prolonged economic downturn, the innovation resources of both the private and public sectors have declined, and there are fewer hands available to do things. This results in needs to change prioritisation and structures. The decline in public RDI funding has also resulted in national development programmes being completely shut down, sometimes at very short notice. Regional innovation policy is strongly controlled by national policy, and the fragmentation of control is seen as problematic in development organisations. As a counterbalance to this, new processes determining future fields of specialisation and the strengths have been developed and systematically introduced in the regions. The regions have been given additional responsibilities to create processes that support knowledge-based management and the networking of participants. The regional government reform on the horizon will change the existing structure of regional administration and the fields of functions of organisations very significantly.

Possible future orientations and opportunities can be summed up under three headings:

- **Processes that involve participants in assessing and measuring the effects of innovation**

The effectiveness of contact and discussion between sectors on innovation activity can be improved through systematic processes, which the regions themselves can plan and implement from their own starting points in the ways that they see fit. People actively opening discussion and 'setting the shared table' can include, for example, funding authorities such as regional councils. An essential part of processes is the analysis of the latest available information in addition to different participatory elements.

Local actors are united by a desire to act in the interests of regional development, to enrich it by carrying out the right development measures and to improve the societal influence of their work. The field of individual actors is also often fragmented and human resources in decline. Networking between specialists promotes both cooperation in toppling barriers and human motivation.

- **Onwards from cluster development**

Cluster-based instruments have been terminated and innovation policy is seeking a new direction. National funding resources are being reduced and this is guiding development towards agile, actor-centred and cost-effective operating models. Innovation platforms and an approach based on regional ecosystems have been proposed as the basis of a new way of thinking. Participatory platforms based on open

innovation also support new challenges such as the solving of social issues in a new way.

Now a stage of experimentation with different approaches is ongoing, seeking the most effective new angle of approach to replace cluster policy. For innovation participants and development organisations, this manifests itself as a stuttering and fragmented programme policy. It might, however, be a question of a proactive transitional period.

- **New regional governments, new innovation actors?**

In the coming years, Finland will see a significant regional government reform, which will considerably change the existing regional administration structure. The social and healthcare services are being transferred from the municipalities to new regional governments. The functions of regional councils in the form of municipal federations and the state-run Centres for Economic Development, Transport and the Economy will be combined with new regional government organisations. The details of this have yet to be specified. However, the regional government reform package is also a question of the future innovation policy system and structures channelling innovation funding. The regional governments will offer the chance of reform to regional innovation policy and for the introduction of local innovation ecosystem policy, if it is so decided.

# 1. Advanced Manufacturing: Advanced Materials and Nanotechnology

## 1.1 Overview of performance and trends

Manufacturing industry has a significant effect on European society, its economic success and on the development of the milieu of citizens. It is estimated that the manufacturing industry still employs about 30 million people, the net sales it generates for companies is about €7 trillion, and that its share of total exports is about 80%. The industrial sectors' share of private R&D investments is some 80%. Its indirect effects on the rest of the business community are also considerable: according to estimates, one job in industry indirectly creates two in the service sector. (Tuokko, 2014.)

Nanotechnology is intrinsically a cross-cutting key enabling technology (KET), whose basic method of manufacturing can be utilised in many different industries. It can be used to produce innovations in materials, products, equipment and processes, which lead to increasingly high added value. The utilisation of new materials and nanoscale technologies are producing vast potential for the modernisation and stimulus of existing industry.

Since 2008, the European manufacturing industry has lost about 5 million jobs which, depending on the business and export structure, is evident in many countries either as a prolonged economic crisis or at least slow growth. The effects of the global financial crisis have also been very significant to Finland's manufacturing and to the whole economy. Its production structure, which emphasises capital goods, is subject to international economic trends. The number of industrial jobs in the country has been falling since 2008. The reduction in 2008–2009 was most significant, in total about 60,000 jobs (-15%). The years 2010 and 2011 were times of germinating hope, but the situation deteriorated again. In total, Finnish industry has lost almost a quarter of its jobs since the years preceding the financial crisis. (Statistics Finland, 2015.) The developing sectors have been unable to produce a similar number of new jobs to the number that has been lost in the traditional manufacturing industry. Structural change has been channelled into increasing and sustained unemployment.

West Finland is an area of significant and traditional industrial production in Finland. Many of the country's present and former flagship industries, such as engineering and the forest, energy, mobile phone, textile and marine industries, started life in West Finland. Of the country's industrial turnover, more than a quarter is still generated in the region, although the significance of industry in the turnover has contracted in the last eight years, as it has throughout the country. While between 2007 and 2012 the total turnover of companies grew by an average of 6%, during the same period the turnover of the industrial sectors in West Finland contracted by 9%. The effects of economic trends and demand have been particularly bad in (sub-)regions of Central Finland (industrial turnover -29%) and in the Tampere region (-11%). Particularly intensive regions in terms of the manufacturing industry are Ostrobothnia and Satakunta, half of whose turnover is generated by these sectors. The other regions too are more industry-centred than the national average (see Appendix C).

The contributions of regions to national industrial production are reflected in the strategic choices and in the areas that education focuses on, among other things. The profile of the Tampere region's manufacturing industries is especially focused on rubber and plastic products and on engineering. The Tampere region is the largest of West Finland's regional economies with a share of about 9% of the national population and industrial turnover. Because of its greatest emphasis, the turnover structure of the region is on average similar to that of West Finland. Satakunta particularly focuses on manufacture of basic metals, Central Finland on the refining of bioproducts, South Ostrobothnia on the food industry and leather and related products and Ostrobothnia particularly on the electrical equipment industry.

West Finland is home to globally leading companies and comprehensive clusters of companies, whose success is based on science-led creation of added value and on high-technology intensity. The manufacturing sector in West Finland is above the EU28 average, and new expertise is particularly produced in the region's areas of top scientific research, whose future potential is important for the modernising industry.

The sustained deterioration in the economic cycle has inevitably reduced the private sector's RDI investments in Finland and in West Finland. National investment in research and product development has been restored to the level preceding the financial crisis, but in West Finland the situation is worse than average. Companies' RDI investments have clearly contracted. The situation is weakest in regions focusing on the electronics industry (Nokia) such as the Tampere region and Central Finland. In West Finland, the number of patent applications correlates to the RDI investments of companies. The number of patents in West Finland contracted in comparison to the situation preceding the recession. The structure of the patenting sectors follows the priorities in the regions' field of research and training (Appendix D).

West Finland is home to well-established and internationally-renowned research institutes in the field of nanotechnology as well as spin-offs that have sprung from them. Nanoscale technologies produce high expectations in innovation and renewing the industry. With regard to new materials, nanotechnology can be utilised in the manufacture of very different materials, in the improvement of the properties of existing materials and in the production of new kind of material compounds. Nanotechnology can be used to produce new added value by improving the material properties of products, for example by increasing the wear resistance and dirt-repellent properties of coatings, by creating new properties for particles, for example in oils, paints and lubricants, by improving the structure, durability and lightness of products, for example through composite properties, or by exploiting nanotechnology in electronics, health technology and in human technological biomaterials.

Global value chains are said to be falling apart and the movements of the parts of the production chain accelerating. In the fields of high-technology, international networking has always been a basic prerequisite, as key RDI clusters are globally comparatively few in number and market potential is also basically international. The strength of West Finland is that manufacturing expertise is produced vertically for each level from material and production work to top-level research and product development. The same goes for expertise in nanotechnology. The local compactness of value chains is promoted by supporting the creation of forms of cooperation at the interface between the business and research sectors and between different fields of research.

## 1.2 Business sector perspective

On account of its cross-cutting nature, it is difficult to assess businesses in the nanotechnology sector. Operations and innovation results are not located only in one or a few sectors whose success could be monitored through general statistics. For example, the Tampere region has roughly estimated that small companies in the fields of nanotechnology and photonics employ approximately 160 people, and their turnover has been estimated to be about €50m (2012). When large companies are included, the employment effect rises to as many as 2,000 people. (Tampere Region Economic Development Agency Tredea, 2013.) In its exploratory phase, the Vanguard Initiative Pilot Action on Nanotechnology[1] has identified approximately 70 companies operating in the nanotechnology sector in West Finland. Most of them are located in Tampere Region, where there is a cluster of research, product development and higher education in the field. Two other noteworthy centres of excellence are the Helsinki Metropolitan Area and Jyväskylä in Central Finland. Aalto University, VTT and the

[1] See: http://www.s3vanguardinitiative.eu/cooperations/vanguard-initiative-pilot-action-nanotechnology

linked concentration of businesses in the technology sector in Espoo and Helsinki are significant in terms of resources. The University of Jyväskylä, in turn, has the Nanoscience Center, which is a cross-disciplinary research centre shared by the departments of physics, chemistry and biological and environmental science.

Companies in West Finland utilising or developing nanotechnology are located on the basis of their main application area and position in the value chain in a table in Appendix E. The analysis illustrates the entrepreneurial environment in nanotechnology in the region and positions its value creation. However, it does not endeavour to be an exhaustive list or an unambiguously orthodox approach to modelling. The segments of analysis are divided into four categories which are Materials, Measurement and modelling, Life science and Optics and photonics. Good business cases can be found in all of these application areas in West Finland.

The category with the highest added value is Total Deliveries, which comprises, in particular, large companies that utilise nanotechnology to improve the features and materials of their existing products. These large companies often represent fairly traditional key industrial sectors such as manufacturing of machinery, rubber products and ICT. For example, Nokian Tyres and Metso are global pioneer companies in their sectors. Nokian Tyres has developed a coating material based on nanocrystals, while Metso has developed coatings that prevent wear in mechanical engineering. The ICT sector has been a significant promoter of research and development in West Finland, especially during the golden age of Nokia. As regards nanotechnology, the semiconductor laser and sensor industries linked to the ICT sector play a significant role. On account of their local specific expertise, companies in fields such as neon sign solutions are also standing out.

The products made by companies in West Finland are used mainly in producing finished intermediate products. An example of this is provided by companies whose subcontracted finished laser components are used in the manufacture of end products sold to customers. With regard to new materials, another example are the various developers of rubber and plastic composites and biocomposites.

Various measurement operations and services are also strongly emphasised in the fields of business of companies that utilise nanotechnology. These are related for example to particle emissions, laser measurements and mechanisation. In addition, industry related to energy carries a strong global expectation of growth and potential for utilising nanotechnology. There is already a considerable number of companies that increase the efficiency of generating, using and storing energy by means of nanotechnology. These companies are involved in fields such as the product development of solar panels and biopolicies. The application of metal oxides is common in the energy sector, for example in solar cells and batteries.

The Tampere region in particular has strong research-based expertise in semiconductor structures and nanostructures. Among other things, these are utilised in laser and LED light sources, solar cells and integrated circuits. This is reflected in the large number of optoelectronic companies. A number of these are spin-offs from the Tampere University of Technology (TUT) and the Optoelectronics Research Centre (ORC). Another of the key research hubs in Tampere involves innovative combinations of the medical, biomaterial and technical sectors, which are generated especially in BioMediTech. Nanotechnology has growing potential in health technology and new materials that replace human tissues. Biomaterials also involve various nanopores and organic nanoparticles.

The Nanoscience Center, which operates in the University of Jyväskylä in Central Finland, promotes commercial utilisation of the results of research especially in its focus areas, such as biological nanostructures, organic nanochemistry, spectroscopy of nanostructures, experimental nanophysics and computational nanoscience. However, the research centre has not generated as many spin-offs as the ORC. The economic structure of Central Finland is focused on bioindustry and the forest industry.

Nanocellulose, for example, offers one future possibility for applying nanotechnology in this area.

The economic structure of the Vaasa region is focused on high levels of expertise in energy technology and electrical engineering. Nanotechnology relating to these areas offers potential in new forms of energy and in energy harvesters such as solar panels. The Satakunta University of Applied Sciences is generating photonics-related expertise for businesses. In the agro-bioeconomy specific to South Ostrobothnia, potential areas for the application of nanotechnology include machinery, lighting and the use of energy. For example, the window and door manufacturer Skaala Oy has utilised nanotechnology in product development.

Micro-sized and small companies on one hand and large companies on the other are dominant in the size distribution of companies in the nanotechnology sector. The proportion of medium-sized companies employing more than 50 people is fairly low. The emphasis on small enterprises relates to the fact that companies in the nanotechnology sector frequently emerge in Finland as spin-offs from other companies, from research institutions or from universities cooperating with industry. A transition from a small micro-enterprise to a small business can succeed when the business idea is workable. Public financing to support expansion is also available for early-stage growth. However, growing a business from a small to medium-sized company often seems to constitute an insurmountable threshold. It requires strong-willed linking-up to international markets, an endeavour for which some companies lack the required resources or networks. A notable proportion of businesses are acquired by a large company before their own growth agenda has emerged. For entrepreneurs such as those who pursue serial entrepreneurship or have a researcher's background, this alternative may often be quite agreeable.

Another feature that defines enterprises in the area is that they enter the market directly with a prototype produced from a business idea. The prototype is used to procure initial funding for the development phase, after which the operations turn into a new business rapidly and comparatively frequently. This can arouse interest especially in areas where product development mainly takes place in existing, established companies. Nanotechnology start-ups in West Finland are based on scientific background research of a high quality, which ensures that the new business seedlings are relatively viable and tested.

Systematically collected statistical data on business in the nanotechnology sector in West Finland is hard to find. The size of the impact of new technologies on turnover, performance or employment cannot be precisely determined even for known companies that utilise nanotechnology. In a number of companies using nanotechnology the turnover developed fairly well in the beginning of the 2010s. The most recent results from 2013–2014 show slight turbulence in business activities, which mainly reflects the situation in the global economy. Some bankruptcies have also been experienced (e.g. Epicrystals Oy), which is a natural part of business realism.

One of the success stories of recent years is the laser device manufacturer Modulight Oy, which recently signed a major agreement for the US health technology market. A spin-off company of the ORC, Modulight has operated in the market already for some time, beginning in 2000. Another example of success is the fibre laser company Corelase, which has endogenously succeeded in growing its business to become a medium-sized company.

Among the first challenges of a new company is finding a sustainable sector towards which it can direct its efforts. Nanotechnology companies operate in a very deep and narrow area of expertise, which on the other hand has extensive potential for utilisation in various materials and sectors. For example, the challenge of a business engaged in producing a new material is finding end users: already at the idea stage, the company must have information based on a needs assessment on whom the product or technology under development can be sold to. There are rarely any competing businesses with a completely equivalent focus. Various issues related to commercial

autonomy must nevertheless be taken into account when establishing a business. The creation of business in nanotechnology and new materials is also complicated by lengthy and demanding product development, which is not easily synchronised with marketing and the conception of time prevalent in business. There is always a sense of urgency in the market, but it requires long-term work to launch and further develop a product.

## 1.3 Scientific research potential

The research institutes, universities and other HEIs are active co-operational partners for the advanced manufacturing industry in the region. Developing new materials based on nanotechnology requires considerable capacity from both the scientist and the equipment. Without a functional cooperation interface between businesses and research institutions, it would be easy for key enabling technologies such as nanotechnology, to remain unused by industry. This would reduce the region's ability to specialise. In global competition in a renewing industry, it is essential to adopt the latest research data and innovations. Conversely, the financial investments of the businesses support research work in both basic research and development projects customised to the requirements of private actors. As regards KETs, RDI activities are anchored to the existing business structure to which the new specialised technology brings growth potential. Cutting-edge research in a sector requiring deep expertise can also awaken global interest towards the businesses that utilise it.

The Tampere region and Central Finland are the main regions in West Finland involved in research and innovation activities in order to produce new materials using nanotechnology. The strategic areas of focus in the Tampere University of Technology are industrial competitiveness, the digital operating environment, health technology and energy- and eco-efficiency. Nanotechnology cross-cuts all of these. Strong cooperation with businesses is reflected in a top ranking on the Times Higher Education list: The TUT ranks 11th (2015) in joint publications with businesses. The leading fields of research at the TUT include signal processing, optics and photonics, intelligent machines, biomodelling and the built environment. Teaching and research are divided between four faculties. The Optoelectronics Research Centre (ORC), which focuses on nanotechnology, is in the Faculty of Natural Sciences, while the Department of Materials Science is in the Faculty of Engineering Sciences.[2]

The ORC is the leading nanophotonics research centre in Finland. Its main focus areas are nanotechnology and ultrafast and intense optics. The nanotechnology research area includes a comprehensive chain of research activities from synthesis of semiconductor heterostructures by molecular beam epitaxy (MBE) and structural investigations of semiconductor materials to studies of surfaces and interfaces. It also covers processing of optoelectronics devices and nanolithography, as well as specific activities for device characterisation. The Surface Science Laboratory was incorporated into the ORC in 2011 for the purpose of supporting interdisciplinary research. The ORC employs approximately 70 people and produces more than 150 scientific publications, business services and courses every year.[3]

The strategic key sectors of the Department of Materials Science include hybrid materials and polymeric nanocomposites, functional ceramic surfaces, advanced engineering coatings and advanced fibre materials. The department is involved in two joint units: the Thermal Spray Center Finland and the Laser Application Laboratory. The Tampere Wear Center, which concentrates on wear-related phenomena in materials, also operates within the Department. The Center has a total of some 110 research staff. It collaborates closely with, BioMediTech and the Finnish Metals and Engineering Competence Cluster (FIMECC), among others.

[2] See: http://www.tut.fi/en/research/index.htm

[3] See: http://www.tut.fi/en/about-tut/departments/optoelectronics-research-centre/index.htm

BioMediTech is a joint institution of the University of Tampere and the TUT. Its main areas of research are in the fields of cell and molecular biology, biomaterials, biosensors, genetics, biomedical engineering and regenerative medicine. Leading-edge research in the fields of bio- and nanotechnology collaborates among other things in growing replacement tissues. Here the research operates in the material interface on the nanoscopic scale. The production of commercial applications generated from leading-edge research is a key goal at BioMediTech. It "aims to nurture innovation and commercialisation of research results via an active patenting policy, by providing expert advice to its scientists on the innovation potential of their discoveries, and by fostering spin-offs. During the last ten years research groups have produced nearly 100 patents and over 10 commercial spin-offs."[4]

The Nanoscience Center operating at the University of Jyväskylä in Central Finland is a cross-disciplinary research centre shared by the departments of physics, chemistry and biological and environmental science. The Nanoscience Center has succeeded internationally in the fields of computational metal nanoparticles, supramolecular synthetics and structural chemistry. Focus areas in its research also include the dynamics of chemical and biological nanoscale processes and the electromagnetic and thermodynamic properties of customised nanostructures. Also cross-disciplinary research is conducted on the properties of carbon nanotubes, cells and viruses as well as on materials in tomographic X-ray imaging on the nanoscopic scale. Research is carried out in approximately 30 teams by 16 professors, 20 post-doctoral researchers and 70 post-graduate students. The Nanoscience Center also coordinates the National Doctoral Programme in Nanosciences (NGS-NANO). An international Master's Programme in nanosciences has been running for ten years.[5]

In addition, the Satakunta University of Applied Sciences conducts research in photonics and robotics and provides training in advanced manufacturing. Applications include, among others, machine vision systems for product identification, measuring and sorting; spectral imaging research in material identification; colour verification and sorting of substances; near infrared imaging research for moisture detection; and thermal imaging research in welding and casting processes.

## 1.4 Role of intermediary institutions

The most typical forms of intermediary organisations in Finland are technology and innovation centres, development companies formed by one or more municipalities, business hatcheries and hubs, business cooperation between universities and universities of applied sciences and other comparable business service organisations, some of which are multidisciplinary and some more specific. Intermediary organisations promote the awareness of businesses regarding the most recent research results, support academic expertise and business networks, promote their target area to national and international funders and investors and provide various support services for people intending to become entrepreneurs or aiming at growth entrepreneurship.

In Finland, intermediary organisations have been important actors in implementing national development programmes such as the recent Centre of Expertise Programme (OSKE). Changes in programme instruments have affected the activities of the organisations operating them. For example, Jyväskylä Innovation Oy and Culminatum Oy had been implementing the OSKE programme in nanotechnology but were wound down when the programme ended at the end of 2013. Subsequently, a business incubator titled the Jyväskylä Business and Innovation Factory has been established. Intermediary organisations whose funding basis was not exclusively based on OSKE activities survived by changing their areas of focus when the programme ended. For

[4] See: http://www.biomeditech.fi/

[5] See: https://www.jyu.fi/science/muut_yksikot/nsc/en

instance, in the Tampere region Hermia Oy (numerous clusters in OSKE, including nanotechnology) and FinnMedi Oy (HealthBIO and the cluster of Well-being) still operate today as business and innovation service providers and intermediaries. Among other things, FinnMedi Oy participates in the Innovative Cities programme which followed OSKE and in a number of life science projects. During the change of focus, Hermia Oy changed its name to New Factory Ltd (Innovaatio Oy Uusi Tehdas), which focuses on the provisions of services operating on innovation platforms. Nanotechnology no longer features as a particular focus area in the company's operations.

The cluster-based OSKE programme was followed by the Innovative Cities (INKA) programme, which is headed by the largest city regions, in practice through their Economic Development Agencies. The central city regions of all the regions in West Finland have been involved in INKA. The INKA programme will be short-lived (2014–2017), as it has already been decided to end it. Any new development instrument based on clusters or competence areas has not yet been proposed to replace it.

The Strategic Centres for Science, Technology and Innovation (SHOKs) have provided cooperation networks for innovation-oriented businesses and leading-edge research. The activities of each SHOK are the responsibility of a non-profit limited company whose members are key companies, universities and research institutions. As in the case of INKA, Tekes funding for SHOKs is about to end. In West Finland, a key SHOK has been FIMECC. Within its programmes, lighter and more durable materials have been created (such as DEMAPP, HYBRIDS and LIGHT: Breakthrough Materials). Nanotechnology also has a close interface with CLEEN-SHOK (the Cluster for Energy and Environment). It has been reported that over 40 research organisations and 700 companies, accounting for a total of 80 per cent of Finland's export business, have participated in SHOKs (SHOK, 2014).

An operating model for innovation platforms has emerged as a new intermediary form for interfaces. It offers an easy-to-adopt co-creation opportunity for businesses and experts with various backgrounds. Unlike in organisation- or cluster-oriented RDI activities, platform thinking in innovation activities is seen to be realised most fruitfully by colliding different modes of thinking, pieces of background expertise and needs. In particular, the Tampere region is among the pioneer areas in the development of innovation platforms. For example, New Factory includes Demola Tampere, which facilitates innovative cooperation projects of students and companies as well as start-up activities that support new entrepreneurship. An example of a campus arena innovation platform, Kampusareena, is presented in chapter 1.4.

National actors providing funding, innovation services and networking, such as Tekes and Team Finland, can also be regarded as intermediary organisations. In addition to Tekes and the ELY Centres, the Team Finland service model which aims to internationalise businesses, is also implemented by Finpro, Finnvera and local public and private partners.

## 1.5 Developing skills for the future

Universities, other HEIs and research institutions provide high-level education and expertise and are co-operative partners for the industry in the region. In West Finland, employment in high and medium high-technology manufacturing is exceptionally high compared with both the national and the European average: seven per cent of the population in employment are employed in occupations requiring demanding technical expertise (2014: Finland, 5.1%; EU28, 5.7%) (Eurostat, 2015). However, in West Finland, the proportion of persons with tertiary education is slightly lower than average. The situation means that there is greater than average pressure in the region to produce and renew a well-educated labour force, especially in industrial sectors requiring high technological competence.

Pressure regarding competence requirements is also deepened by the ongoing structural shift in demographics and the economy: the size of young age cohorts is

decreasing, the number of people retiring is growing and the traditionally profitable export industry is in trouble. The regions are endeavouring to identify future educational and competence needs, among other things by means of future foresight processes and smart specialisation.

The sectors with competence needs and the educational level of employees vary markedly in the regions of West Finland. As regards development of new materials using nanotechnology, the business, education and research activities are concentrated fairly strongly in the previously mentioned areas of the Tampere region and Central Finland. Pori, too, offers photonics-based polytechnic-level education and research, while Ostrobothnia and South Ostrobothnia have future potential in nanotechnology related to the energy industry. The proportion of the population with university-level education varies from 30.2 per cent in the Tampere region to 23.5 per cent in South Ostrobothnia (Statistics Finland, 2015). The universities in West Finland (the Universities of Tampere, Jyväskylä and Vaasa and the Tampere University of Technology) have a total of 42,300 students. Satakunta and South Ostrobothnia have university centres comprised of branch units of universities. There are almost 35,000 students at the 11 universities of applied sciences in the area.

The shrinking of the financial basis for the universities has led to profiling and closer mutual networking and also to entirely new structural solutions. In the spring of 2015, the Academy of Finland opened a call for projects aimed at strengthening the profiles of the universities. The majority of applications aimed at multidisciplinary actions. The application procedure for the four-year funding will henceforth be arranged annually.[6] In addition, an interesting case from the perspective of the educational structures of the whole country is Tampere3, in which the local universities and the university of applied sciences in Tampere are preparing the establishment of a new university with a joint structure that differs from the traditional dual model.

In nanotechnology fields requiring a high level of technological competence, the creation of expertise is a long-term process. Experts are usually familiarised with their job by the employer organisation itself. The problem is that if an expert leaves, for example to relocate from a research institution to industry, a replacement employee may not immediately be available. Research institutions should endeavour to retain student talent through projects during the first years of study. In particular, industry attracts process engineers and employees of the “hands-on” type.

The international aspect is in many ways important when discussing highly specialised areas of expertise. Promotion of internationalisation has been identified in more or less all the official strategy documents of HEIs and research institutions. A remote country like Finland must work actively to persuade international talent to study and work in the area. This is possible through successful specialisation and marketing the country’s cutting-edge strengths. Moreover, linking to international networks can facilitate the sharing of equipment and infrastructure. New materials-related RDI activities and preparation are expensive, and a small country should not invest in equipment on a decentralised basis. It would be possible to expand shared use of expensive equipment by developing both national and international network models.

## 1.6 Major investment projects

The prolonged economic imbalance has negatively affected the desire to invest in both the private and public sectors. In West Finland, the situation is also hampered by the downfall of the technology industry, which has had a clear impact on the volume of private sector investments. Nokia and its subcontractor companies were significant users of RDI investments in the region before the decline of the mobile phone sector. The Tampere region and Central Finland have particularly suffered from the structural

[6] See: http://www.aka.fi/en/about-us/media/press-releases/2015/academy-of-finland-grants-funding-to-strengthen-university-research-profiles/

change in the technology industry. In this context too, there are high expectations for the reform of industry and advanced manufacturing in the regions.

The structural reform of industry is being supported by the fact that the regions offer a highly educated workforce, which has attracted centres of product development and expertise to invest in and locate to West Finland. For example, the production and test base for Cargotec's largest container terminal in the world was located in Tampere a couple of years ago.[7] The reasons for the decision to locate there are almost always stated to be the good availability of a skilled workforce, efficient logistical connections and more reasonable labour and office costs than in the Helsinki metropolitan area.

In the production of new materials using nanotechnology, the most significant investment needs are targeted at the equipment stock and clean facilities required for research and manufacturing, among other things. Equipment and facilities must be cutting-edge in order to achieve innovative research and product development results. For example, TUT has just acquired a brand-new clean room at a cost of €4 million, and is planning a €3 million investment programme for the next three years. The condition and measurement chamber at Jyväskylä's Nanoscience Center were revamped a few years ago. Modern working equipment serves as a calling card and is emphasised on research institutes' websites.[8]

With regard to investments in advanced manufacturing, Ostrobothnia is building a new energy research and development unit with shared laboratories, Satakunta is developing a research and product development environment for smart clothing technology and South Ostrobothnia is studying future training factory concepts. 3D printing that increases material is one of West Finland's key areas of investment and there are new initiatives for it on several levels.

Despite the challenging economic situation, the region's institutes of higher education are continuing to invest strongly in shared facilities for companies and research organisations such as Kampusareena presented in chapter 1.9. One of the most recent initiatives is the new Smart Machines and Manufacturing Competence Center (SMACC) announced by VTT Technical Research Centre of Finland and TUT, which is located in Kampusareena. This centre is a manifestation of the deepening partnership between the parties, which is described as being Finland's most significant alliance between manufacturing and material technology research specialists to date.[9]

BioMediTech's cross-disciplinary life science centre is a joint institute of the two research universities located in Tampere. BioMediTech is situated in the immediate vicinity of the University Hospital and University of Applied Sciences. The research institute is developing many branches of biosciences and medical technology including human spare parts. With the aid of tissue technology, it is possible to produce living spare parts tailored to people. This method has the potential to emerge as the third mode of treatment alongside traditional surgery and pharmacotherapy. Expectations in terms of exports are high in the life science and medical technology industries, and BioMediTech has attracted significant investments. Funding decisions worth millions of euros by Tekes, the Academy of Finland and the EU Structural Fund have been directed at human spare parts and the creation of BioMediTech's operating models. Such funding has created a unique scientific community even on an international scale. In addition to human spare parts, other BioMediTech research programmes

[7] See: http://verkkolehti.pirkanmaa.fi/fi/maailman-satama-automaation-keskus-tuli-tampereelle

[8] See: https://www.jyu.fi/science/muut_yksikot/nsc/en/facilities and http://www.tut.fi/en/about-tut/departments/optoelectronics-research-centre/services-for-business/index.htm

[9] See: http://www.tut.fi/fi/tietoa-yliopistosta/uutiset-ja-tapahtumat/alykkaiden-koneiden-ja-valmistuksen-osaamiskeskittyma-avasi-ovensa-kampusareenassa-x147446c2

include FinMIT (Mitochondrial disease and ageing) and the Prostate Cancer Research Center.[10]

With regard to the development of cleantech, an interesting initiative is underway in the Tampere region. In the Kolmenkulma Eco Industrial Park (ECO3), a diverse cleantech business zone in a business park is being created. Kolmenkulma ECO3 is situated on the border between three towns. This industrial-scale bio- and circular economy park serves as a pilot- and demonstration environment for new technologies in relevant fields. The new-generation infrastructure entity has been created in private-public partnerships. Anchor companies investing about €50 million have already been confirmed for the park.

Some examples of nanotechnology related research projects in the departments of Tampere University of Technology[11]:

- Hybrid organic-inorganic nanostructures for solar cell (Chemistry and Bioengineering. Financer: Academy of Finland, 2013- 2017.);
- PhotonicQCA – Photonically addressed zero current logic through nano-assembly of functionalised nanoparticles to quantum dot cellular automata (Chemistry and Bioengineering. Academy of Finland, 2012-2016.);
- Visible-Light Active Metal Oxide Nano-catalysts for Sustainable Solar Hydrogen Production – SOLAROGENIX (Chemistry and Bioengineering. EU FP7, 2013–2016.);
- Biofunc – Biofunctionalisation of stainless steel surfaces using novel electrospray mediated supersonic molecular beam deposition technique (ORC. Academy of Finland, 2011–2015.);
- Nanostructured Efficient White LEDs based on short-period superlattices and quantum dots (ORC. EU FP7 NEWLED, 2012–2016.);
- Fast mineral analytics of rear-earth elements using laser spectroscopy – LaseREE (Universities of Jyväskylä, Oulu and Tampere. Academy of Finland, 2014-2018.);
- The Finnish-Estonian Beamline for Materials Science (FinEstBeaMS) Phase II - MAX-IV Infrastructure Contribution (FIRI project) (ORC. Academy of Finland, 2014–2015.);
- Multifunctional thin coatings (Hybrid Materials Programme, HYBRIDS FIMECC) (ORC. Tekes, 2014–2018.);
- Programmable multi-wavelength Mid-IR source for gas sensing – MIREGAS (ORC. EU Horizon 2020, 2015-2017.);
- RANDFIELDS – Random fibre lasers for telecommunications and distributed sensing (ORC. The project has six partners in the UK, Finland, Belgium, Russia and is coordinated by Aston University. Marie Curie.);
- Time dynamics and control in nanostructures for magnetic recording and energy applications – CRONOS (Physics. European Commission, 2012-2015.);
- Centre of Excellence in Computational Nanoscience – COMP (Physics. Funded for 2012-2017 by the Academy of Finland.); and
- BioRA - Biomedical Robotics and Applications (Automation Science and Engineering. European Commission, Marie Curie Action, 2014– 2017.).

[10] See: http://www.biomeditech.fi/research/

[11] See: http://www.tut.fi/en/research/research-projects/index.htm

The research groups of Nanoscience Center in the University of Jyväskylä (2015) related to nanostructures and new materials are:

- Synthetic and Structural Chemistry of Supramolecules and Nanomaterials;
- Supramolecular Chemistry; and
- Nanoparticles and supramolecular systems in catalysis.

Prior to the turn of the decade, nanotechnology was much more clearly the subject of programmed development work than it is now. In 2005, Tekes launched the FinNano programme. A year later, the Academy of Finland launched the similarly named FinNano research programme and then Ministry of Education the 'Nanoscience Spearheads in Finland' programme. In the years 2007 to 2013, the Nanotechnology Cluster Programme in OSKE focused on developing an interface between companies and research. Through Finnish development investments, the aim was to ensure that Finnish nanoscience and technology remained at an internationally interesting level.

According to the final assessment, Tekes' FinNano programme promoted international partnerships particularly with China and Russia, as well as the development of a national network between companies, universities and research institutes. Equipment acquisitions were made within the framework programme. FinNano invested greatly in nano materials. A large part of the commercial applications created were material-based, for example on a carbon nano tube, ALD (atomic layer deposition)-developed materials and graphene. Nanophotonics and nanocellulose for the forest industry were also developed within the framework of the programme. (Lämsä et al., 2011.) The Academy of Finland nanoscience research programme, FinNano, combined nano-scale research between the fields of chemistry, physics and the biosciences. It had common functions with the Tekes FinNano programme. The teams were selected on the basis that, through the support of basic research, it could be possible to achieve significant potential in terms of basic innovative research data, sustainable development and industrial competitiveness. The research programme included ten Finnish consortium projects between 2006 and 2010. Also under the FinNano umbrella were five internationally funded Finnish-European and Finnish-Russian projects. The Academy participated in the nanoscience ERA-NET & ERA-NET Plus projects (NanoSci-ERA, NanoSci-E+) funded by the EU's 6th and 7th framework research programmes.[12]

## 1.7 International cooperation

The integration of universities, other institutes of higher education and research institutes into international networks gives scientific communities the chance to form new kind of cooperative and research groups, optimise existing resources, develop new innovation models and find new business opportunities by joining network partners' business contacts and value chains. International cooperation is improving awareness of the top-class expertise in the region, thus attracting international talents and new business contacts. International cooperation is both expanding and deepening the opportunities for growth. It is opening up opportunities to achieve a critical mass, which is one of the core challenges of a small country, and on the other hand it is helping to target the right type of human capital from a limited supply.

For the above-mentioned reasons, international activity plays a key role at all institutes of higher education and research institutes in West Finland. Researchers are actively participating in international research projects, the funding of which is obtained in the face of stiff competition. For example, a total of 78 FP7 and 12 Horizon 2020 projects are underway at the Tampere University of Technology in 2015.[13] The ORC's research projects are being carried out, for example, within the framework of

[12] See: http://www.aka.fi/en/research-and-science-policy/academy-programmes/completed-programmes/baltic-sea-research-programme-bireme-2003-200511/

[13] See: http://www.tut.fi/en/research/research-partnerships/index.htm

European Cooperation in Science and Technology (COST) networks and other bilateral collaborations with industry and research groups in Europe, the USA and China.[14] European-external research funding is often channelled through the Academy of Finland.

The Finland Distinguished Professor Programme (FiDiPro) is a programme jointly funded by the Academy of Finland and Tekes for the temporary recruitment to Finland of top-class foreign researchers or professor-level Finnish researchers who have spent a long time abroad. The European Marie Curie Initial Training Networks (ITN) projects are targeted at researchers in the early stage of their career.

Regional organisations are promoting international partnerships, through which they can support regional development through funding, expertise and good practices. Regional councils are maintaining and creating relations with different EU bodies with representatives such as members of the Commission, Parliament and Committee of the Regions. Cooperative relations are particularly created with those European regions with which shared interests have been perceived. Networks concerned with innovation activity include the European Regions Research and Innovation Network (ERRIN; West Finland European Office and Tampere Region EU Office) and Smart Specialisation Platform (S3). The theme of nanotechnology is particularly emphasised in the Vanguard Initiative for New Growth through Smart Specialisation and the RIM Plus project. The Baltic region networks Interreg Baltic Sea Region and Interreg Central Baltic Programme are based on the Baltic region strategy. Political lobbying groups include the Assembly of European Regions (AER), Baltic Sea States Sub-regional Co-operation (BSSSC) and The Midnordic Region. The organisations are involved in the activity of European networks and bodies which support the aims of the region and through which it is possible to build and strengthen international cooperative relations. Joint European networks provide support for example when applying for the EU's direct funding mechanisms and programmes such as the Horizon2020 and Interreg programmes.

The Vanguard Initiative pilot action on Nanotechnology was initiated in spring 2015. It is co-led by Skåne, Sweden and the Tampere Region, Finland. The aim of the initiative actions is that "by pooling the area's resources and connecting regional strengths to create a strong European industrial fabric within nanotechnology, new value chains will emerge within the realms of innovative nanomaterials. This would require linking European R&D and laboratory infrastructure with different types of industries. The regions of the Vanguard Initiative are a unique base for this type of ambition."[15]

Bilateral signed cooperation agreements have shown a mutual desire to deepen networking. Generally speaking, this form of activity has declined in recent years and, instead of signed cooperative agreements between regions or cities, international networking has become increasingly thematic and based on functional networks and networks of people.

## 1.8 Policy support and delivery mechanisms

The key documents guiding the regional development work are the sub-regional (hereinafter: regional) strategies. These are NUTS 3-level policy documents composed in the sub-regions by the local regional councils. In Finland and West Finland, there is no NUTS 2-level formal political body or strategy between the national and sub-regional level.

The regional strategy is the common name for the regional plan and the regional strategic programme referred to in the Regional Development Act. It includes both

[14] See: http://www.tut.fi/en/about-tut/departments/optoelectronics-research-centre/research/index.htm

[15] See: http://www.s3vanguardinitiative.eu/cooperations/vanguard-initiative-pilot-action-nanotechnology

long-term development targets stretching to 2040 and a concretising programme of strategic actions and implementation for the period 2014–2017. The regional strategy and the regional strategic programme are political statements jointly approved by the sub-region. The operative time perspective has been reconciled with the EU programme period, which supports regional, national and EU-level political reconciliation. The contents of the Smart Specialisation Strategies have also been closely connected to the composition.

The regional vision emphasises the strengths of the sub-regions and the will to develop in national and international contexts. ”Bold… but suits you!” is the current strategy for the Tampere region (Council of Tampere Region, 2014). It is divided into four development entities: Smart, Well-balanced, Sustainable and Accessible Tampere region. The strategy emphasises scenario-based regional development outlining and a shared story based on strong choices, which justifies the region’s specialisations. It is felt that a smart and vital Tampere region will be created by the combining of different technologies, multidisciplinary operating practices and internationally attractive innovation environments. The funding of RDI functions will be selectively targeted at nationally and internationally distinctive top classes. Fields of top-level research in the Tampere region include smart machines, health and biotechnologies (such as spare parts for people), optics and photonics and signal processing. There is a desire to turn the structural change in the manufacturing industry in the direction of growth through advanced manufacturing.

The vision of Central Finland is to be “a skilled and healthy international region of the bio- and digital economies” in 2040 (Regional Council of Central Finland, 2014). Strategic emphases are placed on the region’s significant bio-economic resources and attempts to tackle future challenges, especially by the means presented by digitisation. In the Central Finland interpretation, the bioeconomy and the smart utilisation of bio-based resources also cover new technological solutions. Wood- and fibre-based materials are being developed innovatively and with an eye on export. Central Finland is home to a significant bioeconomic cluster, which was further strengthened in spring 2015 when Metsä Fibre announced a billion-euro investment decision to build a new plant for bioproducts.[16]

The development vision for Ostrobothnia has been encapsulated in the slogan “Ostrobothnia of new energy – energy from top-class expertise, multiculturalism and a strong community spirit”. The most significant energy cluster in the Nordic countries is evident in cluster priorities. Advanced manufacturing is particularly linked to energy technology solutions such as innovations aimed at introducing the use of renewable energy and at the promotion of low-carbon and energy- and material-efficient solutions. Instead of sector-specific priorities, attention is increasingly being focused on the development of technologies and networks that transcend sectors. In order to promote the objectives, Ostrobothnia is home to concrete top-level projects (2014–2017), including the New Energy Research and Development Unit with its shared laboratories (Vaasa Energy Institute, Palosaari Innotalo Laboratory Centre and Energy Lab development platform). (Regional Council of Ostrobothnia, 2014.)

The key sectors that characterise the business structure of South Ostrobothnia are the food industry and the broader agro-bioeconomy. The regional strategy is aptly called “Future Provisions for South Ostrobothnia” after the region’s special area of strength. It is particularly focusing on sustainable food systems and the new solutions of the bioeconomy (including the smart use of materials and raw materials in food systems, support for downstream product innovations and an increase in the degree of processing of forest raw materials) as well as smart and energy-efficient systems (product development the smart products and new materials, service business and cleantech). One developing form of product development in the top-level projects is

[16] See: http://bioproductmill.com/articles/metsa-group-to-build-next-generation-bioproduct-mill-in-aanekoski

the so-called 'quadruple helix' of deepening cooperation between users, companies, researchers and the public sector. Rarely for West Finland, the strategy is also drawing attention to ownership change between generations, a topical theme in the traditional Finnish field of business. South Ostrobothnia has more entrepreneurs than average. Start-up and growth entrepreneurship are also mentioned as areas in the development of business expertise. (Regional Council of South Ostrobothnia, 2014.)

The Satakunta regional plan is called the Satakunta Handbook for the Future 2035. Its development vision is encapsulated in the slogan "the good life in Satakunta 2035", the development themes of which are pure vitality, supportive community spirit and human-centred solutions. Renewable industry is mentioned as part of the development theme of Pure Vitality. Sectorally, also Satakunta highlights the bioeconomy (as in Central Finland) and energy (as in Ostrobothnia) as cutting-edge sectors in the industry and commerce. With regard to these sectors, Satakunta is endeavouring to support the creation of wind and solar power, bioenergy and new bioproducts and biotechnologies. Export growth is also sought in the fields of clean water and food and related technological expertise. The traditional industrial structure of the region is particularly characterised by the marine industry, the metal and chemical industries, engineering, energy production and the forest industry. Foreign trade is also very important to the region. (Regional Council of Satakunta, 2012.)

On a national and regional level, there are at present no specific development programmes for the nanotechnological development of new materials. Nanotechnology appeared in development instrument headlines before the turn of the decade, when FinNano programmes of Tekes and the Academy of Finland and the Nanotechnology Centre of Expertise (OSKE) were ongoing.

At present the theme of advanced manufacturing is being promoted in the Innovative Cities (INKA) programme, in which Tampere is responsible for running the themes of Smart City and Renewable Industry. INKA's themes of Sustainable Energy Solutions, Future Health and Bioeconomy are also possible areas for the application of nanotechnology and developing forces for new materials. INKA's funding is administered by Tekes. The annual funding of approximately €30 million is divided into three parts between the state, local government and the European Regional Development Fund. (Tekes, 2015.)

The aim of the INKA programme is to support the specialisation of urban regions in their own areas of expertise, and to strengthen cooperation between the state and urban regions nationally and internationally in the implementation of significant research, development and investment projects. The programme is targeting the creation of attractive clusters of innovation and platform-type urban development. In the urban regions of West Finland, energy, health and smart traffic development projects, among others, are being supported by INKA funding. So far at least, no funding for nanotechnology has been channelled through INKA.

External research funding is vitally important for institutes of higher education and research institutes. At universities, off-budget funding channels are the Academy of Finland, Tekes, ERDF and ESF funding, EU framework programme funding and other EU funding, private companies, funds and foundations, local government and municipal federations and ministries.[17] Institutes of higher education and research are networking and seeking out funding programmes based on their own strategic areas of emphasis. Universities are significant partners in discussion and in the preparation of both regional strategies and national policies.

The Strategic Centres for Science, Technology and Innovation (SHOK) have formed a platform for cooperation for innovative companies and top-level research. A not-for-

[17] See: https://vipunen.fi/fi-fi/_layouts/15/xlviewer.aspx?id=/fi-fi/Raportit/Yliopistojen%20ulkopuolinen%20tutkimusrahoitus%20-%20yliopisto.xlsb

profit limited company is responsible for the operations of each SHOK centre, the members of which include key companies, universities and research institutes in their own fields. The partners prepare a research strategy and decide upon its implementation. Also parties that are not partners may participate in research programmes and projects. Research work is done in a virtual organisation, which may comprise units that are geographically in different places. The national SHOKs are Cluster for Energy and Environment (CLEEN), Finnish Bioeconomy cluster (FIBIC), Metals and Engineering (FIMECC), Built Environment Innovations (RYM), Health and Well-being (SalWe) and Internet economy (DIGILE).[18]

Figure 1 Development themes in INKA programme (2014-2017)


Source: Tekes.

The institutional framework of Finland's and West Finland's innovation system and the development of key support measures are described in more detail in Chapter 2. The development and implementation of support measures in the area of new materials and nanotechnology are taking shape in dialogue between a broad group of stakeholders. National innovation policy guidelines are setting the main direction of development. Active institutes of higher education, research institutes and regional development organisations are providing input for a national picture and also linking up with international networks in their own fields of expertise.

## 1.9 Good practice case

This section presents four examples of good practice cases drawn from methods of working that have promoted the development of advanced manufacturing, new materials and nanotechnology in West Finland. The examples have proven novelty value and the ability to change the operating practices of an entire industrial sector or organisation. The good practice cases are: Nanotechnology and laser industry ecosystem development in Tampere region; Kampusareena, the University of

[18] See: http://www.tekes.fi/en/programmes-and-services/strategic-centres/

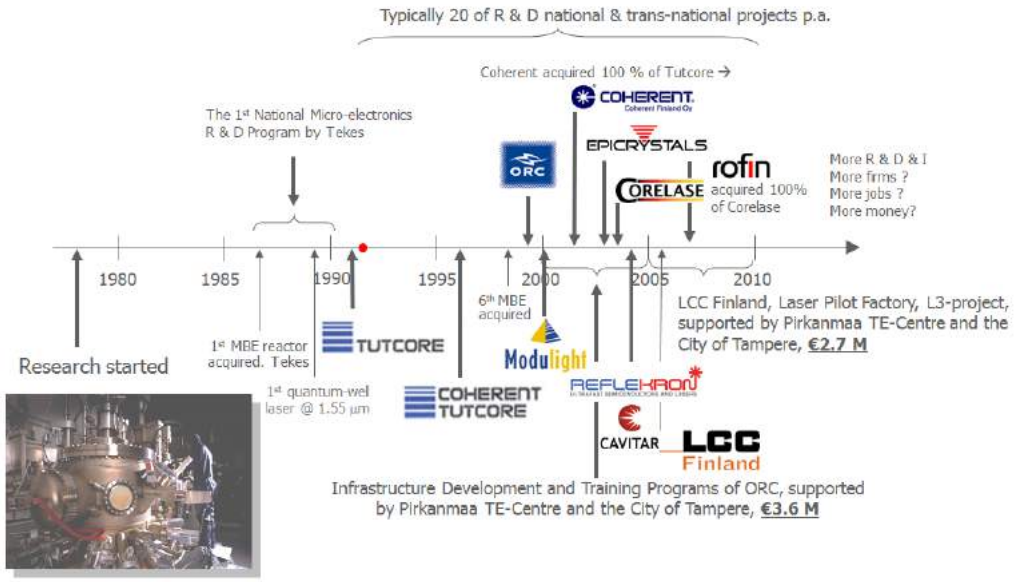
Technology's open innovation platform; South Ostrobothnian University Network (Epanet) as a multiactor network; and Nanotechnology Cluster Programme.

*Academic research turned into high tech industry: Nanotechnology (laser) industry ecosystem development in the Tampere Region*

High quality optics and optoelectronics research has created a totally new industry in the Tampere Region. An ecosystem of research and business activities based on a high level of expertise has developed through long-term cooperation between a university of technology, businesses, project funding and programmatic tools. Behind the story of development is a group of pioneers who have been in the right place at the right time when promoting a new discipline. A parent university encouraging commercialisation, business-oriented and innovative researchers and continued supporting seeds from all funding organisations have been essential for the success.

The long tradition of research activity in the field dates to the end of the 1970s. At that time, the thin-film research started at the TUT. This led to light-emitting diodes and semiconductor lasers long before anyone spoke of nanotechnology as a separate field of technology or science. The first research and development programmes on microelectronics at the national level began at the end of the 1980s, when the first clean room for processing semiconductor components was built in TUT. The development of semiconductor technology took a huge leap forward when the first MBE reactor was acquired with assistance from Tekes. The development of know-how in laser technology gave rise to the first spin-offs from the university in the 1990s, when Tutcore (later Coherent Finland) and Dekati were started. A cluster of start-ups emerged at the beginning of the 2000s when Modulight, Liekki, EpiCrystals, Corelase, RefleKron and Cavitar, among others, started business activities. One factor behind the commercialisation of research know-how was the start of the Optoelectornics Research Centre, ORC's operations in 2000. (Savolainen, 2015.)

Figure 2 Ecosystem development case in Tampere Region




Source: Optoelectronics Research Centre.

ORC at the TUT is the leading nanophotonics research centre in Finland. The surface science laboratory was incorporated in ORC in 2011 to support its multidisciplinary strengths. Among other things, the surface science laboratory specialises in improving the surface properties of metallic materials. It cooperates with actors such as FIMECC and BioMediTech. The other main research groups in ORC are in semiconductor technology, in ultrafast and intense optics and in nanophotonics. Research topics cover a broad spectrum ranging from basic research in the properties of new materials

to development work on new light sources and solar cells, and on to commercially applicable technologies. The most recent achievements of the research include an efficient yellow laser for artificial star applications and a high-efficiency multi-junction solar cell for space applications. The research institution operates at the interface of advanced manufacturing companies, producing innovations and expertise for their use.

ORC has produced an exceptionally large number of spin-offs, and it attracts a considerable portion of European research funding directed to the Tampere Region. Significant research funders include the EU and the European Space Agency (ESA). The accelerating of diode laser industry in Finland can be regarded as one of the merits of ORC. The companies established on the basis of the results of its research produce and develop diode and fibre lasers for purposes such as optical information transfer, laser welding, medical instruments and various nanoscale measuring devices. Nanophotonics is one of the TUT's five key areas of research, based for the most part on the ORC's activities. In 2008, the ORC won an Honourable Mention at the national InnoFinland contest for its work in commercialising optoelectronics based on compound semiconductor technology. According to an international evaluation report published in 2012 by the Academy of Finland, the ORC is "extremely well-organised and its research quality is outstandingly high". It employs approximately 70 people, and in terms of equipment it is one of the best academic research units in Finland. The value of the research equipment is more than €23m. Among other things, the equipment includes five commercial MBE reactors, surface analysis equipment and complete facilities for processing and characterising optoelectronic components. There are approximately 40 ongoing research projects, and they produce over 150 publications annually. In addition to research activities and various services for businesses, the ORC teaches courses on various aspects of optoelectronics and surface sciences, and a number of PhD and MSc degrees are completed there every year.

During its early years, the ORC received public financing to develop and establish its infrastructure from local actors, the city of Tampere, the Tampere Region TE Centre (nowadays ELY Centre) and Tekes. ERDF projects have supported the operations of the early years and the creation of networks. This is an excellent example of a long-term development process of an ecosystem, where a number of individual projects have contributed to a buoyant continuum.

As part of the national Centre of Expertise Programme in Nanotechnology, one of the achievements of Tampere's nanotechnology cluster is the foundation of the national Laser Competence Centre (LCC). LCC Finland, founded by Hermia and the ORC, functioned as a cooperation network between researchers, education organisations, equipment manufacturers and users during the period 2005–2011. It networked across a number of other national and international platforms (EPIC, IVAM, MINAM, AILU, Photonics21). The ORC's spin-offs formed the core of the network. The model was reproduced to create the national network of Photonics Finland, which brings together photonics research institutes and businesses on a national level. Photonics Finland is a project coordinated by the ORC that emerged after the Nanotechnology OSKE. As a result, the Finnish Optical Society became the business-driven network Photonics Finland, which is currently managed from Joensuu. It has around 300 members, of whom over 10 per cent are companies and organisation members.

Since the OSKEs, which were based on the internal development of clusters, the importance of multidisciplinary cooperation has increased. The trend is also visible in the field of nanotechnology, although the interdisciplinary application possibilities of nanotechnology have always been recognised very widely. New innovations are created with, for example, developers in life science (BioMediTech), the ICT sector, space materials and mechanical engineering. When different fields of research are made to collide, something entirely new often emerges. In this case, the expectations of commercialisation are seldom met as quickly or certainly as when predefined product development is aimed at. When successful, interdisciplinary cooperation between key research units creates highly innovative end results, and it is to this that the present nanotechnology ecosystem in the Tampere region aspires.

*Kampusareena: The University of Technology's open innovation platform*

Kampusareena is a shared innovation platform of companies, researchers and students in the middle of the campus area of Tampere University of Technology. Kampusareena is also architecturally and technologically of high-quality, but its strongest novelty value lies in its concepts: it combines the world's best benchmarked platform concepts supporting the shared use of company collaboration and research equipment, which is based on co-creation and agile cooperation. The aim has been to develop a completely new, expandable innovation campus concept, which also serves as a visiting card for the TUT campus area. The Technical Research Centre of Finland (VTT) and numerous high-tech companies are already located in the direct vicinity of it. The whole area includes about 2,000 workers and 10,000 students.

Of the space in Kampusareena, which opened in autumn 2015, 60% is for the use of functions administered by the university and 40% is leased for office and business use. Getting different functions and user groups into cross-disciplinary interaction is causing much-needed collisions promoting the creation of open innovations. Kampusareena's service models include Kampusklubi, redesigned services targeted at SMEs, an international office hotel network, the open TUTLab prototype workshop to be built on the campus, other test platforms and Demola open innovation platform activity.

For example, Kampusklubi is a community of 50 businesses specialising in product development and representing different sectors. Kampusklubi's earning model is to sell club memberships to companies at a monthly price. In order to manage the activities, TUT provides innovation workshops for members and organises monthly networking events. Among the first companies to locate themselves at Kampusklubi are Nokia Oyj, Cargotec Finland Oy, Valmet Automation Oy and Optofidelity Oy. A part of the key industrial companies have participated in developing the concept.

One of the first companies to locate to the office facilities in Kampusareena is Nanofoot Finland Oy, which manufactures automated laser diode measuring systems for different quality monitoring systems. The entire production is exported. The company was founded as a TUT spin-off in 2006 and currently employs also basic degree students at TUT. Locating to Kampusareena makes possible the flexible availability of employees and research expertise from different departments.[19]

Kampusareena is a strategic investment for TUT, and the university is committed to investing in cooperation with companies that have concluded a club agreement. In a spirit of mutual cooperation, only companies that are committed to making genuine efforts to cooperate with the science community and students of the University of Technology are selected for introduction into the Kampusareena community. Top-class laboratories, the expertise of international research groups as well as business support services are then immediately at hand. By cooperating, companies can share costs and risks and, through connection with the university, make contact with new developing specialists.

For work more short-term than Kampusklubi, an entrepreneur may, for example, invest in the services of an international office hotel network. Membership also provides access to other locations part of the network all over the world. TUTLab, for its part, is a concept that opens up TUT's laboratory services to increasingly flexibly be at the disposal of companies and the internal users of the university. In addition to opening up the stock of equipment, material library services are also being connected to the service. TUTLab will open in early 2016. (Raunio et al., 2015.)

In late 2015, the Smart Machines and Manufacturing Competence Centre (SMACC), opened at Kampusareena. VTT and TUT have agreed on a broad strategic partnership, which can be described as Finland's most significant alliance to date between research

[19] See: http://www.kampusareena.fi/tampere/yritykset/nanofoot-finland-oy/

parties in the field of manufacturing and material technology. SMACC is expected to strengthen the future of the Finnish manufacturing industry, by offering fast solutions (SmaccACUTA Clinic) especially for the use of SMEs and high-level research expertise on a one-stop-shop principle.[20]

*Epanet, a multi-actor network to support knowledge-base of a region that does not have its own university*

Epanet, the Research and Innovation Programme of South Ostrobothnia, aims to develop a new kind of research culture and co-operation between universities, research institutes, enterprises and local organisations. The focus of activities is on the science based research and development work with private firms and public service producers, enhancing of the further university-level studies in region and popularisation of the research results. University Network Epanet has revealed to be an organisational innovation in contemporary academic world. It enlarges R&D functions in a region that has no traditional university by establishing a network of applied research work in the region, activating innovation culture by more challenging research projects and allowing the local community of researchers and development agents to enlarge their functions.

The first programme agreement on Epanet was signed in spring 2001 by five universities (University of Helsinki, Sibelius Academy, University of Tampere, Tampere University of Technology, University of Vaasa), Seinäjoki University of Applied Sciences (then Polytechnic), Regional Council of South Ostrobothnia, Employment and Economic Development Centre of South Ostrobothnia, South Ostrobothnia Health Care District, City of Seinäjoki, Provincial Government of West Finland and University Association of South Ostrobothnia. At the starting phases of the work structural funds of the European Union (ERDF and ESF) had decisive role in assuring the resource base. At the beginning of 2004 University Consortium of Seinäjoki was founded to strengthen the co-operation of the universities and to plan new level of university services in research, development and education. In summer 2005 also University of Turku started their first professorship in Seinäjoki. The second programme agreement was signed in 2008. The new signatories that joined in the programme were University of Turku, Foodwest Ltd and Seinäjoki Technology Centre. The signatories represent unique partnership between regional authorities and national academic organisations. The agreement expresses common will of signatories in order to create serious development and research work in the region.

Original goal of Epanet was to found 12 new research groups or professorships. The areas of research were selected in order to best contribute the regional development of South Ostrobothnia. The emphasis was laid in the applied research and development work and in the expanding branches of the region. Nationally new, interdisciplinary, applied subjects were preferred. Finally, five categories of research were chosen: material technology, information technology, economics and business administration, food industry and welfare. Nowadays the core of the network consists of over 20 new, fixed-term research professors (5 years at the first phase), each of whom gathers a group of 3–5 researchers. The teams form a new kind of research community combining several disciplines and universities. Their social and professional networks reach the entire Finnish and international scientific world through the partners.

In university–industry interaction new modes of interaction is needed. Especially there is demand for concepts that are at strategic level, represents ambitiousness and are also available to small and medium size firms. Nowadays only minor group of private firms exploit scientific research in strategic development of business. In global division of labour western economies need more knowledge- and quality oriented development paths. Also public services have faced new demand of ever higher level of

[20] See: http://www.tut.fi/fi/tietoa-yliopistosta/uutiset-ja-tapahtumat/alykkaiden-koneiden-ja-valmistuksen-osaamiskeskittyma-avasi-ovensa-kampusareenassa-x147446c2

quality in services and at the same time limits in financial resources. Rethinking and wider international knowledge is needed. Challenge for new policy is bigger outside of the metropolitan regions like in semi-rural and rural communities.

Bottom-up policy is possible and rewarding also in development of higher education services. By networking strategy scattered resources can be combined and new level of innovation policy realised. Well prepared and co-operative policy can create enthusiastic atmosphere that cause numerous consequential positive effects. There is need for innovative, flexible and demand-based university level services to ensure the resilience of the regional economies. (Alarinta and Kolehmainen, 2015.)

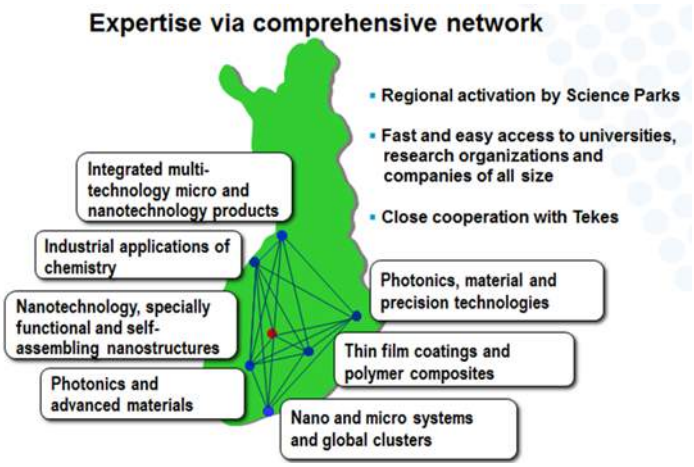
*Nanotechnology Cluster Programme in The Centre of Expertise Programme (OSKE)*

The Finnish Centre of Expertise Programme (OSKE) was a temporary special Government programme, which directed activities at nationally important fields of focus. The idea behind the programme was to promote the utilisation of internationally top level expertise based on regional strengths. OSKE was carried out as during three programme periods over a total of 20 years (1994–1998, 1999–2006 and 2007–2013). In the final period, cluster-based cooperation was developed in 13 different areas of focus. The nanotechnology cluster programme was one containing specialised themes of nano- and micro-systems and future materials. (OSKE, 2013.)

At the start of the programme, the focus was on identifying the strengths of areas and on deepening development work between the public sector, companies, institutes of higher education and research institutes. The city regions of Tampere, Vaasa and Jyväskylä participated in the programme from the outset, and later on the centres of expertise from Seinäjoki and Satakunta also joined. It is estimated that the programme disseminated a significant amount of innovation, and brought benefits particularly to small- and medium-sized companies in the urban regions. It is considered successful that it was possible to network expertise spread all over Finland and to initiate innovation cooperation between urban regions.

OSKE's nanotechnology cluster was divided into almost 20 micro-clusters, localising the focuses of expertise of different cities. Expertise was identified in the themes of Aerosols, Surfaces and Coatings, Photonics, Printed Intelligence, Applications in Built Environments, Chemical Industry, Electronics, Forest Industry, Machinery, Marine Industry and Metrology, Nanoparticles, Green Nano, Clean Nano, Human Nano, Lean Nano and Safe Nano (Viinikka, 2013). The nanotechnology cluster was coordinated by Jyväskylä Innovation Oy and Culminatum Oy under contract to the Ministry of Trade of Industry (currently Ministry of Employment and the Economy). Tekes also acted as a close cooperative partner. Regional activation was led by local science parks.

Figure 3 Network of the Nanotechnology Cluster in OSKE 2007-2013




Source: Peltonen E. (2007)

OSKE has been described as a pioneer in smart specialisation that created new ways of starting development projects and programmes as cooperation between different organisations. Experimentation with new funding models enabled fast reaction in changing market situations. Decision-making and administration that took place in the programme was adapted to correspond to the expectations of the business community, which promoted the commitment of companies to the strategic goals. The operating method proved to be effective, and some of the projects were established as permanent fixtures. Over 250 development projects, 36 new companies and 126 new jobs were born in the Nanotechnology Cluster Programme in 2007-2013.

OSKE was a Finnish social innovation, which proved widely interesting and also served as a benchmark in the start-up of the EU's regional smart specialisation strategy. What was particularly pioneering was that the focus was on strengthening already strong clusters of expertise, instead of solving the problems of the weaker areas. The programme was also an effective channel for directing structural funds. For the Finnish innovation system, OSKE created good practices and brought together skills-based networks especially between the worlds of research and business. In general, people were quite satisfied with the results. But from a point of view of innovation policy, it was felt that there is a need to move on from cluster-based programmes. From the "cluster stretch", it was moved towards support for the demand- and user-centred innovations of cities (INKA) and the promotion of multidisciplinary RDI environments. (Joensuun tiedepuisto, 2015.)

During OSKE, technological skills in the fields of nanotechnology matured and scientific research was commercialised. Good cooperation and cross-cutting with other centre of expertise themes were also considered successes for the nanotechnology field of OSKE. Cross-disciplinarity is still being highlighted in the development tools that have succeeded OSKE. During the programme, association-based operating models and cooperative networks were created, and they can still be exploited, for example when seeking research funding and forming consortia.

## 1.10 Leveraging the existing potential

The main observations about the challenges to and potential of revamping the industry of West Finland and utilising new materials in the field of nanotechnology:

- **Challenge 1: Declining private and public RDI expenditure**

Owing to the prevailing economic situation, the industrial manufacturing sectors in West Finland are struggling. The prolonged deterioration of economic conditions for business has inevitably also affected the level of private-sector RDI investments. On a national level, investments targeted at research, product development and innovation have returned to the level preceding the financial crisis, but the situation in West Finland is more difficult than the average. The weakest situation is in regions such as the Tampere region and Central Finland that are weighted towards the electronics industry and its subcontractors, where recovery from the structural change caused by Nokia is still incomplete. Nokia's RDI investments were once very considerable in West Finland.

Public research and product development resources can no longer revive the situation. Financial reserves have contracted in structural funds allocated to West Finland, in national Tekes funding and in basic funding for institutes of higher education. On the other hand, it is noticeable that institutes of higher education have strong motivation to develop cooperation with business life, which is evident as significant investments such as Kampusareena and SMACC, and they are also changing their own structural existence owing to strategic needs (e.g. Tampere3).

Connected to the challenges in the funding of new materials and nanotechnology is the fact that nanotechnology is no longer very visible in the keywords of public innovation policy programmes. In addition, national innovation funding has been criticised for discontinuity and sudden shifts in programme policy. The reduction in national public

funding reserves is increasing the tendency to seek out international, especially European, funding.

- **Challenge 2: The commercialisation of top-level research and business activity**

The generation of business from science is a common challenge for all research institutes and universities. West Finland has good examples of the commercialisation of top-level research in the field of nanotechnology, the creation of wholly new industrial sectors based on it and of spin-offs, but the above-mentioned reduction in RDI funding is challenging research institutes to improve their commercialisation activities.

According to experts, there is good entrepreneurial spirit in the scientific activity of West Finland, which stems from a genuine desire to commercialise business ideas based on the latest research results and product development. Research institutes and institutes of higher education are encouraging researchers to refine their expertise into new business and, for example, to establish start-up companies. A great many nanotechnology spin-offs have been created at the Optoelectronic Research Centre (ORC) at Tampere University of Technology.

So far people have felt that early funding for new companies has been reasonably easy to obtain. Tekes, for example, has offered financial instruments to safeguard first-year operations. In this regard the situation might, however, weaken, if the provision of financial support becomes more loan-based. The threat is that this might reduce the number of people considering entrepreneurship, and thereby reduce new business activity.

Establishing a company is seen as considerably easier than accelerating its growth after start-up. The growth stage has been identified as a critical point for new nanotechnology businesses. A critical stage is when the basic vital functions of a company have been established, and the micro or small business should then enter into international competition. This means either a need for aggressive expansion or selling the IP to another larger company, for example. West Finnish nanotechnology start-ups have found good buyers, which is a testament to the effectiveness of well-tested business ideas and the high technological level of start-up companies in the region. On the other hand, however, expansive growth sought on international markets as an independent company has been more difficult to achieve.

- **Challenge 3: Fragmentation of skills and equipment resources**

Innovation work in the fields of nanotechnology requires plenty of time and an expensive equipment infrastructure applicable to special needs. The progress of technology within the sector requires regular investments in equipment, which are not necessarily profitable or even possible to make in a decentralised manner in a small country. The possible solutions to this challenge could be the centralisation of top-level skills or strengthening the cooperative networks nationally and internationally. Bearing in mind scarce research and development resources, both proposals are current topics for discussion.

The opportunities of new fields of application, interdisciplinary research cooperation and open innovation are seen as the key accelerators of future potential:

- **Cross-disciplinary application of different fields of research**

Nanotechnology is an example of a cross-cutting key enabling technology, whose fields of application are almost limitless. West Finland's traditional manufacturing sectors include the rubber and plastics industry, chemicals, food and the manufacture of electrical equipment. They have succeeded in increasing their turnover even during the most recent recession. The potential to utilise new technologies rests, on the one hand, in the abilities of these basic industries to modernise and, on the other hand, on completely new fields of application, whose success cannot be fully predicted. For example, human spare parts, tissue materials and surface materials related to the

gathering of renewable energy are fields of application creating great expectations. For them, nanotechnology offers completely new development potential. The innovation expectations are high when two top-level fields with high presuppositions meet.

The basic problem of innovation policy is that innovation is a somewhat unpredictable added value that cannot necessarily be promoted through focus points precisely defined for funding programmes. Flexibility provided for the areas in funding allocation, multidisciplinarity and platform-based solutions can help in this. Dialogue between regional triple-helix actors is important for different sectors to work together, see each other's needs and clarify messages to be shared with other networks.

- **International networking**

International networking is often more fruitful than trying to achieve a domestic critical mass. In high-technology fields, international networking is usually a basic prerequisite, as the RDI clusters are globally relatively few in number, the supply of top-class experts limited and market potential is basically international. Networking also increases international investors' and financiers' awareness of local operations.

Interesting network projects aimed at deepening cooperation in European advanced manufacturing include the Vanguard Initiative for New Growth through Smart Specialisation and RIM Plus in which, by developing a shared database, actors seeking partnerships, positions in value chains and opportunities for the creation of new business in different areas can be located. International cooperation in the added-value manufacturing industry is supporting, for example, the objectives of the Horizon 2020 framework programme and internationalisation strategies set by regions.

- **Increasing company cooperation and business potential through opening up**

Innovation-oriented advanced manufacturing requires opening up organisation-centred activity externally towards networks and agile operating models. In practice, this means increasing scientific research and cooperation with the private sector and deepening networks between developers locally, nationally and internationally. Interfaces can be opened up by different networking initiatives and the active participation of the regions in them, mutual agreements or by taking advantage of multi-organisational development platforms.

In Finland, a noteworthy paradigm shift from traditional agent organisation-centred operating models to platform-based mechanisms has been discernible. In this development, the Tampere region in particular has been a pioneer. Open innovation platforms are based on shared creation by teams from multiple backgrounds, controlled interactive models and a culture of experimentation. The scarcity of organisations' own research and development resources has created a need for cheaper and more agile innovation processes enabled by the platforms. A significant part of the regions' innovation ecosystems has come from open innovation platforms. In recent years, platform-based co-creation has proliferated particularly in campus areas.

Different subcontractor chains are a fundamental part of traditional industrial manufacturing. The introduction of advanced manufacturing and new technologies affects the roles of subcontractors and thereby the entire industrial value chains. Rather than 'subcontractors', business partnerships based on new technologies could be better described as, say, interactive suppliers or network suppliers. New technologies bring new actors to industrial value chains, with whom the business relationship is often clearly more active than in traditional subcontractor chains.

# 2. Regional Innovation Performance Trends, Governance and Instruments

## 2.1 Recent trends in innovation performance and identified challenges

According to the Regional Innovation Scoreboard 2014, West Finland is one of Europe's leaders in innovation. The report, published for the sixth time, offers comparison information based on data about the performance of European regions with regard to innovation. In recent reporting years, West Finland has maintained the same leading position. Only Switzerland, Denmark and Germany are leading innovation countries, similar to Finland in terms of geographical coverage of the leading regions.

Of the Regional Innovation Scoreboard indicators, West Finland performs particularly strongly in terms of population having completed tertiary education, R&D expenditure in the business sector as a percentage of GDP, non-R&D innovation expenditure, innovative SMEs collaborating with other SMEs and EPO patent applications. Slightly weaker comparative results were achieved from the indicators SMEs introducing marketing or organisational innovations as a percentage of all SMEs, R&D expenditure in the public sector as a percentage of GDP, SMEs innovating in-house as a percentage of all SMEs and SMEs introducing product or process innovations as a percentage of all SMEs.

In a statistical comparison of European innovation, West Finland still performs well, but several significant indicators have deteriorated in recent years. Unemployment amongst those with higher education degrees and particularly doctors has increased in West Finland and Finland as a whole, whilst the average European development has gone in the other direction. In Finland, experts are worried that this situation will lead to a brain drain. Neighbouring countries like Sweden and Estonia as well as countries in Central Europe have a lack of ICT engineers for example, whilst West Finland has been releasing plenty of them onto the job market. Still more likely to leave than Finnish experts are highly skilled international workers, among whom unemployment has also increased. However, a degree from an institute of higher education still protects against unemployment significantly better than a lower degree or no qualifications at all. Tertiary education still proliferates among the population of West Finland, even though the promise of a good job has weakened. Both the level of education of the population and the level of unemployment vary considerably by region. (Statistics Finland, 2015.)

RDI investments have declined in all sectors in West Finland as have the number of patents that correlate to them. Instead positive development has been recorded in the number of growth companies, which is an indication of the ability of the business community of the region to renew itself. Likewise, the number of foreign degree students and researchers has increased, which reflects the internationalisation of skills capital. (Statistics Finland, 2015 and Council of Tampere Region, 2015.)

According to the latest Innovation Union Scoreboard (2015), Finland is still an innovation leader in the European context. Finland's innovation performance increased quite steadily until 2012. Since then performance using different indicators has weakened slightly in a European comparison. In spite of this, the country's performance based on many indicators is still better than average. Especially in PCT patent applications, international scientific co-publications and licence and patent revenues from abroad, the country's comparative position is strong. The weaknesses of the country lie in numbers of non-EU doctorate students, non-R&D innovation expenditure and exports of knowledge-intensive services. Performance in only two innovation dimensions has improved: in open, excellent and attractive research systems and intellectual assets.

The field of Finnish innovation and competitiveness face significant challenges, and there is no strong global economic growth on the horizon, which might improve the situation in itself. In addition to the above-mentioned developments, problems have

been noted in private sector competitiveness, its capacity for reform, the deterioration of demographic care relations, the transfer of production overseas and a current account deficit. Furthermore, foreign direct investment, a measure of the attractiveness of a country, is still quite low. In the big picture, however, significant long-term success factors such as equal education, research, healthcare, social stability and infrastructure all still exist. In order to move forward from the short-term challenges, development measures must encourage growth-centred reform and an entrepreneurial spirit. (Research and Innovation Council, 2014.)

Every year, the Tampere region prepares the study of the Situational Picture of Innovation in Tampere Region. The operating model is described in Chapter 2.5. In connection with this, it also produces Innovation Health Check-up for the region using a SWOT analysis (Strengths, Weaknesses, Opportunities and Threats). Many observations regarding strengths and weaknesses can also be extrapolated to the level of West Finland:

“Physical condition and resistance” (Strengths)

- The diversity of business activities, the reform of industrial fields and the increase in digital services have together kept the number of jobs fairly stable;
- The diverse university field refines intellectual capital;
- The region has international experts and a tradition of export expertise;
- Growth and stock exchange listings are common in various fields; and
- The development culture is active. The region is working towards the future.

“Basic regional health problems” (Weaknesses)

- Regardless of the resilience of business life, more jobs are disappearing than the growing fields are able to produce. Job-seeking movers add pressure to the management of the employment situation;
- The highly educated and expert population and international human capital cannot be harnessed for economic growth;
- Universities have not been able to extensively create a general readiness for or willingness towards entrepreneurship;
- The region depends on external R&D funding. Private capital investments are fairly low;
- R&D funding instruments need to be modernised. The ability to take risks is deficient. The corporate-centred way of thinking and the allocation of R&D assets to stabilised operators do not respond to the structural changes; and
- There are a vulnerably low number of key employees in the innovation field, and resources are fragmented.

The key challenges to innovation in West Finland identified are:

- **Challenge 1: The value of higher education has weakened**

Innovation activity is based on the application of high-level expertise, produced with the help of tertiary education. Problems with the innovation system are reflected in unemployment amongst university graduates. High-level expertise cannot be fully utilised as a source of economic growth. The danger is that skilled young people will leave not only the region but the country.

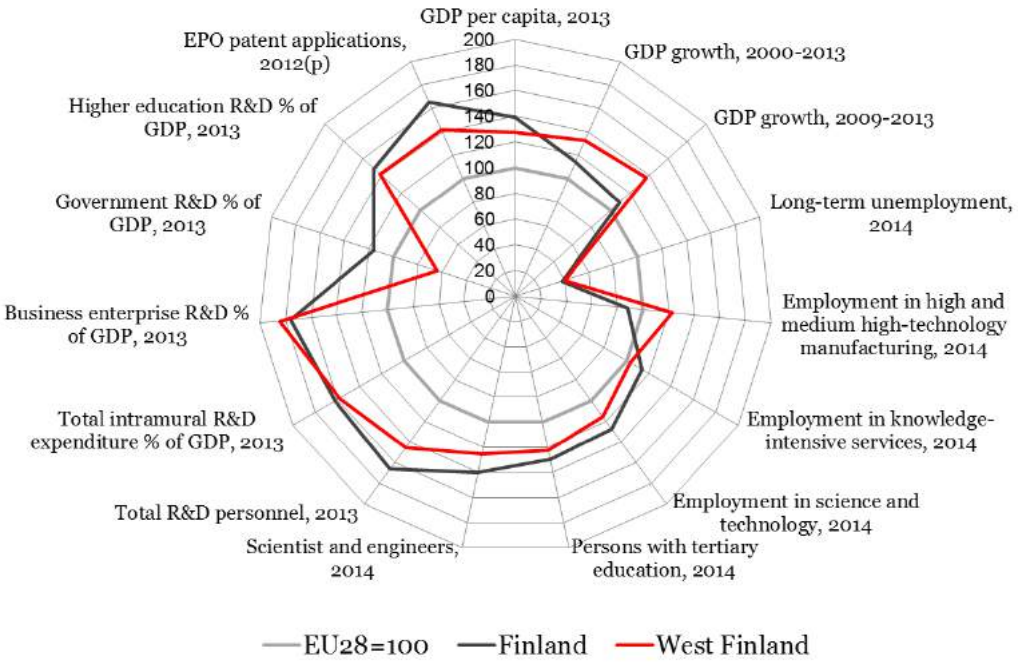
- **Challenge 2: The prolonged poor economic situation is in danger of paralysing RDI activity**

In view of the weak economic prospects, the will to develop and take risks of both the private and public sectors is on the decline. The funds available to RDI activity are continuing to contract. The desire to invest will decline unless there is more optimism.

- **Challenge 3: Coping with structural change requires new operating models**

West Finland is an industrial export-intensive area, which has long been suffering from a severe lack of international demand. A sudden change in the structure of industry is further hampering the situation. The present operating models have been unable to create new jobs in growing sectors at the same speed as they have been lost from traditional professions. New efficient development tools are expected of innovation policy.

Figure 4 Innovation performance in West Finland and Finland




Data Source: Eurostat.

Table 1 Key figures of the innovation performance

| | FI19 West Finland | FI Finland | EU28 | Year |
|---|---|---|---|---|
| GDP per capita (Euros), at current market prices | 33900 | 37100 | 26600 | 2013 |
| GDP growth (%), 2000-2013 | 47.4 | 41.1 | 35.7 | 2013 |
| GDP growth (%), 2009-2013 | 11.9 | 9.4 | 8.6 | 2013 |
| Long-term unemployment (% of active population) | 2.0 | 1.9 | 5.0 | 2014 |
| Employment in high and medium high-technology manufacturing (% of total employment) | 7.0 | 5.0 | 5.7 | 2014 |
| Employment in knowledge-intensive services (% of total employment) | 41.1 | 45.1 | 39.8 | 2014 |
| Employment in science and technology (% of active population) | 35.8 | 39.3 | 30.9 | 2014 |
| Persons with tertiary education (ISCED) (% of active population) | 38.1 | 40.5 | 31.2 | 2014 |
| Scientist and engineers (% of active population) | 8.4 | 9.4 | 6.7 | 2014 |
| Total R&D personnel (% of total employment), numerator in head count | 2.81 | 3.21 | 1.93 | 2013 |
| Total intramural R&D expenditure (% of GDP) | 3.22 | 3.30 | 2.03 | 2013 |
| Business enterprise R&D (% of GDP) | 2.38 | 2.27 | 1.29 | 2013 |
| Government R&D (% of GDP) | 0.16 | 0.29 | 0.25 | 2013 |
| Higher education R&D (% of GDP) | 0.68 | 0.71 | 0.48 | 2013 |
| EPO patent applications (per million inhabitants) (2012p) | 84.1 | 97.5 | 59.1 | 2012 (p) |

Data Source: Eurostat.

## 2.2 Institutional framework and set-up

In Finland, innovation policy is shaped primarily according to guidelines, objectives and instruments that have been defined at the national level. The responsibility for deciding the policy direction of the innovation system lies with the Finnish Government. The responsibility for preparing the package of measures rests with the Ministry of Employment and the Economy (MEE) and the Ministry of Education and Culture (MEC). The Finnish Funding Agency for Innovation (Tekes), the Technical Research Centre of Finland (VTT) and the Academy of Finland are key national actors in implementing the innovation system and channelling its funding. Regional actors, major cities, universities and other research and education institutions implement regional innovation activities. The regional councils are responsible for coordinating regional development objectives for the regions and for preparing related innovation activities. In Finland, there is no formal policy body covering West Finland, between the national and (sub)regional level (i.e. on NUTS level 2).

The uppermost guiding strategy at the national level is the National Innovation Strategy (2008), whose guidelines formed the basis for the later 'Reformative Finland: Research and innovation policy review 2015–2020' (2014) and the programme prepared by the MEE and the MCE, 'Growth through expertise – Action plan for the research and innovation policy' (2012), as approved by the Research and Innovation Council.

In the National Innovation Strategy (MEE, 2008), the main drivers of social and economic change in Finland have been identified as globalisation, sustainable development, new technologies and demographic changes in the population. The main objective for change in the innovation strategy is to broaden innovation policy and its implementation in an internationalising Finland. Economic growth and increasing the competitiveness of the regions will be sought through technological development, new business models and innovations for working life and public services. For example, nano- and biotechnologies have been mentioned as potential new application areas leading to innovations.

The Research and Innovation Council, chaired by the Prime Minister, sets the policy line for its sector once during its every term of office. The policy for the new government term, 'Reformative Finland: Research and innovation policy review 2015–2020', has been prepared in an economic situation that is stunted both nationally and globally. The prospects for growth are modest, and a number of Finland's structural factors are facing challenges or have already faced some. The political messages of the document emphasise the need for both rapid experiments and changeovers to open-minded practices and for proactive investments in education, research and innovation over a time span as long as 20 years. The difficult economic situation requires both rapid and long-term solutions.

The reform of the country's research and innovation policy can be summed up in the following key points, to which the funding solutions presented in the document are also geared:

- Radical reform of the higher education system;
- Furthering the exploitation and impact of R&I results; and
- Strengthening new sources of growth, intellectual capital and entrepreneurship.

Other key targets for development are:

- Improvement of the overall knowledge base of the population and selective support for cutting-edge skills;
- Reform of the public sector and closer cross-administrative cooperation; and
- Adequacy and targeting of R&D funding.

The document points out that Finland's long-standing strengths are not enough to enable it to survive the tighter economic situation. Working life, competence requirements and ways of doing things are changing. Change is advancing as a result of progress in digitalisation, intellectual capital and intangible value creation and scientific activity. Innovation is diversifying as a result of open innovation communities, demand-driven and user-driven activities and comprehensive social media. This sets a challenge for all business skills in the country. The new culture of openness and internationalisation requires political measures to promote it. The ingredients of new growth will be created through specialisation. The public sector is also defined as taking on a new role in the activation of innovations, and it is expected to adopt new agility.

*The role of regional councils*

The regional councils are responsible for preparing the policy at regional level and for distributing structural funds. There are 18 regions and regional councils in mainland Finland, of which five (Central Finland, South Ostrobothnia, Ostrobothnia, Satakunta and the Tampere region) are located in West Finland. The regional development programmes which reconcile the use of structural funds in the sub-regions are prepared in cooperation with the stakeholders. The regional programmes draw together various other planning instruments and strategies of individual organisations. Administrative guiding influences derive from national regional development targets, plans and programmes specific to one administrative sector and EU programmes.

The strategic programme documents for the regions in West Finland were updated in 2014. Regional strategy is a collective term for the regional scheme and regional programme such as are referred to in the Regional Development Act. It includes both long-term development targets and concrete measures to implement them. The strategic development vision is directed towards 2040, with the exception of the Satakunta Regional Plan up to 2035. An operational regional programme section has been prepared for the years 2014–2017. For the first time, the regional strategies were now prepared to include both a long-term regional plan and a medium-term regional programme. The strategy document is also supplemented by an implementation plan in the form of a short-term development document. This presents projects and measures that realise strategic visions in a concrete manner and also includes details on their funding. Timing the regional strategy concurrently with the preparation for the EU programme period will support coordination between regional, national and EU-level policy. The regional strategy is a policy statement jointly approved by the region.

*Regional strategies and schemes*

A new feature in regional strategies and schemes is that they have been increasingly worked on using methods that are proactive and based on scenarios of the future. Regional proactive cooperation was incorporated in the responsibilities of the regional councils in 2010. The Tampere region foresight model, Pilkahdus, is visualised in Appendix F as one process example. For example, the Satakunta Regional Plan is called the Future Handbook 2035 for Satakunta Region, and the Regional Strategy for Tampere Region 2040 is based strongly on a scenario-type narrative. Likewise, preparation of the Smart Specialisation Strategy is closely linked to the regional strategies and programmes for 2014–2017.

A regional management committee (MYR) coordinates structural fund activities in the region and monitors the effectiveness of development measures. The regional management committees are convened by the regional councils. The committee includes representatives of various central organisations, businesses and authorities and the largest municipalities in the region.

In addition to the structural funds, by the turn of 2015 the regional councils had some regional development funding that was not pledged to programmes at their disposal. This resource was important in an ideological sense, as it was the only budgetary

allocation freely available for the implementation of the strategy. However, the amount was reduced throughout the 2010s, and the funding instrument was then abolished entirely. In the autumn of 2015, the MEE announced a new toolkit for launching regional innovations and experiments, 'Alueellisten innovaatioiden ja kokeilujen käynnistäminen' (AIKO).[21] It consists of 1) proactive measures on structural change (ERM); 2) a growth agreement between the government and cities; and 3) the creation of nationally significant growth zones. The new tool is an instrument aiming at agile experiments and improvements in the resilience of businesses. The projects that are to be realised under it will be decided on by the regional councils on the basis of an implementation plan in the regional programme and a proactive structural change plan (i.e. contingency plan), which is to be drawn up now for the first time. The contingency plan will utilise foresight knowledge collected by the regions. The use of AIKO funding must be based on the national priorities for development in the regions, a regional programme and a smart specialisation strategy.

*Regional government bodies*

The Government's regional administrative authorities in economic policy include the Centres for Economic Development, Transport and the Environment (ELY Centres). Fifteen ELY Centres operate in the country, and there is a branch in each of the regions in West Finland. The ELY Centres fund projects pursuant to the regional programme through funding from the European Regional Development Fund and the European Social Fund. They also have at their disposal substantial substance allocations for their three areas of responsibility. Among other things, the ELY Centres provide advice to new businesses, aid for enterprises and funding for commercialising inventions. Internationalisation services of the Team Finland network are on offer to growth-oriented SMEs. Tekes's regional offices also operate in conjunction with the ELY Centres.

Tekes is a significant actor that promotes development and innovation in industry and services as well as growth in global competitiveness. To organisations, it offers innovation funding (loans, grants and fund investments) and networking platforms with services. Supporting financing consists of open funding channelled according to demand and funding allocated to selected strategic programmes. The Tekes programmes are topical entities targeted at financial and expert service areas. Their usual duration is 3–6 years. There are currently 15 ongoing programme entities that promote Tekes's strategic focus areas, such as new business ecosystems, market access, digital technology and resource efficiency.[22] The FinNano programme ran during the period 2005–2010, but at the present time nanotechnology has not been elevated to Tekes programme level. Tekes is under the financial control of the MEE, and its strategic focus areas have been defined in cooperation with Finnvera, Finpro, Sitra, the Academy of Finland and VTT.

At the beginning of 2015, Tekes's activities in innovations and inventions, as well as its tasks on internationalisation of business and energy support, were concentrated in the ELY centre of the Tampere region to be managed there at the national level. The tasks were organised into a new Growth and Innovation Unit consisting of approximately 120 experts (ELY Centres of Finland, 2015). Funding from the Horizon2020 programme can also be applied for through Tekes.

In addition to the regional councils and ELY Centres, the municipalities are important stakeholders in innovation policy. They have their own right of taxation, which also gives them budgetary power. Also the regional councils are joint authorities owned by the municipalities, and they coordinate viewpoints of the municipalities with policies at the national and international level. Promotion of businesses in the municipalities is realised either in regional business development companies, which are a common

[21] See: https://www.tem.fi/files/44363/aiko-ermohje.pdf

[22] See: http://www.tekes.fi/en/programmes-and-services/tekes-programmes/

form of operation especially in large urban areas, or through their own business developers. The municipalities are often partial sources of funding through structural funds or in development projects implemented from national programmes. They also enable the creation of various innovation environments by means of their infrastructure and build a profile for themselves through the institutions of higher education in their region.

The number of actors in organisations steering innovation activities has been gradually falling in recent years. The institutional thickness is getting weaker. Especially in central government, personnel resources have been reduced through productivity programmes. This is reflected as a decrease in the number of operators in the innovation field, for example in ELY Centres and universities and in central administration. The need to reduce employee costs has also made it more common in various sectors to operate through project funding. Especially the various intermediary organisations have been in difficulty if their financing has been based mainly or solely on programme instruments which have been decided to be discontinued at the national level. As the ability to allocate national funding has decreased, the competition for project funding has become tighter and the pressure to seek international financing has increased.

## 2.3 Regional innovation policy mix

The regional innovation policy mix is to a considerable extent guided by the instruments and policies determined at the national level. The regions have a responsibility, crystallised as a regional strategy, for aligning and bringing together regional-level viewpoints in order to guide the allocation of structural funds in particular. Other regional stakeholders that implement regional innovation strategies and innovation support measures include universities, research institutions, development companies and business interest organisations. Universities and strong central cities, especially, have resources and focus areas for innovation activities defined in their own strategic processes. Tekes is a significant actor through which innovation funding is channelled to companies and other organisations.

The European structural funds have constituted a significant development resource since Finland joined the European Union in 1995. The fourth programme period for Finland is currently under way. The European Regional Development Fund and the European Social Fund is steered by a single national programme, 'The Sustainable Growth and Jobs 2014-2020 – Structural Funds Programme of Finland'. The significance of business and innovation development grew in ERDF targeting compared with the previous period. The low-carbon approach emerged as a new theme. Thematic focusing was increased, and the developing regions were allowed to select only a few focus areas from the list.

The Structural Funds Programme of Finland includes five priority axes and 13 specified objectives. The priority axes are: 1) Competitiveness of SMEs (ERDF), 2) Producing and using the latest information and knowledge (ERDF), 3) Employment and labour mobility (ESF), 4) Education, skills and lifelong learning (ESF) and 5) Social inclusion and combating poverty (ESF). Activities promoting innovation were targeted especially at priority axes 2 and 1. 'Producing and using the latest information and knowledge' include specific development objectives such as development of the centres of research, expertise and innovation on the basis of regional strengths, strengthening innovation in enterprises and developing solutions based on renewable energy and energy-efficient solutions. 'Competitiveness of SMEs' is about generating new businesses, promoting growth and internationalisation of enterprises and promoting energy efficiency in SMEs.[23]

Eastern and Northern Finland account for 71 per cent and Southern and Western Finland for 29 per cent of the European structural funding (ERDF and ESF). Funding in Western Finland decreased by approximately 30 per cent compared with the previous period, which is a considerable loss of funding volume. The change for the whole country was 18 per cent. The European Union contributes about EUR 1.3 billion to the structural funding in Finland in 2014-2020.

The most recent national development programmes are increasingly highlighting platform and co-creation discourses as new kinds of practices in innovation activity. Both in the public and in the private sector , the level of RDI funding is in danger of decreasing further. The decline in financial contributions is steering the focus towards collaborative development and combining resources with the aim of generating added value. The open innovation platforms are included as a priority area in the Six City Strategy (6Aika) of the six largest cities in the country and a cross-cutting theme in the Innovative Cities Programme (INKA) for city-regions.

6Aika, 'The Six City Strategy – Open and Smart Services' (2014-2020) is a strategy for sustainable urban development carried out by the six largest cities in Finland. The strategy is a part of the implementation of Finland's structural fund programme. Tampere is one of the cities along with Espoo, Helsinki, Oulu, Turku and Vantaa. The strategy will be implemented through three key projects (2015–2018), which are open

[23] See: https://www.rakennerahastot.fi/web/en#.VlQpNb_Uaao

innovation platforms, open data and open participation. The city of Tampere, the Tampere Region Economic Development Agency (Tredea), the University of Tampere and the Council of Tampere Region play important roles in implementing and coordinating the key projects of the Six City Strategy. The Six City Strategy (2014) aims to achieve cross-cutting RDI effects, above all by opening up operating models.

The INKA Programme (2014–2017) is being implemented in the country's largest city-regions, including all the central city communities in the regions of West Finland. The aim of INKA is to turn the cities into attractive, international-level hubs that will receive support from the national network and be able to create new, competence-based business activities. The development themes are in line with the European Structural Fund Programme: Smart city and renewal of industries (responsible city Tampere), Sustainable energy solutions (responsible city Vaasa; Pori included as a partner), Cybersafety (responsible city Jyväskylä), Future Health (Tampere as a partner) and Bioeconomy (Jyväskylä and Seinäjoki as partners). The mission of INKA has been to accelerate business activities based on innovations by promoting development platforms operating at the interface of various sectors as well as innovative public investments and procurement. This has been seen to promote the growth of SMEs and to contribute to smart specialisation of city regions.

INKA replaced the Centre of Expertise Programme (OSKE), which finished at the end of 2013. It was also decided to end the INKA programme already during 2015. The activities will be wound down gradually. The original programme period was set to last until 2020, but it has been shortened to end in 2017.

Table 2 Regional innovation support measures

| Title | Duration | Policy priorities | Budget | Organisation responsible | More information |
|---|---|---|---|---|---|
| Sustainable growth and jobs 2014-2020, Finland´s structural funds programme | 2014-2020 | 4.1. Direct funding to business R&D and innovation<br>2.1. R&D cooperation projects between academy and industry | €1.3b (Finland total), €204m (West Finland) | Regional Councils (ERDF) and ELY Centres (ESF, ERDF) | https://www.rakennerahastot.fi/web/en#.VkxOS7_Uaao |
| Botnia-Atlantica Interreg | 2014-2020 | 5.1. Cluster development | €36m (Finland, Sweden and Norway total) | Regional Councils of Ostrobothnia and South Ostrobothnia | http://www.botnia-atlantica.eu/home-fi/ |
| Central Baltic Interreg | 2014-2020 | 4.5. Knowledge transfer and cooperation between firms (incl. technology acquisition) | €115m (Finland, Estonia, Latvia and Sweden total) | Regional Council of Satakunta and Council of Tampere Region | http://www.centralbaltic.eu/programme |
| Innovative Cities Programme (INKA) | 2014-2017 | 2.4. Demonstration projects, proto-types and proofs of concepts | €30m annually (Finland total) | Tekes | http://www.tekes.fi/en/programmes-and-services/tekes-programmes/innovative-cities/ |
| The Six City Programme: Open Data and Interfaces spearhead project | 1/7/2014–30/6/2017 | 5.1. Cluster development<br>2.4. Demonstration projects, proto-types and proofs of concepts | €8.1m (Finland total) | The lead partner is the City of Tampere | http://6aika.fi/spearhead-projects/ |

| Title | Duration | Policy priorities | Budget | Organisation responsible | More information |
|---|---|---|---|---|---|
| The Six City Programme: Open Innovation Platforms spearhead project | 1/2/2015–31/1/2018 | 2.4. Demonstration projects, proto-types and proofs of concepts | €12.4m (Finland total) | The lead partner is City of Oulu | http://6aika.fi/spearhead-projects/ |
| The Six City Programme: Open Participation and Customership spearhead project | 1/4/2015–31/3/2018 | 7.1. Public sector innovation initiatives | €8.98m | The lead partner is the City of Turku | http://6aika.fi/spearhead-projects/ |
| AIKO for launching regional innovations and experiments | 2016-2018 | 7.1. Public sector innovation initiatives | €30m (Finland total) | Regional Councils and MEE | https://www.tem.fi/files/44363/aiko-ermohje.pdf |
| Open Tampere Programme | 2012-2018 | 4.3. Fostering start-ups and gazelles<br>5.1. Cluster development | €1.45m annually | Tampere Region Economic Development Agency Tredea and City of Tampere | http://www.avointampere.fi/en/ |

## 2.4 Appraisal of regional innovation policies

At both the national and regional level, innovation activities have been regarded as a key solution to protracted stagnation and to structural problems. The development policies of RDI activities in the regions are linked to the strengths of the regions' businesses and research, where the structures often change rather slowly. A vision extending over the strategy periods has been the desire to expand regional economies by commercialising RDI know-how by means of either identified key areas or forecast growth areas, which are also frequently identified through traditional key fields. In general, there is a consensus in the regions' strategies regarding the importance of RDI activities, even though their level admittedly varies according to RDI expenditure, the competence and technology level of businesses, the educational structure of the population and research intensity.

The main needs for innovation and regional specialisation in the five regions of West Finland have been highlighted in the regional strategies. The implementation plans identify the main project entities and financing information in development work and open up the discussion on needs with key ministries, thereby giving tangible form to the dialogue between the region's stakeholders. The main financing instruments and focuses of the innovation activities are established at the national level, although naturally in dialogue with the regions and key operator organisations. This arrangement is a central factor in determining the innovation policy of the regions.

One challenge in Finnish innovation policy is that the operating field is fairly broad at both the regional level and the level of national administration. The regional strategies coordinated by the regional councils consist of the point of views of actors in the cities, city-regions, Economic Development Agencies, ELY Centres, Regional State Administrative Agencies, hospital districts, chambers of commerce, higher education institutions and other education providers, as well as third-sector actors, among others. At the national level, innovation policy is steered by the MEE and the MEC. Regional development in general is also guided by various other ministries.

There is a concern regarding basic arrangements that is arising from the regions. It concerns three issues above all. First of all, concern over decreasing funds is a common feature for all regions in West Finland. A second point is that the short-term nature of development programmes guided at the national level does not support sustainable development work; on the contrary, it consumes the resources of regional developers. Thirdly, the regions feel that projects elevated to a key level do not always fit sufficiently well in the local ecosystem.

The regions' capability to develop is based on knowledge on its business structure, economy, demographic trends, educational structure and competence needs, as well as its research, development and innovation activities. Systematic regional evaluation processes concentrating solely on the innovation activities are fairly rare. Chapter 2.5 presents two exemplary processes of participatory evaluation from West Finland: the structured dialogue process serving Ostrobothnia's smart specialisation strategy and the situational picture of innovation in the Tampere region. Both are excellent examples of tools developed by the areas themselves that aim at monitoring and creating a participatory process to improve the effectiveness of innovation activities.

Alongside local reviews, the situational picture of innovation activities in the Tampere region also includes comparisons by region. The metrics of Value Network Capability compares regional typologies created on the basis of regions in high economic productivity, a boldly experimental and entrepreneurial atmosphere, a global search for and connection to growth, a high level of expertise and strategically allocated funding. In addition, the sectoral structure and growth rate of growth companies in the regions have been visualised. Comparisons provide information on the success of the regions' innovation activities and specialisation. For example, it has been noted with respect to the Tampere region that growth companies have increased above all in high-competence services but also in the sector of manufacturing industries. The trend indicates modernisation of the economic structure. Other key observations include the spread of work with innovation platforms, temporary stabilisation of RDI funding which had been falling for some time, growing entrepreneurship and an increase in international human capital. It can be shown through the observations that the strategic spearheads have developed in the right direction.

The Satamittari service developed in Satakunta monitors statistical trends in the competitiveness of Finland's sub-regional units and city-regions. The comparison of competitiveness is based on six factors: labour productivity, employment rate, ability to innovate, education levels, business dynamics and industry dominance. Based on an indicator composed of these factors, the city-region of Vaasa ranks number one in the country. Its strengths are its ability to innovate, labour productivity, employment rate and education levels. The metropolitan city-region of Helsinki ranks second, and in third place is Tampere, whose strengths are its ability to innovate, education levels and business dynamics. Southern Tampere region (Etelä-Pirkanmaa) (5th) also stands out on the list through vibrant R&D activities, industry dominance and high labour productivity. Rauma and Pori in Satakunta rank 13th and 15th respectively in the comparison, while Seinäjoki in South Ostrobothnia ranks 14th, and Jyväskylä in Central Finland 19th. On average, the sub-regional units in West Finland ranked very well in the comparison. It is striking that number one in the comparison is a city-region outside the metropolitan area: Vaasa in Ostrobothnia.

It must be said for innovation management at the national level that the regions have been offered additional designated processes where they can deepen the local vision and network. For example, regional foresight cooperation, a regional specialisation strategy and as a new feature a proactive structural change process (ERM) will encourage areas to ascertain their own strengths and to build their future on this knowledge base.

During the new Structural Fund period, the financial resources of Western Finland decreased very noticeably, as the focus of support moved more clearly than before to Eastern and Northern Finland. The shrunken frame of financing will inevitably lead either to lower amounts of funding or to more rigorous selection. For example, the

Tampere region has decided strategically on the latter solution: strategic selectiveness. The discourse of regional development has accordingly shifted to "purchasing change" and to a transition "from projects to processes" (Council of Tampere Region, 2012). This means that the regions will strive to support consistent entities through which sustainable changes in the innovation environment and culture can be achieved. In long-term project entities, an individual project is seen as a path to the next developmental stage. An assessment study has identified five developmental entities that have advanced from projects to processes: the innovation environment of Valkeakoski Campus, New Factory as a reformer of the innovation system, the emerge of a biotechnology cluster, development in the plastics and rubber cluster towards natural fibre composites and the cultural sites supporting the region's vitality. An example of the development of an ecosystem in the field of nanotechnology is described in chapter 1.9.

As stated in the previous RIM Plus West Finland Regional Innovation Report (2014), one of the key challenges of regional development activity is project-based development, which tends to end as soon as the project funding has been used. The sum of long-term proactive development activities can give rise to innovation targets of an international standard which will serve as a "calling card" for the region. Another basic dilemma in innovation projects concerns their value creation. An innovative project should create added value which would not arise without it. It is positive for an innovation ecosystem if the project develops the entire system and not just the internal activities of the participating organisation.

In addition to the splinter effects of traditional project activities, programme development too has become increasingly precarious. The short-term nature of funding programmes controlled at the national level is weakening the sustainability of development work. A typical example of this is the previously mentioned INKA, which was decided to be terminated when it had only just advanced to implementation at the operative level.

A key goal of innovation policy targeted at cities is to harness investments made on account of migration and urbanisation to innovation activities. With the measures of the INKA programme, especially, the aim has been to accelerate the practical application of innovations, for example by making the city available as a development and testing platform for businesses. Successful pilot trials in a genuine urban environment can act as references for businesses when they head towards international markets. According to assessments, INKA has succeeded in diversifying public procurement processes, for example in smart traffic. The public sector's threshold for initiating ongoing dialogue before and during the competitive bidding has become lower. It is often more fertile and cost-effective overall to purchase a solution to a problem instead of embarking on competitive tendering. In a national comparison, INKA activities in Tampere can be regarded as especially successful, as around half of the projects started in INKA have been located in Tampere.

The 6Aika programme is spurring the openness of development culture in the country's six largest cities. The cross-cutting theme of openness is being implemented in three spearhead projects of open data, open innovation platforms and open participation. The themes are very effective in realising the Research and Innovation Council's calls for new innovation communities, open data and science and immaterial value creation. As yet, the 6Aika programme has been running for a relatively short period. The open data spearhead project has been put into practice the longest, and results have also been achieved: new data resources have been opened for commercial and public use and application development based on open data has been advanced by means of various competitions. For example, the finances of the cities and the datasets for public transport have fuelled new applications. The spearhead project in open innovation platforms has been running since spring 2015. Each participating city promotes the development of various types of platforms, and the maturity of their platform mindsets and operations is at different stages. Tampere has previous experience of platform-like activities, and the 6Aika work has therefore got off to a good start, according to estimates. Among other things, Tampere is developing the

district of Tesoma into an innovation platform. It is also developing platform management tools and an innovation service voucher. The spearhead project in open participation has only just started.

The INKA and 6Aika programmes have very similar components as their cross-cutting themes: supporting open innovation platforms as new development environments, utilising open data as application material for cities and companies and strengthening the process of involving citizens in the development of services. Now that it is known that INKA is due to end, the 6Aika strategy can be regarded as its successor. If a new instrument resembling INKA or OSKE is not created in the near future, the country will soon be living in an era of innovation policy without any ongoing development programmes based on regional cluster or competence focuses that would involve funding in the millions. If innovation resources are allocated nationally, for example solely on the basis of entries in the Government Programme, the situation may either increase the regions' freedom to specialise or lock options into a narrower range than before.

## 2.5 Policy good practice

Policy good practice highlights two examples of practical processes that activate dialogue between regional innovation actors and develop a strategic vision in West Finland. The structured dialogue of Ostrobothnia in the strategy work of smart specialisation and The Situational Picture of Innovation in Tampere Region as an interactive process of information management are structured methods through which experts in the field of innovation, managers and resource holders themselves endeavour to influence the development of the areas. Both examples have emerged endogenously as part of the actual activities of the regional councils, and neither one is dependent on external project funding.

*Vision of dynamic competitiveness in Ostrobothnia: structured dialogue in creating smart specialisation and innovation partnerships*

The basic idea behind the Smart Specialisation Strategy is that all regions in Europe have the opportunity to develop successful, specialised innovation policy on the basis of their individual starting points. In Ostrobothnia, a dialogue process bridging the partners has been created to promote the smart specialisation strategy (Regional Council of Ostrobothnia, 2015). An attempt is made in it to understand the regional innovation system from the inside and not through externally given examination principles. The process is built from the bottom up by generating discussion between the triple-helix parties in a coordinated manner. The most important innovation partners are the successful export companies in the region that are networked internationally.

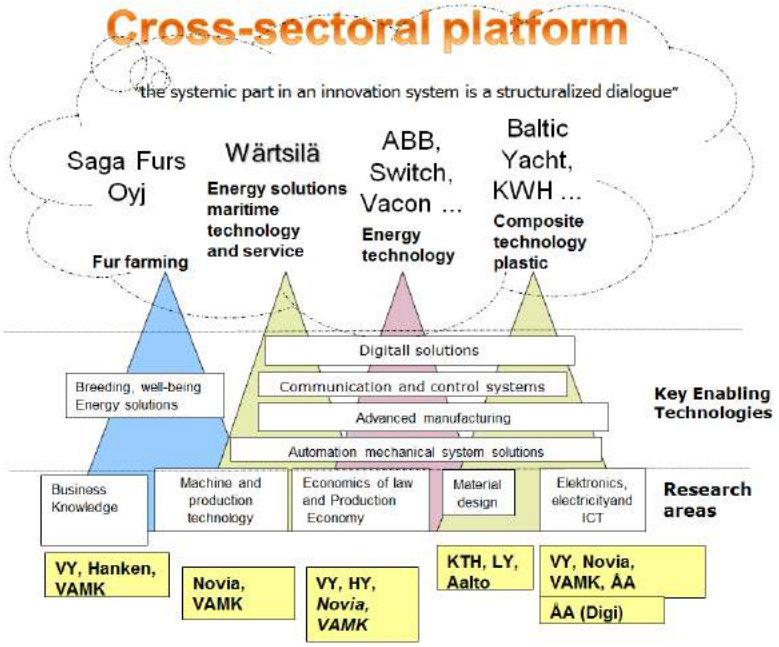
The aim is to find a mutual view on developing the region by coordinating different perspectives. The model has been developed in collaboration with university partners (Virkkala et al, 2014). It is cost-effective and improves information management, as it is run by the region's own actors. Motivation to participate comes from developing the region and the participants' personal circle of contacts.

Ostrobothnia's vision of smart specialisation is to be a dynamic competitive area able to meet changes, where the innovation networks work in close cooperation while increasing their resilience at the same time. Energy technology, maritime technology and service, fur farming and composite technology and plastics have been identified as key areas of specialisation in Ostrobothnia. The topics of structured dialogue are selected so as to uncover the current situation and gaps in the development of strategic innovation partners. Concrete questions include whether the partners in innovation cooperation are located geographically at regional, national or global level, whether the respondent's main partners are from the world of business, higher-education institutions or the public sector, and what the experiences and expectations are with respect to these partners. Another priority is the question of how the role of various technologies is seen now and in the future. The questions are put to the stakeholders,

i.e. interest groups, businesses, universities and research institutions and representatives of the public sector. Experiences of the current situation and future expectations are evaluated on a scale of 1–10 and a gap analysis is produced on the basis of the responses. On account of repetition, it is possible to observe areas where the relationship between expectations and experiences is out of balance or where the experiences have changed. The reasons for the gaps are discussed in joint seminars.

The process of structured dialogue leads the parties to target measures towards the right issues and to allocate funding to rectify more serious weaknesses. By means of the dialogue, important areas of development have been detected at the points where export-led industry, the university and research field and public administration meet. First, the region has found that development investments by the public research sector are insufficient compared with those by the private sector. In the future, this may weaken the infrastructure of the higher education institutions and investment by businesses that value university-level competence. On the other hand, a high level of private R&D expenditure is in itself a positive signal. Second, it has been observed in the discussions that investment decisions on infrastructure are too slow in relation to the requirements of business. The third main observation concerns the innovation strategies, which are often regarded as being excessively general. The regional dialogue process provides a tool for remedying this shortcoming.

Figure 5 Peak industries, technologies and competencies of the smart specialisation in Ostrobothnia




Source: Regional Council of Ostrobothnia.

*The Situational Picture of Innovation in Tampere Region*

The Situational Picture of Innovation in Tampere Region is a structured and proactive information management process (Council of Tampere Region, 2015). Through a situational picture produced annually, signals of change in the field of innovation are identified, and a joint interpretation by the region's actors is created on their significance to the region's development and future. The situational picture formed from current data, from the interpretations drawn from it and from information management practices will create a basis for the planning of the region's own strategic innovation policy, for decision-making and for the implementation of decisions.

System and operating model of situational pictures has been created in cooperation with key actors in the innovation field of the Tampere region. The system is developed dynamically through iteration rounds and learning by doing. The first situational picture was created by core teams of stakeholders, including academics in knowledge management, in the region in 2013, and it has subsequently been republished and expanded every year. The process involves a broad range of experts and leaders from parties such as higher education institutions, innovation platforms, regional administration, start-up community, lobbying organisations and the field of business and venture capital. The situational picture system is assessed actively with the assistance of domestic and international experts (e.g. OECD, MIT), and the work is put into practice by the Council of Tampere Region.

The situational picture of innovation activities is monitoring phenomena in the field of innovation that actors in the Tampere region can influence in the short and medium term and that have jointly been identified as strategically important. The information base is pooled from open data and materials followed by the innovation actors themselves, which makes the process efficient in terms of both costs and work resources. The module-like set of indicators consists of the up-to-date monitoring of 50 indicators. The main themes of the situational picture are RDI funding, institutions of higher education, growth companies, the international dimension, innovation platforms and value network capability. In addition, the situational picture is strengthened by means of current signal analyses, the need for which emerges from the signals provided by the indicators, the interpretations made by the network and the future outlook of the environment.

The principles guiding the process are that a knowledge based view arises when in workshops producing joint interpretations, that processes are communicated on an up-to-date basis and that the resulting information is shared openly in the network's tools. The situational picture of innovation activities in the Tampere region is connected to the effectiveness of regional strategies, to regional innovation policy, to proactive work on the future and to themes in smart specialisation. The modelled process of situational pictures is also reproducible for other regions that actively aim to develop regional management of the innovation on the basis of the co-creation and knowledge of the actors.

## 2.6 Possible future orientations and opportunities

The innovation policy of the regions is changing. As a result of the prolonged economic downturn, the innovation resources of both the private and public sectors have declined, and there are fewer hands available to do things. This results in needs to change prioritisation and structures. The decline in public RDI funding has also resulted in national development programmes being completely shut down, sometimes at very short notice, or before the originally set time for termination. Regional innovation policy is strongly controlled by national policy, and the fragmentation of control is seen as problematic in development organisations. On the other hand, the number of processes that determine regional strengths has increased. The regions have been given additional responsibilities to create networking processes for the observational work of their own fields of strength and future prospects.

Information management processes developed by the regions themselves and adopted by them for systematic implementation are supporting targeting innovation activity and smart specialisation. The process of structured dialogue, a situational picture of innovation activity and cooperative networks aimed at conducting foresight are examples highlighted in this report. There is a need to study these examples more closely and disseminate them as best European practices.

Innovation activity is traditionally considered a solution to the problems of economic growth and competitiveness. According to expert assessments, recently for the first time belief in the omnipotence of innovation policy has been questioned in policy debate. The problem is that considerable sums of money are invested in RDI activity, but the results they achieve cannot necessarily be proven. Project-based innovation

work has increasingly encountered criticism, and initiatives such as innovation vouchers creating innovation market mechanisms and project funding decisions based on the impact on new emerging ecosystems have been proposed in their place. Closer attention is being paid to the effectiveness of measures as the amount of available funds declines. This development has also increased the need for new kinds of tools and processes that can monitor the output, outcomes and impact of innovation policy.

For the first time too, universities and universities of applied sciences are facing actual pressures to save money. This has stimulated discussion about the scope of the higher education network, the profiling of institutes of higher education, the deepening of cooperation, the centralisation of different support functions and the creation of a new structure requiring no less than legislative change in the Tampere3 process, the consortium between the University of Applied Sciences and two universities. The world of higher education must also consider its own possibilities for commercialisation, and the prerequisites for success in the competition for international funding. The development of the effects of higher education innovation has been one of the Government's leading projects.

Innovation policy era focusing on creating new clusters seems to be ending, and the focus is shifting towards talented individuals and the development of agile practices of co-creation and market entry. From cluster-based thinking, we are moving towards an understanding of regional innovation ecosystems and platform-based methods of collaboration. It looks as if we will soon be living through an era of innovation policy in which no million-euro development programme based on regional expertise will be taking place in this country. This situation might either increase the freedom of the regions to specialise or lock the alternatives into a narrower selection than before, if innovation resources are allocated based solely on items in the Government Programme, for example.

National-level priorities do not always sit well on local ecosystems or strategic policies. The basic nature of innovation activity entails unpredictability, which political control from above is more likely to harm than to help. Furthermore, market conditions and local business activity are also difficult to reconcile with harmonised political objectives.

Possible future orientations and opportunities can be summed up under three headings:

- **Processes that involve participants in assessing the effects of innovations**

The effectiveness of contact and discussion between triple-helix actors can be improved through systematic processes, which the regions themselves can plan and implement from their own starting points in the ways that they see fit. People actively opening discussion and 'setting the shared table' can include, for example, funding authorities such as regional councils. The regular monitoring of innovation activity provides justification based on the latest information available for the targeting of strategy and resources.

An essential part of processes is the analysis of the latest available information in addition to different participatory elements. Such participatory processes in knowledge-based management have been developed for systematic use in, for example, the Tampere region and Ostrobothnia and in all regions of West Finland in relation to cooperation in forecasting and smart specialisation.

Local actors are united by a desire to act in the interests of regional development, to enrich it by carrying out the right development measures and to improve the societal influence of their work. The field of individual actors is also often fragmented and human resources in decline. Networking between specialists promotes both cooperation in toppling barriers and human motivation.

- **Onwards from cluster development**

Cluster-based instruments have been terminated and innovation policy is seeking a new direction. A problem for the development of clusters is seen to be that, on Finland's scale, they are often politically selected priorities rather than groups of actors based on a critical mass of companies and research. For example, in Central Europe clusters are often natural units for development, they are there anyway and do not need to be set up with policy guidelines as in a smaller-scale country.

National funding resources are being reduced and this is guiding development towards agile, actor-centred and cost-effective operating models. Innovation platforms and an approach based on regional ecosystems have been proposed as the basis of a new way of thinking. Participatory platforms based on open innovation also support new challenges such as the solving of social issues in a new way. The concept of experimentation culture, which has become a topic for political discussion in Finland, also encourages quick and open-minded experimentation based on whose logic open innovation platforms function.

Now a stage of experimentation with different approaches is ongoing, seeking the most effective new angle of approach to replace the traditional Finnish cluster policy. For innovation participants and development organisations, this manifests itself as a stuttering and fragmented programme policy. It might, however, be a question of a proactive transitional period.

- **New regional governments, new innovation actors?**

In the coming years, Finland will see a significant regional government reform, which will considerably change the existing regional administration structure and the distribution of tasks between key development organisations. The social and healthcare services are being transferred from the municipalities to new regional governments. The functions of regional councils in the form of municipal federations and the state-run Centres for Economic Development, Transport and the Economy will be combined with new regional government organisations. The details of this have yet to be specified, but the role of municipalities as promoters of industry, commerce and regional vitality seems to be increasing. The regional government reform package is also a question of the future innovation policy system and structures channelling and guiding innovation funding. With regard to the innovation policy steering system, ideas have been put forward that some parts of Tekes funding, for example, could be decided upon by the regional governments. The new regional governments will offer the chance of reform to regional innovation policy and for the introduction of local innovation ecosystem policy, if it is so decided.

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# Appendix B Stakeholders consulted

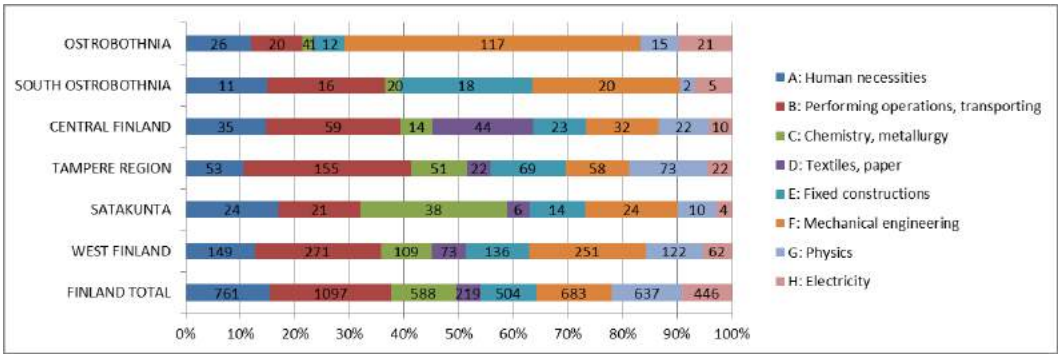
1. Jukka Alasentie, Director (Regional Development), Council of Tampere Region (30 November 2015).
2. Mika Hirsimäki, Senior Research Fellow, Tampere University of Technology, Optoelectronics Research Centre (2 November 2015).
3. Jerker Johnson, Development Planner, Regional Council of Ostrobothnia (19 November 2015).
4. Jari Kolehmainen, Research Manager, University of Tampere / University Consortium of Seinäjoki (19 November 2015).
5. Harri Kuusela, COO, Innovaatio Oy Uusi Tehdas Ltd. (17 November 2015).
6. Katja Laitinen, Regional Advisor, Regional Council of Satakunta (3 December 2015).
7. Heli Rintala, Deputy Regional Development Director, Regional Council of South Ostrobothnia (3 December 2015).
8. Petri Räsänen, Director (Innovation and Foresight), Council of Tampere Region (30 November 2015).
9. Pekka Savolainen, Director, Tampere University of Technology, Optoelectronics Research Centre (17 November 2015).
10. Reijo Tuokko, Emeritus Professor, Tampere University of Technology, Mechanical Engineering and Industrial Systems (26 October 2015).

# Appendix C Table of regional industrial profiles according to turnover in 2013

| | Turnover in 2013, MEUR | | Regional and industrial proportions of the country, % | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Finland | West Finland | *Finland* | *West Finland* | *Satakunta* | *Tampere Region* | *Central Finland* | *South Ostrobothnia* | *Ostrobothnia* |
| **INDUSTRIES TOTAL (A-X)** | 393,947 | 77,606 | *100* | *20%* | *4%* | *7%* | *3%* | *2%* | *3%* |
| **C Manufacturing** | 129,569 | 32,873 | *100* | *25%* | *5%* | *9%* | *3%* | *3%* | *5%* |
| **10 Manufacture of food products** | 9,783 | 3,455 | *100* | *35%* | *7%* | *5%* | *3%* | *15%* | *5%* |
| **11 Manufacture of beverages** | 1,261 | 42 | *100* | *3%* | *n/a* | *n/a* | *0%* | *3%* | *n/a* |
| **12 Manufacture of tobacco products** | n/a | n/a | *100* | *n/a* | *n/a* | *n/a* | *n/a* | *n/a* | *n/a* |
| **13 Manufacture of textiles** | 447 | 263 | *100* | *59%* | *12%* | *37%* | *2%* | *6%* | *2%* |
| **14 Manufacture of wearing apparel** | 497 | 178 | *100* | *36%* | *13%* | *20%* | *1%* | *1%* | *1%* |
| **15 Manufacture of leather and related products** | 238 | 105 | *100* | *44%* | *6%* | *10%* | *1%* | *27%* | *1%* |
| **16 Manufacture of wood and of products of wood and cork, except furniture** | 5,462 | 1,565 | *100* | *29%* | *5%* | *6%* | *8%* | *6%* | *3%* |
| **17 Manufacture of paper and paper products** | 17,800 | 5,102 | *100* | *29%* | *6%* | *11%* | *7%* | *0%* | *4%* |
| **18 Printing and reproduction of recorded media** | 1,361 | 351 | *100* | *26%* | *3%* | *11%* | *7%* | *2%* | *4%* |
| **19 Manufacture of coke and refined petroleum products** | n/a | n/a | *100* | *n/a* | *n/a* | *n/a* | *n/a* | *n/a* | *n/a* |
| **20 Manufacture of chemicals and chemical products** | 6,891 | 1,340 | *100* | *19%* | *9%* | *4%* | *3%* | *0%* | *3%* |
| **21 Manufacture of basic pharmaceutical products and pharm. preparations** | 1,659 | n/a | *100* | *0%* | *n/a* | *n/a* | *n/a* | *n/a* | *n/a* |
| **22 Manufacture of rubber and plastic products** | 3,184 | 1,960 | *100* | *62%* | *6%* | *41%* | *2%* | *3%* | *10%* |
| **23 Manufacture of other non-metallic mineral products** | 2,788 | 613 | *100* | *22%* | *4%* | *8%* | *3%* | *2%* | *6%* |
| **24 Manufacture of basic metals** | 7,155 | 1,967 | *100* | *27%* | *22%* | *2%* | *0%* | *1%* | *2%* |
| **25 Manufacture of fabricated metal products, except machinery and equipment** | 6,877 | 2,695 | *100* | *39%* | *7%* | *12%* | *4%* | *11%* | *5%* |
| **26 Manufacture of computer, electronic and optical products** | 25,735 | 1,430 | *100* | *6%* | *0%* | *5%* | *0%* | *0%* | *0%* |
| **27 Manufacture of electrical equipment** | 4,623 | 1,292 | *100* | *28%* | *2%* | *3%* | *n/a* | *1%* | *23%* |
| **28 Manufacture of machinery and equipment n.e.c.** | 14,790 | 7,662 | *100* | *52%* | *8%* | *21%* | *5%* | *3%* | *16%* |
| **29 Manufacture of motor vehicles, trailers and semi-trailers** | 1,433 | 745 | *100* | *52%* | *1%* | *27%* | *5%* | *9%* | *10%* |
| **30 Manufacture of other transport equipment** | 1,641 | 482 | *100* | *29%* | *14%* | *4%* | *5%* | *3%* | *5%* |
| **31 Manufacture of furniture** | 1,056 | 352 | *100* | *33%* | *9%* | *5%* | *5%* | *11%* | *3%* |
| **32 Other manufacturing** | 694 | 153 | *100* | *22%* | *3%* | *12%* | *1%* | *1%* | *5%* |
| **33 Repair and installation of machinery and equipment** | 2,588 | 896 | *100* | *35%* | *6%* | *14%* | *5%* | *3%* | *7%* |

Data source: Statistics Finland.

# Appendix D Domestic patent applications in West Finland by IPC section, years 2011-2013 total




*Colour blocks: regional division of the IPC sections in years 2011-2013.*

*Numbers in blocks: number of patent applications by IPC sections in years 2011-2013.*

Data source: Statistics Finland.

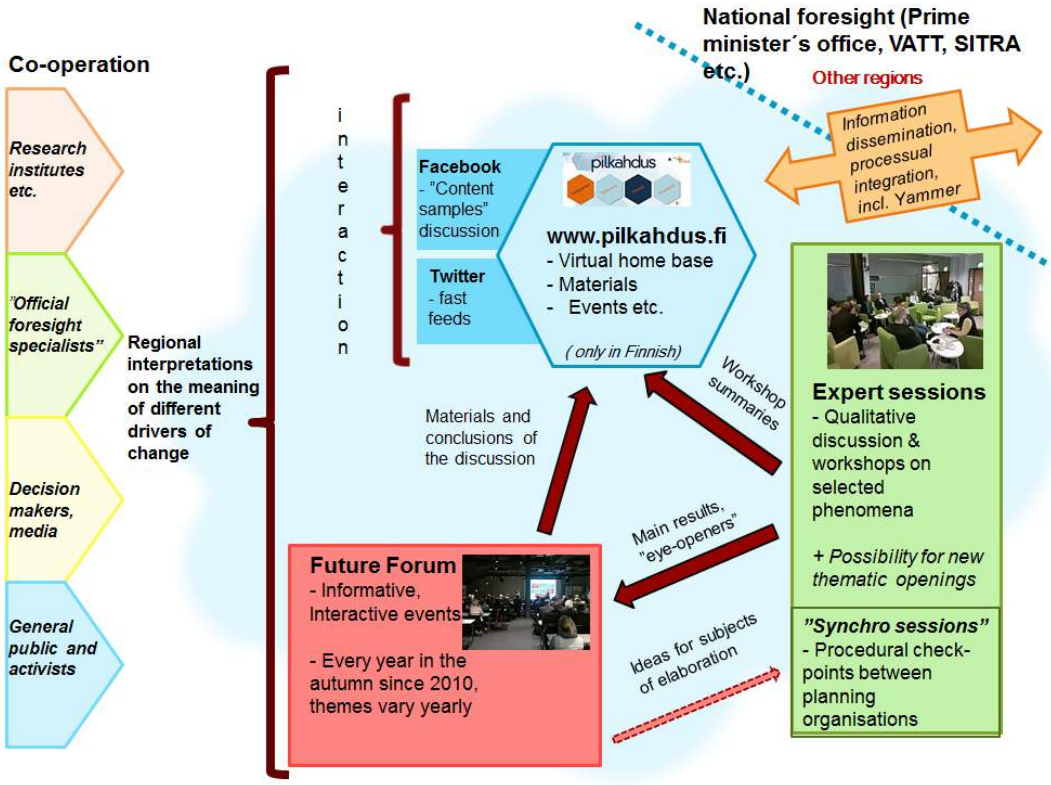
# Appendix E Business sector cases in West Finland

| | SEGMENTS IN NANO CLUSTER | | | |
|---|---|---|---|---|
| POSITION IN VALUE CHAIN | **Materials (e.g. Hybrids, Nano Structured, Coatings, Active)** | **Measurement and Modeling (e.g. Surface, Aerosols, Ultra-fine Particles)** | **Life Science (e.g. Medical Devices, Biomaterials, Implants, Diagnostics)** | **Optics and Photonics** |
| Total Deliveries | Metso: Special nanostructured steels, coatings and hybrids in the end products to resist wearing and extreme conditions.<br>Nokian Tyres: Carbon nanoparticles, hybrids.<br>Metso Minerals<br>Sandvik | Metso | Santen | Millog<br>Metso<br>Nokia<br>TammerNeon<br>Satron Instruments<br>Neonelektro<br>KeepLoop<br>Teleste |
| System Deliveries | Teknikum: The components of the rubber compound are selected on the basis of the functional specifications of the product and the needs of the manufacturing | Pixact: Custom-designed image-based measurement and analysis systems for process industry.<br>Cavitar: Illumination | Modulight: Laser-based solutions for a light-assisted drug delivery system in cancer treatment; laser components and custom-made laser | Modulight<br>Oseir<br>Ceraheat<br>Pixact<br>Corelase<br>Primoceler<br>Nanofoot: |

| | SEGMENTS IN NANO CLUSTER | | | |
|---|---|---|---|---|
| | process. | lasers for industrial monitoring systems and system manufacturing integrators.<br>Oseir: Equipment for monitoring and controlling the thermal spraying process in industry.<br>Decati: Fine particle measurement and analysis instrumentation. Particle detection including engine exhaust, combustion emissions, air quality and pharmaceutical aerosols.<br>OptoFidelity | instrumentation and solutions.<br>Bionavis: Surface Plasmon Resonance technology instruments with superior features and performance. | Automated testing and quality assurance systems for the LD/LED manufacturing industry and research institutes. |
| Materials, Component Deliveries | IonPhasE: a solution provider of static dissipative polymers that helps to manage ESD and static electricity related issues in plastic materials.<br>Millidyne: Specialty coating raw materials combining nanotechnology and surface engineering.<br>Fineko Green Technologies: Building materials and primary chemical products based on third-generation nanotechnology. | Pegasor: sensors enabling the measurement of both particle number and mass, both critical to emission regulations and the health effects of particulates. Fine particle emission and air quality monitoring instruments. | Bioretec<br>Inion<br>Conmed<br>Ozics | Modulight<br>Corelase: Innovative laser applications and processes for the manufacturing industry.<br>Primoceler: Laser-assisted micro-welding processing of sensitive transparent materials; products to help prevent heat which can cause problems with sensitive components.<br>Nanofoot |
| Tools, Enabling Technologies | Research and higher education institutions such as Tampere University of Technology, University of Tampere, University of Jyväskylä, University of Vaasa, ORC, Nanoscience Center, VTT, BioMediTech, Tampere Wear Center, FIMECC and Universities of Applied Sciences. | | | |

Source: Tampere Region Economic Development Agency Tredea (2013) Nanotech cluster in Tampere Region.

# Appendix F The regional foresight model, Pilkahdus




Source: Council of Tampere Region.

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