Review on regional resources and further development of Analytical Research Infrastructures

Regional maps of science and business collaboration networks

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Baltic TRAM - Transnational Research Access in the Macro-region

WP 4

Forewords

This report has been edited by Sari Stenvall-Virtanen, Development and project manager at the Brahea Centre at University of Turku in close cooperation with the project partners, as part of the Baltic TRAM (Transnational Research Access in Macro-Region) project. Contributors of this report are mentioned in the respective country specific sections.

Baltic TRAM project in Brief

Baltic TRAM (Transnational Research Access in Macro-Region) establishes structures to serve as interface between analytical research institutes and companies, so called Industrial Research Centres (IRECs). During the project invited companies are offered consultations and access to research facilities to test their ideas.

The Baltic TRAM project offers companies free access to state-of-the-art analytical research facilities across the Baltic Sea Region, providing technical and scientific expertise to help solve challenges associated with developing new products or services. The overall objective is to boost innovation, secure the implementation of smart specialisation strategies, and encourage entrepreneurship by supporting small and medium size enterprises – thus contributing to the regional effort of making the Baltic Sea Region innovative, sustainable and competitive.

To achieve this, Baltic TRAM also feeds into the transnational research and innovation agenda. It performs benchmarking analysis on national roadmaps for research infrastructures and smart specialisation strategies, and provides recommendations to policy makers.

Baltic TRAM builds on the findings of Science Link, an initiative which received EU project funding 2012-2014. Science Link is currently operated as a network. The purpose of Science Link network is to encourage innovation and entrepreneurship in the Baltic Sea Region, to strengthen the region's competitiveness in a global context. It supports industrial research with synchrotron radiation and neutrons at research facilities in northern Europe. The aim is to create awareness of the possibilities offered at research facilities in the region and to show how research and development at these sites can contribute to innovation within European industry.

Baltic TRAM Project budget: 4,157,013.60 EUR

Interreg Baltic Sea Region Programme contribution: 3207699,40 EUR

The project runs from March 2016 until February 2019.

Baltic TRAM website: www.baltic-tram.eu

Keywords

SME development, smart specialisation, Baltic Sea Region, transnational cooperation, research infrastructures, innovation, regional development

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1. Introduction

As part of the on-going Baltic TRAM (Transnational Research Access in the Macro-region) project activities an extensive review on regional analytical research facilities, related intermediaries and current operational networks and resources and their further development in the context of the transnational science-business collaboration in the Baltic Sea Region was drafted. The first results of this work are published in this report which brings together knowledge of the current number, status and nature of the regional analytical resources, the state of their intermediate and supporting administrative organisations and the research, development and innovation networks of the project-partner regions. Inevitably, this mapping exercise reflects different national and regional approaches to regional innovation systems. For example, it is noteworthy mentioning that in some cases the optimal region has been defined (by the project-partner) to cover the whole country and in others the administrative regional limits shape also the regional innovation system selected for further analysis. The second part of the country specific sections presented in this paper includes descriptions of the strong and emerging clusters and their connections to the smart specialisation strategies. This part of the analysis is also focusing on interactions between the RIS3, clusters and research infrastructures and innovation development from national level towards the regional and finally the local level.

Identified actors in the Baltic TRAM project regional innovation ecosystems included the following: Governmental agencies and bodies; the most important Funding instruments for SMEs innovation and development; higher education institutions with research services and technology transfer [TT] offices; other Research and Technology organisations; Commercial analytical laboratories and Big Companies with own R&D infrastructures; Intermediaries and regional development organisations; Incubators, science parks and Chamber of commerce and other relevant trade organisations. Inevitably, this mapping exercise reflects different national and regional approaches to regional innovation systems. It is noteworthy mentioning that in some cases the optimal region has been defined (by the project-partner) to cover the whole country and in others the administrative regional limits shape also the regional innovation system selected for further analysis.

The second report on the regional mapping exercise is *also published by the Baltic TRAM project (Review on regional resources and further development of Analytical Research Infrastructures – The needs and potential for interregional cooperation).* The second report builds strongly on the content presented in this first descriptive report. The second part brings together the most important findings and conclusions based on the country specific mappings and further analysis. The objective of the report is to offer a short summary on identified regional analytical research facilities, related intermediaries and operational networks and resources and their further development in the context of the Baltic TRAM project in the Baltic Sea Region. Findings are then also summarised by focusing in the needs and potential for macro-regional research cooperation based on regional realisations. Finally the report presents suggestions for a sustainable way forward in the interregional research cooperation in the field of material sciences in the form of the forthcoming Network of IReCs.

The objective of this report is to offer an extensive descriptive review on regional analytical research facilities, related intermediaries and operational networks and resources and their further development in the context of the on-going Baltic TRAM (Transnational Research Access in the Macro-region) in the Baltic Sea Region. The report is one of the key sources of evidence on which to build and orient the forthcoming Network of IReCs.

In general, the term ‘research infrastructures’ [RI] refers to facilities, resources and related services used by the scientific community to conduct top-level research in their respective fields, ranging from social sciences to astronomy, to genomics and to nanotechnologies. Examples include singular large-scale research installations, collections, special habitats, libraries, databases, biological archives, clean rooms, integrated arrays of small research installations, high-capacity/high speed communication networks, highly distributed capacity and capability computing facilities, data infrastructure, research vessels, satellite and aircraft observation facilities, coastal observatories, telescopes, synchrotrons and accelerators, networks of computing facilities, as well as infrastructural centres of competence which provide a service for the wider research community based on an assembly of techniques and know-how. RIs may be ‘single-sited’ (a single resource at a single location), ‘distributed’ (a network of distributed resources), or ‘virtual’ (the service is provided electronically). These key infrastructures have not only been responsible for some of the greatest scientific discoveries and technological developments, but are also influential in attracting the best researchers from around the world and in building bridges between national and research communities and scientific disciplines[1].

In the case of the Baltic TRAM project, the focus is on a part of RIs, namely on *Analytical research facilities [*ARFs], i.e. materials measurement infrastructures. Identified actors in the Baltic TRAM project regional innovation ecosystems included the following: Governmental agencies and bodies; the most important Funding instruments for SMEs innovation and development; higher education institutions with research services and technology transfer [TT] offices; other Research and Technology organisations; Commercial analytical laboratories and Big Companies with own R&D infrastructures; Intermediaries and regional development organisations; Incubators, science parks and Chamber of commerce and other relevant trade organisations.

The mapping of ARFs, their intermediaries and operational networks reflect Business-university collaboration which is an important component of the regional innovation ecosystems. Innovations are complex, non-linear processes, so the complexity of the regional innovation ecosystems is not at all surprising either. However, the complexity of the policy support mechanisms for research and innovation poses a barrier to business engagement in collaborative activities, especially for small businesses. It also makes it difficult for government to take a systems’ view of its support mechanisms for research and innovation. The governmental actors should therefore seek to reduce complexity wherever possible and, where simplification is not possible, every effort should be made to ensure that the interface to businesses and academics seeking support for collaborative R&D is as simple as possible[2].

All country specific reports have been edited by the WP4 Leader Sari Stenvall-Virtanen from University of Turku based on the partner contributions. Respective contributors for the country specific parts are mentioned in the respective country specific sections.

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[1] European Commission, Research Infrastructures, http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=what, retrieved April 18th 2016

[2] The Dowling Review of Business-University Research Collaboration, 2015, http://www.raeng.org.uk/policy/dowling-review/the-dowling-review-of-business-university-research

1. Denmark

Martina Simurda, Sönke Wolter & Frank Juergensen

Denmark has a broad cluster landscape which is supported by the national, regional and local policies and governments[3]. The overarching Cluster Strategy 2.0 2016-2018 structures the joint efforts and categorises clusters according to their strategic focus such as level of internationalisation or integration of industry, research and education and sets cross-cutting performance indicators. This report will concentrate on the region of Southern Denmark (DK03) and elaborates on the relevant clusters solely in this region which consists of altogether 22 communes.

Denmark was affected by the financial crisis a lot. Not only the GDP was influenced by the crisis but the R&D expenditures were affected as well. There was a great fall down in GDP annual growth rate from 2008 to 2009. The GDP growth rate (annual %) was -0,7 % in 2008 and -5,1 % in 2009. Then the situation got better in 2010 with GDP annual growth rate 1,6 % and 2009 the GDP annual growth rate was 1,2 % and in 2012 the GDP annual growth rate went again into minus with -0,7 %.The annual growth rate of GDP in 2013 in Denmark was -0,5% (after the -0,7% in 2012) and in 2014 1,1%.5. The R&D expenditures in % of GDP decreased from 3,1 % in 2009 to 2,9 % in 2010 and then increased to 3 % in 2011 and stayed the same in 2012 and later on increased to 3,1 % in 2013.

The main responsibility in the area of innovation and research in Denmark has the Ministry of Higher Education and Science. The Ministry of Business and Growth has some tasks related to business development and ministeries such as the Ministry of Climate, Energy and Building, the Ministry of Food, Agriculture and Fisheries, the Ministry of Environment and the Ministry of foreign Affairs have larger R&D programmes. The ministries have specific agencies to implement the respective policies. To the main performs in the area of research counts universities. The main collaboration partners of the private sectors are GTS institutes ("Godkendte Teknologiske Serviceinstitutter"). Other important institutions for Danish research and innovation are several Danish hospitals, three national laboratories and the nine independent academies of professional higher education.

The main public bodies for policy and funding in Denmark are the Danish Agency for Science and Higher Education and the Danish Agency for Institutions and Educational Grants. The agencies belong to the Danish Ministry of Higher Education and Science. Among the main areas, the agencies are working with, are Research and research-based education, Research funds, EU-wide and global collaboration on research and education, International education programmes, Research infrastructure and Analysis and statistics, Innovation infrastructure, Administration and grants. A detailed description of the agencies' task is provided below.

2.1 Clusters and emerging clusters and their connection to the RIS3

Regarding smart specialisation, supporting the investments of Cohesion Policy´s programming period 2014 – 2020 as well as other funds supporting smart specialisation implementation in Denmark, the country doesn´t have one single national or regional innovation strategy for smart specialisation (RIS3). Nevertheless, the S3 framework of Denmark has a strong focus on the

[3] Cluster Excellence Denmark, http://www.clusterexcellencedenmark.dk

development of viable clusters and innovation networks which is also reflected in the regional development strategies. The economic development strategy of the Region of Southern Denmark for the period 2012-2020 identifies three business areas which are specifically strong in the region and are supported due to their growth potential.

These areas are:

- Health and social innovation

The increasing national and international demand for innovative welfare solutions, including welfare technologies and service, is generating a large international market that the companies of Southern Denmark can exploit.

- Sustainable energy

The increasing demand for energy resources is creating an expanding global market in the field of energy-efficient technologies, the extraction of fossil fuels and sustainable offshore energy.

- Experience economy

Southern Denmark has internationally popular destinations that are attracting an increasing number of holidaymakers and commercial tourists. Southern Denmark possesses strong skills in the fields of food and design – skills that can contribute to boosting the companies' revenues.

According to this strategic outline those clusters supporting these three business areas are especially relevant for the region. These clusters are shortly described in the table below.

Table 2.1.1: Strong Clusters in Southern Denmark

Cluster	**Description**	**Web**
The welfare technology cluster – Welfare Tech Region	Welfare Tech is a Danish national cluster and hub for innovation and business development in healthcare, homecare and social services.	www.welfaretech.dk
The energy efficiency cluster - Lean Energy Cluster	CLEAN is a world-leading cleantech cluster based in Denmark and with an international foot print. Our mission is to accelerate the green and sustainable transition while realizing growth for the Danish cleantech sector.	www.cleancluster.dk
The design cluster - Design2Innovate	D2i – Design to innovate is a cluster organization focused on design-driven innovation. D2i brings design research and practices to businesses, public authorities and other knowledge-based institutions that are already working with or wish to work with design.	www.cdcm.dk

Offshore Centre Denmark and LORC	The overall purpose is gathering the offshore sector's players, strengthening the offshore industry's innovation capabilities and enhancing cost-reduction through strategic partnerships between offshore companies, universities and technical service providers	www.offshoreenergy.dk
Danish Food Cluster	Danish Food Cluster empowers businesses, academia, and public authorities to achieve more innovation and growth together than they could ever achieve alone.	www.danishfoodcluster.dk/

In addition to these clusters which are supporting directly the regional development strategy further clusters and innovation networks became relevant to the region involving regional players so called diversification clusters, where one example is the RoboCluster (http://en.robocluster.dk) which brings together Danish expertise in the field of robotics research, development and design. The network provides you with the latest knowledge on robotics and intelligent solutions and services for several areas of great political and developmental attention. Get new input for your challenges in the field of robotics and automation and get closer to the Danish robotics environment.

2.2 Interactions between RIS3, clusters and regional development strategies guiding research and innovation

With the innovation strategy the Danish government ensure substantial public investments in research, innovation and education that should lead to more growth and job creation. The vision of the innovation strategy is: "Denmark should be a nation of solutions, where innovative solutions to great societal challenges are translated into growth and employment." There are three main focus areas in the strategy:

1. Innovation driven by societal challenges – Demand for solutions to specific societal challenges must be given higher priority in the public innovation policy.

2. More knowledge translated to value – Focus on mutual knowledge exchange between enterprises and knowledge institutions and more efficient innovation schemes.

3. Education as a means to increase innovation capacity – A change of culture in the educational system focusing more on innovation[4].

[4] Ministry of Higher Education and Science, Research 2020, http://ufm.dk/en/research-and-innovation/political-priority-areas/research2020/about-research2020, retrieved May 23rd 2016

The overall strategic document *Research 2025* guiding research and innovation in Denmark was renewed and published in June 2015 by the Ministry of Higher Education and Science. The strategy functions as a source of inspiration and knowledge and helps to prioritize research investments in various contexts such as political negotiations of the distribution of the research reserve, strategic considerations at Danish knowledge institutions and in relation to Danish participation in international research cooperation. The strategy focuses on following topics:

- Better health
- Green growth
- People and society
- New technological opportunities (digitalisation, bio- and life sciences, production, materials)

In addition, the Danish Ministry for Higher Education and Science published in 2015 a strategic plan for how Denmark can make the most of the ESS. The strategy encourages and involves also all research organisations in Denmark to make the best use of the ESS facilities for research and innovation.

The University of Southern Denmark made with the help of national and regional governments and stakeholders in the last years strategic investments in small-, mid- and large-scale research and innovation infrastructure e.g.

- Clean room
- ORION helium ion microscope
- Roll-to-Roll print facility

The university supports the following strategic research focus areas[5]:

- Welfare innovation
- Drones
- Open data

2.3 Regional resources and national networks of ARFs in Denmark

Denmark has well performing research and innovation system. According to the Union Innovation scoreboard is Denmark one of the leaders in the area of innovation. Denmark has really strong culture for innovation and it is an open and dynamic welfare society[6].

[5] University of Southern Denmark, The university is enhancing its research and development activities in three areas: Drones, welfare innovation and open data, http://www.sdu.dk/en/samarbejde/strategiske_indsatsomraader

[6] Grimpe, 2015, RIO Country Report Denmark 2014, p. 1, https://rio.jrc.ec.europa.eu/sites/default/files/riowatch_country_report/RIO%20Country%20Report%202014_Denmark.pdf, retrieved 31st May 2016

Governmental agencies and bodies

The most important institutions connected to science, technology and innovation in Denmark belong to the Ministry of Higher Education and Science, as the main public body for policy and funding in Denmark:

- The Danish Agency for Science and Higher Education
- The Danish Agency for Institutions and Educational Grants

The Danish Agency for Science and Higher Education has responsibility for all tasks that require particular expertise within the areas of research and education – across all institutions.

The agency lays the foundation for further development of high-quality Danish research and higher education, and works to promote good international interaction in both research and education areas. The agency contributes to new analyses, and follows professional developments and discussions within the sector. The agency also manages tasks that support a high level of quality in national research infrastructure. It is also the Danish space authority.

Other areas covered by the agency include EU and global cooperation within education and research, international education programmes, assessment and recognition of foreign education programmes, accreditation, and the space area.

Moreover, the Danish Agency for Science and Higher Education contributes expert knowledge in the provision of ministerial services and policy development in cooperation with the Department.

The Danish Agency for Institutions and Educational Grants has primary responsibility for institutions that fall under the Ministry of Higher Education and Science, including all higher education institutions, public research foundations, GTS (Advanced Technology Group) institutes, etc. The agency allocates and administrates grants and funding to institutions and has the main contact and dialogue with institutions regarding control of targets and results, inspection and administration.

The agency also has primary responsibility for SU (Danish students' Grants and Loans Scheme), including regular educational grants, the state's adult education grants, as well as other special grant schemes for educational applicants. The agency also has responsibility for ongoing operation and development of SU systems, as well as sector- and institutional-related IT.

Furthermore, the Danish Agency for Institutions and Educational Grants contributes expert knowledge in the provision of ministerial services and policy development in cooperation with the Department.

Funding programs for research and innovation

There are several funding programs and possibilities for the area of research and innovation in Denmark. Some of the most important ones are listed in below, which are all managed by the Innovation Fund Denmark[7].

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[7] Ministry of Higher Education and Science, 2013, Funding programmes for research and innovation, https://ufm.dk/en/research-and-innovation/funding-programmes-for-research-and-innovation/find-danish-funding-programmes, retrieved February 12th 2018

The goal of EUopSTART is to intensify more the internationalisation of Danish research as well as strengthen the relations between research institutions and businesses in the area of research and innovation. That is why the EUopSTART allocates grants for the preparatory work of Danish

The Industrial PhD is a program managed by The Innovation Fund Denmark. It is a three year industrial project that focuses on research in a specific area. The Industrial PhD is carried out by a company and university. The goal of this program is to increase knowledge sharing between universities and private sectors firms.

The Innovation assistant program is a possibility for small and medium-sized companies to hire a highly educated person. The programme is managed by Innovation Fund Denmark.

The Innovation Voucher Scheme supports collaborative projects between small and medium sized enterprises and knowledge institutions. The purpose is to increase the innovation capacity of the enterprises and introduce them to the opportunities of collaboration with knowledge institutions.

The Innovation Consortia program acts as a facilitator of the collaboration projects between companies, research institutions and non-profit advisory and knowledge dissemination parties. The goal is to develop together technology or knowledge that can be beneficial both for the individual company and for the entire industry within the Danish business community. The parties should cooperate on a high-quality research which is relevant to Danish companies. The knowledge for the cooperation should be converted into competences and services that are aimed at

SPIR funds (Strategic Platforms for Innovation and Research) initiatives which seek to strengthen the link between strategic research and innovation, dissemination and possibilities for fast application of new knowledge in connection with innovation in the private and public sectors.

In addition, funding is available for Strategic Research Programmes within the following areas:

- Sustainable energy and environment
- Health, food and welfare
- Strategic growth technologies
- Individuals, disease and society
- Peace and conflict
- Transport and infrastructure

Finally, the Independent Research Fund provides grants for independent research based on the researchers' own ideas within all fields of science. It covers also a Career programme for young research talents.

The aim of the Innovation Network Denmark is to help to establish network and cluster organizations. There are approximately 23 innovation networks all over the Denmark right at the moment. The Innovation Network Denmark is supporting the knowledge exchange between SME's and knowledge institutions. An innovation network can be described as a cluster organization where all relevant Danish universities and technology institutes within a specific technological area, a business sector or a cross-disciplinary theme are participating. Innovation networks in Denmark are the following:

- Innovation Network AluCluster - Knowledge and technology centre for aluminium
- Innovation Network Animation Hub
- Danish Sound Technology Network

- Innovation Network for the Food Sector – FoodNetwork
- Innovation Network for Biotech – Biopeople
- The Danish ICT Innovation Network – Infinit
- Innovation Network InnoBYG - Innovation Network for Energy efficient and Sustainable construction
- Innovation Network for Environmental Technology
- Innovation Network for knowledge-based experience economy – InViO
- Innovation Network for Biomass
- Danish Lighting Innovation Network
- Innovation Network for Market, Communication and Consumption
- Innovation Network Service Platform Service Cluster Denmark
- Innonet Lifestyle Interior & Clothing Innovation Network for Lifestyle
- Plastic and Polymer Innovation Network
- Innovation Network No Age National Partnership for innovative solutions for elderly people
- Innovation Network Offshore Center Denmark
- Innovation Network RoboCluster
- The Transport Innovation Network – TINV
- Innovation Network UNIC National Partnership for the Use of new Technologies in Innovative solutions for Chronic patients
- Innovation Network for Renewable Energy VE-Net
- Innovation Network for Water National Partnership for Water in Urban Areas
- Welfare Tech - Innovation Network for Health and Welfare Technology

Higher education institutions with research services

The most important role in the public sector in terms of research plays eight universities: Copenhagen University, Aarhus University, the Technical University of Denmark, the University of Southern Denmark, Aalborg University, Roskilde University, Copenhagen business School and the IT University. In our report we should concentrate only on the South Denmark region, where the University of Southern Denmark and one part of Aalborg University are located. Moreover there will be mentioned university colleges from the region of Southern Denmark which are relevant for the purposes of this report.

The main campus of the University of Southern Denmark is located in Odense. The other regional campuses are in Slagelse, Kolding, Esbjerg and Sønderborg. There are approximately 27 000 students studying at five faculties (Faculty of Engineering, Faculty of Health Sciences, Faculty of Humanities, Faculty of Science, Faculty of Business and Social Sciences) of the SDU, almost 20% of students are from abroad. The SDU employs more than 4000 persons.

There are five research centers connected to the SDU. These are:

1. DaMBIC (Danish Molecular Biomedical Imaging Center)
2. NanoSyd
3. NAC (Nucleic Acid Center)
4. NANOCAN (Nanomedicine Research Center for Cancer StemCell targeting)
5. ABACUS 2.0

The DaMBIC was established as cooperation between two faculties at the SDU, between the faculty of Natural Sciences and Health Sciences in Odense. To this centre are connected two main locations, one at the MEMPHYS Centre at the Natural Sciences faculty and the other at the Animal Research facility at the Health Science faculty. The centre objective is to create a multidisciplinary state of the art, open access, multi modal molecular bio-imaging research centre. This centre should be suitable for imaging specimens ranging from single molecules to rodents.

The NanoSYD centre is located at the University of Southern Denmark. Centre's overarching field is nanotechnology with special emphasis on thin films, device development from organic molecules, nanofabrication and nanophotonics. NanoSYD combines fundamental research on film growth and investigation of charge transport and transfer processes with applied research on device fabrication and characterization, including micro- and nanofabrication.

Nucleic Acid Centre was established from the grant from the Danish National Research Foundation in 2001. The idea behind the centre is to combine synthetic organic chemistry and the encoded recognition pattern of nucleic acids in novel innovative and creative ways. The location of this centre is at SDU at the Department of Physics, Chemistry and Pharmacy and the Department of Biochemistry and Molecular Biology.

NanoCAN Nanomedicine Research Center for Cancer Stem Cell Targeting Therapeutics NanoCAN is connected to nanotechnology, molecular biology, cancer and stem cell research. The center focuses on breast cancer research. The aim of this centre is the development of a novel and smart nano-drugs which can kill the cancer stem cells without any effect on the normal stem cells of the body.

ABACUS 2.0 is a supercomputer that can perform 582.2 teraflops. This supercomputer is able to carry out more than half a billion of calculations per second. ABACUS is open to all Danish researchers and industry and offers unique research opportunities for its users. Currently it has been used in advanced modelling and simulations in chemistry, material science, biophysics, high-energy physics, engineering, computational medicine, archeology as well as scientific data visualization.

Aalborg University was established in 197437 and is located in Aalborg, Esbjerg and Copenhagen. It is an educational and research institution within natural sciences, social sciences, humanities, technical and health sciences. It has more than 20 000 students and more than 4500 employees.

Danish Centre for Risk and Safety Management (RISK) is a cross-disciplinary center which is focusing on research and education in the field of risk and safety management. RISK's aim is to help reduce stakeholder's exposure to risk and to design safe system and work procedures. RISK was opened in 2011 as collaboration between Aalborg University and University of Southern Denmark.

University College Lillebælt offers education in following professions: social educators, teachers, nurses, radiographers, physiotherapists, occupational therapists, biomedical laboratory scientists, public administrators and social workers. It was established in 2008 and has around 7000 students and 700 employees.

University College South Denmark is offering higher education study programs and courses. The emphasis is on Educational Sciences, Health Sciences, Social Sciences and Communication.

National Centre for Health Promotion and Disease Prevention is a new research and development centre for health promotion in practice. The centre aims to provide evidence-informed practice-oriented and application-oriented knowledge in an innovative way. It tries to provide solutions to some of the challenges that the welfare society is facing right now.The centre works closely with local, regional and other partners on research and development in three areas:

1. Children, young people and health
2. Adults and Health Promotion

3. Welfare technology and rehabilitation

FABLAB is a facility which should inspire entrepreneurs to turn their ideas into new products and prototypes. Thanks to different types of materials, facilities, machinery, available staff and other is the FABLAB source for the inspiration. The Lab offers 3D printers, laser cutters and CNC machines. It is a place for prototyping, product development and idea generation. FABLAB offers workshops, teambuilding and training sessions focus on innovation, creativity and prototyping.

Other Research and technology organisations (RTOs)

GTS is Advanced Technology Group which is a network consisting of independent Danish research and technology organisations which are called GTS institutes and together create the GTS network. The GTS institutes are contributing to enhance the international competitiveness of the Danish business sector and are trying to help to Danish society to benefit in general. These institutes offer knowledge as well as technology and consultancy, co-operation on technological and market-related innovation, testing, quality assurance, and different types of certifications, benchmarking and optimization.

GTS institutes:

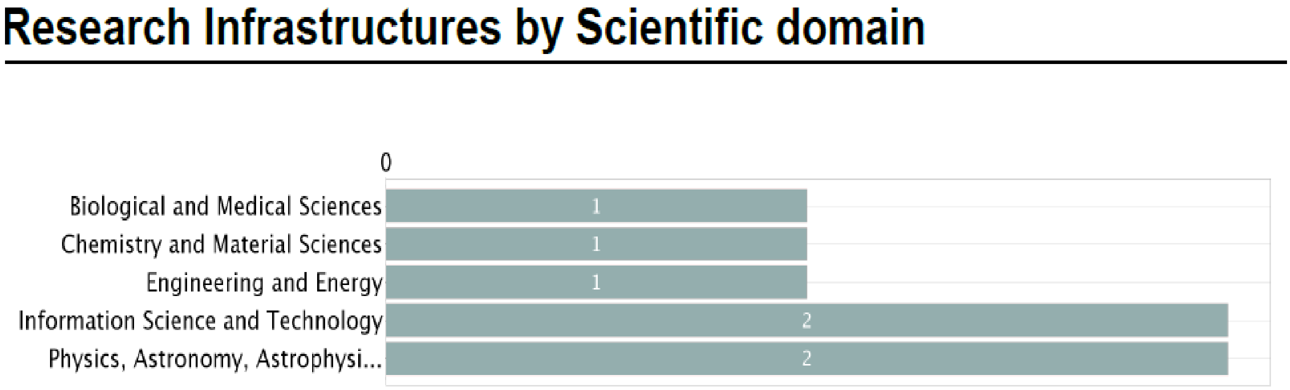
- Alexandra Institute - Aarhus[51]
- Bioneer - Hørsholm[52]
- DBI – Danish Institute of Fire and Security Technology - Hvidovre[53]
- DELTA a part of FORCE Technology – Danish Electronics, Light & Acoustics - Hørsholm[54]
- DFM – Danish Institute of Fundamental Metrology – Kgs. Lyngby[55]
- DHI – Water and Environment – Aarhus, Hørsholm[56]
- DTI – Danish Technological Institute - Aarhus, Taastrup[57]
- FORCE Technology - Brøndby[58]

Commercial analytical laboratories and Big Companies with own R&D infrastructures

Top ten Danish private R&D performers:

1. Novo Nordisk
2. Danske Bank
3. H Lundbeck
4. Novozymes
5. Danfoss
6. Vestas wind systems
7. Grundfoss
8. GN Store Nord
9. William Demant
10. ARLA Foods

Figure 2.3.1: Research Infrastructures by scientific domain in Denmark[8]



Intermediaries and regional development organisations

Business Development Centre Southern Denmark is a non-profit organization which offers its help to both national and foreign entrepreneurs with starting and further developing a business in the region of Southern Denmark. All services are free of charge. The Centre is responsible for business support in the region of Southern Denmark.

Syddanske Forskerparke is a science park located in Southern Denmark. It has two locations in Sønderborg and one in Odense. The role of the Park is to assist innovators in commercializing ideas and help the innovators into viable business. Headquarter is located in Odense and it is Denmark's

2.4 Development needs and gaps at regional level

The strategy, *Research 2025*, identifies specific research needs in the four thematic areas outlined above. The document discusses a broad range of research topics in subthemes such as digitalisation e.g. identifying the research areas Internet of things, big data and artificial intelligence, quantum computer, IT-security, block chain, digital infrastructure, interaction design and usability.

Due the comprehensive approach of the strategy the single research needs and gaps are discussed in this document as the details are available in the research strategy. The development strategy of the Region of Southern Denmark identifies the following general challenges and development needs:

- Flow from research to market is too weak
- Lack of skilled labour

Although the intensity of these gaps varies between the thematic areas, the University of Southern Denmark addresses these issues by strengthening the collaboration with regional industry partners e.g. in the frame of the Centre for Industrial Electronics, which is a academy-industry collaboration within research and education to be established between the University of Southern Denmark and

[8] MERIL (Mapping of the European Research Infrastructure Landscape) portal, https://portal.meril.eu/meril/, retrieved September 29th 2016

partners from the industry and the local government. This approach allows to match better both the needs for research and engineering education.[9] Anyhow the identified needs and gaps within the thematic areas discussed in chapter 3 are especially relevant to the Region of Southern Denmark. The competences and facilities at University of Southern Denmark and the regional research organisations provide the relevant resources to address the development needs and gaps successfully.

[9] See http://www.sdu.dk/en/om_sdu/institutter_centre/industrialelectronics , accessed in January 2018

2. Estonia

Ott Rebahne & Marco Kirm

In 2016, Estonia's population was about 1.3 million, GDP stood at €21b and GDP growth amounted to 1.6%. The input of shale oil refining industry had helped to double total intramural R&D expenditure and GERD intensity reached 2.37% in 2011 but this percentage has steadily declined to 1.74% in 2013 and to 1.28% in 2016, as the impact of investments to the shale oil refining industry disappeared. Also the R&D investment from the national budget (incl. European structural funding) has decreased because in that year, the beginning of the new budget period of EU, several large scale support measures (e.g. Programme for the funding of Estonian Research Infrastructure Roadmap objects, Institutional Development programme for Universities and Research Organisation "Per Aspera ad Astra") were launched only. As of 2016, about 52% of all R&D investments have come from the private sector[10]. The development of technology has produced only one third of the remarkable economic growth during the last 20 years in Estonia. While the economic growth has been based mostly on increasing involvement of labour force and capital, in the future it is more likely to occur through accelerating technological development and capital involvement. The expenditure into R&D has amounted to less than 2% of GDP on average in the last years (1.28% in 2016), but the long-term goal of "Estonia 2020" aims to bring this number up to 3% of GDP and business sector R&D investments at the level of 2% of GDP. In 2016, R&D financed by the business enterprise sector (% of GERD) was 52% and the share of government sector made up 46.7% of GERD in 2016.

The share of persons employed in research and development among employed people is still relatively low compared to the international level and most of them are active in the public sector i.e. at universities rather than in enterprises. The main players in the Estonian research system are the six public universities (the only private university is focused mostly on education in social sciences, not in technology research). There are around 400 companies actively conducting R&D in Estonia and around 10% of them account for most of the research, development and innovation investments.

It has been stated that the impact of Estonian R&D system is relatively weak in the local context and is not adequately connected to entrepreneurship, which means that the system doesn't create enough economic output. This is why Estonia is recommended to focus its RD&I activities on economic growth areas which are strong via smart specialization in order to achieve an increase in added value.

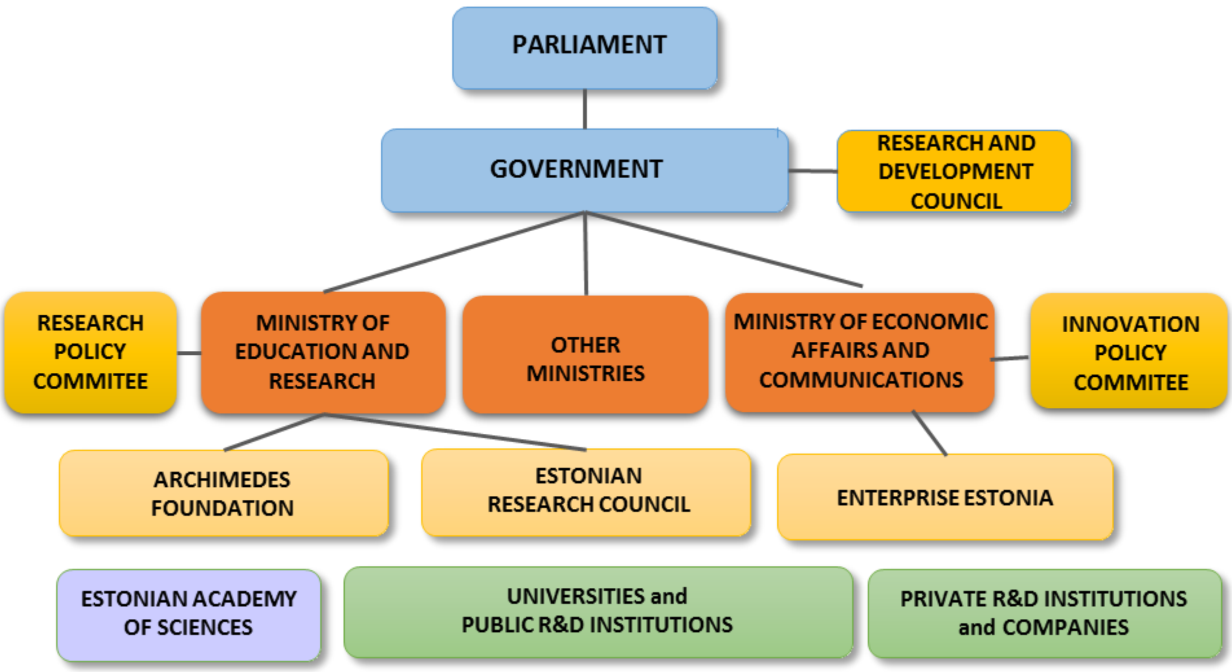
The important sectors of the Estonian economy are the manufacturing industry (approximately 15.7% of the overall production), transport, storage and communications (13.5%), commerce (12.2%) and real estate, rental and letting (10.3%). Agriculture and forestry amount to 2.2% of the overall production, construction approximately 6% and government, education and health care to more than 16.5%. Many of these sectors have a lot of potential to include innovations which could be researched and developed in cooperation with the Baltic Tram partners by using their corresponding capabilities. It can be noted that Estonia as a less developed European region is advised to focus on the applications rather than the general development of technology. The analysis of global entrepreneurship in Estonia from 2014 by the Development Fund (which in 2017 was replaced partly in its functions by the Foresight Centre at the Estonian Parliament) predicts that these activities are declining, which means

[10] Eesti Statistika, 2017, Kulutused teadus- ja arendustegevusele mullu vähenesid, https://www.stat.ee/pressiteade-2017-128, retrieved March 13th 2018

that additional conditions favouring entrepreneurship have to be created. Although Estonian National Research and Innovation System is one of the fastest growing innovation follower in Europe, the biggest problem is still the small economic effect of innovation since the innovation system is detached from the economy.

Figure .0.1 depicts the whole RD&I policy system with all decision/organisational levels responsible shown in Estonia. Strategies and general policies are discussed in the level of Estonian parliament "Riigikogu", which is the official body adopting these documents on the highest political and state governance level. The recommendations and goals are prepared in cooperation of various organisations and structures set up by government. The inputs are prepared by two leading ministries: by Estonian Ministry of Education and Research as well as by Estonian Ministry of Economic Affairs and Communications, but also other stakeholders like universities, private companies, renowned scientists and technology leaders, etc. are involved in the preparation phase. The ministries are also responsible for specific program design, implementation and monitoring. In the case of smart specialisation common efforts of different ministries are consolidated to achieve the goals set. Since 2016 the new political direction approved is to introduce research and development programs at various ministries in order to contribute to develop specific knowledge at their areas of responsibility. This is targeting societal needs for specific RD and I creation and implementation. The program management occurs in the next (third) level, where organisations responsible for implementation of the specific programs operate. They cover national and also structural funding (e.g. Estonian Research Council, Enterprise Estonia, divisions of ministries) or solely for European structural support (e.g. Archimedes Foundation etc.). The actual RD&I work is carried out by public Universities (6), state owned research organisations and private initiatives.

Figure 3.0.1: The Estonian Institutional Framework for RTDI policy. Note function of Estonian Development Fund a partly replaced by activities of the Foresight Centre at the Estonian Parliament, operating since 2017



The third Estonian R&D strategy "*Knowledge-based Estonia* 2014-2020" is available online[11]. The main difference from former two strategies is that this one is targeting to apply the potential of RDI system for growth of Estonian economy and development of society. Formerly, the strategies goal was mostly to enhance development of RDI system itself.

The overall aim of the development of Research Development and Innovation is to create favourable conditions for an increase in productivity and in the standard of living, for good-quality education, and for the longevity and development of Estonia. The strategy establishes four main objectives in Estonia:

1. Research in Estonia is of a high level and diverse.
2. Research and development functions in the interests of the Estonian society and economy.
3. RD makes the structure of the economy more knowledge-intensive.
4. Estonia is active and visible in the international RDI cooperation.

The Estonian research and innovation system can be divided into four levels. The Estonian Parliament and the national Government rule the highest level. In matters related to research, technology and innovation policy, the latter is supported by a high-level advisory body, the Research and Development Council. The Research and Development Council advises the Government of the Republic in matters relating to research and development strategy, thereby directing the systematic development of the national research, development and innovation system. The council is led by the Prime Minister. The Estonian Parliament Riigikogu and the national Government rule the highest level. In matters related to research, technology and innovation policy, the latter is supported by a high-level advisory body, the Research and Development Council[12]. The second level consists of the ministries, of which the Ministry of Education and Research and the Ministry of Economic Affairs and Communications play the main role in research and innovation policy. At the third level of the Estonian Innovation system we find the competitive R&I funding and the R&D funding agencies like Enterprise Estonia (EAS) and Estonian Research Council (ETAg).

Moving to the next level of the Estonian innovation system, the fourth level is comprised of the public organisations that conduct research: public comprehensive universities (3), universities of applied sciences or specialized universities (9). There are also 9 centres of excellence[13] which are presently funded until 2022.

Due to the low number of universities and public research institutes the Estonian research system is not too fragmented, but concentrated around the 2-3 largest universities. Most of these players in the Estonian innovation ecosystem affect the analytical research infrastructure and are discussed in more detail below. At the moment, there is a consolidation processes going on, which is expected to decrease number of state owned higher education and research organisations in the research

[11] Ministry of Education and Research, 2014, "Knowledge-based Estonia 2014-2020", https://www.hm.ee/sites/default/files/estonian_rdi_strategy_2014-2020.pdf, retrieved March 13th 2018

[12] Government Office, 2018, The Research and Development Council, https://riigikantselei.ee/en/research-and-development-council, retrieved March 14th 2018

[13] Archimedes Foundation Structural Funds Agency, 2016, Eurotoetuste abil alustab Eestis tegevust üheksa uut teaduse tippkeskust, http://adm.archimedes.ee/str/2016/03/04/eurotoetuste-abil-alustab-eestis-tegevust-uheksa-uut-teaduse-tippkeskust, retrieved March 14th 2018

landscape.

3.1 Clusters and emerging clusters and their connection to the RIS3

The ESFRI Roadmap 2016 identifies the new Research Infrastructures (RI) of pan-European interest corresponding to the long term needs of the European research communities, covering all scientific areas, regardless of possible location[14]. Since 2010 Estonia has its own national roadmap of research infrastructures (please see Estonian Roadmap[15]). This is a long term planning instrument (10-20 years) of research infrastructures in Estonia and abroad (including ESFRI objects). The funding decisions of particular activities are made separately, so it does not mean an automatic funding for any objects appointed. The list is regularly updated with the cycle of 3 years (most recently in 2014). The most of significant analytical research infrastructures in the context of Baltic Tram are the objects of Estonian roadmap. 8 objects from 18 of the Estonian roadmap can be qualified as analytical research infrastructures. The next funding decision round (2016-2022) were decided in 2016. These funds will be available for further development of analytical research infrastructures.

Estonia participates in the following ESFRI roadmap objects:

1. ELIXIR: The European Life Science Infrastructure for Biological Information
2. European Spallation Source ERIC
3. BBMRI ERIC: Bio banking and Biomolecular Resources Research Infrastructure
4. CLARIN ERIC: Common Language Resources and Technology Infrastructure
5. ESS ERIC: European Social Survey
6. EATRIS ERIC: European Infrastructure for Translational Medicine

The main document, which defines the development and governance of clusters in Estonia is one of the three programmes run by the funding authority Enterprise Estonia. Enterprise Estonia has tailored its support to 12 clusters in line with the national smart specialisation priorities and channels the funding provided by the European Regional Development Fund, in line with the main goal to support the international competitiveness of selected clusters´ partners, strengthening the export potential of Estonian small and medium sized businesses. (Enterprise Estonia, 2017) Indeed, as demonstrated in the interim evaluation of the national cluster programme conducted in 2013, the main reason for engagement in a cluster on the Estonian business side is to expand its access to foreign markets, "but the clusters´ capacity for locating new contacts for enterprises on foreign markets is not particularly high yet". This is one of the reasons why clusters don´t serve as the main channels facilitating the business expansion in foreign markets[16].

[14] European Strategy Forum on Research Infrastructures, 2016, ESFRI Roadmap 2016, http://www.esfri.eu/roadmap-2016, retrieved March 14th 2018

[15] Estonian Research Council, Estonian Research Infrastructures Roadmap, http://www.etag.ee/en/funding/infrastructure-funding/estonian-research-infrastructures-roadmap, retrieved March 14th 2018

[16] Mihkelson, P., Rebane, T, Peters, E. & Lember, K. (2013), p. 59. Klastriprogrammi vahehindamine. Interim evaluation of the cluster], Tallinn, http://workestonia.eu/images/doc/sihtasutusest/uuringud/ettevotlus/klastriprogrammi-vahehindamine2013.pdf

Furthermore, in order to provide a better understanding about the level of maturity attained through the support incentives of the selected 12 clusters and thus the level of excellence attained in advancing the niche expertise in selected smart specialisation domains, it should be noted that one Estonian cluster (Estonian ICT Cluster) now holds the Silver Label, and that Enterprise Estonia has contracted ESCA for the evaluation of the other 11 Estonian clusters by the European Secretariat of Cluster Analysis and all of these clusters have got the bronze label as of 2017 Autumn.

Estonian RIS3 priorities are stated as follows:

- Information and communication technology (ICT) horizontally through other sectors
- Health technologies and services
- More effective use of resources

While having strong clusters also for example in medicine, based on the ESCA assessment there is only one strong cluster namely the ICT cluster in Estonia which has silver label being definitely in line with 1 of the 3 Estonian Smart Specialization Priorities. Estonian ICT cluster is the main force to support ICT companies' collaboration and development in Estonia. It is ICT enterprises collaboration platform, which objective is to increase the usability of ICT in other economic sectors of domestic and foreign markets. Through this, we aim to foster the development of new solutions, the creation of new products, and to improve the companies' competitive ability in the international market.

Estonian ICT Cluster partners are smart product developers and creators of the world-recognized ICT solutions. The common denominator for Estonian ICT companies is their efficiency, creativity and the ability to ignore the concept of impossible. Most public and private e-solutions have been made by ICT cluster partners. The cluster is a joint platform to foster the export of ground-breaking e-solutions that have been developed and implemented in Estonia.

The three Smart Specialisation Areas resulted from the careful selection process lead by the Estonian Development Fund in Estonia are following:

1. Information and communications technology (ICT) horizontally via other sectors. Prioritized sub-sectors include use of ICT in industry (incl. automation and robotic), cyber security and software development.

2. Health technology and services. Estonia has the greatest potential in biotechnology and e-medicine.

3. More efficient use (enhancement) of resources. Prioritized sub-sectors are materials science and industry, development of the "smart house" concept and food that supports health.

3.2 Interactions between RIS3, clusters and regional development strategies guiding research and innovation

Estonian Research and Development and Innovation Strategy 2014-2020 has four main objectives: research in Estonia must be of a high level and diverse, research and development has to function in the interests of Estonian society and economy, RD has to make the structure of the economy more knowledge intensive and Estonia has to be active and visible in international RDI cooperation.

Estonian Entrepreneurship Growth Strategy 2014–2020 focuses on 3 main challenges to increase the wealth of Estonia: increasing productivity, stimulating entrepreneurship and encouraging innovation.

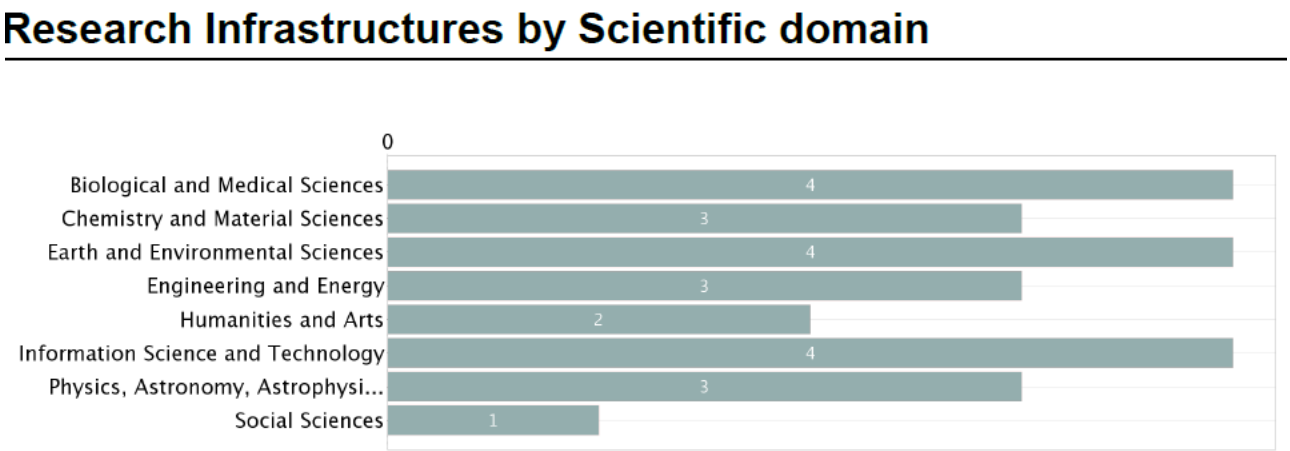
In Estonia, clusters in their activities are often quite similar to those of industrial associations and their roles can overlap or be used synonymously. There are at least 26 clusters in Estonia[17]: Cell Therapy Cluster, Connected Health Cluster, Defence- and Security Cluster, Digital Construction Cluster, ESTRONICS – Smart Electronics Cluster, Film Industry Cluster, Finance Estonia, Furniture Cluster, Green Economy Cluster, Health for Active Life Innovation Cluster, Health Tourism Cluster, ICT Cluster , Logistics Cluster, Medicine Export Cluster Medicine Estonia, Plastics Estonia, Real Estate and Energy Cluster, Road Cluster, Smart City Cluster, Timber Cluster of South-East Estonia, Wind Power Cluster, Wind Technology Cluster, Wood Industries Cluster, Wooden Houses Cluster, Recreational Craft Construction Cluster, Space Technology Cluster, Wooden Construction Cluster, etc.

Based on these data, one may conclude that there is 1 strong cluster and around 10 emerging clusters in Estonia. Most of these are connected to the RIS3 priorities for Estonia, which are ICT, healthcare and better use of resources.

3.3 Regional resources and national networks of ARFs in Estonia

According to the European Meril database there are altogether nine nationally important research infrastructures in Estonia representing altogether eight different RI categories.

Figure 3.3.1: Research infrastructures by scientific domain in Estonia[18]



In addition, there is a significant amount of smaller scale equipment (and services) available at the University laboratories. Information on these devices (incl. these described before) and services can be found at the Estonian Research Information System website[19]. In order to provide easy access to

[17] Estonian Clusters, http://www.estonianclusters.ee, retrieved July 27th 2017

[18] MERIL (Mapping of the European Research Infrastructure Landscape) portal, https://portal.meril.eu/meril/, retrieved September 29th 2016

[19] Estonian Research Information System, Products and Services, https://www.etis.ee/Portal/ProductServices/Index?lang=ENG, retrieved March 14th 2018

research capacity of academic institutions, University of Tartu and Tallinn University of Technology launched jointly a network ADAPTER, which provides a quick and reliable link for companies and organizations to the research and development community. At the moment all six Estonian public universities have joined the ADAPTER network, in total there are 10 partners. Two research institutions (NICPB, TFTAK), a competence centre (STACC) and a university of applied science (TKTK) in Tallinn joined ADAPTER recently.

3.4 Development needs and gaps at regional level

Any gap analysis has to compare a desired result with the current model and outcomes. The desired outcome should be a better world, which here could mean a prosperous, sustainable and friendly society. This requires effective work to be done by companies (i.e. organized groups of people) and some sharing of resources and knowledge. In addition to increasing the motivation of talented people to become entrepreneurs, the system also has to create good opportunities to collect required background knowledge and enable creation and use of innovative solutions. Although gaps in the system could be in multiple places, this analysis focuses on companies reaching technological innovations, which brings some benefit though the company to the society. It is important to note that European support through structural funds is crucial for faster development of the key areas connected with Estonian RIS3 priorities. Therefore, in Estonia many programs designed by various ministries a specially foreseen for the RIS3 priorities areas. Also in the selection processes of projects, which have stronger contribution to smart specialisation areas will have advantage.

It is important to point out that enterprises in Estonia are rather small as 91 % of them belong to category of "micro", which have less than ten employees. This means that capacity for R&D work is limited due to staff numbers, which is really a gap for innovation and cooperation with academic and research organisations.

Clusters

The range of existing and EAS-supported clusters seems to be sufficient to cover all of the RIS3 priorities of Estonia. In fact, only these clusters, which are connected to the smart specialization strategies, can get financial support from e.g. Enterprise Estonia programmes i.e. a combined financing by European and Estonian Funds. More clusters exist, but their activities are not prioritised and publicly funded. This is not a gap in the RIS3 sense. But this means that the publicly supported RIS3-related clusters are often run like a project, which have a starting date and an end date, and only operate with the help of EAS financial support. The gap here could be related to existing experience. The clusters are not yet aware that the funding made available should be seen as a seed to bring about some larger goals/activities and ensure sustainability without future support. Cluster members, who are often competitors in the local market and have difficulty trusting the common cluster activities, should change their attitude not to look too much at their own profit rather than the cluster's. Another gap is related to the size i.e. the clusters are simply too small and do not have enough the expert staff (with required competence) who could help members to find new markets or improve their position in the value chain. The roles of clusters and professional unions/organisations are also not yet quite clear – there seems to be a lot of overlapping there. The clusters do not cooperate enough, although many of them have a common value chain and could benefit from coordinating their efforts. Making the cluster internationally more visible is also a problem for Estonian clusters.

In some cases, a reasonable range of innovation activities that the cluster is capable to provide is available (e.g. Plastics Estonia). Clusters in general should receive information of better quality about the innovation-supporting capabilities of the surrounding scientific community and on the analytical research facilities. Clusters should also have direct contacts with the local Industrial Research Centres so that to be able to guide their members to necessary R&D activities. The clusters that are supported by Enterprise Estonia have the means and need to create relevant contacts and innovation possibilities but often do not reach the full potential in using local expertise within the country.

Innovative start-ups

The creation of start-ups and looking for good start-up ideas is popular and well-supported in Estonia. Also, start-ups have relatively good access to the scientific knowledge and measurement/research capacities since many of them are related to universities (see the list of spin-offs at University of Tartu[20]). Even some bridge-funding exists to develop the start-up into an operational production company. There may be a gap in the knowledge transfer, which is required to transfer the start-up to a series-manufacturing (or similar operational) stage efficiently.

Increased innovation in industry

The well-established companies sometimes have an inner reluctance to switch to a more efficient technology or solution. Only when a competitor is seen to have an edge because of the new technology is this reluctance overthrown because of financial reasoning. Well-established and larger companies also have enough resources to pay for the necessary R&D, but their inertia often prevents them from changing. There exist also mechanisms to increase such innovation, but a gap can be between the amounts that the funding mechanisms are willing to support innovation in well-established company with and the amount of money, which is needed to really get useful effect for the industry.

There seems to be a knowledge gap also for the players in the industry and the scientists, who are researching relevant topics. Therefore the Baltic TRAM model for supporting pilot projects via IReC-s and through ARF-s is seen to be one that helps close this gap.

Industry 4.0 style manufacturing

The slow increase in manufacturing automation and machine vision inspection and using smart algorithms to increase manufacturing efficiency is still a gap. The current project is not specifically addressing this gap, but increased funding to help the transition to industry 4.0 is seen as necessary in Estonia as well. It is also marked under RIS3 priorities as information and communication technology (ICT) horizontally through other sectors.

It would seem that there is a gap in the "Information and communication technology" RIS3 direction, but there is actually no gap and in addition to joint excellence center on computer science of the University of Tartu and the Tallinn University of Technology, Estonia even has the NATO leading facility in Cyber defence: CCDCOE, the NATO Cooperative Cyber Defence Center of Excellence in Tallinn, Estonia. Activities in information and communication technology are supported by Estonian Scientific Computing Infrastructure (ETAIS), which also belongs to the Estonian scientific infrastructure roadmap.

[20] University of Tartu, Spin-off Companies of University of Tartu, https://www.ut.ee/en/business/spin-companies-university-tartu, retrieved March 14th 2018

Identified gaps and development needs:

1. Estonian universities and researches organisation possess modern research infrastructures, which are more and more used for cooperation with entrepreneurs. However, despite of active information delivery towards potential clients, there is still gap exists reaching enterprises with R&D need. Hopefully, ADAPTER and special programs launched by Universities (e.g. A strategic partnership programme at University of Tartu) will help to overcome this problem and promote research/analytical capacity of academic community.

2. Better communication of the regional research capabilities towards clusters. This includes targeted information delivery and organising events for industry associations and clusters.

Funding-investments: This is a general problem addressed in Estonian Entrepreneurship Growth Strategy 2014–2020. According to statistics (2011) private and venture capital investments were eight times smaller than the European average forming only 0.04 % of the Estonian GDP.

3. A funding gap to promote innovation in well-established industries.
4. A funding gap to promote implementation of industry-4.0-style manufacturing.
5. Counselling to bridge the "valley of death" between Start-up Company and fully functioning service or manufacturing company.
6. Training of engineers and R&D specialist on using and understanding potential of modern analytical research equipment and benefits arising for innovation.

3. Finland

Ninetta Chaniotou & Sari Stenvall-Virtanen

In this country specific section we present an overview of the national and regional level science-business innovation ecosystem actors that have been identified as relevant in the Baltic TRAM framework. In addition to the network mapping we will also try to build a connection between the operational level science-to-business collaboration parties and policy level smart specialisation strategies and finally describe topical development challenges in the Finnish ecosystem. The main current challenge in the Baltic Sea Region is to strengthen the flow from research to market and to better match the research, analytical research facility services and offering with the needs of the regional industries and companies.

From the regions engaged in this Baltic TRAM project and regional analysis the region of Southwest Finland is especially strong in Industrial modernisation and manufacturing, especially in the maritime industry; sustainable innovations and human and health industries. Then again the most promising innovation potential in Kainuu region tend to be connected to bioethanol production; Wood construction in Kantola business park, Modern pulp mill (Bio product factory) and Concentration and utilization of valuable components of biomasses such as berries and their industrial side streams. In below sections we will discuss all these aspects in more detail.

4.1 Clusters, emerging clusters and their connection to the RIS3

Over the past twenty years Finland has developed a strong national and regional innovation policies. As outlined already in the Baltic Sea Region policy briefing regarding the smart specialisation, Finland does not have one single national level smart specialisation strategy in place[21]; however, there exist nationally expressed Smart specialisation priority areas, i.e. prioritised industries[22]:

1. Manufacturing & industry
2. Key Enabling Technologies
3. Sustainable innovation
4. Human health & social work activities
5. Information & communication technologies[23]

Already before the RIS3 discussion Finland recognised national industrial clusters since 1996 including the forest cluster, the metal cluster, the energy cluster, the telecommunications cluster, the well-being cluster, the environmental cluster, the transportation cluster, the chemical cluster, the construction cluster and the food production cluster. Analysis of focus, economic importance

[21] Halme, Saarnivaara & Mitchell, 2016, p. 33 in BSR Policy Briefing 4/2017.

[22] European Commission, 2017, Smart Specialisation - Strengthening Innovation in Finland, http://ec.europa.eu/regional_policy/en/information/publications/factsheets/2017/smart-specialisation-strengthening-innovation-in-finland, retrieved March 15th 2018

[23] Šime (ed.), 2017, National innovation and smart specialisation governance in the Baltic Sea region. Laying grounds for an enhanced macro-regional science-business cooperation, BSR Policy Briefing Series 4/2017

and relations between the clusters is important when we try to match clusters to regional, national and international networks.

The nationally defined priorities[24] of the Finnish regional S3 strategies are bioeconomy, cleantech, digital economy and the health sector, as well as intangible value creation[25]. A difference is noted between the regional priorities definitions and the national level S3 accepted by the EC. Two observations are important here:

1. The RIS3 concept as a structural funds conditionality was introduced in 2012 and ever since the prioritisation of industries has been evolving in line with the RIS3 literature, i.e. becoming more and more concrete;
2. In both cases, i.e. recommendations of 2014 and officially accepted industries of July 2017, reflect and reinforce the long term acknowledged national clusters.

4.2 Interactions between RIS3, clusters and regional development strategies guiding research and innovation

In addition to the national level policies the joint municipal authorities Regional Councils develop regional strategies including priorities of their structural funds including RIS3 prioritised industries (all Regional Councils in Finland are Intermediate Bodies of the ESIF). Their implementation is given form through national innovation funds (TEKES); regional and national development funds, and the structural funds. RIS3 is implemented based on adjusted criteria for funding, in principle[26], structural funds projects aligned with or contributing to RIS3 advancement.

According to regional council in Kainuu the Top priorities of smart specialization in Kainuu in 2014-2020 include three thematic areas:

- ICT and information systems including measuring technology, gaming and simulation technology, data centers and data center ecosystems,
- Natural resources where focus is on sustainable development in mining and bio-economy
- Health and wellbeing where focus is on activity tourism and innovations of nutrition, health and sport.

According to regional council in Turku (Maakuntaohjelma 2018-2021) the regional S3 priorities and

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[24] Research and Innovation Council of Finland, 2014, Reformative Finland: Research and innovation policy review 2015–2020, p. 20

[25] *"Intangible value creation is a national success factor. The central question is how to create expertise-based growth and how to create as much as possible of the value of products and services in Finland or through measures directed from Finland".* Ministry of Economic Affairs and Employment, Intangible value in business operations, https://tem.fi/en/intangible-value-creation, retrieved March 15th 2018

[26] Finland's structural funds budget for research and innovation is 813 million €, out of which 391 million € come form the EU and 422million € are national funds. (European Commission, Strengthening innovation in Finland, http://ec.europa.eu/regional_policy/sources/docgener/guides/smart_spec/strength_innov_fi_en.pdf, retrieved March 15th 2018) It follows that while RIS3 is an ESIF conditionality, regions are often challenged with the funding requirements for an effective RIS3 implementation.

primary target areas for development incentives for Southwest Finland currently include the following three large thematic areas:

- Blue Growth and industrial modernisation;
- Innovative value chains in Food Sector and
- Life Science and Health Technologies[27].

In terms of cluster development, thus far the overall trend in Finland has been to develop clusters according to the regional and local needs, less so towards transnational competitiveness. RIS3 literature foresees interregional connectivity among its key principles[28] and the structural funds regulation (CPR) the period 2014 -2020, article 70[29] foresees interregional spending beyond the programme area and beyond the Interreg programmes. These provisions facilitate the (needed) macro-regional approach in accessing research services. On the other hand, the political awareness and qualified intermediaries are of vital importance. Finnish aspirations to increase the competitiveness of the business sector by closer cooperation with analytical facilities, thus paving way for more applied activities, experimentation and reinforced partnerships with industry.

Enhanced science-business partnership could pave the way for further exploration how the interregional ties are developed with specific examples of processed business enquiries. To put the interregional dimension in a wider context, it should be added that in the Finnish case, there is an essential and strategic coherence between RIS3 and traditional regional innovation governance. It is due to several factors. Firstly, the bottom up development tradition in Finland plays a major role. Secondly, the triple helix approach encourages the interaction between clusters, industries and research-infrastructures. Thirdly, the framework RIS3 provisions (CPR) are of relevance. Furthermore, in Finland cooperation between cohesion (like ESIF) and innovation funds (like Horizon 2020, CPR´s Annex I) is emphasized outlining both:

1. "upstream actions" to prepare regional R&I players to participate in Horizon 2020 ("stairways to excellence");

2. "downstream actions" to provide the means to exploit and diffuse R&I results, stemming from Horizon 2020 and preceding programmes, into the market with emphasis on creating an innovation-friendly environment for industries in line with the regional S3.

However, RIS3 and traditional regional development approaches also differ due to RIS3 having a role of a change agent. It builds on place-based actions to reach out towards global demand. To this end, it acknowledges feasibility preconditions of any regional innovation effort, and among them critical

[27] Varsinais-Suomen Liitto, Varsinais-Suomen Maakuntaohjelma 2018-2021, http://www.varsinais-suomi.fi/fi/tehtaevaet-ja-toiminta/maakuntastrategia/maakuntaohjelma, retrieved February 5th 2018

[28] Please consult "The four Cs of smart specialisation" section "Connectivity and Clusters" in Foray et al., 2012, Guide to Research and Innovation Strategies for Smart Specialisations (RIS 3), page 347

[29] Regulation (EU) No 1303/2013 of the European Parliament and of the Council of 17 December 2013 laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083/2006.

mass and connectivity. Regional triple helixes, however, often do not address such feasibility factors. Nevertheless, today, it is generally understood that for most regions, addressing innovative growth requires interregional solutions. There are many reasons for this. One of them, especially relevant in peripheral areas, is that in certain cases traditional economic systems are out-dated because of radical change. For example, through economic evolution formerly thriving businesses have been closed or relocated. In such case, a new economic base must be then introduced to renew the economic growth of the region. In such context, it should not be forgotten that due to these major shifts, the industrial system which once supported a dynamic business has become obsolete, thus, also leaving the employees, specialisation research units and locally tailored educational programmes just as obsolete. To renew the economy of such a region, one solution is to strengthen ties with higher education and research units located outside the region, since local generation of new areas of expertise might take too much time to generate the very much needed new economic growth process.

Another reason for closer interregional ties is the mutual exchange of acquired expertise, which relevant to advanced but not too large economies (for example, many regions in southern Finland) due to being a financially, human resources and time-wise cost-efficient approach in niche expertise development. Advanced research produces new types of knowledge, as well as new types of research orientations of potential practical relevance not just for the region where it has been generated, but also to other regions with similar innovation and smart specialisation orientations encompassing KETs, industry 4.0, creative industries, etc. Thus, Baltic TRAM in the Finnish setting, holds the potential of providing further impetus to these interregional innovation spill-over effects which serve as much needed boosters for the overall benefit of regional economies.

4.3 The Finnish research & innovation governance / Regional resources and national networks of ARFs in Finland

The Finnish research system is relatively decentralised, with its main research being conducted at the 16 universities, 26 polytechnics and 18 government research institutes[30].

The Finnish innovation and research system framework consists of four operational levels (4.3.1). Level 1 The Finnish Parliament and the national Government rule the highest level. In matters related to research, technology and innovation policy, the latter is supported by a high-level advisory body, the Research and Innovation Policy Council (RIC). The RIC gives recommendations for the strategic development and coordination of Finnish research and innovation policies and is led by the Prime Minister[31]. Level 2 consists of the ministries, of which the Ministry of Education and Culture (MEC) and the Ministry of Employment and the Economy (MEE) play the main role in research and innovation policy. At Level 3 we find the competitive R&I funding and the R&D funding agencies (Academy of Finland, TEKES, and others[32]). Level 4 consists of the public organisations that conduct

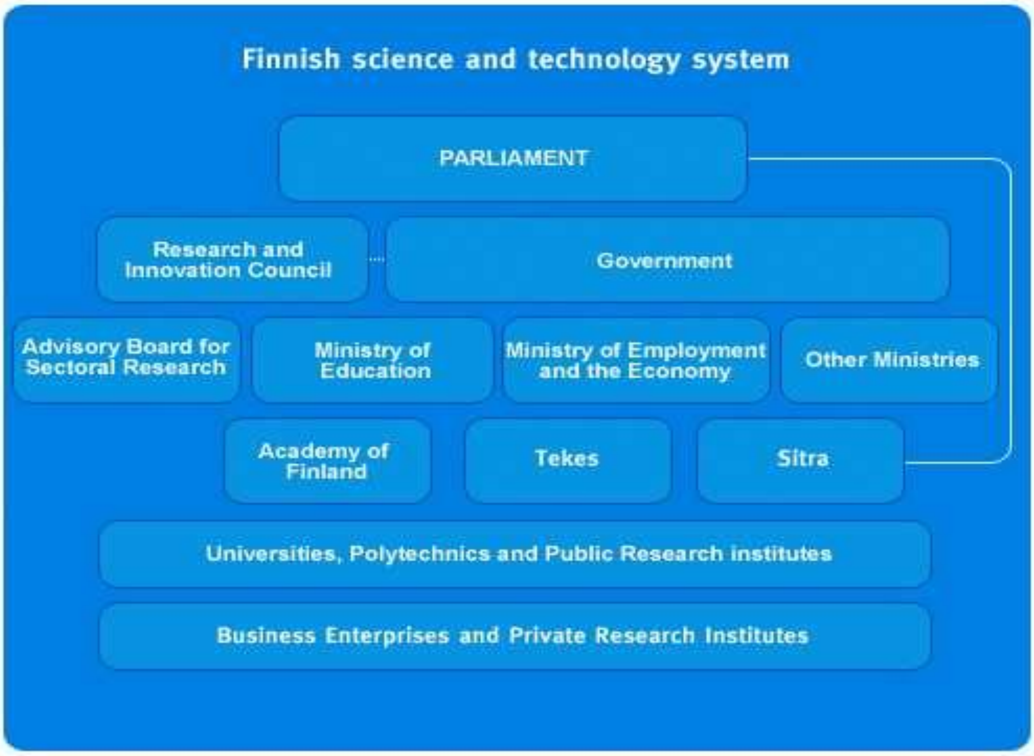
[30] ScienceNordic, Research in Finland, http://sciencenordic.com/about/research-finland, retrieved March 15th 2018

[31] Saarnivaara, 2015, RIO Country Report 2014: Finland. JRC Science for policy report, Research and Innovation Observatory country reports series

[32] "Technology programs (TEKES) – Grants (subsidies) for industrial R&D – Grants (Research funding) – research institutes, universities – Capital loans; Venture capital funding – Finnish Industry Investment (Teollisuussijoitus) – Sitra (National Fund for Research and Development); Service provision: Finpro – promoting commercialization of technologies and

research: universities (14), public research organisations (12) and Polytechnics, also known as Universities of Applied Sciences (26). The reform of the central government's sectorial research institutes has proceeded so that the number of the institutes has declined from 18 (2012) to 12 (2015). Still, due to the high number of universities, polytechnics and public research institutes the Finnish research system is rather fragmented.

Figure 4.3.1: The Finnish research and innovation system[33]



Despite the heavy cuts in the share of the RDI-funding TEKES - the Finnish Funding Agency for Innovation is still the most important funding agency for applied research in universities, research institutes and large companies. TEKES provides competitive grants and loans for development and innovation in SME's, grants and loans for Young Innovative Companies and contributes to seed phase VC-investments. A special target of TEKES funding is to build incentives for cooperation and knowledge interaction. Centres for Economic Development, Transport and the Environment (ELY Centres) are responsible for the regional implementation and development tasks of the TEKES. Hence the importance of TEKES is especially high in terms of supporting innovation development in the companies.

The BT-project identified also several other national level funding organisations, as for example TESI, Finnish Industry Investment Ltd, Finnvera Ltd and SITRA - the Finnish Innovation Fund. However, the role of these funding organisations is not so focused on product development or on supporting

internationalization of firms (SMEs); Foundation for Finnish Inventions (Keksintösäätiö). NO tax incentives ". Aalto University, 2015, Finnish Innovation System: Technology policies, policy organizations and instruments, page 7

[33] Aalto University, 2015, Finnish Innovation System: Technology policies, policy organizations and instruments, page 4

innovations in SMEs but they do have a crucial role in the commercialization phase of the new ventures.

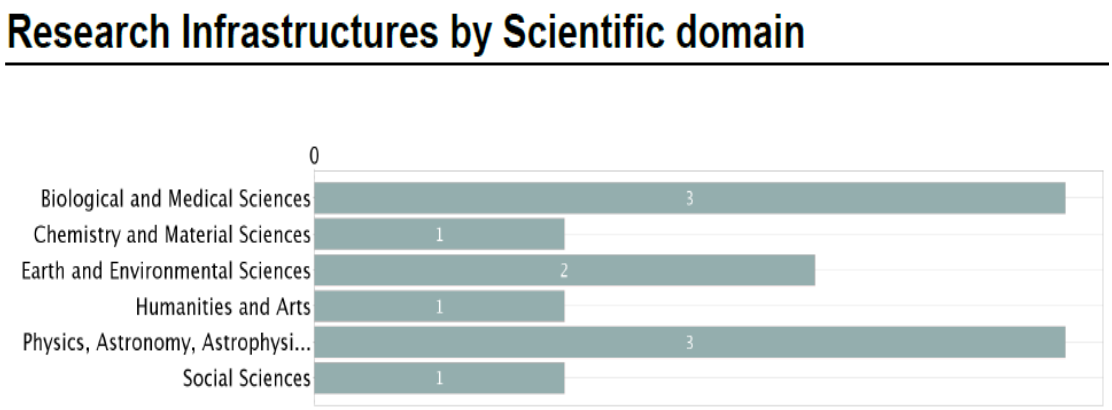
In Finland two NUTS2 regions were identified to form the framework for the analysis of regional Analytical Research Facilities and national innovation networks and ecosystems. The selected regions were Southwest Finland and North & East Finland, Kainuu where the Southwest region represent advanced growth centres and Kainuu northern sparsely populated areas with specific economic features and characteristics.

Local infrastructures, national research infrastructures, key partnerships in European infrastructure and international research institutes [RI] together, form pools of analytical research resources to be used in regional business development. Enhancing the impact of research is of primary importance in Finland and a higher yield from R&D inputs is expected. This is achieved, in principle, by long term, multilateral R&I activities, i.e. networks, by means of structural development and funding, multidisciplinary cooperation practices for parties producing, applying and exploiting research[34].

Summary of all research infrastructures at national level

Currently there are altogether 11 nationally important Research Infrastructures mapped in the European Meril database. 5 of these infrastructures are single-sited and 5 distributed by type. Majority of the nationally relevant infrastructures are in the field of natural sciences. All these infrastructures are presented in figure 4.3.2 below.

Figure 4.3.2: Research infrastructures by scientific domain in Finland[35]



In addition to the national level research infrastructures the regions have their own regional infrastructures. In the following sub-sections a summary of these resources is presented in a form of a regional networks of Turku region and Kainuu region[36].

[34] Research and Innovation Policy Council (2014). Research and Innovation Policy Council (2014) Reformative Finland: Research and innovation policy review 2015–2020.

[35] MERIL (Mapping of the European Research Infrastructure Landscape) portal, https://portal.meril.eu/meril/, retrieved August 29th 2016

[36] The Finnish research infrastructure Committee, 2013, Finland's strategy and roadmap for research infrastructures 2014-2020.

Southwest Finland regional network of ARFs

The economic profile of the Southwest Finland is very rich and diverse. Especially strong industries are sea and maritime industries and medicine and drug development which both are also strongly represented in the strategies of the University of Turku and Åbo Akademi. In the Turku region the amount of RDI-competent industrial companies which benefit from the high number of education institutions and educated work force in general. The overall research and development intensity is in Turku region higher than on average in the Finnish regions. Regional strengths are the diversity of the economic structure, many strong industries: Sea and maritime; Life-Science and Agri-Food; good geographical location and working infrastructures; strong educational offering at all levels. The strong industries are closely connected to both research and education but also to companies and clusters which are also internationally well recognised. Development of the Life-Science cluster is also supported by the Life Science accelerator founded in 2016 in the Turku Science Park. At the national level the importance of the Sea and Maritime industry is exceptional. The industry includes both ship building and related planning, on-shore and off-shore business activities and logistics. Also tourism in the archipelago is connected to this industry even though the full potential of the exceptional archipelago is not fully utilised at the moment. Other regionally important strong industries are also represented in many other regions in Finland[37].

All relevant analytical research facilities in the respective region were mapped during the early months of the Baltic TRAM project. In this report we are focusing in the core analytical research facilities including both academic facilities, commercial laboratories and other RTOs (Research and Technology organisations) like for example The Finnish Environment Institute and the Natural Resources Institute etc. that were recognised and mapped during the project.

According to the analysis of the ARFs the competences and facilities at the HEIs (University of Turku, Åbo Akademi and Turku University of Applied Sciences in the region of Southwest Finland) provide relevant resources and research and development competencies to address the development needs of the companies in the core fields of business. In addition to the higher education institutions in the regions, especially in Kainuu region, interregional connectivity and collaboration with other regions in Finland and also internationally further widen the possibilities (see the following section). The RI categories that are presented in the universities and core RTO's in the Southwest Finland region can be summarised in table format (See Annex 1).

At the HEI level the RIS3 areas are also well represented in the strategic planning. University of Turku has a research infrastructure policy which defines the most important profiling research infrastructures. In 2013-2016 these infrastructures were Turku Bioimaging, infrastructures in the department of physics and astronomy and FinLTSER. Turku Bioimaging and the FinLTSER have also been included in the list of the most important national infrastructures in Finland defined the ministry of education and culture. The research environments of the University of Turku aim to support the creativity of the researchers and to allocate support to the fields that are effective in their research and at good phase of development. The research of University of Turku is profiled through the following thematic fields (those relevant to the Baltic TRAM context are marked with bold letters):

- **Biofuture**
- **Digital Futures**
- Cultural memory and social change
- Children, young people and learning

[37] Wennberg, Toivanen, Oosi & Jauhola, 2017, Alueiden vahvuuksien analyysi, Työ- ja elinkeinoministeriön julkaisuja 24/2017

- **Drug development and diagnostics**
- **Sea and Maritime studies**

North & East Finland, Kainuu regional network of ARFs

The Ministry of Economic affairs and employment published a study which analysed the regional strengths and competitive advantages and possibilities to interregional collaboration[38]. The study was implemented in close collaboration with the regional councils connecting the information with the overall regional development plans. The economic growth and strengths of the region in Kainuu rely on natural resources, forestry biomass, minerals and natural products. According to the analysis the forest economy is the most important sector in the regional and depends heavily on raw material and further development. One of the biggest regional advantages is that the rich natural resources are easily accessible (supporting infrastructures) and exploitable, which creates good business opportunities for the local companies. In addition also the utilisation of the natural resources in the field of tourism is important industry to the region. Together with the forest industry, mining, companies producing natural products (luonnontuoteala) and tourism form a firm basis for industries that are built on the rich local natural resources in one form or in another[39].

Figure 4.3.3: S3 priorities in Kainuu[40]

S3 Priorities as Encoded in the "Eye@RIS3" Tool

Priority Name	Description
ICT and information systems	Measurement technology, data-centres, games and simulators.
Natural resources	Mining (Green mining, process and environmental applications) and Bioeconomy (Forestry biomass, Bioenergy and Wood industry)
Health and Well-being	Activity tourism, innovations of nutrition, health and sport & fitness
Wood industry	Woodworking industry, wood construction and training.
Forestry biomass and bioenergy.	Forestry biomass and bioenergy.

All relevant analytical research facilities in the respective region were mapped during the early months of the Baltic TRAM project. In this report we are focusing in the core analytical research facilities including both academic facilities, commercial laboratories and other RTOs (Research and

[38] Wennberg, Toivanen, Oosi & Jauhola, 2017, Alueiden vahvuuksien analyysi, Työ- ja elinkeinominiseriön julkaisuja 24/2017

[39] ibid.

[40] European Commission, Joint Research Centre, Kainuu, http://s3platform.jrc.ec.europa.eu/regions/fi1d4/tags/fi1d4, retrieved March 15th 2018

Technology organisations) like for example The Finnish Environment Institute and the Natural Resources Institute etc. that were recognised and mapped during the project.

The University of Oulu does not have a regional strategy but services to the local businesses in the bio-based economy and the censor industry are part of their research objectives and priorities. In addition the health and sport industries are also represented in the research and strategic planning of the Kajaani University Consortium (University of Jyväskylä). The strategy of the University is based on five thematic, internationally important research focus areas:

- Creating sustainability through materials and systems
- Molecular and environmental basis of life-long health
- Digital solutions in sensing and interactions
- Earth and near-space system and environmental change
- Understanding humans in change

In each one of the four focus areas the University of Oulu advances high-quality research and provides support services through multidisciplinary umbrella organisations, namely

- Biocenter Oulu in biosciences and health
- Eudaimonia in human sciences and economy
- Infotech Oulu in information and communication technology
- Thule Institute in arctic and environmental issues

These institutes provide multidisciplinary doctoral training, and organize and develop open access research infrastructure services serving many research groups in the University of Oulu and the larger local community such as companies. Part of these infrastructures are of national and international significance and hence included in the Finnish Research Infrastructure Roadmap. The institutes also coordinate specific tasks of the University of Oulu, such as participation in arctic networks, and support high-level research in the faculties.

The Academy of Finland's Centres of Excellence (CoEs) are the flagships of Finnish research. They are at the very cutting edge of science in their fields, carving out new avenues for research, developing creative research environments and training new talented researchers for Finnish society and business and industry. University of Oulu is at the moment coordinating three CoEs and partnering in another three CoEs including for example Centre of Excellence in Laser Scanning Research, coordinated by the Finnish Geodetic Institute.

4.4 Development needs and gaps at regional level

The most recent RIO Country Report for Finland (2016) offers an analysis of the research and innovation system in Finland, including relevant policies and funding instruments with particular focus on topics of critical importance for EU policies. The report identifies the main challenges of the current Finnish research and innovation system and assesses the policy responses implemented[41].

[41] Halme, Saarnivaara, Mitchell, 2017, RIO Country Report 2016: Finland. JRC Science for policy report, Research and Innovation Observatory country reports series

The report identifies three current general innovation challenges in Finland. First challenge is connected to the harnessing of knowledge and competence to boost innovation for societal and economic renewal. In order for Finland to be more effective in producing innovations, Finland should focus on creating better coordinated research and innovation policies that better harness innovation. Productivity growth in Finland has stopped and exports are declining due to high labour cost level. As a response to this situation the national reform programme is mentioning a couple of policy responses to tackle this challenge. First the national innovation policies should aim at diversifying the structure of the industries, improving the level of research activity and reforming public sector research structures to support sustainable growth and employment[42]. The Government programme also includes research and development policy objectives on university-business collaboration to better utilise and commercialise research results. It also plans to support new skills based on business activity by building environments as well as innovation and development platform for digital business and providing open data resources. Investments in new growth industries, including bio economy, clean and green technologies, healthcare and digitalisation which cuts across the industries[43].

The second challenge introduced in the RIO Country report 2016 is connected to public and private R&I investments. According to the report the central government and business R&D investments have declined since 2010, completely changing the R&I landscape in Finland. Especially the share of business relevant applied and academic research is low and the impacts of the most recent budget cuts will still increase this development. Research and development investments outside the leading companies are at the moment merely at average level and below average for small and medium-sized companies. As a policy response to this there are several Key Projects in the Government programme focusing on innovative procurement, piloting, experimentation, internationalisation growth companies and near to markets incentives. Other changes in budget allocations for research emphasise curiosity driven research especially targeted to young and innovative companies. The Finnish R&I system has long been characterised by a combination of top-down coordination and bottom-up consensus building, which have integrated public priorities with business views and by a strong trust on the positive impacts of investments in education and research and innovation activities. However, this tradition is now changing as the focus of recent heavy cuts in public R&D funding are not at all aligned with the objectives of the Government Programme and are not likely to increase R&D investments of businesses[44].

The RIO Country report 2016 furthermore introduces third challenge to be connected to strengthening the quality and relevance of the science base and increasing internationalisation of R&I. In terms of quality and internationalisation of research, the performance of the Finnish innovation system is at the average EU level. Despite high R&D investments in the recent past and shares of new doctoral graduates, it has not been matched so well with high quality scientific output. One explanation to this is that specialisations in key strategic fields have not been sufficiently pursued, resulting in low number of research at the top of their field. The situation has been acknowledged and there are number of measures aimed at increasing the quality of the science base through structural changes, improving financial incentives and reforming the financial models, as for example the new university funding model, the structural development scheme for universities of applied sciences, the reform of research institutes and research funding including the establishment

[42] ibid.

[43] ibid.

[44] ibid.

of the Strategic Research Council, the Finnish Research Infrastructure Committee and updated national roadmap for infrastructures 2013[45].

Furthermore the OECD Review of Innovation Policy Finland 2017 introduces a recent SWOT analysis of the Finnish innovation system where the most striking weaknesses and threats are laid open. Among the biggest weaknesses the report mentions:

- Advanced but small peripheral market, companies need to export early to secure the growth
- Only few exporting sectors and firms; few leading industries and companies
- SMEs play a very small albeit growing role in R&D and innovation
- Still low overall rate of entrepreneurship despite a growing start-up scene
- Low rate of radical innovation, business innovations mostly focus on minor improvements and operational efficiency, even if new to the world, little ability to capitalise on it
- Talents leaving due to reduced research budgets
- Imbalanced funding paters, under-emphasising applied research and enabling technologies
- Only few domains of university "excellence" in education and research
- Limited foreign direct investment; domestic business R&D poorly integrated with business R&D internationally
- Lack of vision, ambition and holistic approach to develop new forms of public-private partnerships and innovation programmes to tackle industrial renewal[46].

Furthermore OECD Territorial Review on Northern Sparsely populated Areas addresses special development challenges that are common to sparsely populated areas like for example Kajaani in Finland. The report also introduces recommendations on how to address these challenges. In short the report suggests to give better support for entrepreneurship and innovation in the Northern sparsely populated areas by:

- Improving incentives and support for engaging rural SMEs in innovation initiatives
- Providing capacity and technical support for start-ups and SMEs to access financial instruments
- Support initiatives and regional clusters which enable local small companies to build scale and access opportunities in external markets
- Encouraging and supporting regions to collaborate on joint opportunities related to their smart specialisation strategies and linking with research and higher education institutions in urban centres in Finland and internationally[47].

The development strategy draft 2018-2021 of the Region of Southwest Finland is not actually addressing any regional development challenges. However, the strategy identifies a need to better utilisation of regional development funding, better acknowledging the EU strategies in regional

[45] ibid.

[46] OECD Reviews of Innovation Policy: Finland 2017

[47] OECD Territorial Reviews: Northern Sparsely Populated Areas, 2017 (Finland)

development; better connecting the future planning and development activities with the strategic and policy work of the region and deeper analysis and utilisation of the regional development maps[48].

In terms of linking the RIS3 together with effective regional development work in the less populated areas, including Kainuu in Finland, one of the most important objectives is to improve the effectiveness of RIS3 implementation by addressing structural challenges, in this case mismatches between the knowledge and productive base of non-innovation leader regions. These challenges can be remedied by strategically and operationally linking RIS3 priority industries in less advanced regions with the knowledge base available in other regions, as a way towards faster growth while, at the same time, enhancing the embeddedness of the missing knowledge through good practice transfer on at least three fronts: innovation infrastructures, methodologies for research/university to industry partnerships, and funding approaches.

Linking productive and knowledge and technology bases across EU borders requires, in the first place, that advanced regions are willing to share knowledge and search for suitable transfer processes as well as less advanced regions have the understanding, absorptiveness capacity, and willingness to invest in R&D outside their ESIF programme area.

4.4 Summary and conclusions

In line with the national or regional level development challenges described above in the country specific sections the main current and future efforts in the BSR is to strengthen the flow from research to market and to better match the research, ARF offering and the needs of the regional industries. In this work different regions have their special needs and framework conditions to address. Accordingly initiatives such as for example the Baltic TRAM project[49] should be further strengthened and intensified in order to further systematize the marketing of research services to companies in certain regional contexts. The fact that RIS3 supports KET production and applications, advanced materials and advanced manufacturing are all pointing to the relevance of macro-regional solutions.

Another way, besides project cooperation, to strengthen such research-to-business macro-regional initiatives would be to integrate them into regional policies, on the base of current and projected research needs and anticipated economic development. Once such a strategic decision is made, more options are open, for example findings from other initiatives, such as examples from the on-going BRIDGES project:

- The implementation of a framework for research / universities and businesses interactions, focusing on technological connectivity, between advanced and less advanced regions.
- Rationalisation and clarification of the funding of such interactions, modelling transferrable win-win types of cooperation between advanced and less advanced regions.
- Strengthening of industry-related expertise in the regions.
- Strengthening of the integration of peripheral regions into the knowledge – based economy by strengthening the technological connectivity to knowledge centres.

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[48]http://www.varsinais-suomi.fi/fi/tehtaevaet-ja-toiminta/maakuntastrategia/maakuntastrategian-valmisteluMaakuntaohjelmaluonnos 2018-2021 (Varsinais-Suomi), Accessed 6.10.2017.

[49] Šime (ed.), 2017, National innovation and smart specialisation governance in the Baltic Sea region. Laying grounds for an enhanced macro-regional science-business cooperation, BSR Policy Briefing Series 4/2017

- Contributions to economies of scale and commercialisation of research of the advanced innovation region.

The issue of firms' innovation absorptiveness capacity is equivalent to the discussion on firms' absorptiveness capacity of external information. The issue has been discussed since 1950s, and the connection to innovation since the late 1980s. The term 'absorptive capacity' was introduced in 1990 by Cohen and Levinthal[50]: "The ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends is critical to its innovative capabilities. We label this capability a firm's absorptive capacity and suggest that it is largely a function of the firm's level of prior related knowledge". Absorptive capacity is related to the knowledge spill over theory (knowledge spill overs can happen if a firm can appreciate / grasp good practices, successful patterns of other firms). Maximising knowledge spill over results (in terms of technological connectivity and good practice transfer) requires understanding the absorptiveness capacity of the regions' RIS3 industries matched with the relevant research availability of the region itself and in the cooperating innovation advanced regions.

From the regions engaged in this regional analysis the region of Southwest Finland is especially strong in Industrial modernisation and manufacturing, especially in the maritime industry; sustainable innovations and human and health industries. In addition it clearly seems that the most promising innovation potential in Kainuu region is connected to bioethanol production; Wood construction in Kantola business park, Modern pulp mill (Bio product factory) and Concentration and utilization of valuable components of biomasses such as berries and their industrial side streams.

According to the innovation mapping conducted in the BRIDGES project in addition to the needs of connectivity in *research-to-business* options also other fields of connectivity needs in lagging regions are apparent relating to research-to-industry and research-to-regional innovation systems. Research-to-industry connectivity connected to the improvement of productivity and sustainability of the RIS3 (and other relevant) industries, in terms of improved or new products and / or processes. In research-to-industry connectivity one possible path to consider is to build on/ expand the economic base of the industries of the most performing businesses and strengthen the relevant knowledge-connectivity system. For example building consortiums around certain expertise or development question (Clusters) including partners from different regions

Research-to-regional innovation systems connectivity needs are more about the "dialogue" of the triple (and quadruple) helices. There is a nominal triple helix in all the regions, which however, does not always work either because of knowledge mismatches (i.e. the knowledge and productive bases are not demonstrating effective complementarities), or because the localised triple helix is not functioning, is only partially meaningful, or even because the needed specialisation is missing also from national level.

In terms of building sustainable Network of IReCs in the longer run, we need to address all the above-described connectivity needs and to promote the following:

- Industry-led excellence-based connectivity focusing in issues prioritized by industry in IReCs ("competence centres of high quality collaborative research). The approaches of the IReCs will be planned so that the results of the collaborative research will be applicable to the

[50] Cohen & Levinthal, 1990, Absorptive Capacity: A New Perspective on Learning and Innovation, Administrative Science Quarterly, p.128-152, p.129
http://links.jstor.org/sici?sici=0001-8392%28199003%2935%3A1%3C128%3AACANPO%3E2.0.CO%3B2-5

prioritized industries in the regions. Interregional connectivity in this case, is related to missing knowledge and research resources on regional and national levels, and availability of such resources in the innovation advanced or otherwise collaborating region.

- Innovation management needs are research/university-to-business/industry/region interactions that improve the quality & embeddedness of triple helix processes and ensure access to research results. They are about complementarity of innovation management at interregional level is a certain knowledge source is not available locally or if research commercialization needs can benefit from interregional solutions.

Connectivity needs lead inevitably to regionalised (rather than localised) innovation systems. The fundamental reason for regionalised innovation systems is that the diversification of specialisation resulting from market and research trends is so wide and fast evolving, that it is very hard for regions to address comprehensively both, currently and anticipated research needs. It is issue of resources[51], but it is also issue of time, i.e. with the exception of leading regions, the rest of the regions need to catch up with the development in the meanwhile witnessing business-based income generation slowing down[52]. Thus, regionalised, i.e. network-based innovation systems seem to be inevitable in the future. In the EU, the introduction of the RIS3 as a Structural Funds conditionality as much as an effective concept for regional economic renewal and the continuous, related and on-going strong discussion, have legitimised the notion of macro-regional innovation systems. The sustainability of the forthcoming IReC network is also part of this thematic. In this direction, our practical tools should be a combination of the current and anticipated economic bases of regions, their current and anticipated research bases, and the policies that one way or another support specialised growth. The macro-regional network-based development will result from answering realistically to the questions in each one of the five boxes of Table 4.3.1 and Table 4.3.2.

[51] OECD Economic Surveys FINLAND, 2016, https://www.oecd.org/eco/surveys/Overview-OECD-Finland-2016.pdf, page 43, retrieved March 15th 2018

[52] Internationalisation of research is a priority in many countries, e.g. Finland, but it is still evolving. Ahonen, Hjelt, Kaukonen & Vuolanto (eds.), 2009, Internationalisation of Finnish scientific research, Publication of the Academy of Finland 7/09, http://www.aka.fi/globalassets/awanhat/documents/tiedostot/julkaisut/7_09-internationalisation-of-finnish-scientific.pdf.

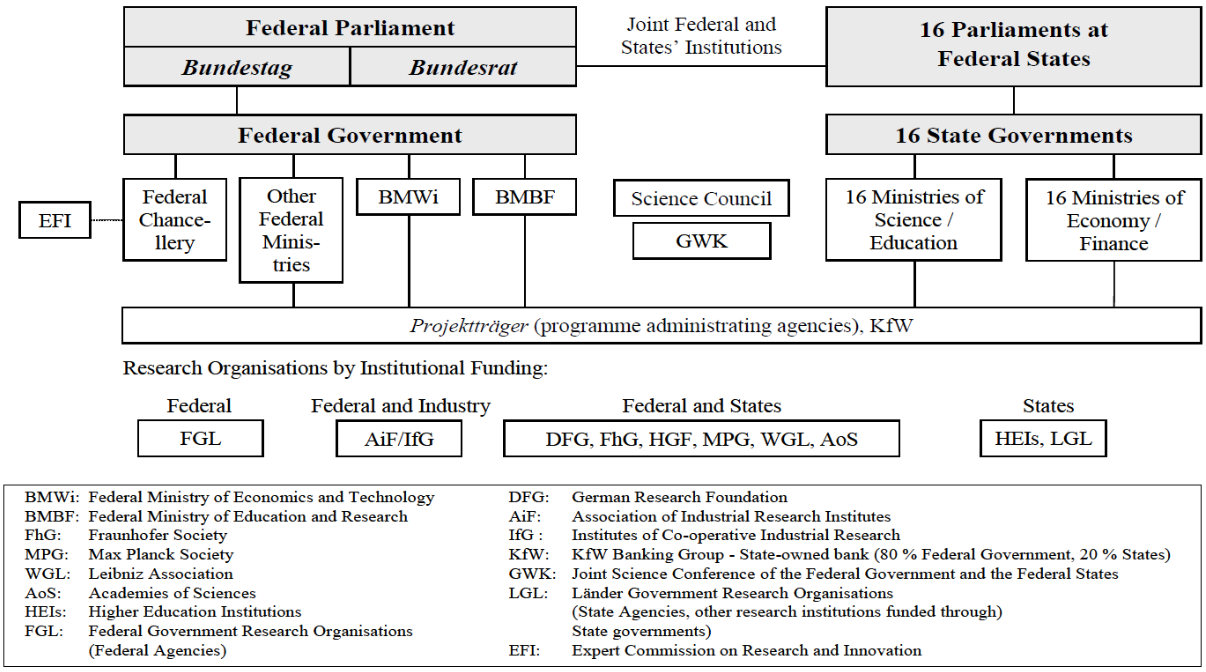
"Internationalisation must be integrated in all R&I development and decision-making. It is not a separate activity: global cooperation must be an elemental part of Finnish R&I. To promote internationalisation, inter-administrative cooperation will be highly needed. […] Key R&I policy development areas include: […] promoting the exploitation and impact of research results; […] public sector reform and closer cooperation; and adequate R&D funding". Research and Innovation Policy Council, 2014, Reformative Finland: Research and innovation policy review 2015–2020, page 14

4. Germany

Anja Habereder, Uwe Sassenberg

The federal republic of Germany consists of sixteen federal states. The jurisdictions are shared between the federal level and the federal states. The federal level has the exclusive responsibility for national interests, such as foreign affairs and state defense. For a multitude of other topics, such as research and economical strategy, a concurrent legislation consists and the jurisdiction is shared between the federal level and the federal states.[53]

Figure 5.0.1: Germany's RDI governance system[54]



In Germany, three NUTS levels can be identified. The program area of the Interreg Baltic Sea Region program covers only the NUTS 2 regions of northeast Germany; they are shown in the figure below.

As a first step this report will focus on the NUTS 2 regions DE6 (Hamburg) and DEF (Schleswig-Holstein), representing the federal states of the headquarters of the two Helmholtz Centers DESY and HZG.

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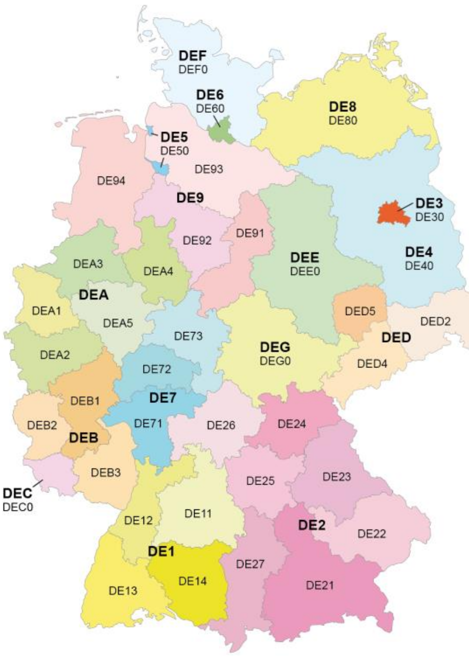
[53] Art. 70-74 GG, Articles 70-74 of the Basic Law of the Federal Republic of Germany. http://www.gesetze-im-internet.de/gg/BJNR000010949.html#BJNR000010949BJNG000800314, Retrieved on March 23rd 2018.

[54] Sofka, Wolfgang (2015). RIO Country Report 2014: Germany. JRC Science for policy report, Research and Innovation Observatory country reports series

Table 5.0.1: NUTS:DE[55]

NUTS:DE	NUTS 1	Code	NUTS 2	Code
	Berlin	DE3	Berlin	DE30
	Brandenburg	DE4	Brandenburg	DE40
	Bremen	DE5	Bremen	DE50
	Hamburg	DE6	Hamburg	DE60
	Mecklenburg-West Pomerania	DE8	Mecklenburg-West Pomerania	DE80
	Lower Saxony	DE9	Luneburg	DE93
	Schleswig-Holstein	DEF	Schleswig-Holstein	DEF0

The key actors on the political and strategy level in Germany are the ministries for research and economic issues on the federal (mainly BMBF and BMWI) and authorities on the Länder (e.g. BWFG or BWVI in Hamburg). The ministries are supported by project management agencies, such as DLR Project Management Agency, Project Management Jülich or PT-DESY.

On the national level, the German Federal government published a strategy for innovation, the "High-Tech Strategy", in 2006. It was updated in 2010 and being developed further in 2014. New topics and new instruments were added to fund innovation. The current version, "The new High-Tech Strategy[56]", focuses on five core elements:

1. Priority challenges with regard to value creation and quality of life
2. Networking and transfer
3. The pace of innovation in industry
4. Innovation-friendly framework
5. Transparency and participation

As a consequence, Germany is focusing research and development on six priority tasks relative to the future prosperity and quality of life:

1. The digital economy and society

[55] European Commission, Eurostat, http://ec.europa.eu/eurostat/documents/345175/7451602/nuts-map-DE.pdf, retrieved March 16th 2018. Map image: Wikipedia, 2018, NUTS:DE, https://de.wikipedia.org/wiki/NUTS:DE, retrieved March 16th 2018

[56] Die Bundesregierung, The new High-Tech Strategy, https://www.hightech-strategie.de/de/The-new-High-Tech-Strategy-390.php, retrieved January 18th 2018

2. The sustainable economy and energy
3. The innovative workplace
4. Healthy living
5. Intelligent mobility
6. Civil security

Access to analytical infrastructures, such as provided in the Baltic TRAM project, can particularly foster innovation in the R&D topics 2, 4 and 5.

Due to the federal system, Germany does not have one single national but sixteen regional innovation strategies (RIS), formulated by the sixteen federal states. The German federal states are intermediate bodies of the ERDF in Germany. As a framework of the sixteen RIS, Germany and the European Commission have a partnership agreement, which refers to the current version of the "The new High-Tech Strategy" and to the innovation concept ("Innovationsstrategie[57]") of the Federal Ministry for Economic Affairs and Energy.

2017, the European Commission[58] classified Germany as an innovation leader and summarized the priority areas for innovation in Germany as the following:

1. Manufacturing & industry
2. Key Enabling Technologies
3. Information & communication technologies
4. Sustainable innovation
5. Human health & social work activities

The regional innovation performance of the German NUTS regions is quite inhomogeneous: The best innovation performances can be found in the southern federal states, followed by mainly the former Western Germany regions. The weakest innovation performances were shown by the rural northern and eastern regions. The federal city states Berlin, Bremen and Hamburg are sited in the middle of these rural regions, having the capability to act as an innovation booster for their neighbourhood.

5.1 Clusters and emerging clusters and their connection to the RIS3

The German federal states published each a separate regional innovation strategy (RIS) for the structural support period 2014 to 2020. The key enabling technologies specified by the federal states are mainly guided by the existing clusters and industry networks. Clusters are mainly organized on the federal level. Some clusters – e.g. Maritimes Cluster Norddeutschland or Life Science Nord – work transregionally in more than one federal state. Table 5.1.3 gives an overview on the clusters and networks in the German Interreg Baltic Sea regions.

[57] Bundesministerium für Wirtschaft und Technologie, 2012, Technologie- und Innovationspolitik, https://www.koinno-bmwi.de/fileadmin/user_upload/publikationen/Technologie-_und_Innovationspolitik_-_BMWi.pdf, retrieved January 18th 2018

[58] European Commission, 2017, Smart Specialisation - Strengthening Innovation in Germany, http://ec.europa.eu/regional_policy/sources/docgener/guides/smart_spec/strength_innov_de_en.pdf, retrieved January 18th 2018

Hamburg has a long history of clusters. The first cluster was incorporated in 1997, followed by seven more clusters until 2011. Especially the oldest four clusters are well established in the regional economy. Hamburg's RIS is strongly connected to these eight clusters.

In the RIS, Hamburg defined sixteen key enabling technologies and eight branches that are important for Hamburg. They were oriented on the strengths of the local economy. Accepted by the European Commission were (only) the following seven S3 priority tasks, listed in Table 5.1.1. Obviously, the S3 are well connected to the existing clusters of Hamburg's economy. The young cluster for maritime industry of the five federal states Bremen, Hamburg, Lower Saxony, Mecklenburg-West Pomerania and Schleswig-Holstein Maritimes Cluster Norddeutschland is not directly represented by one S3 priority task, but well considered in the RIS of Hamburg.

Table 5.1.1: S3 priority tasks according to Eye@RIS3[59]

S3 priority tasks according to Eye@RIS3	Cluster
Aviation	Hamburg Aviation*
Creative society	Kreativgesellschaft
Life sciences	Life Science Nord (LSN)*
Health industry	Gesundheitswirtschaft Hamburg
Logistics	Logistik-Initiative Hamburg*
Media	nextMedia Hamburg
Renewable energy	Renewable Energy Hamburg (EEHH)
	Maritimes Cluster Norddeutschland (MCN)
**Gold Label of the European Cluster Excellence Initiative (ECEI)*	

Schleswig-Holstein's RIS is based on existing clusters and key enabling technologies. Based on these, Schleswig-Holstein defined five S3 priority fields.

In Schleswig-Holstein already many clusters and networks exist. However, a lack of integrated cluster policy hinders getting a better exploitation of clusters with high potential. The RIS gives therefore action approaches on how to enhance and further develop the regional cluster strategy.

[59] European Commission, Eye@RIS3: Innovation Priorities in Europe, http://s3platform.jrc.ec.europa.eu/map, retrieved February 27th 2018

Table 5.1.2: S3 priority tasks according to Eye@RIS3[60]

S3 priority tasks according to Eye@RIS3	Cluster	Emerging clusters and networks
Nutrition industry	foodRegio	
ICT and media	DiWiSH – Digitale Wirtschaft Schleswig-Holstein	
Renewable energies	Erneuerbare Energien Schleswig-Holstein (EE.SH) windcomm Schleswig-Holstein	Norddeutsche Initiative Nanomaterialien (NINa) Netzwerk Leistungselektronik Schleswig-Holstein
Life sciences	Life Science Nord (LSN)*	
Maritime economy	Maritimes Cluster Norddeutschland (MCN)	
Logistik-Initiative Schleswig-Holstein e. V.		
Tourismus-Cluster Schleswig-Holstein		
**Gold Label of the European Cluster Excellence Initiative (ECEI)*		

[60] ibid.

	Bremen	The administrative district of Luneburg in Lower Saxony	Hamburg	Schleswig-Holstein	Mecklenburg-West Pomerania	Berlin and Brandenburg *Clusters of Brandenburg only; **Clusters of Berlin only
Maritime Industry	Maritime Industry Maritimes Cluster Norddeutschland (MCN)	Maritime Industry Maritimes Cluster Norddeutschland (MCN)	Maritime Industry Maritimes Cluster Norddeutschland (MCN)	Maritime Industry Maritimes Cluster Norddeutschland (MCN)	Maritime Industry Maritimes Cluster Norddeutschland (MCN) MAZA MV e. V.	
Mobility	Automotive and Aviation AVIABELT Bremen e.V. Automotive Nordwest	Aviation Niedersachsen Aviation MORE AERO CFK VALLEY	Aviation Cluster Hamburg Aviation		Automotive, Aviation and Aerospace automotive-mv e. V. HANSE-AEROSPACE e. V.	Automotive, Aviation, Aerospace, Rail Traffic Cluster Verkehr, Mobilität und Logistik
Mechanical Engineering	Materials Science Multifunktionelle Materialien und Technologien (MultiMaT) I-KON				Mechanical Engineering CIM-Netzwerke	Materials Science Cluster Kunststoffe und Chemie* Metal Cluster* Cluster Optik** OpTecBB** Biokon**
Energy	Renewable Energy Windenergie-Agentur Bremerhaven/ Bremen e.V. (wab)		Wind, Solar and Biomass Energy Erneuerbare Energien Hamburg (EEHH)	Renewable Energy Erneuerbare Energien Schleswig-Holstein (EE.SH) windcomm	Renewable Energy Wind Energy Network WTI e. V. 3N	Power Engineering, Renewable Energy Cluster Energietechnik Fördergesellschaft Erneuerbare Energien**
Life Science	Life Science Life Sciences Bremen e.V. (LSB) Gesundheitswirtschaft Nordwest e. V.	Life Science BioRegioN	Life Science Life Science Nord	Life Science Life Science Nord	Life Science BioCon Valley® GmbH ScanBalt BioRegion	Health economics Health Capital
Food	Food Food Nordwest	Food NieKE		Food foodRegio	Food FANI-Technologies	Food Food Industry Cluster*
Other clusters and networks	Sustainability Initiative Umwelt Unternehmen (iuu)	Innovation Innovationsnetzwerk Niedersachsen			Miscellaneous BalticNet-PlasmaTec e. V. AMA Verband für Sensorik und Messtechnik e.V. VWT Verband Wehrtechnik MV e. V.	

Table 5.1.3 Clusters and networks in the German Interreg Baltic Sea Regions

5.2 Interactions between RIS3, clusters and regional development strategies guiding research and innovation

As part of the implementation of the national “High Tech Strategy”, the funding system shall be improved. Achievements of a good collaboration are several portals and platforms describing and presenting relevant national programs and measures:

- *foerderdatenbank.de*: Funding programs of the Federal Government, the Länder and the EU
- *clusterplattform.de*: Database of German clusters funded by the Federal Government, the Länder as well as by the private sector
- *research-in-germany.org*: Survey of the German research landscape, especially for foreign researchers
- *kooperation-international.de*: Platform with information for international cooperation

On behalf of the High-Tech Strategy the BMBF launched a new initiative in 2016, announcing that the overall funding of the BMBF for SMEs will increase by 30% up to €320m in 2017[61].

On the level of the Länder, regional development organizations support the implementation of the RIS. Table 5.2.1 gives an overview on the German regional development organizations.

Table 5.2.1 An overview on the German regional development organizations

Federal State	Regional Development Organization
Bremen	Bremeninvest
The administrative district of Luneburg in Lower Saxony	Wirtschaftsfördergesellschaft mbH für Stadt und Landkreis Lüneburg (WLG)
Hamburg	Hamburg Business Development Corporation (HWF)
Schleswig-Holstein	Witschaftsförderung und Technoglogietransfer Schleswig-Holstein GmbH (WTSH) Wirtschaftsförderungsagentur Kreis Plön (WFA)
Mecklenburg-West Pomerania	Invest in Mecklenburg-Vorpommern GmbH
Berlin	Berlin Partner for Business and Technology
Brandenburg	Brandenburg Invest (WFBB)

[61] Bundesministerium für Bildung und Forschung, Vorfahrt für den Mittelstand, https://www.bmbf.de/pub/Vorfahrt_fuer_den_Mittelstand.pdf, retrieved March 16th 2018

Hamburg

In 2010, Hamburg developed a strategic guideline for innovation together with 160 partners from science, economy, politics, institutions and organizations (the so called *Innovationsallianz*; Engl. "alliance for innovation"). During periodic events (e.g. workshops), partners from economy, science, politics and administration meet to further develop the existing strategy. These guidelines ask for industrial networks for strong branches. Especially for companies, that are not part of a network, central contact points to science and research institutes could enhance innovation.

- The planned network of Industrial Research Centers (Baltic TRAM IReC Network) as deliverable of the Baltic TRAM project is directly linked to this concept of central contact points for companies to (publicly funded) science and research institutes.

The RIS of Hamburg follows the strategic guidelines from 2010 and asks for a better linkage of business, science and education by raising the mutual awareness. After identifying the benefits of scientific and business cooperation, a common ground (e.g. special events, networks) should be created for transparent and efficient communication to adapt supply to demand. Intermediaries are necessary to bring together actors from science and industry.

Defined the strategic guidelines and adopted in the RIS, eight specialization areas describing Hamburg's unique selling points. To strengthen the specialization areas, strategic initiatives, such as clusters and networks, shall be supported.

Schleswig-Holstein

In 2015, Schleswig-Holstein's Ministry of Economic Affairs, Transport, Employment, Technology and Tourism formed an alliance with partners from industry, the so called *Bündnis Industrie S.H.* Lately in March 2017, this alliance published its recommendations for action in the areas of the energy transition, maritime industry, education, digitization and marketing. The alliance recommends developing and accomplishing a joint policy together with all federal states of Northern Germany to strengthen regional innovation potentials for maritime industry, wind energy, food industry and chemical industry.

According to their cluster strategy[62], Schleswig-Holstein fosters cross-border cooperation of their clusters. In the long run, all clusters of Schleswig-Holstein shall network cross-border with clusters of neighboring regions. The aim of the regional cluster policy is to further develop the existing cluster structures in the medium run to in the direction of internationalization, technology leadership and innovation potential.

5.3 Regional resources and national networks of ARFs Germany

The German research and innovation system is strongly interconnected. Publicly funded research is being conducted at universities, applied universities (both core funded by the respective federal

[62] Ministerium für Wirtschaft, Arbeit, Verkehr und Technologie, Grundlagenpapier zur Clusterpolitik, Clusterstrategie und Clusterförderung des Landes Schleswig-Holstein, https://cluster-sh.de/file/grundlagenpapierclusterstrategie.pdf, retrieved March 12th 2018

states), at the eight academies of sciences and at more than 80 research facilities of Fraunhofer, 18 Helmholtz research centres of, 93 Leibniz research institutes and 84 the Max Planck research institutes.

- *Frauenhofer Society* (FhG) (funded by the public sector (approximately 30%) and through contract research earnings (roughly 70%))
- *Helmholtz Association* (HGF) (core funded by the German Federal Ministry of Education and Research (BMBF))
- *Leibniz Association* (WGL) (jointly core funded by the Federation and the federal states)
- *Max Planck Society* (MPG) (core funding by the German federal government and its states, project funding by the German government and its states, the European Union and grants from private individuals)

Furthermore, a number of research institutes are operated by the Länder and about 40 national institutes[63] with federal authority conduct research – especially industrial relevant applied research.

In 2017, Germany had four running large research facilities (PETRA III, FLASH, BESSY II and BER II) and two which are under construction (FLASH II and XFEL) in the Interreg region. The large research facilities are operated by five research centers.

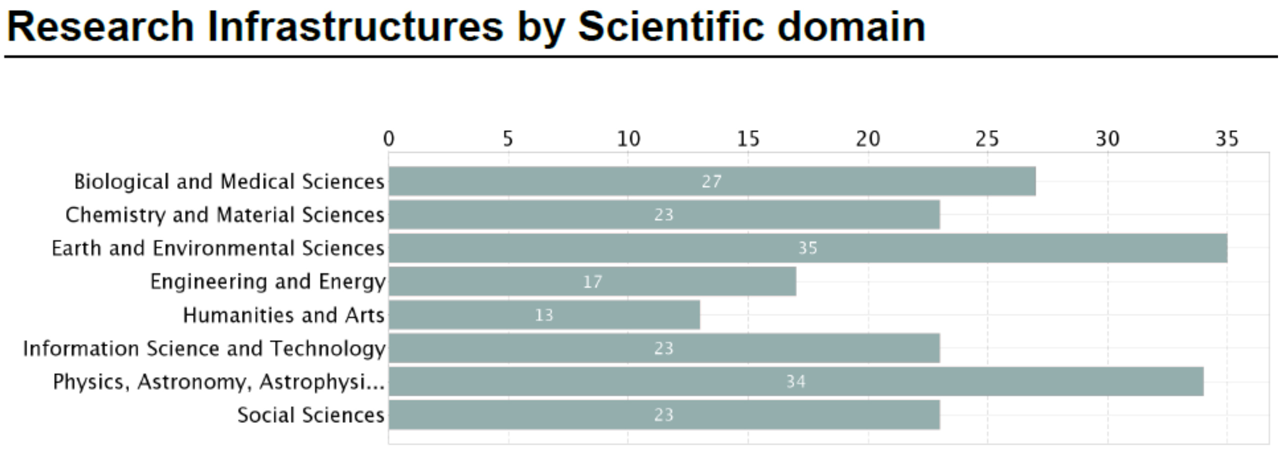
Figure 5.3.1 The largest research facilities in the German BSR

The public research funding system of Germany consists of institutional funding, project funding and commissioned funding. The project funding of the Federal Ministries is organized by the *Projektträger* (programme administration authorities, English: "project management agencies") and by the *Deutsche Forschungsgemeinschaft* (DFG; English: German Research Foundation) DFG. A large number of public trusts are also funding research in Germany, however their programs address individuals and public institutes only. A good overview on existing funding programs of the Federal Government, the federal states and the European Union gives the database foerderdatenbank.de released by the Federal Government.

Additionally, applied research is being conducted at the research institutes of the two privately funded research organizations: the Deutsche Industrieforschungsgemeinschaft Konrad Zuse (Zuse-Gemeinschaft, English: Zuse Association) and the Arbeitsgemeinschaft industrieller Forschungsvereinigungen "Otto von Guericke" e.V. (AiF; English: German Federation of Industrial Research Associations), which is also a project management agency working for the Federal Ministry for Economic Affairs and Energy.

[63] Ressortforschung, Mitglieder, https://www.ressortforschung.de/de/ueber_uns/mitglieder/index.htm, retrieved March 7th 2018

Figure 5.3.2[64] **Research infrastructures by scientific domain in Germany**



5.4 Development needs and gaps at regional level

Hamburg, as well as Schleswig-Holstein, lacks centralized contact points at analytical research institutes to connect researchers with industry and to offer scientific support and access to analytical infrastructures, especially at higher education institutes. The front pages of websites of the majority of Germany's higher education and analytical research institutes address students and researchers only, even though many research groups offer access to their lab infrastructures. Specific information on the offers is often difficult to find by outsiders. One solution to close this gap could be, to have a regional – or even transregional – network of technology transfer offices that can give an overview on the available services and analytical infrastructures.

In German, no funding system for short-term cooperation between analytical research institutes and partners from industry is available (e.g. for solving only one short scientific challenge by one measurement). Funding programmes of the federal ministries (such as *ZIM* or *KMU innovativ*) focus on merely long-term projects with the objective to raise the technology readiness level and or even with the market launch as the project outcome. Collaborations to solve challenges that appear in the production process after the market launch cannot be funded in Germany.

Hamburg

Hamburg identified a lack of innovation parks, which is why Hamburg decided to plan four new innovation parks linked to existing incubators for innovation.

[64] MERIL (Mapping of the European Research Infrastructure Landscape) portal, https://portal.meril.eu/meril/, retrieved September 28th 2016

Table 5.4.1 Innovation parks, incubators and KET in the German BSR

Innovation Park	Nucleus/Incubators	Key enabling technologies
Altona	Deutsches Elektronen-Synchrotron	Life Science, Nano and Laser Technology, Materials Science
Bergedorf	Hamburg Applied University, Fraunhofer IAPT (LZN), Fraunhofer IWES	Wind Energy, 3D-Laser Technology, Energy Storage, Optics, Grid and Grid Integration
Harburg	Technical University of Hamburg Harburg	Green Technologies, Aviation and Maritime Industry, Medical Engineering, Digitalization, Materials Sciences
Finkenwerder	Center of Applied Aeronautical Research (ZAL), Airbus	Aviation

Schleswig-Holstein

Compared to the federal city state Hamburg, Schleswig-Holstein has a much lower density of industry for key enabling technologies and analytical research infrastructures. The players of innovation are scattered across the federal state. The existing clusters are quite small and also less strong than the ones of Hamburg or other further developed regions of Germany. Schleswig-Holstein faces the challenges in creating a transregional and even transnational innovation strategy, e.g. by joining transregional clusters for life sciences and maritime industry. According to the new strategic guidelines of 2016[65], Schleswig-Holstein lacks a concept for an enhanced cooperation of science and industry to enable innovation. As some starting points for a better innovation infrastructure, Schleswig-Holstein plans

- to strengthen the existing Fraunhofer institutes and improve the network of non-university research institutes,
- to foster the knowledge and technology transfer in maritime industry, renewable energies and medicine,
- to modernize existing innovation parks and innovation centres and incorporate new ones.

[65] Der Ministerpräsident des Landes Schleswig-Holstein, 3.4 Innovationen und forschung – Ideen und kreativität als entwicklungstreber begreifen, December 2016. http://www.schleswigholstein.de/DE/Schwerpunkte/Landesentwicklungsstrategie/Downloads/neue_leitlinien/innovationForschung.pdf?__blob=publicationFile&v=7. Accessed 12.3.2018.

6. Latvia

Lauma Muizniece, Reinis Markvarts

6.1 Clusters and emerging clusters and their connection to the RIS3

Historically there hasn't been any significant clustering in Latvia thus cluster formation has been supported via various funding instruments. The first funding programme that was designed specifically for supporting cluster formation and development was introduced during the 2007 – 2013 EU programming period. The funding available from the ERDF was approximately 407 289 EUR. It was planned that several clusters would be developed in 11 industrial sectors and would receive funding for managerial activities, providing services for other members of the cluster as well as publicity and other related activities. A second, slightly modified cluster programme with funding more than 6 ml EUR was launched in 2016 within the 2014 – 2020 programming period.

The industrial sectors where the clusters have formed are the following:

- electronics
- chemistry and pharmacy
- space technologies' and logistics
- wood-processing
- agriculture
- food
- metal industry and mechanical engineering.

Latvian clusters are becoming more active in participating in European-wide cluster activities. Two clusters are participating in BSR Innovation Express programme - Latvian IT Cluster with the project *Opening CIS markets for smart technology SMEs from Latvia and Sweden* and Latvian High Added Value and Healthy Food Cluster with the project *Cross-sectoral collaboration for efficient and sustainable food value chains in the Baltic Sea Region*[66].

None of the Latvian clusters is certified by the ECEI, however, both aforementioned clusters are implementing activities within The Cluster Excellence Programme to achieve this certification.

[66] Nordic Council of Ministers' Office in Latvia, Two Latvian clusters receive support from Baltic Sea Region Cluster Program „Innovation Express", http://www.norden.lv/en/news/130217-two-latvian-clusters-receive-support-from-baltic-sea-region-cluster-program-innovation-express-/, retrieved March 16th 2018

6.2 Interactions between RIS3, clusters and regional development strategies guiding research and innovation

Research and Innovation Policy in Latvia

According to the Law on Scientific Activity (in force since 2005), it is the Cabinet of Ministers that determines the State policy for the development of science and technology, as well as innovation and also approves the priority scientific directions and State research programmes, as well as determines the procedures for the control of the utilisation of the financial resources allocated for the implementation of such directions and programmes.

Another government body highly involved is the Ministry of Education and Science (MoES) which develops the State policy for the development of science and technology and also prepares a request for the allocation of annual State budget resources to ensure these activities. MoES is the ministry responsible for developing the Science, Technology Development and Innovation Guidelines 2014-2020 (R&D Guidelines). These guidelines are aimed at identifying macro- and micro-level bottlenecks hindering and might hinder future development of export-oriented sectors, i.e. identifying main industrial policy directions based on current development trends, global challenges and potential opportunities of the sectors towards production of products with higher value added and outline the activities necessary in improving the R&D environment and include improvement of R&D activities, development of infrastructure, facilitating technology transfer, support industry-science cooperation to boost the commercialization of research results, supporting the expansion of innovative and technology-oriented companies as well as offering new financial instruments (seed and venture capital) for companies, especially innovative SMEs[67].

Meanwhile the Ministry of Economics (ME) is responsible for the development of innovation and national industrial policy including facilitation of technology transfer projects and programmes, raising awareness about innovation and the benefits from innovating, as well as the good examples[68]. It has been responsible for developing Guidelines on National Industrial Policy for 2014-2020 (Industrial Policy) that outline the national priorities and courses of action to promote innovation by targeting areas such as: knowledge capacity, innovation supply, innovation demand, and transfer system[69].

There is also the Latvian Council of Science (LCS), which is a collegial body of scientists that has been established as a direct administrative institution subordinate to the MoES mainly to prepare proposals for the formulation of State R&D&I policy, budget for these activities and distribution of the budget, as well as the provision of opinions regarding scientific usefulness of the use of the allocated resources from the State budget.

Aside from the ministries, there are also ministry agencies that are highly involved in implementing the policies set out by their respective ministries. Investment and Development Agency of Latvia

[67] Cabinet order No 685, 2013, Guidelines for Science, Technology Development, and Innovation 2014-2020 (Informative part), https://em.gov.lv/files/nozares_politika/2014ino.pdf, retrieved March 16th 2018

[68] Ministry of Economics, 2016, Innovation, https://www.em.gov.lv/en/sectoral_policy/innovation/, retrieved March 16th 2018

[69] Ministry of Economics, 2014, Industrial Policy, https://www.em.gov.lv/en/sectoral_policy/industrial_policy/, retrieved March 16th 2018

(LIAA) is a state agency and since 2013 its official status is a direct administration institution subordinated to the Minister of Economics of the Republic of Latvia. The functions of LIAA are:

1. implementation of activities supporting the export potential and external trade;
2. bringing foreign investments to the economy of Latvia;
3. support formation and development of businesses;
4. promote innovative entrepreneurship, including support for science-industry relations;
5. implement activities in accordance to state support programmes;
6. ensure effective administration of EU and other foreign financial instrument activities[70].

Currently LIAA is responsible for implementing a set of support programmes, advancing grants to entrepreneurs to increase their competitiveness. The supportive programmes within 2014-2020 will focus on research, technology development and innovation, raising competitiveness of small and medium-sized enterprises and increasing energy efficiency. Due to this, LIAA is currently implementing a state-wide programme for improving the technology transfer system that includes innovation vouchers for companies and commercialization grants for public research organizations up to 300 000 EUR for developing products with high commercial potential[71].

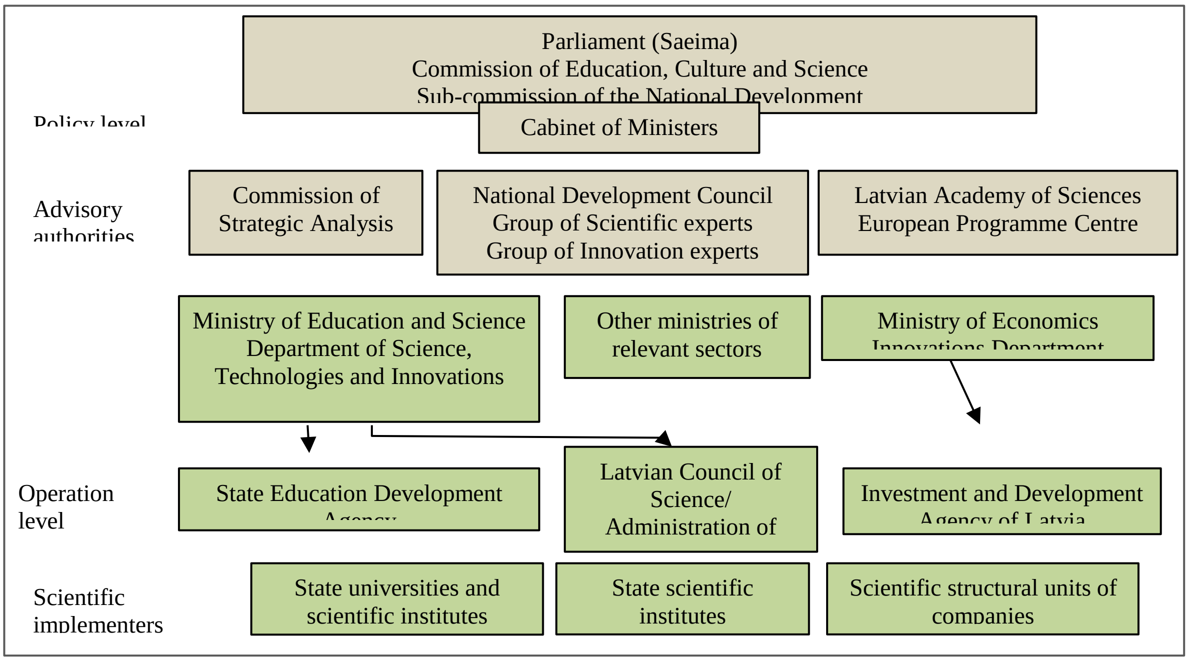
Meanwhile the State Education Development Agency (SEDA) is a direct administration institution which is subordinated to the Ministry of Education and Science and the aim of its activities is to implement the national policy in the field of development of higher education and science, lifelong learning system, vocational education system and general education system and to implement and monitor projects financed by European Union (EU) Structural Funds, education innovation projects, EU programmes and other financial instrument programmes, projects and initiatives[72].

[70] Cabinet of Ministers' Regulations No 857 of December 11, 2012

[71] Cabinet of Ministers' Regulations No 857 of December 11, 2012

[72] State Education Development Agency (VIAA), About Us, http://viaa.gov.lv/eng/about_us/about_seda/, retrieved March 16th 2018

Figure 6.2.1: Summary of the research system in Latvia[73].



The main strategic documents in Latvia related to R&D and Innovation are the National Development Plan for 2014- 2020, Guidelines on National Industrial Policy of Latvia, Regional Policy Guidelines 2013-2019, Education Development Guidelines 2014-2020, Information Society Development Guidelines 2014-2020, Latvian Tourism Development Guidelines 2014-2020, Cultural Policy Guidelines 2014-2020 *Creative Latvia* and Intellectual Property Rights Protection and Enforcement Guidelines 2014-2018. The National Reform Programme 2015, however the main documents targeted particularly at these topics are the Guidelines on National Industrial Policy for 2014-2020 and the Science, Technology Development and Innovation Guidelines 2014-2020.

Simultaneously national innovation policy objectives and actions are set out in the Science, Technology Development and Innovation Guidelines 2014-2020[74] (approved by the Cabinet of Ministers in December 28, 2013). These activities include improvement of R&D activity, development of infrastructure, facilitating technology transfer, support industry-science cooperation to boost the commercialization of research results, supporting the expansion of innovative and technology-oriented companies as well as offering new financial instruments (seed and venture capital) for companies, especially innovative SMEs[75].

All the aforementioned documents have been developed in accordance with the smart specialization strategy that was introduced for the 2014 – 2020 programming period. A Smart Specialization

[73] Ministry of Education and Science, http://izm.izm.gov.lv/upload_file/Zinatne/vpp/Zinatne_Latvija_EN.pdf, Accessed in January 2018

[74] Cabinet order No 685, 2013, Guidelines for Science, Technology Development, and Innovation 2014-2020 (Informative part), https://em.gov.lv/files/nozares_politika/2014ino.pdf, retrieved March 16th 2018

[75] https://www.em.gov.lv/en/sectoral_policy/industrial_policy/innovation/innovation_support_activities/

Strategy has been developed in 2014 to concentrate public R&D investment in programs that would improve Latvia's innovation performance among other objectives. The strategy aims at restructuring of export by inducing change and growth in production and export structure in traditional sectors of economy, future growth of sectors in which exist or may be products and services with high added value as well as sectors with significant horizontal impact and contribution in transformation of national economy.

RIS3 priorities selected by Latvia:

- high value-added products
- productive innovation system
- energy efficiency, information and communication technologies (in line with the digital growth)
- innovative education system
- knowledge based economy
- polycentric development.

The smart specialisation in Latvia is tailored according to five thematic areas:

- knowledge-based bio-economy;
- biomedicine, medical appliances, bio-pharmacy and bio-technology;
- advanced materials technologies and engineering systems;
- smart energy;
- information and communication technologies[76].

Strategic goals and funding mechanisms

As other EU member states, main strategic goals have been set in Europe 2020 for Latvia as well and the target regarding R&D expenditure is 1.5% of the GDP. Thus, national level policy planning documents are also working toward reaching this goal.

The same target is laid out in Latvian National Development Plan 2014 – 2020[77] that also foresees that half of the R&D expenditure would be coming from the private sector by 2020. Meanwhile, R&D Guidelines and Industrial Policy focus on the means of reaching this target.

The main goal of the *R&D Guidelines* is the development of knowledge base and innovation capacity as well as innovations system's coordination in Latvia. Infrastructure for technology transfer and innovation (technology development centres, incubators, parks, prototyping labs, experimental

[76] Ministry of Education and Science, 2014, Smart Specialisation Strategy, http://www.izm.gov.lv/en/Science/smart-specialisation-strategy, retrieved March 16th 2018

[77] Cross-Sectoral Coordination Centre (CCSC), 2012, National Development Plan of Latvia for 2014–2020, http://www.pkc.gov.lv/sites/default/files/images-legacy/NAP2020%20dokumenti/NDP2020_English_Final.pdf, retrieved March 16th 2018

production units) is necessary for the development of new technologies and commercialization of research results. The main strategic targets of the R&D Guidelines are the following[78]:

- Increasing the competitiveness of STI field
- Development of human resources
- Development of excellence in research
- Reduction of resource fragmentation
- Support internationalisation of science and international cooperation
- Linkage of science, technology and innovation with the needs of social and economic development
- Building the knowledge base and focusing research on directions important for societal development
- Promote the orders from industry ministries and municipalities
- Integration of education, science development, technology, innovation and business
- Strengthening innovation and knowledge absorption capacity in companies

Effective management of STI industry

- Improving coordination among involved government bodies as well as stakeholders
- Increasing investment efficiency
- Increasing State budget funding
- Calculation and allocation of institutional or base funding in accordance with policy settings
- Gradual increase in R&D funding allocated by public procurement
- Creation of new financial instruments
- Support research in higher education institutions
- Development of policy implementation monitoring and impact assessment system
- Rising of public awareness, promotion of science and innovation
- This includes various promotion and awareness raising measures, increase of interactivity between organisations, regions etc., involvement of society etc.

The main goal of the *Industrial Policy* is to promote structural changes in economy in favour of production of goods and services with a higher added value. The emphasis in this document is on the industry thus it discusses the necessity to increase the role of industry, modernize the industrial sector and support the production of more sophisticated products and services among other things[79].

In order to reach this goal, the following targets are set for 2020:

- the proportion of manufacturing industry shall reach 20% of the gross domestic product
- the increase of the productivity of manufacturing industry shall reach 40% in comparison to 2011
- the increase of manufacturing industry shall reach 60% in comparison to 2011
- investments in research and development shall reach 1.5% of the GDP.

[78] Cabinet order No 685, 2013, Guidelines for Science, Technology Development, and Innovation 2014-2020 (Informative part), https://em.gov.lv/files/nozares_politika/2014ino.pdf, retrieved March 16th 2018

[79] Ministry of Economics, 2012, Guidelines on National Industrial Policy of Latvia (Unofficial translation), https://em.gov.lv/files/uznemejdarbiba/finl_en.pdf, retrieved March 16th 2018

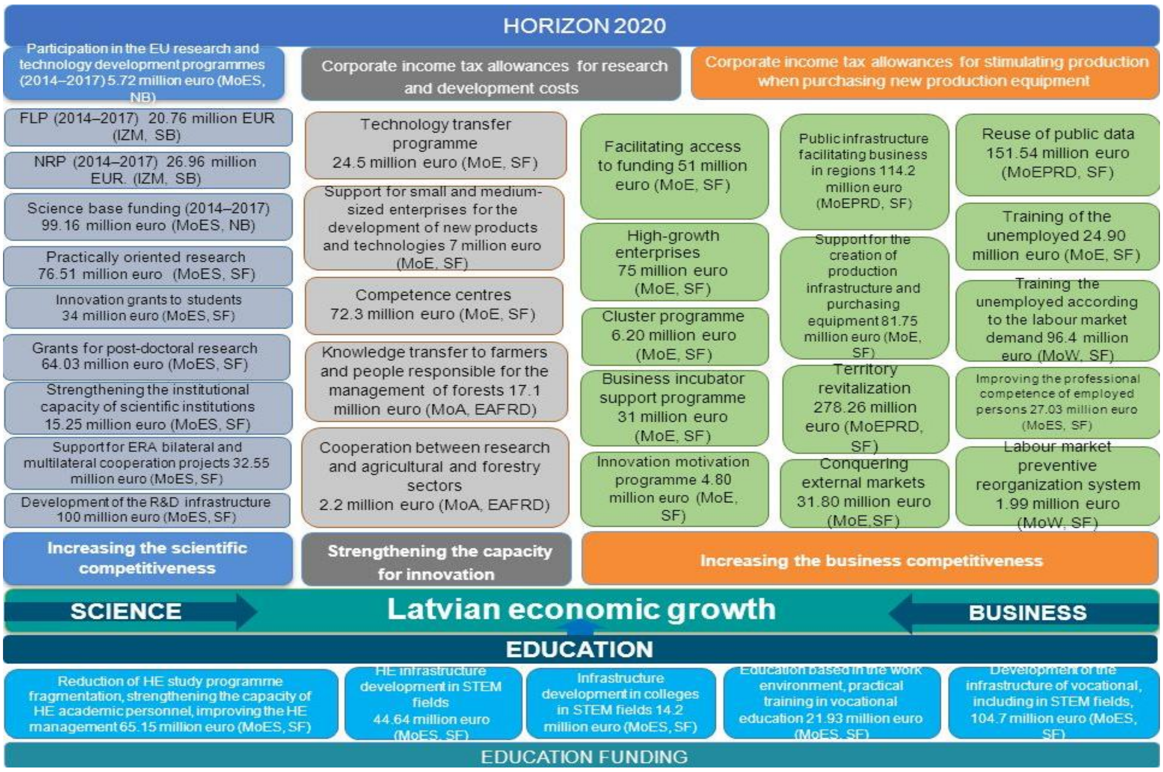
The activities planned to reach these targets are the following:

- The improvement of the existing support instruments
- Ensuring terminated access to finance to a wide group of entrepreneurs
- Elaboration of modern cluster policy by promoting collaboration of firms acting in the industry
- Support for export with higher added value
- Attraction of foreign direct investment
- Providing support for entering foreign markets.

To conclude, there are two main challenges for Latvia's research and innovation system: 1. encouraging private sector innovation capacity, investment and collaboration with science, 2. continuing the reform in the public research system and strengthening public R&D capacity[80].

During the last two decades Latvian research and innovation policy has gone through many changes. After joining the EU, there has been a shift towards common goals of all member states and a pressure to close the gap in innovation performance comparing to the innovation leaders. A significant part of research and innovation funding consists of EU funding while funding from the state budget is scarce.

Figure 6.2.2: Summary of all EU funding programmes within the competence of Ministry of Economics (Source: Ministry of Economics in Latvia)



[80] Kulikovskis, Petraityte & Stamenov, 2016, RIO Country Report 2015: Latvia. JRC Science for policy report, Research and Innovation Observatory country reports series

6.3 Regional resources and national networks of ARFs Latvia

Research system in Latvia has been fragmented already since early 1990ies despite consolidation efforts. Before its amendments, the Law on Scientific Activity allowed creation of small research organisations eligible for research base funding from the government. However, after an evaluation of Latvian research system by Technopolis Group was published in 2014, further efforts to concentrate research in the best performing institutions were under way. Research is conducted in several higher education institutions and research institutes.

There are 6 universities and 13 non-university type higher education institutions in Latvia and the ones with research infrastructure that concerns BalticTRAM are listed below:

- University of Latvia (13 faculties and more than 20 research institutes) (TTO established);
- Riga Technical University (103 departments and divisions, 33 institutes) (TTO established);
- Latvia University of Agriculture (8 faculties and 2 institutes) (TTO established);
- Rīga Stradiņš University (9 faculties, 12 research centres and laboratories) (TTO established);
- Daugavpils University (3 faculties, 13 institutes and research centres) (TTO established);
- Vidzeme University of Applied Sciences (2 faculties and 1 institute);
- Ventspils University College (3 faculties, 2 research centres) (TTO established);
- Rezekne Academy of Technologies (3 faculties) (TTO established).
- Other Research and technology organisations (RTOs):
- The Institute of Solid State Physics, University of Latvia - 17 specialised laboratories including a cleanroom developed for company use
- Latvian State Institute of Wood Chemistry - the main centre of wood science in Latvia, founded in 1946. The mission of the IWC is the development of scientifically grounded, environmentally friendly, waste less technologies for obtaining of competitive materials and products from wood and wood biomass. Researches carried out in eight laboratories.
- Latvian Institute of Organic Synthesis - specialises in drug discovery, research carried out in 17 laboratories
- Institute of Food Safety, Animal Health and Environment "BIOR" – specialises in food and environmental hygiene, veterinary medicine/animal health, fisheries
- Latvian State Forest Research Institute "Silava".

There have been efforts in building networks among research organisations already during the 2007 – 2014 period, for example the National Significance Research Centres. It was a programme funded by the ERDF that aimed to develop a form of research institution cooperation to improve scientific excellence, overcome fragmentation, share infrastructure and increase science-industry cooperation. Nine National Significance Research Centres were established:

1. IT and Telecommunication
2. Nano- and multifunctional materials
3. Pharmacy and Biomedicine
4. Public Health and Clinical Medicine
5. Energy and Environment technologies (including transport sector)
6. Forestry and Water Resources
7. Agriculture and Food
8. Language, Cultural Heritage and Creative Industries

9. Socioeconomics and Public Management

Another programme that was launched in order to increase university-industry cooperation as well as networking was a programme *Support to Technology Transfer Contact Points* - launched to support creation of TTOs. It started in 2008 and the projects ended in 2013. The goal of this programme was to establish TTOs in the main higher education or research institutions in Latvia. Eight TTOs were established - 4 in Riga (UL, RSU, RTU and the Art Academy of Latvia) and the rest in other regions in Latvia.

Several programmes that further aim to continue building networks and cooperation are implemented within the 2014 – 2020 period as well (see Figure 6.2.2), especially the Innovation Voucher programme (activity within the broader support for technology transfer system programme) and Business Incubator programme implemented by LIAA.

In order to identify research cooperation needs and potential (especially important for the further networks of IReCs) an analysis of the existing regional research facilities and their networks and the regional economic base can be summarised together matching them with the anticipated industrial trends, research base needs and current development policies at the regional level. (See Table 6.3.1)

6.4 Development needs and gaps at regional level

The main challenges and development issues Latvia is currently experiencing are there due to the historical background and a number of decisions that were taken over the course of the transition period that were related to specialisation, the structure of the innovation system etc. The country is depending too much on the funding from EU ESIFs and tend to disregard the fact that is meant to be allocated as a transitional funding, not for solving the countries everyday needs such as funding research on a daily basis etc. Also the need to increase R&D expenditure fast, large proportion of the R&D funding is directed towards acquiring new infrastructure, however, it is often not used to it is full potential as there tend to be overlaps in the equipment among research groups. Therefore, programmes like the cluster programme are necessary to reduce this fragmentation. However, currently the cluster programme is focused on co-production, however, it has been pointed out that clusters addressing similar issues should be considered.

Overall, the main conclusion is that a number of valuable funding and support programmes are in place, however, they have to be monitored and adjusted if the results are less than satisfactory to reduce the possibility of running an unsuccessful programme for the whole programming period.

The main recommendations for further development in addition to the ones identified in the policy documents, are to focus the funding not only on R&D infrastructure but also on increasing the skills of potential users (both in public research organizations and local industry) and reduce bureaucratic procedures and top-down planning in order to motivate companies to utilise PRO owned infrastructure and to cooperate. Additionally:

- Embrace a less linear understanding of innovation and incorporate more flexible and informal instruments in the policy mix

- Allow PROs to experiment with inner funding mechanisms for collaboration with the industry

- Establish collaboration platforms that focus on continuous collaboration that expands beyond the initial aim, e.g. information exchange platforms that expand into consortia engaged in both informal and formal technology transfer activities.

Improving science-industry linkages is among the priority areas in the whole EU, thus a substantial amount of funding has been directed to R&D in various ways. One of the major avenues for governments to boost R&D expenditure and support science-industry collaboration is to make investments into research infrastructure and open it up to the private sector.

Despite implementing major structural changes, R&D spending is low (0.62% of GDP in 2015) and its historical background continues to influence the economy resulting in low innovation absorption capacity among other things.

The major issues currently are:

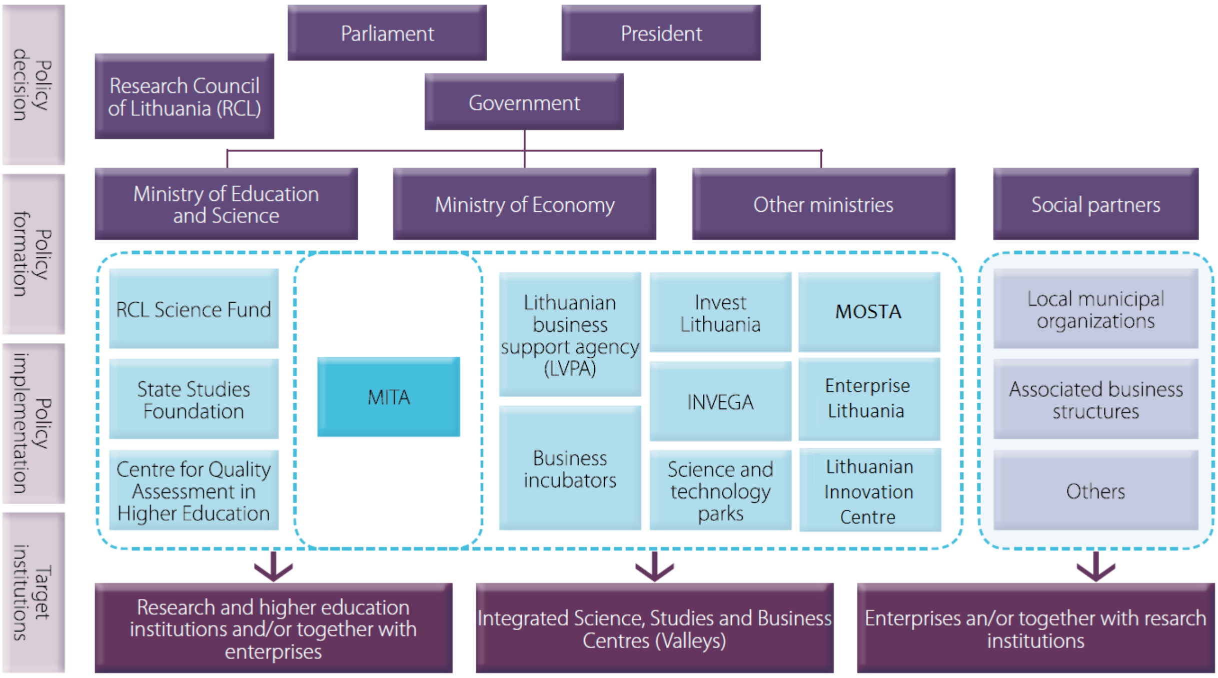
- Private sector R&D spending is lagging behind public investment.
- Substantial part of public investment comes from European Structural and Investment. Funds (ESIF), replacing national funding.
- Fragmented national innovation system.
- Insufficient commitment from policy makers.
- In the past, no strict decisions regarding specialization in certain domains in science were made so the priority areas were very broad and inclusive - the present RIS3 has similar characteristics.
- The scarce funding was (and still is) divided among the fragmented institutions, the capacity of companies to absorb innovation and research organisations to create was reduced.
- Large proportion of R&D funding is directed towards acquiring new infrastructure, however, it is often not used to it is full potential.
- Fragmented innovation system, lack of specialisation is also reflected in the infrastructure
- Duplication of infrastructure and equipment, lack of connection to units' research agendas
- Weak clustering, consolidation rather administrative.
- Researchers are used to public funding and are often not motivated enough to collaborate with the industry.
  Major part of industry R&D needs can be met using the existing facilities and competences
- Entrepreneurs in traditional manufacturing areas often cannot see their innovation potential. HEIs/ PROs should make a first step.
- Difficulties with planning R&D needs for longer periods of time.
- Small enterprises are often interested in cooperation with HEIs, but have limited financial resources.
- The lack of publicly available information about R&D opportunities in PROs hampers the first step towards cooperation.
- Communication difficulties between researchers and entrepreneurs.
- Mutually satisfactory cooperation models need to be worked out (IP rights etc.).
- Companies reluctant to engage in EU funded activities.
- EU funding causes barriers - different interpretations by local authorities, many organisations involved, issues with state aid and insufficient funds to co-finance.
- Policy is implemented in a Top-down approach.
- Several infrastructure databases – further fragmentation.

7. Lithuania

Arturas Mickus

At the highest decision-making level, the Lithuanian STI policy is set by Parliament (Lithuanian Seimas) and the government of Lithuania (Figure 7.0.1). Development of R&D and innovation is a responsibility of the Strategic Research Council of Lithuania (LMT). The Council is chaired by the prime minister and consist of the representatives of the ministries in charge of or engaged in R&D and innovation development, LMT, MITA research institutions and HEIs, business, social and economic partners and independent experts.

Figure 7.0.1: Institutional structure of the innovation system in Lithuania[81]



The two ministries mainly responsible for the development of science and innovation policy are the Ministry of Education and Science (MES) and the Ministry of Economy (ME). The MES is mainly responsible for policy development in the areas of research excellence in public science system, highly-skilled human resources, including for R&D, etc. The Ministry of Education and Science is in charge of a major part of financial and other resources for the implementation of national research policy. The ministry also proposes the establishment, reorganization and closure of research institutions.[82]

[81] Agency for Science, Innovation and Technology, MITA (2011). Innovation system in Lithuania. Booklet printed by MITA.

[82] Ministry of Education and Science of Lithuania Republic, 23.05. 2014. Integrated Science, Studies and Business centres (Valleys). http://www.smm.lt/web/en/science1/science_1, Retrieved 23.3.2018.

The Ministry of Economy is the principal institution involved in designing policy for promotion of innovation and business development. The ME coordinates the establishment and the operations of innovation support organizations such as science and technology parks (STPs) and business incubators. Other ministries are active in sector-specific STI policies in their respective policy domains.

The RCL Science Found is responsible for implementing decisions of the Council concerning the funding of research programmes and projects and carries out administrative duties of the Council, e.g., drafting regulations and procedures for the RCL funding schemes and administering calls for proposals. The Director of the Research Foundation reports to the Chairperson of the Council.

Public Institution Lithuanian Business Support Agency (LVPA) is a non-profit institution established by the Ministry of Economy for the purpose of administering European Union (EU) support and co-financing funds. As the executive institution in the structure for the administration of EU funding in Lithuania, LVPA administers EU funding granted for the development of Lithuanian business, R&D, tourism, and the energy sector. LVPA aims to achieve transparency and provide quality services and information for Lithuanian business enterprises.

Invest Lithuania (Investuok Lietuvoje) is a non-profit organization owned by the Ministry of Economy. Its mission is the attraction of foreign investment. Invest Lithuania provides free advice and introductions to on the ground experts to global companies interested in doing business in Lithuania. The agency serves as a point of contact for foreign companies and guides international businesses through every step of the process of setting up operations in Lithuania. Company consists of an investment promotion and infrastructure department, a marketing division, representative office in Belgium. The organization has announced to open an office in Silicon Valley.

Research and Higher Education Monitoring and Analysis Centre (MOSTA) is a limited liability public legal entity. Legal status of the MOSTA is a public institution. The state is the founder and owner of MOSTA. The Office of the Government of the Republic of Lithuania implements the rights and obligations of the owner of MOSTA. The aim of MOSTA is to provide evidence-based information and guidance regarding adoption of decisions on formation and implementation of research, higher education, and innovation policy relevant to the public.

The State Studies Foundation is a state budgetary institution. The Foundation started its activities in 1993 when the Government of the Republic of Lithuania established the Lithuanian State Science and Studies Foundation, whose primary function was to administer support for the projects of groups of scientists. Until 2008 the Foundation had expanded its functions and had become the major institution administering public funds allocated for science; in 1998 it started issuing loans for students. As of the 1st January 2010 the Foundation operates under new name and regulations. Its mission - to implement the higher education policies, by ensuring accessibility and quality of higher education, transparent management of the financial support for students using modern technologies and e-services.

Centre for Quality Assessment in Higher Education (SKVC) is an independent public agency established in 1995. The Centre implements the external quality assurance policy in higher education in Lithuania and contributes to the development of human resources by creation of enabling conditions for free movement of persons. The Centre was founded by the Ministry of Education and Science of the Republic of Lithuania as an expert institution. The main function of the Centre is to assist HEI to assure quality and to constantly improve it.

Agency for Science, Innovation and Technology (MITA) was established in 2010 with the aim to foster business and science cooperation and to create a friendly environment for business needs and innovation. These goals are foreseen in national Innovation Strategy for the year 2010-2020, approved by Lithuanian Government. Two ministries: the Ministry of Economy and the Ministry of Education and Science are the main founders of MITA.

MITA is the main governmental institution, responsible for implementation of innovation policy in Lithuania. Agency provides free of charge services for clients from business, science and public sectors, interested in possibilities to develop strong cooperation relations with international partners and get financial support for research and innovation projects. The main activity is the coordination of national activities and international programmes (*HORIZON2020*, *EUREKA*, *EUROSTARS*) of research, technological development and innovation and other financial schemes (innovation vouchers, protection of industrial property rights). MITA provides national financial support for projects participants and also promotes business and science cooperation, commercialization of research and protection of intellectual property rights.

The guarantee institution JSC Investicijų ir verslo garantijos (INVEGA) was established by the Republic of Lithuania Government in 2001 for Small and Medium-sized Business Development. The Ministry of Economy was tasked with the performance of the company founder and supervisor’s functions. INVEGA manages financial instruments designed to help with starting up or expanding a small or medium-sized business, i.e. soft loans, loan guarantees, interest rate subsidies, and support for the first job.

Enterprise Lithuania (Versli Lietuva) is a non-profit agency under Ministry of Economy established to promote entrepreneurship, support business development and foster export. The Enterprise Lithuania is a reliable adviser and assistant for start, growth and export of national businesses with focus on SME’s. Agency supports the establishment and development of competitive businesses in the country and fosters the country’s exports by facilitating cooperation with partners’ networks and providing quality training, consultancy, market analysis, and business-partner search services for businesses.

The Public Institution Lithuanian Innovation Centre (LIC) is a non-profit organisation, providing innovation support services to enterprises, research institutions, industry associations and business support organisations. LIC stakeholders are the Ministry of Economy, Ministry of Education and Science and the Lithuanian Confederation of Industrialists.

Science and/or technology parks (STP) operate as legal entities, whose main functions are to stimulate scientific knowledge and technology dissemination processes, create conditions for commercialization of scientific research results, encourage relations between science and business, and promote a culture of innovation.

STP’s play the main role in fostering and promoting innovation, encouraging the establishment of new innovative companies and development of the existing companies, stimulating cooperation between science and business, and carrying out activities related to the provision of innovation support services. R&D is one of the instruments to facilitate the development of novelties and promotion of technological changes.

In Lithuania, there are currently nine science and technology parks (e.g. the biggest cities Kaunas and Klaipeda), in three of which the Ministry of Economy implements the rights and duties of the state as a stakeholder.

7.1 Clusters and emerging clusters and their connection to the RIS3

Like all other EU Member States, Lithuania undertook to prepare the national smart specialization strategy over the new period of funding from the EU structural support planned for 2014-2020. This strategy will have a considerable impact on the prospect of cooperation between Lithuanian science and business and on the competitiveness of the state in Europe and worldwide. Clusters are one of the main measures to achieve common EU targets, to take advantage of all capabilities provided by R&D and innovation development to the utmost, to raise economic level of states, to promote long-term processes of business development of a state based on the cooperation among business, science and public sector.

In order to encourage clusters development, clusters integration into international networks, to increase the innovative potential of clusters, to promote the potential of Lithuania's clusterization the Government of Lithuania plans to allocate more than 85 million Euros of the EU Structural Fund investments for the period 2014-2020[83]. These challenges include the following measures:

- *Inoklaster LT* (total amount 23.7 million Euros): the aim is to support clusters R&D operations (cluster strategies, research (insights, market research, etc.), preparation of training programs, cluster marketing, cooperation among cluster members, attracting new members, engaging in international networks, etc.); Investments in the cluster's R&D infrastructure.
- *Inogeb LT* (total amount 1.4 million Euros): the aim is to promote research and technology, innovation, business and science partnerships, knowledge commercialization and technology transfer.
- *Verslo klasteris* (en. Business cluster, total amount 13 million Euros): the aim is to encourage the groups of micro, small and medium-sized enterprises (SMEs) to join together in international networks in order to find new export markets for their products.
- *Kompetencijos LT* (total amount 16.9 million Euros): the aim is to provide special trainings for the development of sectorial competencies for enterprises, clusters; to provide trainings for the development of the competences of the staff of start-up companies and etc.
- *Naujos galimybės LT* (en. New opportunities LT, total amount 28.9 million Euros): the aim is to support participation of Lithuanian enterprises, clusters in international exhibitions, fairs and missions.
- *InoConnect LT* (total amount 1.45 million Euros): the aim is to promote international partnerships and networking through the European Enterprise Network in finding opportunities to participate in international EU research, development and innovation initiatives and to establish contacts with international partners, thus increasing the costs of R&D in Lithuania, exports of R&D services and attracting foreign investment.

One more measure for clusters internationalization is BSR Innovation Express, a joint call for proposals implemented within the framework of the BSR Stars programme. The call is funded by national/regional funding agencies to initiate, develop or enhance transnational cooperation activities – leveraging cluster organizations (or similar) to develop proposals for their SME members.

[83] Kucevičius, Director of Innovation Department at Ministry of Economy of the Republic of Lithuania, presentation in Lithuanian on may 31st 2017. http://www.lca.lt/wp-content/uploads/2017/06/2_Dimitrijus-Kucevic%CC%8Cius_Klasteriu-pletros-koncepcija_2017_05_31.pdf

The priorities of cluster project initiatives mentioned above are the following:

- smart specialization;
- long-term jobs;
- labour productivity;
- export.

The departments of the Ministry of Economy (ME) and other public institutions that work with clusters or their initiatives are as follows:

- Innovation Department at ME;
- EU Structural Support Coordination Department at ME;
- Investment and Export Department at ME;
- MITA (the main task is to identify new potential clusters, to coordinate their activities, to assist young clusters, to present their products and services internationally).

7.2 Interactions between RIS3, clusters and regional development strategies guiding research and innovation

At present, there are altogether 59 clusters identified in Lithuania[84]. Some of them are still at the embryonic stage, average age of the cluster is approximately 4.6 year in Lithuania, or they are presented only by groups of enterprises whose gathering was sparked by the desire to take advantage of the EU structural funds. Only a 25-30 % of the identified clusters are being formed naturally, in developing new products or services through long-term co-operation and seeking to gain a bigger market share, thus enhancing the overall competitive ability of the cluster enterprises.

Another problem is that small, non-expanding, potential-lagging, uncompetitive, fragmented clusters predominate in Lithuania. In most cases, the cluster consists of 5 to 10 members, meanwhile in Europe critical mass per cluster is 30 – 50 members[85]. Statistically, the Lithuanian cluster consists of SMEs (63%), large companies (13%), universities/state R&D institutions (9%), associations (5%), non-state R&D / academic institutions (5%), brokers / suppliers (3%) and other public authorities (2%). The most common legal form of clusters in Lithuania is a joint activity agreement (46%), association (27%), JSC (13%), public institution (7%) and other (7%)[86].

7.3 Regional resources and national networks of ARFs in Lithuania

There are 23 universities in Lithuania (14 of them are public, 8 are private, and one is a branch of a Polish university). The main universities, R&D institutions are concentrated in 4 cities: Vilnius (52 % of

[84] Lasionis, Enterprise Lithuania, in Cluster Forum, May 31st 2017

[85] Paškevičius, Guidelines for clustering development, in Cluster Forum, May 31st 2017

[86] Mindaugas Steckis and Mantas Zegeris, Cluster - a model for cooperation in Lithuania presentation (2015) http://kurklt.lt/wp-content/uploads/2015/11/Klasteris-%E2%80%93-bendradarbiavimo-modelis-Lietuvoje-Mindaugas-ir-Mantas.pdf). Retrieved 0n March 31st 2018.

the total number of R&D employees in Lithuania), Kaunas (35.4 %), Klaipėda (8.7 %) and Šiauliai (2.8 %). The list of the major universities, institutes is presented below.

As was mentioned above in the section *Integrated science, research and business centres (valleys)*, all R&D resources located in the valleys must be available for the public on the basis of open access. For this reason, universities and research institutes established open access R&D centres/ laboratories (OAC), where business and public partners can access the newest R&D resources, the most advanced technologies and get highest quality services in accordance with the Regulation of Management of Open-Access Centres (approved the updated version by the Ministry of the Education and Science, 21.04.2016, Nr. V- 359).

Furthermore, Open R&D Lithuania network is a newly launched platform of cooperation between open access R&D centres/ laboratories of 14 Lithuanian Universities, 13 Public Research Institutes as well as 8 Science and Technology parks. In order to simplify the access to the information about R&D services and other available resources, MITA has created the e-science gateway platform. At present 25 open access R&D centres are acting in Lithuania. [87]

7.4 Development needs and gaps at regional level

Global experience shows that clusters are the main driving force for many regional / national economies. The formation of clusters in different industry sectors is at the primary stage in Lithuania. The Concept of the Development of the Lithuanian Clusters is approved by Minister of Economy of the Republic of Lithuania on 27 February 2014 (Resolution Nr. 4-131) in accordance with the national progress strategy *Lithuania 2030* and the *National Innovation Development Programme for 2014–2020*.

Clusters are developed in economically strongest cities of Lithuania (Vilnius, Kaunas, Klaipėda, Šiauliai, near 85%), where the concentration of operating economic entities and the employability are the highest. Nevertheless, some signs of clusters may be also found in Lithuanian regions (counties), especially in those which clearly specify in one of another field (Anyksciai, Birzai, Druskininkai, etc., for more information please visit Lithuanian cluster map website[88]).

According to *Cluster Study, 2012* conducted by association Žinių Ekonomikos Forumas (Forum on Knowledge Economy), the following key strengths, weaknesses, opportunities and threats of the Lithuanian clusters were identified:

Strengths: relatively cheap qualified workforce, favorable location in terms of logistics, well-developed infrastructure of logistics, high level of corporate technological base;

Weaknesses: poor cooperation between companies, lack of trust and competence, reluctance of companies to improve their competence and develop high added value;

Opportunities: production of niche products, integration to international networks;

[87] Agency for Science, Innovation and Technology in Lithuania, MITA. Agency for Science, Innovation and Technology, MITA (2011). Innovation system in Lithuania booklet printed in 2011 by MITA.
[88] Lietuvos klasterių žemėlapis, 2018, http://maps.klaster.lt/, accessed 22.3.2018

Threats: absence of regional specialization, shortage of qualified specialists and emigration, inability to compete with state manufacturers with low operating costs, inability to join international networks.

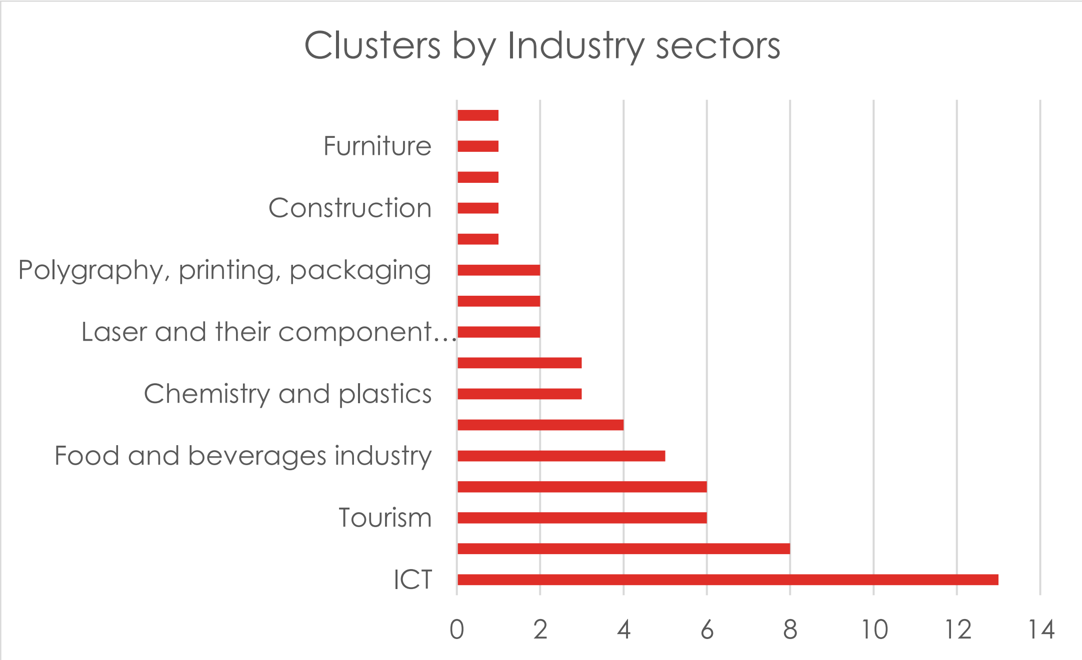
The three following directions of the development of the clustering processes could be distinguished in Lithuania[89]:

1. Development direction of clusters in the sector of high technologies. The focus of this direction is the expansion of the high technology industry by promoting the development of clusters in the fields of biotechnologies, mechatronics, laser technologies, information technologies, nanotechnologies and electronics.
2. Direction of regional development of clusters. This direction is oriented towards the promotion of cluster initiatives in the regions (counties) focusing on problematic ones in particular, the implementation of modern and high impact technologies which are important for innovativeness of industry and growth of the whole economy thus ensuring the competitiveness of the state in all sectors. It is important to emphasize that clusters which consolidate companies from different sectors (operating in all segments of the value (creation) chain of the cluster), science and study institutions and other entities tend to be more innovative.
3. Development direction of clusters in traditional sectors of industry. The focus of this direction is put on the development of clusters in traditional industrial and service sectors which is aimed at cooperation among the enterprises operating in the sector of traditional industry as well as at their collaboration with science and study institutions.

In accordance with the details of the Lithuanian cluster map, there are more clusters in the field of services than in industrial sectors in Lithuania. The number of clusters is especially high in the fields of information technologies, health improvement and creative industries. With regard to traditional sectors of industry, most clusters are concentrated in the industry of food and beverages, the lowest number of them is seen in the sectors of textile, wood and furniture industry, manufacture of machinery and equipment, chemistry and plastics, electronics, etc. It should be noted that the number of regional clusters is particularly low. Currently there are only a handful of clusters and they mainly focus on tourism services. The distribution of clusters by industry is presented below.

[89] Žinių Ekonomikos Forumas, 2012, Cluster Study, http://www.zef.lt/, Retrieved 23.3.2018.

Figure 7.4.1: Clusters by Industry sectors[90]



It is also important to mention that 67% of Lithuanian clusters are business oriented, 13% of clusters focused into R&D and business, and 20% of ones only to R&D[91].

Despite the fact that Lithuania, according to the state of cluster development, is ranking only on 97th place among 138 countries[92], there are some success stories. According to Marius Pareščius (executive director of the Lithuanian Cluster Association and ESCA Cluster Benchmarking Expert) three Lithuanian clusters have been awarded the Bronze Label of the European Cluster Excellence Initiative:

- Wellness Cluster iVita;
- Lithuanian Medical Tourism Cluster LitCare;
- Lithuanian Prefabricated Wooden Houses Cluster PrefabLT.

[90] Lasionis, Enterprise Lithuania, in Cluster Forum, May 31st 2017

[91] Mindaugas Steckis and Mantas Zegeris, Cluster - a model for cooperation in Lithuania presentation (2015) http://kurklt.lt/wp-content/uploads/2015/11/Klasteris-%E2%80%93-bendradarbiavimo-modelis-Lietuvoje-Mindaugas-ir-Mantas.pdf). Retrieved 0n March 31st 2018.

[92] Schwab, Klaus (ed.), 2016, Global Competitiveness Report 2016-2017. Insight report. World Economic Forum. http://www3.weforum.org/docs/GCR2016-2017/05FullReport/TheGlobalCompetitivenessReport2016-2017_FINAL.pdf. Accessed 23.3.2018.

8. Poland

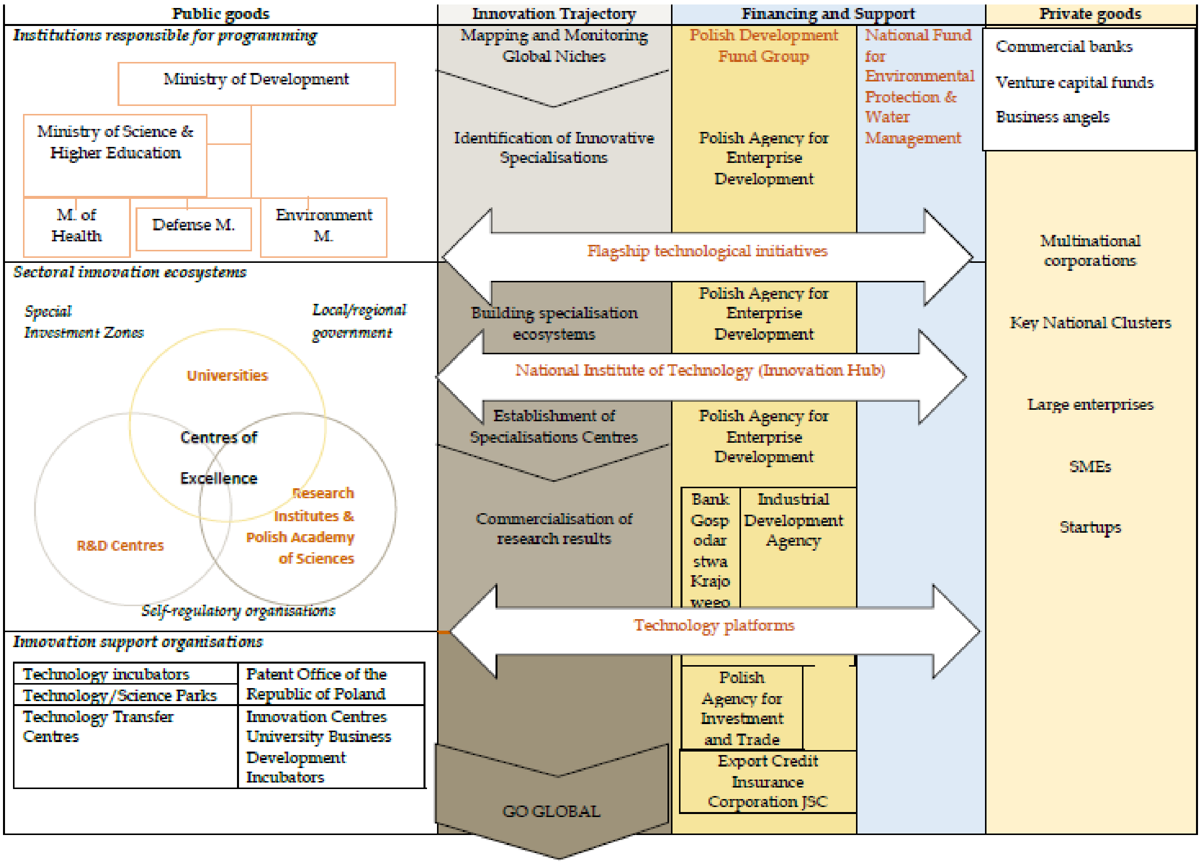
Piotr Szmigielski & Adriana Ciołka

At present the Poland is one of the largest economies in the European Union. The R&I system is still dominated by public funding, but the role of private capital has increased in recent years, with business enterprises accounting for a growing share of GERD (37.3% in 2013). Poland is divided into 16 regions (voivodeships), and the regional diversity is mirrored by the differences in intramural expenditures on R&D, with the highest GERD per capita in Masovia (with the capital, Warsaw), Lesser Poland and Pomerania. Regions have own, relatively small, RDI budgets, supplementing the centrally distributed funds, with funds mostly allocated to innovation support and indirect support of R&D by promoting the appropriate enabling environments.

The first aim of this chapter is to outline the specificity of Poland's research and innovation system, both in terms of who the main actors in this system are, and what the main, relevant precepts of national strategies for the development of R&I in the public and private sectors are. The second aim of this chapter is to show to what extent key concepts such as smart specialisation are operationalised and integrated into practice on the national level and regional level. The third aim of this chapter is to look at what the state of play is in terms of cooperative arrangements, which help in beginning to understand the chances of success of an initiative such as a regional (or national) IREC. The state of play will mostly have a regional focus (specifically NUTS2 Małopolska) and can be understood as an attempt to draw up a competitive strategy that is necessary to assess the likelihood of success of the operations of the Polish IReC.

The Parliament as the legislative body and the Cabinet (Council of Ministers) as the executive shape the relevant national R&I policies, with the President having the right to initiate legislative procedures and accept the new legislations. The two most important actors involved in devising and refining R&I Policies are the Ministry of Development (previously known as the Ministry of Economy) and the Ministry of Science & Higher Education. The Ministry of Development defines the strategies related to innovativeness and supervises the Polish Agency for Enterprise Development (PARP), which supports enterprises based on funds from the state budget and the EU Structural Funds, and through involvement in international projects, including COSME. PARP co-ordinates the National Service System for Small and Medium-Sized Enterprises (KSU), a network of organisations providing consulting and training services for SMEs, as well as loans and credit guarantees. The Ministry of Science and Higher Education (MNiSW) manages the science budget and supervises two key R&D funding agencies: the National Science Centre (NCN), which finances basic science projects, and the National Centre for Research and Development (NCBiR), which funds applied research and innovative development, including R&D projects run by business enterprises. These institutions are thus responsible for policy formulation and policy implementation via targeted funding.

Figure 8.0.1: An overview of Poland's national innovation ecosystem, as drawn up by the Ministry of Development[93]



8.1 Clusters and their connection to the regional RIS3

From the very beginning of defining smart specialisation in Poland it has been shaped in a cross-cutting way by the Ministry of Development through its *Technology Foresight for Polish Industry – InSight 2030* and the Ministry of Science and Higher Education which is leading the National Research Programme. Furthermore, the Ministry of Economic Development has drafted and the Council of Ministers approved the Strategy for Responsible Development which is an extension and operationalisation of the *Plan for Responsible Development*. The Strategy for Responsible Development is an updated variant of the medium-term development strategy - National Development Strategy 2020. Consequently, the documents dependent on the National Development Strategy 2020 are also under evaluation and will be matched to the results of the evaluation[94].

[93] Based on the schematic in the Ministry of Development's Strategy for Responsible Development, https://www.mr.gov.pl/media/48672/SOR.pdf, retrieved January 15th 2018

[94] Šime (ed.), 2017, National innovation and smart specialisation governance in the Baltic Sea region. Laying grounds for an enhanced macro-regional science-business cooperation, BSR Policy Briefing Series 4/2017

In the last 5 years, successive governments have drafted policy documents meant to reflect a coherent approach to developing and supporting economic growth including growth which builds on a sustainable R&I system. There is no one document which reflects strictly R&I policy aspirations. Starting with the *Strategy for Innovativeness and Efficiency of the Economy* (SIEE, 2013) and ending in the most recently approved *Strategy for Responsible Development* (2017), law- and policymakers have increasingly put industrial re-development (reindustrialisation) and support for innovation-based growth front and centre. The Ministry of Development's *Strategy for Responsible Development (SRD)*, which in itself is an update on the medium-term development strategy - *National Development Strategy 2020*, has as one of its 5 pillars: the *Development of innovative firms (building a business-friendly environment and system for supporting innovation)*.

The SRD identifies 5 barriers to growth: average income (need for wage-led growth to bring up average pay while increasing productivity without losing in terms of international competitiveness), imbalance (not enough support for domestic investors), mediocre products (only 6 domestic companies are considered top-notch international players, only 13% of companies introduces innovations into their products, only 8.5% of products exported are considered innovative), demographic challenge (in 2016 there were 7 mln people in pre-productive age; in 2036, this number is expected to drop down to 5.6 mln) and institutional weaknesses (revenue losses from uncollected or avoided VAT/corporate income tax; lack of effective coordination of public policies).

The SRD also focuses in on smart specialisation as a means of identifying the most significant branches of the Polish economy. Whilst the number of National Smart Specialisations (developed in 2014) has gone down somewhat from the original 20 (each consisting of subsets of smart specialisations) to 17 (changes as of December 2017), the changes are cosmetic rather than substantial. What is significant is the emphasis of the Ministry of Development on prioritising the most promising smart specialisations (aka First Tier Programmes), bringing down the smart specialisations which will get the most attention to ten areas:

1. medical engineering,
2. agricultural/wood products,
3. smart, energy-saving construction,
4. environmentally friendly transport solutions,
5. multifunctional materials & composites,
6. highly efficient, low-emission, integrated energy storage, transmission and distribution systems,
7. novel technologies for recovering, processing and using natural raw materials as well as producing their substitutes,
8. healthcare products,
9. smart geomatics technologies and networks and
10. automation and robotics in technological processes.

The Ministry of Science and Higher Education on the other hand, has since 2016, as part of a multi-year consultation effort known as the *Constitution for Science*, been seeking to identify and specify systemic changes that need to take place to substantially improve the quality of education taught at institutions of higher education and to raise the profile and international record of Polish science. One of the 3 pillars of the strategy (currently known as the *Gowin strategy*) driving the consultations is the commercialisation of research and partnership with business. The strategy includes a collection of recommendations for easing the tax burden on businesses and researchers engaging in R&D. It also calls – inter alia - for phasing out the 5-year time limit imposed on beneficiaries of public funds within which period they cannot benefit financially from bringing an invention (innovation) to market. The one recommendation, which directly concerns facilitating private-research collaborations is the establishment of the Łukasiewicz Network - a network of already existing 38 publicly-funded research institutions (all of which are supervised by one of three government ministries) and the working out of a unified procedure for granting companies (and researchers) access to research infrastructures by the Łukasiewicz Centre, which will be tasked with coordinating the work of the aforementioned Network.

If we narrow in on the Małopolska region, we find out in one report (sample size = 450 businesses) that only 1/3 of companies surveyed cooperated on R&D projects with external organisations, whilst 84.2% declared they did not employ any staff whose primary responsibility was to conduct and advance research & development. Slightly over a quarter (26,5%) of those participating in the survey identified that they planned in the 2016-2018 timeframe to use external services related to R&D processes and bringing products/services/technologies to market[95].

The upward trend noted for innovation activities in select sectors for the period 2012-2014 was accompanied by a 31% increase in R&D expenditures in the engineering sciences, and a modest 9% increase in the natural sciences over the same period.

Małopolska's main strategic document governing support for research and innovation is the *Regional Innovation Strategy for the Małopolska Region*. Approved in 2015, it is one of 9 strategic documents which accompany the Development Strategy of the Małopolska Region for 2011-2020 (enacted in 2011). The Strategy contains a diagnosis, which includes a whole host of conclusions, amongst which the most relevant for Baltic TRAM are:

- Kraków (the capital of the Małopolska region) is rated the 2nd (behind Dublin) most attractive venue for siting outsourcing and offshoring operations in Europe. The authors of the Strategy conclude that there is a risk that the competitive advantage of lower wages that will inevitably shrink with time will cost many jobs. Hence the recommendation that Kraków do more to attract companies to site R&D centres in Kraków (Kraków has lesser % of employees engaged in R&D than the smaller cities of Wrocław, the Tricity (Gdańsk, Gdynia and Sopot), and Rzeszów. (A recent positive development in this respect is the set-up of R&D centres, including by Assa Abloy, a manufacturer of electromechanical locking solutions for doors, decided, which decided late last year to open a corporate R&D centre here).
- R&D investments by locally headquartered businesses in the region were 4,5 smaller than the EU average, 3 times smaller than the level of investments in Catalonia, and 17 times lower than in the NUTS2 Southern Sweden region.
- It was found that in the previous programming period (2007-2013), EU funds specifically designated for co-financing investments by enterprises had a limited effect on innovation which was their express intention (defined as the development and commercialisation of new and better technology solutions and products) and brought with them a certain risk of a 'parallel economy' wherein some enterprises would become dependent on external financing to the detriment of their natural process of innovating and negatively impact competitiveness on the market.

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[95] Małopolskie Obserwatorium Rozwoju Regionalnego, 2016, Innowacyjność i działania badawczorozwojowe wśród małopolskich przedsiębiorstw, https://www.obserwatorium.malopolska.pl/wp-content/uploads/2016/05/streszczenie-Innowacje-UMWM-internet.pdf, retrieved March 19th 2018

The recommended publicly-funded actions to boost innovation activity in the 2014-2020 timeframe included:

- Innovation vouchers
- Competence building of R&D staff employed by enterprises; support for researchers who are carrying out R&D projects whilst interning in companies;
- R&D projects led by companies;
- Investment projects led by companies which are geared to replacing or improving the production process, purchasing or updating devices and technologies necessary to operate a given company;
- Support for cluster development, especially as it concerns building competences to innovate.

The fact that the implementation of the *Regional Innovation Strategy* did not result in a substantial improvement in the innovativeness of the regional economy led to in-house assessments which made a number of insightful conclusions described below[96].

> *"The model for supporting innovation in Poland as a whole has in general been a 'distributed' model, targeting many SMEs, rather than large enterprises, which according to the participants of the debate are where the innovations are born (start-ups are the exception to the rule); this also goes to the question of whether supporting centres of growth shouldn't be preferred over eliminating differences in development. Also shifting the accent to the regions disperses resources, and thereby lessens their impact. Indeed, a point was made that regional policies may actually weaken the capacity to innovate of the economy as a whole. On a related point, it was said that the regional smart specialisations, which were supposed to be a response to the problem of a regional focus in their current form are framed too broadly. Regulations which govern performance of research institutions do not encourage industry-relevant research. Universities and in particular university researchers are not rewarded for cooperating with entrepreneurs. Conversely, in most cases, the "research" problems of entrepreneurs are not of interest to the researchers, because possible solutions do not constitute material for scientific publications. When it comes to cooperation it is rather between a cluster and a particular scientist rather than a cluster and a university. Weak cooperation with business support organisations: technology parks, technology transfer centers, technology incubators, venture capital funds, except situation when business support organisations are active members or coordinators of cluster. Interest in developing clusters has decreased on the part of business support organisations once the public funding of these types of activities has ended. Furthermore a stated fact is that there is a low demand for innovation among companies: the decreasing importance of business support organisations as a channel for the flow of technological knowledge from universities to businesses (the growing role of the internet as a source of information on new solutions, innovations and technologies) – only 7% of entrepreneurs declare their cooperation with business support organisations in 2016. There is low interest in Polish institutional sources, such as the Polish Academy of Sciences' research institutes, research institutes, higher education institutions - 1 to 3% of enterprises rate "high" these sources. Last point driven from the conclusions of the report is that entrepreneurs prefer*

[96] https://www.malopolska.pl/publikacje/gospodarka/ewaluacja-expost-rsi-wm-w-perspektywie-jej-dlugoterminowego-oddzialywania-na-regionalna-innowacyjnosc , pp. 95, 98-99.

to gain knowledge from other entrepreneurs. The point here is most about patenting, copying, and inspiring the solutions used by others rather than cooperation."

From these and other conclusions followed a number of recommendations including making a strong thematic concentration on support for products/services/areas of research representing the greatest potential on the global scale – and by extension regular updating of regional smart specialisations.

The Board of the Malopolska Voivodship adopted the *Regional Innovation Strategy for the Malopolska Region (RIS MR)* for the years 2013-2020 in early June 2014. The RIS MR identifies the following regional smart specialisation areas (SSA's):

- Life sciences;
- Sustainable energy;
- Information and communication technologies;
- Chemical industry;
- Manufacturing of metals and metal products as well as products made of mineral non-metallic materials;
- Electrical engineering and machine-building industry;
- Creative and leisure-related industries.

The regional smart specialisations have not in practice been operationalised except to act go/no-go eligibility criterion, similarly to the national smart specialisations. While working groups for Małopolska's smart specialisations have been set up (according to published data, companies make up 55% of the membership of these working groups), the effects or impact of their work are not (yet) available.

Altogether 5 clusters in the region (Table 8.1.1) are directly linked to one or more of the region's Smart Specialisation Areas and as such provide an opportunity to advance the selected areas in practice[97]. They have been chosen on account of their matching Smart Specialisation areas as well as matching the fields of research and innovation that the Baltic TRAM network is involved in (e.g. clusters set up around creative industries or ICT are left out).

Table 8.1.1 Clusters in Malopolska region

Cluster	Description	Web
MedCluster	Brings together 42 enterprises, is linked to at least 2 of the SSA's listed above – life sciences and information and communication technologies. The cluster encompasses several NUTS2 regions, including Małopolska which make up the southern and south-eastern	www.medcluster.pl

[97] The issue of how the selected clusters reflect – via their activities - the connection to Regional Innovation Strategies for Smart Specialization (RIS3) is difficult to establish, because SSA's were identified in 2014, whereas the most recent analyses of cluster activities date to 2014 and 2015. While strengthening this connection can and should be considered the hallmark of a strong and mature cluster, the sparse literature on the topic addresses cluster maturity using multiple indicators, most of which don't provide a ready link to RIS3.

	NUTS2 regions. The cluster has been operating since the year 2007.	
LifeScience Klaster Krakow	More than 70 entities operate within the framework of the LifeScience Klaster Krakow. The largest group is represented by SMEs (47%), other public institutions (31%) and large enterprises (18%). The cluster primarily matches one of the SSA's listed above – life sciences. The cluster is operated by a foundation, and was initiated by the Jagiellonian University. The cluster was created in 2006.	www.lifescience.pl
South Poland Cleantech Cluster	The cluster currently includes 35 companies active in the clean tech sector, which is aligned to SSA (sustainable energy). The cluster is operated as a limited liability company and is active in several neighbouring NUTS2 regions, including Małopolska. The cluster was created in 2014.	www.spcleantech.com
Modern Cast Cluster	The cluster was created in 2011 and include 14 companies that are active mainly in metal manufacturing sector. The cluster cooperate with AGH University of Science and Technology and Institut of Metallurgy and Material Science Polish Academy of Science. The cluster enters into SSA- manufacturing of metals and metal products. Metallurgical raw materials in Poland constitute a very important component of mineral resources management.	www.moderncast.pl/
Sustainable Infrastructure Cluster	More than 100 entities operate with cluster. The cluster focuses on companies in the field of intelligent sustainable energy-efficient buildings and technologies using renewable energy, therefore is linked to 3 of SSA (sustainable energy, electrical engineering and machine-building industry, information and communication technologies). The cluster was formed in 2011.	www.klasterzi.pl/

Anecdotal evidence as well as a general survey of cluster websites, however, suggests that primary activities of the clusters do not involve research and development (innovation) support as such. They instead focus on facilitating business opportunities via business skills workshops, easier knowledge and access to trade events, easier access to technologies. Several examples illustrate this:

- The Sustainable Infrastructure Cluster is offering access to advanced equipment of interest to the construction industry as a form of de minimis public aid.
- The Life Science Cluster has organised several rounds of workshops which focus on developing business skills useful in engaging international customers. The workshops are available as de minimis aid.

This being said, the openness with which companies approach their involvement in clusters may be conducive to creating opportunities for R&D excellence, including via open innovation schemes.

The only analytical report to date on Małopolska clusters (research performed in 2015) assigned the following indicators of cluster maturity: Defined scope of responsibility and privileges of the coordinator of the cluster; The organisational structure of the cluster; Current development strategy for the cluster (has to have a horizon of 3 or more years); Ongoing activities designed to recruit new members of the cluster; Number of common products and services of the cluster, which are advertised (once every two years the cluster should introduce a new product/service and/or earn revenue on the basis of existing products/services.) and; Cooperation of member companies in a value chain (at least 4 segments of any given value chain should be represented).[98] The report concluded that of the 21 clusters analysed, the majority met the standards defined by these indicators.

The same report likewise determined that the areas of activities of the clusters were overwhelmingly compatible with SSA's, and used the indicator of a/minimum 70% of cluster members belonging to the same branch/sector and b/at least 50% of member companies having (sic!) one regional SSA or cluster companies own or otherwise have at their disposal technology/intellectual property rights encompassing one of these regional SSAs. Małopolska is a relatively economically strong region with noticeable interest in business innovation activities. One of the strongest assets of the region is an extensive research base creating very good conditions for the development of enterprises' cooperation with research units (in joint R&D projects). Analyses indicate that the potential of such cooperation is used by both sides in a fairly limited range – according to research conducted for RIS (Register of Training Institutions) only 7% of SMEs cooperate with innovation supply units in the region and only 4% implements R&D projects.

8.2 Interactions between RIS3, clusters and regional development strategies guiding research and innovation

As outlined also in the *BSR Policy Briefing 4/2017* the National Smart Specialisation list as such isn't in Poland a strategic policy document and does not contain any guidance on implementation or monitoring of progress of operationalising smart specialisation. Such an approach has been praised in the previous analysis for being embedded in a broader R&I strategic framework[99]. The document elaborates on setting up a unit within an existing government institution, namely, the Polish

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[98] https://www.obserwatorium.malopolska.pl/wp-content/uploads/2016/05/Ma%C5%82opolskie-inicjatywy-klastrowe.pdf, p. 23, 25, 26.

[99] Klincewicz, K., & Szkuta, K. (2016). *RIO Country Report 2015: Poland*, p. 34. RIO Country Report 2015. Seville. http://doi.org/10.2791/984739, Retrieved on 27th of March, 2018

Enterprise Development Agency, to aid in the creation of innovation using public funds, which – inter alia – would have under its purview the monitoring of the implementation of smart specialisations nationwide. The document also lists a number of funding incentives for businesses and other applicants to align their work with the smart specialisation priorities, including public funding to support the development of critical clusters, as well as diffusion of information and communication technologies as a growth factor in each of these domains.

Strategy for Responsible Development endorses five strengths of the Polish development, i.e. reindustrialization; development of innovative companies; capital for development; foreign expansion; social and regional development. NIS-3/RIS-3 are included as enablers for reindustrialisation in order to identify national and regional market-related niches and competitive advantages for global markets[100].

Thus, industrial specialisations reflect the set of examples of branches where Poland may be competitive and have a leading role in the global economy: aviation; arms industry; car components; shipbuilding industry; information technologies; chemical industry; furniture; food processing.

The majority of the 16 NUTS II regions represented by 16 regional governments (voivodships) are the authors of their own strategic documents elaborating the smart specialisation priorities set on the regional level. The national and regional level documents were drafted separately, thus from the very beginning these shouldn't be considered as a unified and closely interlinked set of documents. Partly national smart specialisation is directly linked to regional smart specialisations. However, there are some national specialisations which do not have a counterpart at the regional level. It suggests a distributed nature of specialisations and that their critical mass and international potential were identified at national level. This nuance is also mirrored in the fact that the regional drafting of S3 is at different stages of advancement. Furthermore, each region has its own smart specialisation and system of monitoring which is led by individually set-up bodies such as: groups, teams, observatories. In each region and at the national level, there is body which is responsible for defining trends and evaluation of developing potential of Smart Partnerships[101].

All 16 Polish regions have defined their regional smart specialisation strategies as part of their consultation on the Regional OPs for ESI Funds under the framework of the OP "Smart Growth". These strategies vary in quality, some of them being focused, while others are characterised by a rather general approach. The generalist programmes were designed in order to avoid possible technology lock-ins, as the planning horizon was spanning until 2020[102].

8.3 Regional resources and national networks of ARFs in Poland

In the Meril database there are currently altogether four operational national level Polish research infrastructures mentioned out of which two are single-sited and other two distributed by type.

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[100] Šime (ed.), 2017, National innovation and smart specialisation governance in the Baltic Sea region. Laying grounds for an enhanced macro-regional science-business cooperation, BSR Policy Briefing Series 4/2017

[101] ibid.

[102] Klincewicz, K., & Szkuta, K. (2016). *RIO Country Report 2015: Poland*. RIO Country Report 2015. Seville. http://doi.org/10.2791/984739, Retrieved on 27th of March, 2018

In addition to the national level facilities, the Małopolska region has a high potential for scientific research and higher education, while Kraków is leading hub for research & development. 32 higher education institutions and universities, representing 7.1% of all higher education institutions in Poland are located in Małopolska. The most important public institutions of higher education in Małopolska region: Jagiellonian University, AGH University of Science and Technology, Cracow University of Technology and Agricultural University of Kraków. Also worth mentioning is a collaborative scheme between four Kraków-based universities, including the 3 mentioned above, called: The Intramural Centre for New Medical Techniques and Technologies.

The most likely base of cooperation and expertise that the Polish IREC can fall back on during its development is one or more of the three major research universities located in the region, namely: the Jagiellonian University in Kraków, the AGH University of Science and Technology in Kraków and the Kraków University of Technology. Within these institutions, there are several research centres which have a close tie to regional smart specialisations.

- Jagiellonian University: Jagiellonian Centre for Drug Development - Małopolska Biotechnology Centre.

- AGH University of Science & Technology: -Centre for Intelligent Informatics Solutions - Sustainable Development and Energy Efficiency Centre -International Centre for Electron Microscopy for Material Engineering - Energy Centre (including the Rooftop Wind Turbines Lab)

- Krakow University of Technology: -Małopolska Centre for Energy Efficient Buildings -Centre for Research and Development of Industrial Devices CEBEA.

The Research and Knowledge Transfer Centres provide professional research, expert and consulting services, drawing on the knowledge and experience of the University's academics and researchers. There is a specialised centre for technology transfer in all of the public higher education institutions in the Malopolska region. These centres operate on similar principles, however their scope of activities as they relate to creating opportunities for greater interaction between enterprises and university institutions and laboratories varies. Below is a listing of 3 competence centres, which the Polish IREC is most likely to undertake cooperation with, along with a short description of their online capabilities (the only readily available interface that is at least one indicator of the level of preparedness and outreach to the business community):

- Technology Transfer Centre at Cracow University of Technology (no specialization as such; TTC has online updated database listing the R&D services of 23 university laboratories & research units, 123 solutions/methodologies developed in-house and offering commercialization potential); INTECH PK, a spin-off limited liability company tied directly to the Cracow University of Technology is most likely taking over from the Technology Transfer Centre as the primary point of contact for potential research-business partnerships;
- Technology Transfer Centre at AGH University of Science & Technology (no specialization as such; TTC currently seems to be focused on helping commercialise R&D generated by university researchers and students, including spin-off companies. No real advertisement specifically for businesses;

- Centre for Technology Transfer CITTRU at the Jagiellonian University (offers two entry-points for businesses: innovation (28 innovations displayed) and contract research (88 profiled departments/laboratories/ research groups detailing expertise and possible range of research services).[103]

In addition to the university level technology transfer offices there is a country-wide dimension to the work of Polish technology transfer centres (not only the ones from Małopolska) that cannot be ignored, even as it is in its incipient stage (launched in early 2017), namely PSTRYK, which is a government-run single-entry commissioned research website (akin to ADAPTER website). One embedded form and attachments summarizing the R&D challenge(s) a company faces are submitted to over 50 technology transfer centres (including those named above) with a target 48-hour initial response period.

In Małopolska there are several examples of commercial laboratories which provide specialistic R&D services. Below are several examples of private sector RTOs located in Małopolska which offer R&D services to private as well as public entities:

- Createc (services centred on material analysis);
- EC Engineering (services focused on product design for the automotive, railroad, aeronautic sectors).
- Selvita (company offers drug discovery support at every stage of the early discovery phase up to the preclinical research phase for pharmaceutical and biotechnology companies)

Also worth mentioning are public RTOs, owned and/or operated primarily using public (national, regional) funds. A prominent local example is the Institute of Nuclear Physics of the Polish Academy of Sciences (abbrev. IFJ PAN).

Below are several examples of private RTOs located in other NUTS2 regions whose clientele may exist in Małopolska, and who are thematically linked to Małopolska's smart specialisation areas:

- Prueftechnik Technology sp. z o.o. (part of Prueftechnik AG) – design and implementation of IT, electronic and mechanical systems (located in Lower Silesia NUTS2 region);
- ML System R&D Centre for Photovoltaics – R&D branch of ML system, a manufacturer of building-integrated photovoltaic modules. The Centre is open to companies seeking R&D support in commissioned and proprietary projects in the area of nanotechnology (located in neighbouring Podkarpacie NUTS2 region)
- TRICOMED – includes laboratory offering services relating to accelerated ageing, chemical and physical properties (located in Łódź NUTS2 region)
- SoftBlue SA – IT consultancy with R&D specialization in biotechnology (located in Kujawsko-Pomorskie NUTS2 region)
- Pronovum – RTO with Material Research Laboratory offering NDT and SHM of metals & others (located in neighbouring Upper Silesia NUTS2 region)

Various levels of support for newly established companies is also provided by business incubators, which should also be mentioned as a type of business support organisation whose professional

[103] Information gathered from websites of all three technology transfer centres. Retrieved December 19th 2017.

network the Polish IREC could benefit from. There are several business incubators in Małopolska, the vast majority of which are situated in the administrative centre of the region:

- Technological Incubator of the Kraków Technological Park
- Bio-Incubator in Life-Science Park
- Academic Business Incubator of the AGH University of Science and Technology
- Academic Business Incubator of the Kraków University of Technology
- Academic Business Incubator of the Jagiellonian University
- Academic Business Incubator of the Kraków University of Economics,
- Academic Business Incubator of the University of Agriculture in Kraków,
- Academic Business Incubator of the Andrzej Frycz Modrzewski Kraków University and
- Academic Business Incubator of the Tischner European University.

8.4 Development needs and gaps at regional level

The Strategy for Responsible Development and the Constitution for Science tend to be key foundational documents for a results-oriented policy on the R&I system. Their strength are the practical measures proposed in each document, which promise to improve the state of play in the innovation ecosystem. They are a combination of one-time measures (e.g. doing away with burdensome legal requirements), systemic support (e.g. setting up multi-year programmes meant to strengthen the chances of success of Polish start-ups) as well as good practice (e.g. industry-oriented PhDs). Their weakness is the absence of dedicated measures to support the growth of smart specialisations.

As of the beginning of 2018, no dedicated funding instrument or support scheme to boost and strengthen a given smart specialisation has been developed. *The Strategy for Responsible Development* signals that the First Tier Programmes will have appropriate funding for growth of smart specialisations but does not provide any details. While there are certain groups (working groups, the Business Observatory) charged with monitoring and analysing local markets with the view to identify growth trends and promising high-impact niches, their work is not (yet) visible on the national nor on the regional level. The majority of the 16 administrative regions have not developed (or if they have developed, they have not advertised it) any mechanisms for operationalising smart specialisations beyond using smart specialisation as a go/no-go eligibility criterion in their EU funding schemes (i.e. projects are not eligible for funding if the applying company's business activity does not match any of the regional smart specialisations). In short, at the moment there are very few efforts which seek to bring together different constituencies that are interested in strengthening support for smart specialisations.

According to a nationwide survey conducted by Deloitte Polska in 2016[104], there are a few challenges which make it more difficult to reach a critical mass of interest in commercially based R&D services such as those proposed by the Baltic IReC network. These challenges at the national level are

[104] Deloitte Poland/Corporate R&D Report 2016, 2016, https://www2.deloitte.com/content/dam/Deloitte/pl/Documents/Reports/pl_RD-2016-Poland-EN%20(1).pdf, retrieved March 19th 2018

characterised by the responses of the surveyed enterprises (sample size not known) to the following topics:

- R&D&I strategies – almost half of the responders noted that their company does not have such a strategy in place, which is to say that decisions of a strategic nature are made on an ad hoc basis[105];
- R&D spending in excess of 3% of revenue – 33% of companies (as compared with 48% in 2015) noted this[106]; at the same time a slight rise in the % of companies spending more than 10% of their revenue on R&D related investments. This indirectly indicates a sharp fall in spending among smaller businesses, compensated only slightly by an increase in this category amongst large enterprises[107].
- Collaboration with external organisations on R&D projects – 71% of companies surveyed declared they had cooperated in 2016 with external organisations.

In terms of encouraging companies to secure EU grants administered on the national level, one concern noted in the Deloitte report is the lack of clarity on what type of activities fall under the official definition of R&D (i.e. how broad or narrow the interpretation of this definition is done). This has led to the rejection of many project proposals submitted to the *Smart Development Operational Programme*, again, because they do not comply with R&D criteria.

[105] ibid, p. 11

[106] ibid, p. 5

[107] ibid, p. 7

9. Sweden

Carl Malm, Jonas Andersson & Lars Tilly

Sweden has historically been among countries investing a large share of GDP in R&D annually. However, the long-term trend for Sweden shows a decline in R&D intensity, with the figure on total R&D investments as a share of GDP dropping from 4.18% in 2001 to 3.41% in 2012 and to 3.21% in 2013. This development is opposite to most EU countries, where corresponding figures have increased over the same period. The explanation for the decline lies predominantly in the private sector, as Business Expenditures for Research and Development (BERD) relative to GDP have shrunk from 2.55% in 2009 to 2.36% in 2013. Public investment in R&D has fluctuated somewhat in recent years, but remained steady on long term, amounting to approximately 0.8% of GDP in 2012[108].

The Swedish R&I system is characterised by high diversity in its funding arrangements and low diversity in terms of the categories of research performing organisations in the system. Firms account for at least two thirds of the research funded. The public-sector research effort is divided among three main types of research performers: universities and university colleges, research institutes and last but not least public authorities that perform in house research. The university and university college system is the largest part of the public research performing sector. Almost two thirds of publicly financed research in Sweden is done at 36 universities and university colleges. 5 Industrial research institutes are not part of the higher education sector but are classified as knowledge intensive firms and are organised under one umbrella organisation (RISE) which is a publicly owned company. There are a number of small public research institutes that are special purpose organisations such as the Swedish Institute of Advanced Studies but these are not of direct relevance to RI policy. Large scale research infrastructure in Sweden is incorporated in universities so there is no national lab system. University hospitals are excluded from the category "research infrastructure". These units are financed through a shared financing system between the universities and the municipality in which the university is located. There is a special research fund for clinical research and this is administered at the county council level[109].

The Swedish approach to R&I governance is predominantly decentralized. For this reason, it makes little sense to attempt to point to a particular actor as the main policy making body. A more useful approach would be to focus on where the main policy directives emanate from. This point is the Research Bill and the Innovation Strategy. The expert public agencies such as VINNOVA, the Swedish Energy Agency and the Swedish Research Council are key actors in the policy system. VINNOVA is the central coordinating actor for innovation issues while the Swedish Research Council is the principal actor for providing advice on the research system to the government. These actors have key policy implementation roles and are also main sources of advice and expertise to the Ministries. For this reason, it would also be remiss to maintain that policies are made at the Ministry level and then implemented at the Agency level. Instead, there is a complex backward and forward interaction between the Ministries and the Agencies which they govern on the one hand, and the Ministries and Parliament on the other. For R&I policy as in other policy areas, this process of upward and downward

[108] Jacob, 2015, RIO Country Report Sweden 2014. JRC Science for policy report, Research and Innovation Observatory country reports series

[109] ibid.

consultation is iterative and includes input from stakeholders either filtered through the Agencies or directly. In 2014, the new government added another actor to this constellation, and this is the Innovation Council. The status of this entity is advisory and the Prime Minister and the Minister of Finance are members as well as the Minister of Enterprise and Innovation and the Minister of Research and Higher Education[110].

9.1 Clusters and emerging clusters and their connection to the RIS3

The South Sweden region covered by Innovation Skåne AB and Invest in Skåne as partners in BT (NUTS2 SE22) is constituted of Skåne (NUTS3 SE224) and Blekinge (NUTS3 SE221), which each and independently have defined S3 strategies in RIS3, as per below. As for our other material, we combine the review and analysis for the two independent NUTS3 regions even as policy, strategies and goals are set independently.

First a review of the stated RIS3 priorities of each of the regions, and then a listing of identified clusters.

Figure 9.1.1: S3 priority areas in Blekinge[111]

S3 Priorities as Encoded in the "Eye@RIS3" Tool

Description	Capabilities	Target Markets	EU Priorities
Internet of Things			1. Digital Agenda
Metal working	1. Manufacturing & industry 2. Basic metals & of fabricated metal products	1. Manufacturing & industry 2. Basic metals & of fabricated metal products	1. KETs 2. Advanced materials
Marine energy	1. Energy production & distribution 2. Power generation/renewable sources	1. Energy production & distribution 2. Power generation/renewable sources	1. Blue growth 2. Blue renewable energy
Marine technology	1. Manufacturing & industry	1. Manufacturing & industry	1. Blue growth
Mobile health	1. Information & communication technologies (ICT)	1. Human health & social work activities	1. Digital Agenda 2. e-Health (e.g. healthy ageing)
Water jet cutting	1. Manufacturing & industry 2. Basic metals & of fabricated metal products	1. Manufacturing & industry 2. Basic metals & of fabricated metal products	1. KETs 2. Advanced manufacturing systems
Energy optimisation	1. Energy production & distribution 2. Energy distribution	1. Energy production & distribution 2. Energy distribution	1. Sustainable innovation 2. Sustainable energy & renewables
Intelligent transport systems	1. Transporting & storage	1. Transporting & storage	1. Digital Agenda 2. Intelligent inter-modal & sustainable urban areas (e.g. smart cities)
Digital media	1. Information & communication technologies (ICT)	1. Information & communication technologies (ICT)	1. Digital Agenda 2. New media & easier access to cultural contents (e.g. heritage)

[110] Jacob, Lindholm Dahlstrand & Sprutacz, 2016 Rio Country Report Sweden 2015. JRC Science for policy report, Research and Innovation Observatory country reports series

[111] European Commission, Eye@RIS3: Innovation Priorities in Europe, http://s3platform.jrc.ec.europa.eu/map, retrieved July 2017

Figure 9.1.2: S3 priority areas in Skåne[112]

S3 Priorities as Encoded in the "Eye@RIS3" Tool

Description	Capabilities	Target Markets	EU Priorities
Personal health - the development of new products, services, e-health, business models and system solutions for preventive health measures.	1. Information & communication technologies (ICT)	1. Human health & social work activities 2. Human health activities (medical services)	1. Public health & security 2. Public health & well-being
Smart Sustainable Cities. knowledge, products, processes, services and systems at the intersection between a broad range of technological areas that solves cities' sustainability challenges.	1. Information & communication technologies (ICT)	1. Construction	1. Digital Agenda 2. Intelligent inter-modal & sustainable urban areas (e.g. smart cities)
Smart Materials. material science and its innovation	1. Manufacturing & industry 2. Other manufacturing	1. Manufacturing & industry 2. Other manufacturing	1. KETs 2. Advanced materials

Each NUTS3 region has its own priorities and clusters identified, and so the analysis is made for each such region separately. As described in our country specific report previously, the Research and Innovation policy in Sweden is decentralized.

Strong Clusters and emerging clusters in each region, are listed below. Interested reader can find more information on the clusters at the respective Internet sites indicated in the list when applicable.

Skåne Clusters

- Media evolution, http://mediaevolution.se/
- Mobile Heights, http://mobileheights.org/
- Packbridge, http://www.packbridge.se/
- Livsmedelsakademin, http://www.livsmedelsakademin.se/
- Sustainable Business Hub, http://www.sbhub.se/
- Resilient Regions Association, http://www.resilientregions.org/
- IUC Syd (Industriella Utvecklings Centra), http://www.iucsyd.se/
- Medicon Valley Alliance, http://www.mva.org/
- SMTF (Svenskt Marin Tekniskt Forum), http://smtf.se/

Blekinge Clusters

- Blue Science Park - Marine Technology, e-Health and ITC, http://www.bluesciencepark.se
- Netport, http://www.netport.se
- TechTank, https://techtank.se
- Telecom city, http://telecomcity.se
- Tech Network, http://technetwork.se
- Swedish Waterjet Lab, http://www.waterjetlab.se/information-in-english.html
- Energiklustret

[112] ibid.

9.2 Interactions between RIS3, clusters and regional development strategies guiding research and innovation

As the clusters in South Sweden have evolved in a top down process from the strategic initiatives aiming to increase competitiveness through increased innovation we find that the fit between clusters and strategies and RIS3 priorities is very high. For Skåne as well as for the Blekinge region, we see that there are clusters or cluster initiatives responding to all levels of the respective RIS3 strategy. Therefor we can't find any gaps towards the respective RIS3 strategies. At the other hand, you could always do more or less to reach a goal, and we have not, in the gathering of information for this report, been able to tell the successfulness of each cluster/effort.

The Skåne Research and Innovation Council (FIRS) in Skåne leads the work with Innovation strategy. Their stated aim in this work is as follows:

"Skåne needs to evolve as a knowledge and innovation-based region. The aim of the FIRS work is to strengthen Skåne's research and innovation performance and make Skåne Europe's most innovative region in 2020.
FIRS represent a unifying force and a common voice for the region's assets, needs and opportunities. The Research and Innovation Council consists of representatives from the management of Region Skåne, the region's colleges and universities, municipal representatives from the Malmö, Lund and Helsingborg, Kristianstad, Local Authorities, and industry."

The strategy is set in the defining document *An International Innovation Strategy for Skåne, 2012-2020*[113].

The basic document for the work is the EU2020 strategy which states that the greatest challenge for the EU and its member states is to establish a more strategic approach to innovation. This is in response to global challenges, major demographic changes and increased global competition.

By means of regional, national and international collaboration, Skåne can develop into an attractive international innovation environment. The foundation of the strategy is substantial investment in reinforcing Skåne's innovation culture and capacity. A culture which grows out of the creativity, openness and diversity that we have in Skåne today.

Among other things, the focus should be on supporting skills development within the innovation areas where Skåne has the greatest potential to stimulate real innovation. Examples of such areas are personal health and smart and sustainable towns/regions.

The development of knowledge-based, open innovation arenas also plays a key role in the strategy. Examples of such innovation arenas can be in material science, media, mobile communications, tourism, logistics, packaging, cleantech, city training and life science.

[113] Skåne Research and Innovation Council (FIRS) & Sounding Board for Innovation in Skåne (SIS), 2011, An International Innovation strategy for Skåne 2012-2020, https://utveckling.skane.se/siteassets/naringsliv/dokument/innovationssystem/IIFS-eng, retrieved March 19th 2018

The international innovation strategy that the Research and Innovation Council (FIRS) and Soundingboard Innovation in Skåne (SIS) have endorsed is also one of the common bases for an upcoming research and innovation proposal and the OECD study conducted in Skåne in 2011-2012.

In summary, the strategy sets out actions and responsibilities in the regional administration to support the vision and objectives and builds the primary structures to develop the innovation capability in Skåne. In order to create potential for growth and economic success, the need for internationalization is recognized. This is anchored in the RIS3 objectives which link to large scale, global challenges, which should open the international market for commercialization of innovations brought out through the activities.

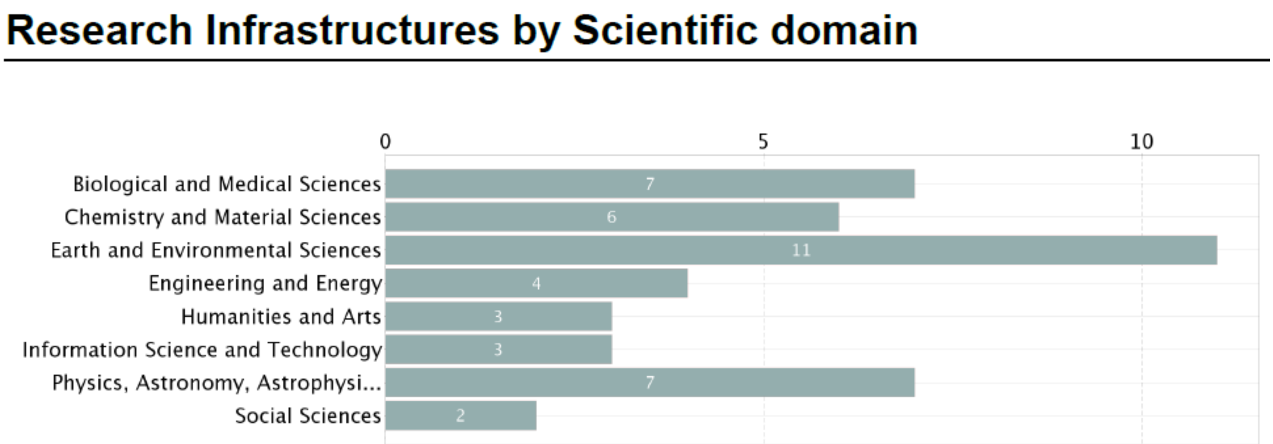
Concretely the strategy is condensed to the three listed S3 priorities which set the focus of the ongoing work in the region. Clusters are created and supported based on triple helix structures corresponding to the identified needs in order to reach the listed S3 priorities. Thus, clusters should be related to the three identified S3 priorities and for the most part they are considered as supporting not one but multiple S3 priorities.

As regards Blekinge, the organisation responsible for the overall strategy is Region Blekinge. The strategy aims at creating favourable conditions for sustainable business and community development in the interface between business, civil society and public sector. The aim is to develop existing international innovative networks and contribute to regional growth; continue to build the region in its strength areas e.g. IT, Health, marine technology, digital media, and energy; to integrate research actors into innovation development; to invest in SMEs within emerging industries that have massive growth potential.

9.3 Regional resources and national networks of ARFs in Sweden

The European Meril database lists currently altogether 16 research infrastructures in Sweden out of which 10 are single-sited, 5 distributed and one virtual by nature.

Figure 9.3.1: Research infrastructures by scientific domain in Sweden[114]



[114] MERIL (Mapping of the European Research Infrastructure Landscape) portal, https://portal.meril.eu/meril/, retrieved August 29th 2016

All identified and relevant regional and regionally accessible national resources are listed and briefly described below.

Intermediaries and regional development organisations

Region Skåne

Region Skåne is a self-governing administrative region, funded by taxes, which is governed by a Regional Council of 149 members who are directly elected by the inhabitants of Skåne. Region Skåne has three main areas of responsibility: 1) Healthcare, 2) Public Transportation 3) Regional Development.

Region Skåne has a permanent commission from the state to coordinate regional development issues and lead the work with creating a Regional Development Strategy, RUS. Region Skåne's role is to coordinate regional development strategy work and act as an inspirer and unifying force for regional developments, but also to participate in some of the implementation measures. We are process leaders for regional development in Skåne County.

In June, 2014, the Regional Council accepted *The Open Skåne 2030* as the Regional Development Strategy for Skåne County. The strategy has been developed in collaboration with municipalities, authorities, universities, business organisations, the ideas-based sector, inhabitants and other parties working with development issues. The Regional Development Strategy is to formulate and create a broad consensus as to a joint goal for Skåne. Together, we have agreed on the goal *The Open Skåne 2030*.

The goal was developed over the course of a couple of years through analyses, meetings and conversations with municipalities, authorities, trade and industry, business organisations, the ideas-based sector, etc. The Regional Development Strategy was accepted by the Regional Council in June, 2014.

Goal for Skåne 2030

Skåne in 2030 is open. Open-minded, open to all, and with an open landscape. Skåne welcomes new people and new influences with open arms. Skåne is the portal to Sweden and out into the world.

The Development Strategy includes five prioritised standpoints for reaching the goal. There are a number of sub strategies and a few goals for each standpoint.

The five prioritised standpoints are:

- Skåne shall offer belief in the future and quality of life
- Skåne shall become a strong motor for sustainable growth
- Skåne shall make use of its geographically multicentric structure
- Skåne shall develop the welfare services of tomorrow
- Skåne shall be globally attractive

Business Region Skåne

Business Region Skåne, is the marketing group of Skåne, promotes with its four companies Skåne in the far south of Sweden as a region for investments, tourism, events and film. Business Region Skåne is owned by the regional council, Region Skåne (85 percent), and the association of municipalities in Skåne (15 percent). The four marketing companies – Tourism in Skåne, Invest in Skåne, Event in Skåne and Film i Skåne – jointly develop, coordinate and improve the brand Skåne, as well as taking an active responsibility for marketing the Öresund region together with other parties on both the Swedish and the Danish side of the Öresund.

Innovation Skåne

Innovation Skåne, fully owned by the regional council Region Skåne, supports innovation and regional development in several ways and areas. The first is the support of start-ups; offering entrepreneurs and innovators professional advice, relevant networking and partnerships. Second, is helping the regional governed healthcare to improve efficiency through innovation by providing exclusive hands-on business development of new ideas that origin from their employees. Innovation Skåne also focus on new industries. There's one project on smart lightning, another on connected healthcare, and a third on materials. The latter is run under the name Materials Business Center, aiming on making the region a global epicenter for new products and businesses based on materials technology and innovation in Southern Sweden.

LU Innovation

LU Innovation is the hub for innovation and commercialisation at Lund University, the largest university in Skåne and second largest university in Sweden. The goal and mission of LU Innovation is to contribute to increased growth in Sweden by ensuring knowledge and research from Lund University benefit society. By supporting and developing research findings with researchers and students LU Innovation works to lead more ideas to company formations and/or licensing deals.

Services for all researchers and students:

- Business development – support and advice
- Verification support – VFT
- Market and IP screening – comprehensive survey of markets, competitors and patent situation

The services are freely available to researchers and students at all faculties at Lund University.

LU Innovation has two sections: one a part of the public authority and the other a holding company, which function as one unit with a joint mission and joint management.

Incubators, science parks and regional cluster programmes

IDEON Science Park

Ideon Science Park is Scandinavia's and one of Europe's most successful meeting places for visionaries, entrepreneurs and for venture capital. At present, Ideon has 120,000 square metres of office space and about 350 companies operate here, employing more than 2,700 people, mainly within the areas of ICT, Life Science and Cleantech. Ideon is run by Wihlborgs Fastigheter AB, Lund University and Lund Municipality. Ideon Science Park offers a wide range of services including ones of an advisory nature, including networks and mentors for different phases of the companies' development. This can involve matters of leadership, financing and business development, or be questions relating to patents, law or accounting.

Medicon Village

Medicon Village is located in Lund and is owned by the Mats Paulsson Foundation for research, innovation and societal development. The foundation aims to promote scientific research, primarily within medicine and other life sciences, so as to benefit healthcare, development, innovation and societal development in Skåne. Medicon Village offers a unique environment for the growth of knowledge- and development intensive companies within the field of biotechnology, pharmaceutical, medical devices, diagnostics and healthcare companies. Medicon Village offer premises for Life Science companies that plan to expand and become successful with a profitable business on an international and/or national level. Also, Medicon Village provide an environment for long-term collaboration with leading organisations from the education field, trade and industry and the public sector, and is a meeting place that facilitates an exchange of experiences and collaboration with representatives from Lund University and academia in the Öresunds region, the healthcare sector and Skåne University Hospital, as well as with the business community.

Research is a key part of the activities within Medicon Village. Together with the Biomedical Centre in Lund (BMC), the Clinical Research Centre in Malmö (CRC) and Medical Malmö, as well as the new research facilities ESS and the MAX IV laboratory, Medicon Village is establishing an infrastructure of world class and thus providing a huge lift to, and enhancing the attractiveness of, the entire region, which is characterised by its internationally acknowledged role in the area of research into, among other things, nanotechnology, cleantech, food and medicine.

Smile Incubator

Smile is a business incubator located at Medicon Village in Lund, Sweden. It helps entrepreneurs and early stage companies in the life sciences develop and commercialize new ideas. Smile provides coaching for early phase management teams and offer need-based, qualified advice in finance, business development and product development. The incubator facilities offer well equipped lab space, advanced instrumentation, office space and conference rooms. In the incubator's core facility, companies have access to a large number of instruments for most applications in life science including: cell and molecular biology, protein chemistry, chemical analysis, histology etc. The incubator and incubator companies together represent very broad expertise in life science and offer training, support and the opportunity to purchase expert and research services when necessary.

The incubator program is aimed at product development and service companies developing trough a screening and selection process wherein interested parties can pitch their business idea and plans for development. Product development companies may be included in the incubator program for up to six years.

Medeon – Science park and Incubator

Medeon is a science park and incubator located in Malmö, Skåne. Medeon's philosophy is that each and every growth industry has its unique needs. The focus is on knowledge-intensive companies in the life science field (pharmaceuticals, medical technology, biotechnology and healthcare). Companies accepted in the Medeon Incubator will gain access to the following services:

- Coaching and industry-specific business counselling.
- Training package: Finance, legal, marketing and sales, IP issues, leadership development. Specific training adapted to life science companies is also offered.
- Network activities: Breakfast meetings, membership in Medeons Life Science Network, invitation to Medeon’s spring and autumn activities, as well as access to attractive supplier agreements for Medeon companies.
- Access to venture capital networks.

PULS

Partners for Development Investments in Life Sciences, P.U.L.S. AB is situated in Helsingborg, Skåne, and invests in novel projects within life science – mostly pharmaceutical development – and has started ten project companies. PULS consists of an operational management team and 40 partners. Their business model is to engage early on with innovators so as to obtain an optimal IP status and high-quality development throughout the project. The common objective is to maximize, clarify and realize the value of project ideas by providing capital, knowledge, cost-effective management and a successful exit. PULS's vision is to make a significant contribution to the life science industry's development by pursuing a robust, long-term profitable private development company within life sciences focusing on pharmaceuticals and medical devices.

Blue Science Park

Blue Science park is a cooperation between Blekinge Institute of Technology, the Blekinge region and the industry, located in the city Karlskrona. Focus areas are telecom/it, e-health and marine technology.

Chamber of commerce and other trade organisations

Sweden's Chambers of commerce consist of eleven regional Chambers of commerce located around the country that work to create a business-friendly environment. The Chamber of commerce network engage with questions relating to economic growth, both nationally and internationally. Sweden's Chambers of commerce primarily promote infrastructure projects in which Sweden's Chambers of commerce wishes to see more interaction between the state and private enterprise. Other issues that they are concerned with are: energy policies, the supply of talent and raising the level of service provided to corporations by municipalities.

Analytical research facilities at regional level

Higher education institutions

Lund University

Lund University, founded in 1666, is today ranked as one of the top 100 in the world providing education and research in engineering, science, law, social sciences, economics and management, medicine, humanities, theology, fine art, music and drama. The university houses 41000 students and 7500 staff members, spread out over the cities Lund, Helsingborg and Malmö.

It's an international university with global recruitment, cooperating with 600 partner universities in over 70 countries and is the only Swedish university to be a member of the strong international networks LERU (the League of European Research Universities) and Universitas 21. There are a range of openly accessible ARIs, governed by the University, within the studied subjects, and the most important are presented below.

MAX IV

Max IV, open for external users in spring 2017, is a state of the art synchrotron radiation facility, replacing and an enhancement of the former rings MAX I-III (closed in 2015). With two storage rings, one on 1,5 GeV and 98m circumference, and another on 3GeV and 528m circumference, it will serve the (until today planned) 14 beamlines with x-rays. Researchers facilitating Max IV varies from the fields of biology, physics, chemistry and environmental science, as well as geology, engineering, pharmacology and cultural heritage.

ESS – European Spallation Source

The European Spallation Source (ESS) is a European Research Infrastructure Consortium (ERIC), a multi-disciplinary research facility based on the world's most powerful neutron source. The unique capabilities of this new facility will both greatly exceed and complement those of today's leading neutron sources, enabling new opportunities for researchers across the spectrum of scientific discovery, including life sciences, energy, environmental technology, cultural heritage and fundamental physics. It's a 2B€ investment located in the city of Lund, and will be operationally open for external users first in 2023.

NRC – Neuronano Research Center

The Neuronano Research Center (NRC) is an interdisciplinary research and innovation center combining neuroscience in vivo and in vitro, nano- and microtechnology, and organic chemistry in the development of a new generation of neural interfaces for communication with the nervous system in basic research and clinical applications.

LBIC – Lund University Bioimaging Center

Lund University bioimaging centre's (LBIC) mission is to combine knowledge in the fields of medical physics, preclinical and clinical medicine, chemistry, technology and applied mathematics in order to provide and develop imaging methods for the advanced study of human morphology, cellular metabolism and physiological function in health and disease. LBIC is a consists of and gather the six platforms that are Preclinical MR, Preclinical Nuclear Medicine, Microscopy (TEM/SEM), Microscopy

(Light), Clinical MR and National 7T facility (Swedish Bioimaging)

nCHREM - The National Center for High Resolution Electron Microscopy

The National Center for High Resolution Electron Microscopy (nCHREM) offers expertise in imaging, element analysis, and sample preparation for a wide variety of sample types, located at the Chemical Center of LU. A few examples of samples recently imaged at nCHREM are nanoparitvles, semiconducting nanowires, crystalline mesoporous materials, nanotubes, protein adsorption on zeolites materials, binders, cells. They also have equipment for plunge-freezing of liquids and cryogenic imaging. It is also possible to make thin slices by microtome sectioning, if required.

SCIBLU

SCIBLU is a centre at Lund University offering integrated service within all the main -omics areas. A range of instrumentation for genomics are provided, like access to the Affymetrix and Illumina technologies for SNP and CNV genotyping, ChIP-on-chip, arrayCGH genomic profiling, DNA methylation analysis, Exon, mRNA and miRNA expression profiling in various formats and species. Quality control of DNA or RNA is also available as a service at the centre. SCIBLU aims to provide guidance to research groups at all stages of a microarray analysis experiment, from study design and experimental protocols, to wet-lab performance and data analysis. Furthermore, the center provides web access to a local installation of BASE, providing data storage and processing with numerous bioinformatics tools.

Lund Nano Lab

Lund Nano Lab is the latest addition among Swedish research and development laboratories for semiconductor material and devices. Inaugurated in 2007, Lund Nano Lab (LNL) offers a cleanroom space, equipment and expertise for cutting edge nanofabrication for fundamental research and device development. One of the missions of LNL, which is the open lab facility, is to provide research infrastructure and knowledge in nanofabrication and epitaxy to both academic users and start-up companies. LNL is also part MyFab, a Swedish research infrastructure for micro- and nanofabrication, with is collaboration between the four greatest national universities, Uppsala University, KTH, Chalmers and Lund University.

Lund Nano Characterization Labs

The Lund Nano Characterization Labs possesses an extremely wide range of world-class characterization techniques ranging from microscopes capable of single-atom imaging to facilities for telemetric monitoring of animals. These characterization laboratories are, as different from Lund Nano Lab (LNL), distributed across Lund University. Two cornerstones of our success are the new cutting-edge characterization methods originally developed in Lund, and the enthusiastic and free sharing of facilities and expertise. To strengthen and coordinate these efforts Lund Nano Characterization Labs was created 2009.

LTH OpenDoor

At the faculty of engineering of Lund University, LTH Open Door gives external users access to a wide range of equipment, to test and develop ideas in the area of electronics.

The Lund Laser Center (LLC)

Lund Laser Center is an organisation for laser, optics and spectroscopy research. It constitutes the largest unit in the field in the Nordic countries. The Centre is characterised by a very strong exchange of ideas, expertise and resources between different projects, where advanced electro-optics form a common denominator. Members in the Centre are the Research Divisions of Atomic Physics, Atomic Astrophysics, Chemical Physics and Combustion Physics, as well as the Lund University Medical Laser Centre. In addition, a National High-Power Laser Facility features spear-head technology installations in the field of lasers and laser spectroscopy. Two additional collaborative centres, the Combustion Centre and the Environmental Measurement Techniques Centre, are associated to the LLC. The particular set up of the Lund Laser Centre, gives a unique and informal access to relevant knowledge also outside the field of lasers, optics and spectroscopy to allow well-balanced, synergetic research projects to be pursued.

Malmö University

The Malmö University, founded in 1998, is today housing 24000 students. These are spread over five faculties, Culture and Society, Health and Society, Education and Society, Technology and Society and finally the faculty of Odontology.

OpenLab

OpenLab is a part of the Malmö University, offering lab space, instrumentation and expertise for outside users, within the fields of life science, chemistry and materials science.

Biofilms Research Center for BioInterfaces

Biofilms Research Center for Biointerfaces is a translational research program with an expertise spanning the range from theoretical modelling to clinical science with the starting point from the industry needs. The general aim of their activities is to understand, predict and control in understanding, predicting ant controlling material/cell/tissue interactions with medical, dental, food and environmental applications.

Blekinge Institute of Technology

Blekinge Institute of Technology, BTH conducts education and research at a high international level in which engineering and IT are integrated with other disciplines such as urban planning, industrial economics, design and health sciences to contribute to solving the challenges facing society. 440 employees serve the 7200 students.

SLU Alnarp

SLU Alnarp is a part of the Swedish University of Agricultural Science, located between the cities of Lund and Malmö. Around 1000 students, and 400 employees are gathered in the main activities that are landscape architecture, horticulture, plant production, agriculture and silviculture in Southern Sweden.

Other Research and Technology organisations (RTOs)

RISE, research institutes of Sweden, is a group of research and technology organisations. In global co-operation with academia, enterprise and society, they create value, growth and competitiveness through research excellence and innovation. The institutes gathered under the name RISE are most easily represented in the list below together with their focusing areas.

- ACREO Swedish ICT – R&D in electronics, optics and ICT
- CBI Swedish Cement and Concrete Research Institute - R&D in concrete and constructions
- Glafo Glass Research Institute - R&D in glass and glass production
- Innventia – R&D in paper, pulp, packaging, graphic media and biorefining
- Interactive Institute Swedish ICT – R&D in art, design and ICT
- JTI Swedish Institute of Agricultural and Environmental Engineering – R&D in agricultural engineering and environmental technolgy
- Sics Swedish ICT – R&D in applied computer science
- SMP Swedish Machinery Testing Institute - Testing, certification, inspection, CE-marking and safety of machinery
- SP Technical Research Institute of Sweden - R&D and testing in several technical core areas along the innovation chain.
- SWEREA IVF – R&D and training for the manufacturing industry
- SWEREA KIMAB – R&D within the corrosion and metal fields.
- SWEREA MEFOS – R&D AND consulting in pyrometallurgy, heating and mealtworking
- SWEREA Sicomp – R&D in manufacturing and design of composite materials
- SWEREA Swecast – R&D and training for the foundry and casting industry
- Viktoria Swedish ICT – R&D for automotive, safety and transport industry

Swedish Defence Research Agency, FOI

Swedish Defence Research Agency, FOI, is the research institute in the areas of defence and security.

Swedish National Road and Transport Research Institute, VTI

Swedish National Road and Transport Research Institute, VTI, is an interdisciplinary research institute, carrying out applied research and development in relation to all modes of transportation.

Swedish Environmental Research Institute – IVL

Swedish Environmental Research Institute – IVL, is combining applied research and development with close collaboration between industry and the public sphere. Common to all of our assignments is the interaction between ecological, economic and social perspectives.

The Forestry Research Institute of Sweden - Skogsforsk

The Forestry Research Institute of Sweden, Skogsforsk, is the central research body for the Swedish forestry sector, and is financed jointly by the government and the members of the Institute.

Relevant commercial analytical laboratories

Colloidal Resource – CS, CR Competence

Colloidal Resource - CS, based in Lund, could be described as a scientific consultancy company, focusing on chemical science. They have a close collaboration with Lund University and its research facilities, mainly the one's at Chemical Centre and MAX lab (Max IV).

SARomics Biostructures

Life Science Consultancy,
Protein Crystallography & Drug Discovery Services

Androit Science

Life Science Consultancy, characterization & formulation from a solid state of view

Swerea IVF / RISE

Stamping test facility in the region, but also provides a range of other facilites at other loctions in Sweden, as intermediator and facilitator.

ARISs at National Level

Openly accessible ARIs in Sweden

Since we've decided to focus on the NUTS 2 level SE22 Southern Sweden, we only present the open accessible ARIs on national level that are listed in the MERIL database. Four out of these (ESS, MAX IV Laboratory, Lund Laser Center and (parts of) MyFab), is located Southern Sweden.

Table 9.3.1: From the MERIL database we find the following openly accessible ARIs, together with describing keywords

Abisko Scientific Research Station	Arctic, long-term data series, climate change, ecosystem science, plant-herbivore interactions, permafrost
Environment Climate Data Sweden	Metadata, portal, e-infrastructure
European Spallation Source	Neutron source
International Neuroinformatics Coordinating Facility	Neuroinformatics, data sharing, atlasing, modeling, ontology, neuroimaging, electrophysiology
Karolinska Center for Transgene Technologies	Gene targeting, transgenic, knockout, cryopreservation
Lund Laser Centre	Laser, spectroscopy, laser physics, femtochemistry, high-power laser facility, combustion
MAX IV Laboratory	Synchrotron radiation, synchrotron, x-ray source, accelerator, beamline
Nordsim facility at the Swedish Museum of Natural History in Stockholm	Secondary ion mass spectrometry, earth sciences, geochronology, stable isotopes
Oden Icebreaker	Oden, icebreaker, research ship
Onsala Space Observatory	Radio astronomy, millimetre radio astronomy, sub-millimetre radio astronomy, astronomy, astrophysics, aeronomy, interferometry, VLBI, space geodesy, geodynamics, geodetic fundamental station
Swedish National Data Service	Data archiving, dissemination, curation, research support
Swedish National Infrastructure for Computing	High performance computing, Scientific data infrastructure, E-infrastructure
Swedish Research Infrastructure for	Micro, nano, microfabrication, microtechnology, nanofabrication, nanotechnology, clean-room, e-beam, lithography, epitaxy, ion-beam, open access

Micro- and Nanofabrication	
Tarfala Research Station	Glaciology, hydrology, sub-arctic climate, mountain meteorology, hydrology, snow-chemistry, permafrost
Terrestrial Arctic Collaborative Network	Arctic, arctic research, circumarctic network, research stations, field site, environment research, climate change effects, climate observations, transnational access, terrestrial infrastructure, interaction, capacity building, research network
Umeå Marine Sciences Centre	Mesocosms, temperature control, thermocline, convective stirring, sediment, filter, indoor, outdoor, UMSC, laboratories

9.4 Development needs and gaps at regional level

The region recognizes the weakness that comes from insufficient IReC support available locally (lack of Institutes as identified in Development Needs and Gaps, Research, below). Baltic TRAM can offer support in ensuring that the existing local IReCs are recognized and integrated in clusters as appropriate. Further there is the opportunity to offer clusters access to the research capacity available in Baltic TRAM. However, the potential of this opportunity will be limited by the fact that currently the close cooperation in clusters between industry and academia is working to resolve the issues of access to research facilities with success.

The identified development needs, given the objective of enhancing the innovation capacity in the region, are as follows:

A strong innovation culture

Innovations only come about where the right conditions exist. The strategy needs to create these conditions and stimulate every individual in Skåne to develop his or her creativity and entrepreneurship. A strong innovation culture is a prerequisite if Skåne is to be perceived as an attractive international location and innovation environment. Major investments need to be made to develop and reinforce the region's innovation culture. These investments should strengthen and develop the culture that already exists while also supporting the development of new cultures such as social innovations and social entrepreneurship. An innovation culture is built up by fostering an innovative attitude. The aim is to foster an innovative attitude that recognises and develops the capacity for innovation in every person in Skåne.

Capability

A strong capacity for innovation must stimulate and respect diversity and variation and an entrepreneurial ability to learn rather than change. Great systemic innovativeness will enhance international competitiveness and generate growth. Innovation cannot be planned or controlled in the same way as production, for example. Solutions quite often come about by chance or as a by-product of other solutions. It is often more appropriate to work with innovation models rather than systems that give the impression that something can be planned when this is only partly true. The innovation models for the region need to be based on openness, broad participation and respect for the skills and methods of the different people involved. The models need to be dynamic so they can be easily adapted to changing external conditions. The ability to change direction at short notice is essential.

Cooperation

Regional, national and international cooperation are essential if Skåne is to develop its potential and become an internationally attractive location. Cooperation implies trust and openness. Great efforts need to be made to build trust and strong relationships within Skåne and at the national and international level.

A strong capacity for innovation is increasingly based on the ability to cooperate. So far, many players have largely focused on what is referred to in the theory as systems optimisation and excellence. Investments in innovation have been mainly based on the idea of supporting enterprises via cluster initiatives, existing sectors and areas of strength, and whole supply chains. We now see a great global need and a large market in areas relating to personal health, sustainable cities and an ageing population. The need for an effective capacity for innovation has therefore increased dramatically. In practice, this means that we must support the emergence of new areas that are not yet defined but which may emerge in cross-fertilization between different sectors or scientific disciplines as the needs arise. Demand-driven innovation based on markets and customers will grow increasingly in importance. The emerging development of existing cluster initiatives focusing on excellence and optimisation into knowledge-based open innovation arenas focusing on open innovation will be very important.

Entrepreneurship

Entrepreneurship is the driving force behind the process that generates innovations. We need to stimulate work on entrepreneurship in schools by developing students' curiosity, creativity and initiative. It is important to support the specific skills that are needed to start up and run a business. Inner drive and motivation are important for entrepreneurial learning at all ages, from pre-school to adult education. Entrepreneurial learning within the education system, stimulating attitudes, skills and behaviour to foster entrepreneurship, are one way of preparing students for the challenges they face in today's society. The lack of entrepreneurs is one of our major challenges. It is therefore important to have an open attitude and encourage everybody's initiative and entrepreneurship, in all areas of society.

Research

Issues relating to research infrastructure need to be raised. One particular issue is the lack of any research institutes in the region. Skåne and Blekinge have no research institutes, which could hamper cooperation with industry. We therefore need to work actively to attract institutes to Skåne. Structural changes have caused many companies to move their research departments away from Sweden just as the ever-increasing rate of change demands new, faster and closer models for cooperation between industry and the academic world. Small and medium-sized enterprises need more active cooperation with universities and institutes of technology. New ways of increasing access to knowledge need to be developed. The focus should be on speed as well as access. Small knowledge-intensive companies generally find it easy to work with academic institutions but for the lack of resources, while other companies experience a cultural gap that demands completely new ways of working in order to bridge it. Even today there is qualified development work being done on the research environments to be created by the establishment of MAXLab IV, ESS and Ideon Medicon Village, for example.

Skills and training

For both industry and public administration, higher education is at least as relevant as research. We can expect to see increased competition for well-trained staff both at the national level and perhaps above all across the Öresund region, where Denmark is already experiencing a manpower shortage in some key areas. Some initiatives put forward, especially in EU 2020, which have close links to the skills issue are: *Innovation Union*, *Youth on the Move*, *An industrial policy for the globalisation era* and *An agenda for new skills and jobs*. Here, the municipalities have an important role to play, not just in training but in linking industry, training and research. We believe that strategic efforts to create good conditions for an effective regional labour market and a sustainable long-term supply of skills are a vital priority area.

Finance

An important element in any innovation process is that there should be financial instruments to support the whole supply chain. The need is obvious in the early phases, but it continues into the later growth phase also. The innovation system in Skåne is heavily focused on these early phases. New financing solutions may need to be developed. But the need for financing in the growth/expansion phase outstrips the supply. We therefore see a great need to adapt the financial instruments to the needs of different companies and industries. The requirements for risk capital and exit strategies differ between life sciences, manufacturing industry, culture, the service sector and social innovations, for example. We will therefore lay particular stress on making the financial instruments more flexible in order to match and address the diversity that exists in Skåne. The most important available public funding instruments for regional research are listed for example in RIO Country Report Sweden 2015 [115].

Analysis and Conclusion on Gaps and Development Needs in the Region

From the list above, which is taken from the FIRS Innovation Strategy document, it is clear that the gap relevant to Baltic TRAM is the issue of availability of research capabilities. Not only ARI/ARF resources are identified as an issue, but also the availability of what we name IReC resources, to guide industry in taking advantage of academic research facilities. The remark about the perceived lack of Research Institutes, which take on the role of IReC, shows that the Baltic TRAM work is well focused on an identified issue in the region. However, at the same time, the main resolution in the clusters is the use of the triple helix organization where industry and academia are working closely together on specific development projects. Here the need for IReC is limited as the two sides are working sufficiently close to share the necessary common understanding. It is also worth noting that even though an IReC eco system exists in South Sweden, as identified in our first report, none of the existing IReCs are part of the clusters identified. This would indicate that a triple helix organization is capable of creating sufficient closeness between industry and academia (ARI/ARF) for the cooperation to work well.

[115] Jacob, Lindholm Dahlstrand & Sprutacz, 2016 Rio Country Report Sweden 2015. JRC Science for policy report, Research and Innovation Observatory country reports series

In the Skåne Region, a new initiative has just been launched, striving to connecting the clusters, or letting the cluster take advantage of whatever they can from each other. The first thing is to create an open innovation portal, where industry needs are posted from each cluster. Then these will be available for all of the Skåne clusters, and hopefully the needs will be solved, if not within the most obvious cluster, within another. This way of collaborating, could be successful method, and if so, our recommendation is to implement it in the Blekinge clusters as well.

- Communicate Baltic TRAM activities and offer to the existing clusters and use them to reach industry and SMEs with potential need for ARI/ARF cooperation.

- Engage the planned Open Innovation activity in Skåne with the Baltic TRAM offering. Support an extension of the same Open Innovation arena to firstly Blekinge and their clusters.

10. Conclusion

As part of the on-going Baltic TRAM (Transnational Research Access in the Macro-region) project activities an extensive review on regional analytical research facilities, related intermediaries and current operational networks and resources and their further development in the context of the transnational science-business collaboration in the Baltic Sea Region was drafted. The result of this work is now compiled into this descriptive report which not only brings together an extensive body of knowledge of the regional analytical resources, their intermediate and supporting administrative organisations but focus also in the interactions between the actors and between the identified RIS3, clusters and practical level RDI development organisations.

The results of this descriptive report will be utilised in the *Review on regional resources and further development of Analytical Research Infrastructures – The needs and potential for interregional cooperation* which will be published in April 2018. Findings are summarised by focusing in the needs and potential for macro-regional research cooperation based on the regional realisations presented in this report. Finally the second report will also present suggestions for a sustainable way forward in the interregional research cooperation in the field of material sciences in the Baltic Sea Region. With these conclusions and suggestions the on-going Baltic TRAM project will try to find beneficial long-term solutions which can help the BSR states to bridge the biggest gaps between the research facilities and the businesses and to promote fruitful cooperation to foster specialised smart growth in different regions and promote entrepreneurship and innovation development in the companies.

The mapping of regional research facilities and their operational networks and connections to different level regional policies is a demanding task. Overall these regional mappings reflect science-business collaboration mechanisms which are important components of the regional (in small BSR states national) innovation ecosystems. Innovation ecosystems are very complex networks which are often very challenging to capture in full detail. Therefore, the regional mapping exercise conducted in the on-going Baltic TRAM project do not even try to be inclusive but rather a description of the current state-of-the-art in these specific regional settings.

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Annex 1: Tables on the regional Analytical Research Facilities and their RI categories

Table 11.1 Research Competence areas at the Danish IReC (Southern Denmark), 10/2017

Research competence areas and facilities in the affiliated ARFs	***Stronly represented***	***Represented***	***Not represented***
Life Sciences			x
a. Biology			x
I.- Basic Biological and Medical Research			x
1.- Biochemistry			x
2.- Biophysics			x
3.- Cell Biology			x
4.- Structural Biology			x
II.- Plant Sciences			x
1.- Plant Biochemistry and Biophysics			x
b. Medicine			x
I. Medicine			x
1.- Clinical Chemistry and Pathobiochemistry			x
2.- Pharmacy			x
3.- Pharmacology			x
4.- Dentistry, Oral Surgery			x
5.- Biomedical Technology and Medical Physics			x
c. Agriculture, Forestry, Horticulture and Veterinary Medicine			x
I. Agriculture, Forestry, Horticulture and Veterinary Medicine			x
1.-Soil Sciences			x
2.- Plant Nutrition			x
3.- Agricultural and Food Process Engineering			x

4.- Basic Veterinary Medical Science			x
5.- Basic Research on Pathogenesis, Diagnostics and Therapy and Clinical Veterinary Medicine			x
Natural Sciences			x
a. Chemistry			
1.- Molecular Chemistry			x
2.- Chemical Solid State and Surface Research		x	
3.- Physical and Theoretical Chemistry		x	
4.- Analytical Chemistry, Method Development (Chemistry)			x
5.- Biological Chemistry and Food Chemistry			x
6.- Polymer Research			x
b. Physics			
1.- Condensed Matter Physics	x		
2.- Optics, Quantum Optics and Physics of Atoms, Molecules and Plasmas	x		
3.- Particles, Nuclei and Fields			x
4.- Statistical Physics, Soft Matter, Biological Physics, Nonlinear Dynamics		x	
c. Geosciences			x
1.- Geology and Palaeontology			x
2.- Geochemistry, Mineralogy and Crystallography			x
3.- Water Research			x
Engineering Sciences			x
a. Mechanical and industrial Engineering	x		
I. Production Technology			x
1.- Metal-Cutting Manufacturing Engineering			x
2.- Primary Shaping and Reshaping Technology			x
3.- Micro-, Precision, Mounting, Joining, Separation Technology			x
4.- Plastics Engineering			x
5.- Production Automation, Factory Operation, Operations Management	x		
II. Mechanics and Constructive Mechanical Engineering			

1.- Construction, Machine Elements			x
2.- Mechanics	x		
3.- Lightweight Construction, Textile Technology			x
4.- Acoustics		x	
b. Thermal Engineering/Process Engineering			
I. Process Engineering, Technical Chemistry			x
II. Heat Energy Technology, Thermal Machines, Fluid Mechanics			
1.- Energy Process Engineering	x		
2.- Technical Thermodynamics			x
3.- Fluid Mechanics			x
4.- Hydraulic and Turbo Engines and Piston Engines			x
c. Materials Science and Engineering			
I. Materials Engineering			x
1.- Metallurgical and Thermal Processes, Thermomechanical Treatment of Materials			x
2.- Sintered Metallic and Ceramic Materials			x
3.- Composite Materials		x	
4.- Mechanical Behaviour of Construction Materials			x
5.- Coating and Surface Technology	x		
II. Materials Science			
1.- Thermodynamics and Kinetics of Materials			x
2.- Synthesis and Properties of Functional Materials	x		
3.- Microstructural Mechanical Properties of Materials	x		
4.- Structuring and Functionalisation	x		
5.- Biomaterials			x
d. Computer Science, Electrical and System Engineering			x
I. Systems Engineering			x
II. Electrical Engineering			x
e. Construction Engineering and Architecture			x

I. Construction Engineering and Architecture			x
1.- Construction Material Sciences, Chemistry, Building Physics			x

Table 11.2 Research Competence areas at the Estonian IReC (Adapter), 10/2017

Research competence areas and facilities in the affiliated ARFs	**Strongly represented**	**Represented**	**Not represented**
Life Sciences			
a. Biology			
I.- Basic Biological and Medical Research			
1.- Biochemistry		*	
2.- Biophysics		*	
3.- Cell Biology		*	
4.- Structural Biology		*	
II.- Plant Sciences			
1.- Plant Biochemistry and Biophysics		*	
b. Medicine			
I. Medicine			
1.- Clinical Chemistry and Pathobiochemistry	*		
2.- Pharmacy	*		
3.- Pharmacology	*		
4.- Dentistry, Oral Surgery			*
5.- Biomedical Technology and Medical Physics		*	
c. Agriculture, Forestry, Horticulture and Veterinary Medicine			
I. Agriculture, Forestry, Horticulture and Veterinary Medicine			
1.-Soil Sciences			*
2.- Plant Nutrition		*	

3.- Agricultural and Food Process Engineering			*
4.- Basic Veterinary Medical Science			*
5.- Basic Research on Pathogenesis, Diagnostics and Therapy and Clinical Veterinary Medicine		*	
Natural Sciences			
a. Chemistry			
1.- Molecular Chemistry		*	
2.- Chemical Solid State and Surface Research		*	
3.- Physical and Theoretical Chemistry		*	
4.- Analytical Chemistry, Method Development (Chemistry)		*	
5.- Biological Chemistry and Food Chemistry		*	
6.- Polymer Research	*		
b. Physics			
1.- Condensed Matter Physics		*	
2.- Optics, Quantum Optics and Physics of Atoms, Molecules and Plasmas		*	
3.- Particles, Nuclei and Fields		*	
4.- Statistical Physics, Soft Matter, Biological Physics, Nonlinear Dynamics		*	
c. Geosciences	*		
1.- Geology and Palaeontology	*		
2.- Geochemistry, Mineralogy and Crystallography	*		
3.- Water Research		*	
Engineering Sciences			
a. Mechanical and industrial Engineering			
I. Production Technology			
1.- Metal-Cutting Manufacturing Engineering		*	
2.- Primary Shaping and Reshaping Technology		*	
3.- Micro-, Precision, Mounting, Joining, Separation Technology		*	
4.- Plastics Engineering		*	
5.- Production Automation, Factory Operation, Operations Management		*	

II. Mechanics and Constructive Mechanical Engineering			
1.- Construction, Machine Elements		*	
2.- Mechanics		*	
3.- Lightweight Construction, Textile Technology		*	
4.- Acoustics			*
b. Thermal Engineering/Process Engineering			
I. Process Engineering, Technical Chemistry		*	
II. Heat Energy Technology, Thermal Machines, Fluid Mechanics		*	
1.- Energy Process Engineering		*	
2.- Technical Thermodynamics		*	
3.- Fluid Mechanics		*	
4.- Hydraulic and Turbo Engines and Piston Engines		*	
c. Materials Science and Engineering			
I. Materials Engineering			
1.- Metallurgical and Thermal Processes, Thermomechanical Treatment of Materials		*	
2.- Sintered Metallic and Ceramic Materials		*	
3.- Composite Materials	*		
4.- Mechanical Behaviour of Construction Materials	*		
5.- Coating and Surface Technology	*		
II. Materials Science			
1.- Thermodynamics and Kinetics of Materials			*
2.- Synthesis and Properties of Functional Materials	*		
3.- Microstructural Mechanical Properties of Materials		*	
4.- Structuring and Functionalisation	*		
5.- Biomaterials		*	
d. Computer Science, Electrical and System Engineering			
I. Systems Engineering			*
II. Electrical Engineering			*

e. Construction Engineering and Architecture			
I. Construction Engineering and Architecture			
1.- Construction Material Sciences, Chemistry, Building Physics			*

Table 11.3 Research Competence areas at the Finnish IReC (Turku), 10/2017

Local ARFs affiliated with the IReC	
University of Turku Turku Materials Research Instrument Center (TuMRIC) Department of Chemistry Turku Bioimaging Instrument Centre Turku Centre for Biotechnology Turku Clinical Biomaterials Centre TCBC	**RTOs** LUKE, Natural Resources Institute, Finland (Turku): Green Bioeconomy, Blue Bioeconomy, Innovative Food System (www.luke.fi) Machine Technology Center: Calibration laboratory; Production Automation Laboratory http://www.koneteknologiakeskus.fi/content/en/
Turku University of Applied Sciences Biomaterials, food and diagnostics Energy and environment, especially solar energy systems Protein	**Commercial laboratories** Lounas-Suomen vesi- ja ympäristötutkimus Oy Solar Simulator Ltd Top Analytica Ltd Auria Biobank Ltd
Åbo Akademi Center for Functional Materials (FUNMAT) Process Chemistry Centre (PCC)	

RI categories of the affiliated ARFs	*Strongly represented*	*Represente d*	*Not represented*
Life Sciences			
a. Biology			
I.- Basic Biological and Medical Research			
1.- Biochemistry		x	
2.- Biophysics		x	
3.- Cell Biology		x	
4.- Structural Biology		x	
II.- Plant Sciences			
1.- Plant Biochemistry and Biophysics		x	
b. Medicine			
I. Medicine			
1.- Clinical Chemistry and Path biochemistry		x	
2.- Pharmacy	x		
3.- Pharmacology		x	
4.- Dentistry, Oral Surgery	x		
5.- Biomedical Technology and Medical Physics	x		
c. Agriculture, Forestry, Horticulture and Veterinary Medicine			
I. Agriculture, Forestry, Horticulture and Veterinary Medicine			
1.-Soil Sciences		x	
2.- Plant Nutrition		x	
3.- Agricultural and Food Process Engineering		x	

RI categories of the affiliated ARFs	***Strongly represented***	***Represente d***	***Not represented***
4.- Basic Veterinary Medical Science		x	
5.- Basic Research on Pathogenesis, Diagnostics and Therapy and Clinical Veterinary Medicine		x	
Natural Sciences			
a. Chemistry			
1.- Molecular Chemistry	x		
2.- Chemical Solid State and Surface Research	x		
3.- Physical and Theoretical Chemistry	x		
4.- Analytical Chemistry, Method Development (Chemistry)	x		
5.- Biological Chemistry and Food Chemistry	x		
6.- Polymer Research	x		
b. Physics			
1.- Condensed Matter Physics	x		
2.- Optics, Quantum Optics and Physics of Atoms, Molecules and Plasmas	x		
3.- Particles, Nuclei and Fields		x	
4.- Statistical Physics, Soft Matter, Biological Physics, Nonlinear Dynamics		x	
c. Geosciences			
1.- Geology and Palaeontology	x		
2.- Geochemistry, Mineralogy and Crystallography	x		
3.- Water Research		x	
Engineering Sciences			
a. Mechanical and industrial Engineering			
I. Production Technology			
1.- Metal-Cutting Manufacturing Engineering			x
2.- Primary Shaping and Reshaping Technology			x
3.- Micro-, Precision, Mounting, Joining, Separation Technology			x
4.- Plastics Engineering			x

RI categories of the affiliated ARFs	*Strongly represented*	*Represente d*	*Not represented*
5.- Production Automation, Factory Operation, Operations Management			x
II. Mechanics and Constructive Mechanical Engineering			
1.- Construction, Machine Elements			x
2.- Mechanics			x
3.- Lightweight Construction, Textile Technology			x
4.- Acoustics			x
b. Thermal Engineering/Process Engineering			
I. Process Engineering, Technical Chemistry			
II. Heat Energy Technology, Thermal Machines, Fluid Mechanics			
1.- Energy Process Engineering		x	
2.- Technical Thermodynamics		x	
3.- Fluid Mechanics			x
4.- Hydraulic and Turbo Engines and Piston Engines			x
c. Materials Science and Engineering			
I. Materials Engineering			
1.- Metallurgical and Thermal Processes, Thermomechanical Treatment of Materials		x	
2.- Sintered Metallic and Ceramic Materials		x	
3.- Composite Materials		x	
4.- Mechanical Behaviour of Construction Materials		x	
5.- Coating and Surface Technology	x		
II. Materials Science			
1.- Thermodynamics and Kinetics of Materials		x	
2.- Synthesis and Properties of Functional Materials	x		
3.- Microstructural Mechanical Properties of Materials		x	
4.- Structuring and Functionalisation		x	
5.- Biomaterials	x		

RI categories of the affiliated ARFs	*Strongly represented*	*Represente d*	*Not represented*
d. Computer Science, Electrical and System Engineering			
I. Systems Engineering			
II. Electrical Engineering			
e. Construction Engineering and Architecture			
I. Construction Engineering and Architecture			
1.- Construction Material Sciences, Chemistry, Building Physics			x

Table 11.4 Research Competence areas at the Finnish IReC (Kajaani), 10/2017

Local ARFs affiliated with the IReC	RI categories of the affiliated ARFs	*Strongly represented*	*Represented*	*Not represented*
	Life Sciences			
	a. Biology			
	I.- Basic Biological and Medical Research			**x**
	1.- Biochemistry	**x**		
	2.- Biophysics		**x**	
	3.- Cell Biology		**x**	
	4.- Structural Biology			**x**
University of Jyväskylä, University Services of the University of Jyväskylä / Sports technology unit (RTO)	5.- Biology of Physical activity			
	II.- Plant Sciences			
	1.- Plant Biochemistry and Biophysics		**x**	
	b. Medicine			
	I. Medicine			

Local ARFs affiliated with the IReC	RI categories of the affiliated ARFs	*Strongly represented*	*Represented*	*Not represented*
	1.- Clinical Chemistry and Pathobiochemistry			x
	2.- Pharmacy			x
	3.- Pharmacology			x
	4.- Dentistry, Oral Surgery			x
	5.- Biomedical Technology and Medical Physics	x		
	c. Agriculture, Forestry, Horticulture and Veterinary Medicine			
	I. Agriculture, Forestry, Horticulture and Veterinary Medicine			
	1.- Soil Sciences			x
	2.- Plant Nutrition			x
	3.- Agricultural and Food Process Engineering		x	
	4.- Basic Veterinary Medical Science			x
	5.- Basic Research on Pathogenesis, Diagnostics and Therapy and Clinical Veterinary Medicine			x
	Natural Sciences			
	a. Chemistry	x		
	1.- Molecular Chemistry			
	2.- Chemical Solid State and Surface Research			
	3.- Physical and Theoretical Chemistry			
	4.- Analytical Chemistry, Method Development (Chemistry)	x		
	5.- Biological Chemistry and Food Chemistry	x		
	6.- Polymer Research			
	b. Physics			
	1.- Condensed Matter Physics			
	2.- Optics, Quantum Optics and Physics of Atoms, Molecules and Plasmas	x		
	3.- Particles, Nuclei and Fields			
	4.- Statistical Physics, Soft Matter, Biological Physics, Nonlinear Dynamics			
	c. Geosciences			

Local ARFs affiliated with the IReC	**RI categories of the affiliated ARFs**	***Strongly represented***	***Represented***	***Not represented***
	1.- Geology and Palaeontology			
	2.- Geochemistry, Mineralogy and Crystallography			
Kajaani University of Applied Sciences (KAMK). (applied research), ***CEMIS*** *(Oulu U., Jyväskylä U., VTT, CSC)* ***(RTO)***	3.- Water Research			
	Engineering Sciences			
	a. Mechanical and industrial Engineering			
	I. Production Technology			
	1.- Metal - Cutting Manufacturing Engineering			
	2.- Primary Shaping and Reshaping Technology			
University of Oulu , MITY, **Kajaani University of Applied Sciences (KAMK). (applied research) RTO**	3.- Micro-, Precision, Mounting, Joining, Separation Technology			
	4.- Plastics Engineering			
Kajaani University of Applied Sciences (KAMK). (applied research) RTO	5.- Production Automation, Factory Operation, Operations Management			
	II. Mechanics and Constructive Mechanical Engineering			
	1.- Construction, Machine Elements			
	2.- Mechanics			
	3.- Lightweight Construction, Textile Technology			
	4.- Acoustics			
	b. Thermal Engineering/Process Engineering			
	I. Process Engineering, Technical Chemistry			
	II. Heat Energy Technology, Thermal Machines, Fluid Mechanics			

Local ARFs affiliated with the IReC	RI categories of the affiliated ARFs	*Strongly represented*	*Represented*	*Not represented*
	1.- Energy Process Engineering			
	2.- Technical Thermodynamics			
	3.- Fluid Mechanics			
	4.- Hydraulic and Turbo Engines and Piston Engines			
	c. Materials Science and Engineering			
	I. Materials Engineering			
	1.- Metallurgical and Thermal Processes, Thermomechanical Treatment of Materials			
	2.- Sintered Metallic and Ceramic Materials			
	3.- Composite Materials			
	4.- Mechanical Behaviour of Construction Materials			
	5.- Coating and Surface Technology			
	II. Materials Science			
	1.- Thermodynamics and Kinetics of Materials			
	2.- Synthesis and Properties of Functional Materials			
	3.- Microstructural Mechanical Properties of Materials			
	4.- Structuring and Functionalisation			
University of Oulu , MITY (basic research & RTO)	5.- Biomaterials			
	d. Computer Science, Electrical and System Engineering			
	I. Systems Engineering			
	II. Electrical Engineering		x	
	e. Construction Engineering and Architecture			
	I. Construction Engineering and Architecture			
	1.- Construction Material Sciences, Chemistry, Building Physics			

Table 11.5 Research Competence areas at the Latvian IReC, 10/2017

Research competence areas and facilities in the affiliated ARFs	*Strongly represented*	*Represented*	*Not represented*
Life Sciences			
a. Biology			
I.- Basic Biological and Medical Research	x	x	x
1.- Biochemistry	x	x	x
2.- Biophysics		x	
3.- Cell Biology		x	
4.- Structural Biology		x	
II.- Plant Sciences			
1.- Plant Biochemistry and Biophysics	x		
b. Medicine			
I. Medicine			
1.- Clinical Chemistry and Pathobiochemistry		x	
2.- Pharmacy	x	x	
3.- Pharmacology		x	
4.- Dentistry, Oral Surgery		x	
5.- Biomedical Technology and Medical Physics		x	
c. Agriculture, Forestry, Horticulture and Veterinary Medicine	x	x	
I. Agriculture, Forestry, Horticulture and Veterinary Medicine			
1.-Soil Sciences		x	
2.- Plant Nutrition		x	
3.- Agricultural and Food Process Engineering	x		
4.- Basic Veterinary Medical Science	x		
5.- Basic Research on Pathogenesis, Diagnostics and Therapy and Clinical Veterinary Medicine	x		

Natural Sciences			
a. Chemistry			
1.- Molecular Chemistry	x	x	
2.- Chemical Solid State and Surface Research	x	x	
3.- Physical and Theoretical Chemistry		x	
4.- Analytical Chemistry, Method Development (Chemistry)		x	
5.- Biological Chemistry and Food Chemistry		x	
6.- Polymer Research	x	x	
b. Physics			
1.- Condensed Matter Physics		x	
2.- Optics, Quantum Optics and Physics of Atoms, Molecules and Plasmas		x	
3.- Particles, Nuclei and Fields		x	
4.- Statistical Physics, Soft Matter, Biological Physics, Nonlinear Dynamics			
c. Geosciences			
1.- Geology and Palaeontology		x	
2.- Geochemistry, Mineralogy and Crystallography		x	
3.- Water Research		x	
Engineering Sciences			
a. Mechanical and industrial Engineering			
I. Production Technology			
1.- Metal-Cutting Manufacturing Engineering		x	
2.- Primary Shaping and Reshaping Technology		x	
3.- Micro-, Precision, Mounting, Joining, Separation Technology		x	
4.- Plastics Engineering		x	
5.- Production Automation, Factory Operation, Operations Management		x	
II. Mechanics and Constructive Mechanical Engineering			
1.- Construction, Machine Elements		x	
2.- Mechanics		x	

3.- Lightweight Construction, Textile Technology		x	
4.- Acoustics		x	
b. Thermal Engineering/Process Engineering			
I. Process Engineering, Technical Chemistry			
II. Heat Energy Technology, Thermal Machines, Fluid Mechanics			
1.- Energy Process Engineering		x	
2.- Technical Thermodynamics		x	
3.- Fluid Mechanics		x	
4.- Hydraulic and Turbo Engines and Piston Engines		x	
c. Materials Science and Engineering			
I. Materials Engineering			
1.- Metallurgical and Thermal Processes, Thermomechanical Treatment of Materials		x	
2.- Sintered Metallic and Ceramic Materials		x	
3.- Composite Materials		x	
4.- Mechanical Behaviour of Construction Materials		x	
5.- Coating and Surface Technology		x	
II. Materials Science			
1.- Thermodynamics and Kinetics of Materials		x	
2.- Synthesis and Properties of Functional Materials		x	
3.- Microstructural Mechanical Properties of Materials		x	
4.- Structuring and Functionalisation		x	
5.- Biomaterials			
d. Computer Science, Electrical and System Engineering			
I. Systems Engineering	x	x	
II. Electrical Engineering		x	
e. Construction Engineering and Architecture			
I. Construction Engineering and Architecture		x	
1.- Construction Material Sciences, Chemistry, Building Physics		x	

Table 11.6 Research Competence areas at the Lithuanian IReC (Kaunas), 10/2017

Research competence areas and facilities in the affiliated ARFs	*Strongly represented*	*Represented*	*Not represented*
Life Sciences			
a. Biology			
I.- Basic Biological and Medical Research		x	
1.- Biochemistry		x	
2.- Biophysics		x	
3.- Cell Biology		x	
4.- Structural Biology		x	
II.- Plant Sciences			
1.- Plant Biochemistry and Biophysics		x	
b. Medicine			
I. Medicine			
1.- Clinical Chemistry and Pathobiochemistry		x	
2.- Pharmacy		x	
3.- Pharmacology		x	
4.- Dentistry, Oral Surgery		x	
5.- Biomedical Technology and Medical Physics		x	
c. Agriculture, Forestry, Horticulture and Veterinary Medicine			
I. Agriculture, Forestry, Horticulture and Veterinary Medicine			
1.-Soil Sciences		x	
2.- Plant Nutrition		x	
3.- Agricultural and Food Process Engineering		x	

4.- Basic Veterinary Medical Science		x	
5.- Basic Research on Pathogenesis, Diagnostics and Therapy and Clinical Veterinary Medicine		x	
Natural Sciences			
a. Chemistry			
1.- Molecular Chemistry		x	
2.- Chemical Solid State and Surface Research		x	
3.- Physical and Theoretical Chemistry			
4.- Analytical Chemistry, Method Development (Chemistry)			
5.- Biological Chemistry and Food Chemistry		x	
6.- Polymer Research		x	
b. Physics			
1.- Condensed Matter Physics			
2.- Optics, Quantum Optics and Physics of Atoms, Molecules and Plasmas		x	
3.- Particles, Nuclei and Fields			
4.- Statistical Physics, Soft Matter, Biological Physics, **Nonlinear Dynamics**		x	
c. Geosciences			
1.- Geology and Palaeontology			
2.- Geochemistry, Mineralogy and Crystallography		x	
3.- Water Research		x	
Engineering Sciences			
a. Mechanical and industrial Engineering			
I. Production Technology			
1.- Metal-Cutting Manufacturing Engineering			
2.- Primary Shaping and Reshaping Technology			
3.- Micro-, Precision, Mounting, Joining, Separation Technology			

4.- Plastics Engineering			
5.- Production Automation, Factory Operation, Operations Management			
II. Mechanics and Constructive Mechanical Engineering			
1.- Construction, Machine Elements			
2.- Mechanics			
3.- Lightweight Construction, **Textile Technology**		x	
4.- Acoustics			
b. Thermal Engineering/Process Engineering			
I. Process Engineering, Technical Chemistry			
II. Heat Energy Technology, Thermal Machines, Fluid Mechanics			
1.- Energy Process Engineering		x	
2.- Technical Thermodynamics			
3.- Fluid Mechanics			
4.- Hydraulic and Turbo Engines and Piston Engines			
c. Materials Science and Engineering			
I. Materials Engineering			
1.- Metallurgical and Thermal Processes, **Thermomechanical Treatment of Materials**		x	
2.- Sintered Metallic and Ceramic Materials		x	
3.- Composite Materials		x	
4.- Mechanical Behaviour of Construction Materials		x	
5.- Coating and Surface Technology		x	
II. Materials Science			
1.- Thermodynamics and Kinetics of Materials			
2.- Synthesis and Properties of Functional Materials		x	
3.- Microstructural Mechanical Properties of Materials		x	
4.- Structuring and Functionalisation			

5.- Biomaterials			
d. Computer Science, Electrical and System Engineering			
I. Systems Engineering		x	
II. Electrical Engineering		x	
e. Construction Engineering and Architecture			
I. Construction Engineering and Architecture			
1.- **Construction Material Sciences**, Chemistry, Building Physics		x	

Table 11.7 Research Competence areas at the Polish IReC, 10/2017

Research competence areas and facilities in the affiliated ARFs	***Strongly represente d***	***Represente d***	***Not represented***
Life Sciences			x
a. Biology			x
I.- Basic Biological and Medical Research			x
1.- Biochemistry			x
2.- Biophysics			x
3.- Cell Biology			x
4.- Structural Biology			x
II.- Plant Sciences			x
1.- Plant Biochemistry and Biophysics			x
b. Medicine			x
I. Medicine			x
1.- Clinical Chemistry and Pathobiochemistry			x
2.- Pharmacy			x
3.- Pharmacology			x

4.- Dentistry, Oral Surgery			x
5.- Biomedical Technology and Medical Physics			x
c. Agriculture, Forestry, Horticulture and Veterinary Medicine			x
I. Agriculture, Forestry, Horticulture and Veterinary Medicine			x
1.-Soil Sciences			x
2.- Plant Nutrition			x
3.- Agricultural and Food Process Engineering			x
4.- Basic Veterinary Medical Science			x
5.- Basic Research on Pathogenesis, Diagnostics and Therapy and Clinical Veterinary Medicine			x
Natural Sciences			x
a. Chemistry			x
1.- Molecular Chemistry		x	
2.- Chemical Solid State and Surface Research	x		
3.- Physical and Theoretical Chemistry			x
4.- Analytical Chemistry, Method Development (Chemistry)			x
5.- Biological Chemistry and Food Chemistry			x
6.- Polymer Research			x
b. Physics			x
1.- Condensed Matter Physics	x		
2.- Optics, Quantum Optics and Physics of Atoms, Molecules and Plasmas			x
3.- Particles, Nuclei and Fields			x
4.- Statistical Physics, Soft Matter, Biological Physics, Nonlinear Dynamics			x
c. Geosciences			x
1.- Geology and Palaeontology			x
2.- Geochemistry, Mineralogy and Crystallography	x		
3.- Water Research			x
Engineering Sciences			x

a. Mechanical and industrial Engineering			
I. Production Technology			
1.- Metal-Cutting Manufacturing Engineering	x		
2.- Primary Shaping and Reshaping Technology	x		
3.- Micro-, Precision, Mounting, Joining, Separation Technology		x	
4.- Plastics Engineering		x	
5.- Production Automation, Factory Operation, Operations Management			x
II. Mechanics and Constructive Mechanical Engineering			
1.- Construction, Machine Elements		x	
2.- Mechanics		x	
3.- Lightweight Construction, Textile Technology		x	
4.- Acoustics			x
b. Thermal Engineering/Process Engineering			x
I. Process Engineering, Technical Chemistry			x
II. Heat Energy Technology, Thermal Machines, Fluid Mechanics			x
1.- Energy Process Engineering			x
2.- Technical Thermodynamics			x
3.- Fluid Mechanics			x
4.- Hydraulic and Turbo Engines and Piston Engines			x
c. Materials Science and Engineering			
I. Materials Engineering			
1.- Metallurgical and Thermal Processes, Thermomechanical Treatment of Materials	x		
2.- Sintered Metallic and Ceramic Materials		x	
3.- Composite Materials	x		
4.- Mechanical Behaviour of Construction Materials	x		
5.- Coating and Surface Technology		x	
II. Materials Science			

1.- Thermodynamics and Kinetics of Materials			x
2.- Synthesis and Properties of Functional Materials		x	
3.- Microstructural Mechanical Properties of Materials	x		
4.- Structuring and Functionalisation		x	
5.- Biomaterials		x	
d. Computer Science, Electrical and System Engineering			x
I. Systems Engineering			x
II. Electrical Engineering			x
e. Construction Engineering and Architecture			x
I. Construction Engineering and Architecture			x
1.- Construction Material Sciences, Chemistry, Building Physics			x

Table 11.8 Research Competence areas at the Swedish IReC (Southern Sweden), 2/2018

Research competence areas and facilities in the affiliated ARFs	*Stronly represented*	*Represented*	*Not represented*
Life Sciences	X		
a. Biology	x		
I.- Basic Biological and Medical Research	X		
1.- Biochemistry	X		
2.- Biophysics		x	
3.- Cell Biology	X		
4.- Structural Biology		x	
II.- Plant Sciences	X		
1.- Plant Biochemistry and Biophysics	X		
b. Medicine	X		
I. Medicine	X		
1.- Clinical Chemistry and Pathobiochemistry		x	
2.- Pharmacy	X		
3.- Pharmacology	X		
4.- Dentistry, Oral Surgery	X		
5.- Biomedical Technology and Medical Physics	X		
c. Agriculture, Forestry, Horticulture and Veterinary Medicine	x		
I. Agriculture, Forestry, Horticulture and Veterinary Medicine	X		
1.-Soil Sciences		x	
2.- Plant Nutrition		x	
3.- Agricultural and Food Process Engineering	X		
4.- Basic Veterinary Medical Science			X
5.- Basic Research on Pathogenesis, Diagnostics and Therapy and Clinical Veterinary Medicine			X
Natural Sciences	X		

a. Chemistry	X		
1.- Molecular Chemistry	X		
2.- Chemical Solid State and Surface Research	X		
3.- Physical and Theoretical Chemistry	X		
4.- Analytical Chemistry, Method Development (Chemistry)	X		
5.- Biological Chemistry and Food Chemistry	X		
6.- Polymer Research	X		
b. Physics	X		
1.- Condensed Matter Physics	X		
2.- Optics, Quantum Optics and Physics of Atoms, Molecules and Plasmas	X		
3.- Particles, Nuclei and Fields	X		
4.- Statistical Physics, Soft Matter, Biological Physics, Nonlinear Dynamics	X		
c. Geosciences		x	
1.- Geology and Palaeontology			X
2.- Geochemistry, Mineralogy and Crystallography			X
3.- Water Research	X		
Engineering Sciences	X		
a. Mechanical and industrial Engineering		x	
I. Production Technology		x	
1.- Metal-Cutting Manufacturing Engineering		x	
2.- Primary Shaping and Reshaping Technology		X	
3.- Micro-, Precision, Mounting, Joining, Separation Technology		X	
4.- Plastics Engineering		X	
5.- Production Automation, Factory Operation, Operations Management		x	
II. Mechanics and Constructive Mechanical Engineering		x	
1.- Construction, Machine Elements		X	
2.- Mechanics		X	
3.- Lightweight Construction, Textile Technology		X	

4.- Acoustics		X	
b. Thermal Engineering/Process Engineering	X		
I. Process Engineering, Technical Chemistry	X		
II. Heat Energy Technology, Thermal Machines, Fluid Mechanics	X		
1.- Energy Process Engineering	X		
2.- Technical Thermodynamics	X		
3.- Fluid Mechanics	X		
4.- Hydraulic and Turbo Engines and Piston Engines		x	
c. Materials Science and Engineering	X		
I. Materials Engineering	X		
1.- Metallurgical and Thermal Processes, Thermomechanical Treatment of Materials	X		
2.- Sintered Metallic and Ceramic Materials	X		
3.- Composite Materials	X		
4.- Mechanical Behaviour of Construction Materials	X		
5.- Coating and Surface Technology	X		
II. Materials Science	X		
1.- Thermodynamics and Kinetics of Materials	X		
2.- Synthesis and Properties of Functional Materials	X		
3.- Microstructural Mechanical Properties of Materials	X		
4.- Structuring and Functionalisation	X		
5.- Biomaterials	X		
d. Computer Science, Electrical and System Engineering	X		
I. Systems Engineering	X		
II. Electrical Engineering	X		
e. Construction Engineering and Architecture	X		
I. Construction Engineering and Architecture	X		
1.- Construction Material Sciences, Chemistry, Building Physics	X		