FRIENZ: Facilitating Research and Innovation Cooperation between Europe and New Zealand

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Abstract

The scope of WP 2 entitled "Innovation Policy and Evaluation" is to share best practise innovation policy approaches aimed at stimulating national innovation systems to drive economic growth. By analysing best practises and new trends in NZ and EU member states it aims at bringing together actors from the whole Research and Innovation spectrum more closely. To be in a position to compare innovation systems in Europe and New Zealand and to identify best practises to applied in the bilateral EU-NZ cooperation it is necessary to get an overview of national innovation systems and measures to accelerate the innovation capacity. In the presented compendium the national innovation systems and innovation measures are described for Finland, France, Germany and New Zealand.

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Versioning and contribution history

Version	Date	Modification reason	Modified by
v01	09.05.2014	Not applicable (First Draft)	Not applicable (First Draft)
v02	09.05.2014	Response to comments	
v03	13.05.2014	Intermediate version	Hans-Jörg Stähle (DLR)
v04	30.10.2015	Final version	Gerd Ruecker (DLR)

Index of all Country Reports included:

The Country Reports are sorted in alphabetic order according to the first letter of the country they deal with. Before starting with the national innovation system profile of Finland, the reader will find an overview on the proposed structure for the country reports.

Structure of the Country Reports

The following overview shows the proposed structure for the country reports. Each author could decide for him- or herself whether and how to use this structure for his or her report. Therefore some of the reports are closer to this structure than others.

1. General features of the STI system

2. Overall STI strategy

3. New initiatives/emerging technology fields

4. Description of mechanisms and assessment of best practices for strengthening the University – industry collaboration and supporting the commercialization of university research

5. Description of partnership models utilized by government and related agencies to encourage clustering and precompetitive research between firms and assessment of best practices

6. Design principles and parameters of arrangements for institutions that have a role in delivering value for the private sector

7. Analysis of public support mechanisms to stimulate innovation that are not R&D-based

Finnish Research and Innovation Landscape

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Abstract

Finland's competitive position is facing challenges and its large export businesses have suffered. Considering its high level of R&D inputs, the country has a relatively low contribution of high-tech and medium-high-tech goods to the trade balance. Within the past few years, the decline of the important electronics (telecommunications) sector in particular has created pressure for structural change in Finland. The decline of this sector is reflected in a decrease in business R&D investments – dominated by Nokia. Consequently, the extent to which the business and public sectors will be capable of absorbing new innovations from the ICT sector – and more concretely the available highly-skilled human resources – is considered a determinant for new growth.
The action plan for research and innovation policy presents four major themes where Finnish research and innovation policy needs to improve itself (MEC and MEE 2012): (1) Increasing the attractiveness of Finland and enhancing the internationalisation of the RDI system. (2) A research and innovation system with better quality and more flexibility: Structural reforms of funding agencies, research institutes and universities have advanced creating relevant mergers and further coordination that are expected to improve, together with more excellence driven funding models, the quality of scientific research. (3) Increasing effectiveness by expanding the scope of innovation activities and increasing experimentation and (4) Greater value and new competitive advantages through intangible investments.
In May 2015, a new Centre Party -led government started its reign. In its strategic programme, the new government states that Finland's competitiveness is built on high expertise, sustainable development and open-minded innovations based on experimentation and digitalisation.

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Quick guide to Finnish Innovation System

	Name	Description	Link
Institutions	Academy of Finland	Academy of Finland allocates research funding to leading-edge scientific research, promotes scientific research and research environments and the application of research results, supports international scientific cooperation and acts as an expert in science policy. The Academy belongs to the administrative branch of the Finnish Ministry of Education and Culture.	http://www.aka.fi/en
	Ministry of Education and Culture	MEC is responsible for higher education and science policy related matters as well as international cooperation in these fields.	http://www.minedu.fi/OPM/?lang=en
	Ministry of Employment and the Economy	MEE was reorganized in September 2011 and is responsible for innovation policy planning and budgeting	http://www.tem.fi/en
	Ministry of Finance	The Ministry of Finance is responsible for economic policy to ensure economic growth	http://ministryoffinance.fi/vm/en/01_main/
	Research and Innovation Council; formerly: Science and Technology Policy Council of Finland	Research and Innovation Council, chaired by the Prime Minister, advises the Government and its Ministries in important matters concerning research, technology, innovation and their utilization and evaluation. The Council is responsible for the strategic development and coordination of Finnish science and technology policy as well as of the national innovation system as a whole.	http://www.minedu.fi/OPM/Tiede/tutkimus-_ja_innovaationeuvosto/?lang=en
	Finpro	Finpro helps Finnish SMEs go international, encourages foreign direct investment in Finland and promotes tourism	http://www.finpro.fi/web/finpro-eng

The Finnish Innovation Fund Sitra	Sitra promotes and stimulates new business models that aim for sustainable well-being. As a public fund, Sitra reports directly to the Finnish parliament. Sitra provides funds for surveys, forward-thinking activities, experiments, and shared strategy processes that promote well-being and are ecologically and socially sustainable. Sitra does not provide funds for academic research projects, dissertations, or commercial research and development projects.	http://www.sitra.fi/en
Tekes, the Finnish Funding Agency for Technology and Innovation	Tekes is the most important publicly funded expert organisation for financing research, development and innovation in Finland. Tekes facilitates collaboration and networking between small and large businesses, industry and academia, public and private sector and non-governmental organisations. To promote international R&D cooperation, Tekes funds collaborative research and development projects and facilitates researcher mobility.	http://www.tekes.fi/en/
Aalto Entrepreneurship Society	Aalto Entrepreneurship Society support students and researchers who want to start companies and aim for international markets and high growth	http://aaltoes.com/
Aalto University	Established in 2010, Aalto University was created by a merger of the Helsinki School of Economics, Helsinki University of Technology and the University of Art and Design Helsinki	http://www.aalto.fi/en/
VTT Technical Research Centre of Finland Ltd	VTT Technical Research Centre of Finland Ltd is the leading research and technology company in the Nordic countries. VTT provides expert services for our domestic and international customers and partners. It serves both private and public sectors.	http://www.vttresearch.com/

Policy Papers	Action plan for research and innovation policy (2012)	The action plan concretises and enhances the implementation of the government's research and innovation policies and document central development measures.	http://www.tem.fi/files/36112/Action_plan_for_research_and_innovation_policy.pdf
	Government strategic programme 2015	New (May 2015) government's strategy programme for their four-year term.	http://valtioneuvosto.fi/documents/10184/1427398/Hallitusohjelma_27052015_final_EN.pdf/f1071fae-a933-4871-bb38-97bdfd324ee6
	Research and Innovation Policy Guidelines for 2011-2015	Together with the Action plan for research and innovation policy "Growth through expertise", this document makes up the two key policy documents which set out at national level the policy guidelines on the required measures and funding and detail out the actions required for the implementation of the government's research and innovation policy.	http://www.minedu.fi/export/sites/default/OPM/Tiede/tutkimus-_ja_innovaationeuvosto/julkaisut/liitteet/Review2011-2015.pdf
	Government Resolution on Comprehensive Reform of State Research Institutes and Research Funding	Resolution that specifies a package of measures for the reform of research institutes and research funding. Through the funding reform, research and analysis work in support of decision making by the government and its ministries will be strengthened by gathering together research funding for deployment in line with government policy	http://vnk.fi/en/comprehensive-reform-of-state-research-institutes-and-research-funding
	National-level Research Infrastructures. Present state and roadmap	The Science and Technology Policy Council in 2009 worked out a roadmap with proposals for organising a national research infrastructure policy in the future. The roadmap includes recommendations for developing infra-structures in specific disciplines are presented along with general recommendations.	http://www.minedu.fi/export/sites/default/OPM/Julkaisut/2009/liitteet/opm04.pdf

	Growth through expertise, Action plan for research and innovation policy (2012)	Together with the Research and Innovation Policy Guidelines for 2011-2015, this document makes up the two key policy documents which set out at national level the policy guidelines on the required measures and funding and detail out the actions required for the implementation of the government's research and innovation policy.	http://www.tem.fi/files/36112/Action_plan_for_research_and_innovation_policy.pdf
Programmes / Projects	Finnish National Reform Programme 2015	The National Reform Programme 2015 intends to diversify the business structure, in particular by hastening the introduction of planned measures to broaden the innovation base. In particular, the programme notes that in order to accelerate economic growth, a tax incentive for research and development activities will be continued and extended to private persons, who invest in starting companies.	http://ec.europa.eu/europe2020/pdf/csr2015/nrp2015_finland_fi.pdf
	Team Finland	The Team Finland network promotes Finland and boosts Finnish enterprises abroad. The network brings together all services offered by state-funded actors which work for the internationalisation of Finnish enterprises, advance investment in Finland and promote Finland's country brand.	http://team.finland.fi/en/frontpage
	VIGO accelerator programme	Vigo is an acceleration programme designed to complement the Finnish innovation ecosystem. The programme bridges the gap between early stage technology firms and international venture funding.	https://vigo.fi/
	Young Innovative Companies - programme	Young innovative company funding is meant for a company that has been in operation for a few years, and has proven its business concept, so that it already has customers. The aim is to substantially accelerate the global growth of the most promising small companies.	http://www.tekes.fi/en/funding/yic/
Clusters	Science parks	The Finnish Science Park Association	http://www.tekel.fi/in_

	and Technology Centres	TEKEL supervises the interests of science park activity in Finland, is an expert on the subject and is engaged in its development. Together with its member centres, it forms a nationwide TEKEL network, which is part of a national innovation system.	english/
	Strategic Centres for Science, Technology and Innovation	SHOKs make up a main policy instrument in Finnish innovation policy. They form cooperation platforms for innovative companies and spearheading research.	http://www.shok.fi/en/

1. General features of the Finnish research landscape

1.1 Basic characterization

Finland is a sparsely inhabited country with 5.4 million inhabitants located in northern Europe. By land mass Finland is the 8th largest country on the continent. The Gross Domestic Product (GDP) at market prices of Finland was €189 billion in 2011 and GDP at market prices per capita was €35,200 thus being clearly above the EU-28 average. Finland has **one of the world's highest R&D intensities**. The country also performs well in terms of scientific and technological excellence. The Finnish economy is knowledge-intensive, and has achieved a continuous change towards a stronger high and medium-high-tech specialisation. The country has several hot-spot clusters in key technologies on a European and world scale, in particular in ICT, environment, materials, energy, security, and food and agriculture. Although the R&D expenditure grew, its share of GDP continued declining in 2012 to 3.55% compared to 3.94% in 2009. In Finland the private sector share of R&D funding is high with around 63% of GERD despite recent decline (Eurostat). In terms of research inputs, measured by human resources in science and technology as a share of labour force (50.7% in 2009), Finland ranks well compared to the EU-28 average (40.1%) and is on the same level with other innovation leaders(Eurostat, Research and Innovation performance in the EU 2014).

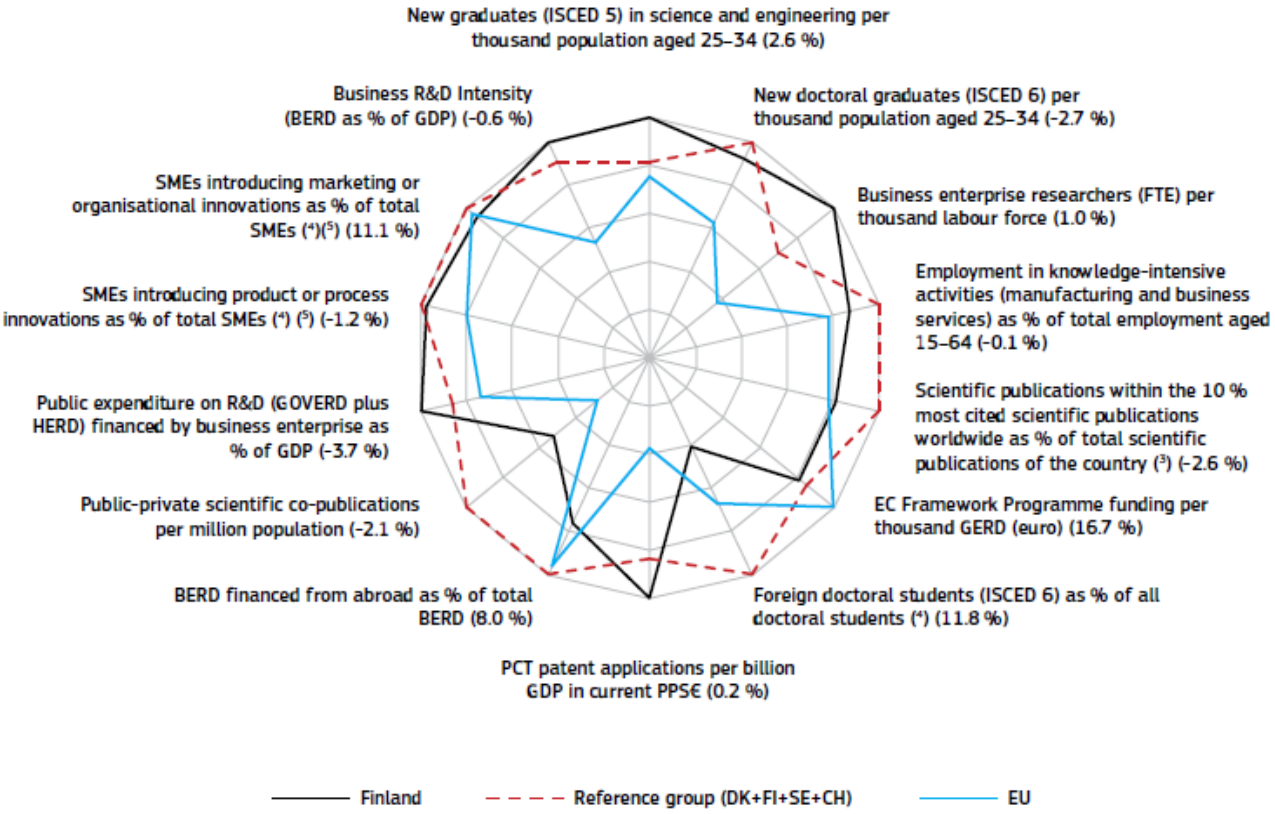

Figure 1. The strengths and weaknesses in the Finnish R&I system. Reading clockwise, the graph provides information on human resources, scientific production, technology valorisation and innovation. The average annual growth rates from 2000 to the latest available year are given in brackets under each indicator. (Source: Research and Innovation performance in the EU 2014)

In December 2012, the government action plan for research and innovation policy described the operating environment of Finnish society, economy and research undergoing a rapid change: "International cooperation and competition have intensified, and uncertainties in the global economy have functioned to weaken our expectations for the future. The business sector is currently undergoing severe structural change. Responding to requirements related to the maintenance of the welfare society and sustainable development as well as the **need for structural change** within society and the economy constitutes the central framework for the research and innovation policy of the present government term."

The **research and development community has been heavily affected** by the hardships faced by Nokia and its subcontractors, and by the downturns of the paper and pulp industry. The drop in orders from the industry, in turn, has led to dismissals at VTT Technical Research Centre of Finland, for instance. In fact, VTT reduced its personnel first time already around 2003–2005. Accordingly, MTT Agrifood Research Finland and Finpro, which are also reckoned as part of the innovation system (e.g. contribution to foresight and education exports, among others) dismissed people in 2013. While the research and innovation system is facing major structural pressures, the expectations on its potential to revive the economy remain high.

1.2 Governance of the Finnish research system

By definition the national innovation system is an extensive entity comprising the producers and users of new information and knowledge and know-how and the various ways in which they interact. At the core of the innovation system are education, research and product development, and knowledge-intensive business and industry. Varied international cooperation is a feature running through the system. Overall, the **Finnish governance system is a strong mix of national and local administration** allowing regions to have a relatively high degree of autonomy in the design and implementation of regional policies. Innovation policies and strategies, however, are guided and directed by the Finnish government, which decides on national development goals and lays down the general guidelines for regional innovation policy.

The Finnish research and innovation system is divided into four operational levels. 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 Council** (RIC). The **RIC is responsible for the strategic development and coordination of Finnish research and innovation policies** and is led by the Prime Minister.

The **second level consists of the ministries**, of which the Ministry of Education and Culture (MEC) and the Ministry of Employment and the Economy (MEE) play the key role with respect to research and innovation policy. MEE was reorganised in September 2011 and is responsible for innovation policy planning and budgeting. MEC is responsible for higher education and science policy related matters. The MEE's budget for 2014 is 3.4 billion euro. Of this, innovation funding accounts for 740 million, the majority of which is channelled to companies and research institutions through **Tekes, the Finnish Funding Agency for Technology and Innovation.** The share of MEC has increased during recent years mainly due to additional funding to universities and the Academy of Finland. The **R&D funding agencies, the Academy of Finland and Tekes, form the third level**. The former funds basic research through

competitive grants and the latter allocates the majority of its funds to R&D projects carried out by businesses. Tekes is also a large financier of research at the universities and public research institutes. Tekes funding appropriations have been slightly declining during the last few years.

Other **important instruments are the R&D programmes by Tekes** (such as the new programmes "Industrial Internet – Business Revolution 2014–2019", "Innovative Cities 2014–2020", and "Bits of Health 2014–2018"), the Academy of Finland and various ministries. Additionally, the MEE has published an action plan for measures to support demand-led and user-driven innovation policy and the Academy of Finland has also published a strategy for research programmes.

The **fourth level is comprised of the organisations that conduct research**: universities (16), public research organisations (18), private research organisations and businesses. Due to the high number of universities, polytechnics and government research institutes the **Finnish research system is rather decentralised**. The biggest state research organisation is Technical Research Centre of Finland (VTT) with an annual budget of approximately 290 million euros. The reform of the central government's sectorial research institutes strengthens multidisciplinary research and supports large research projects.

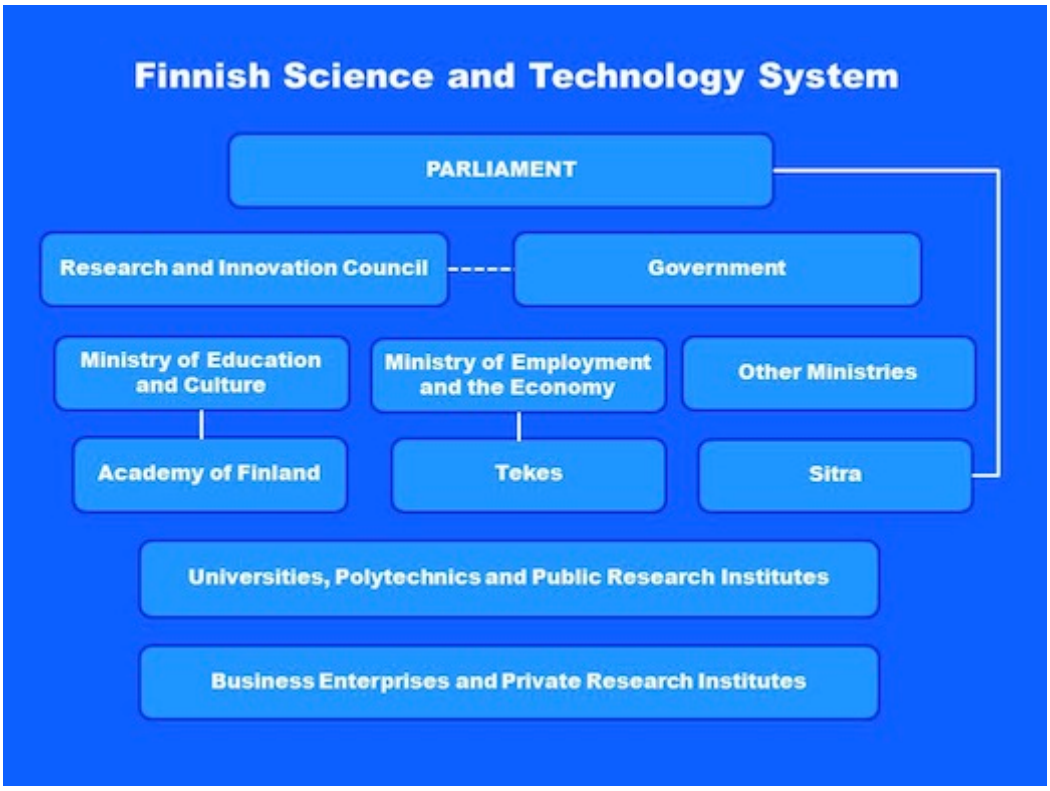

Figure 2. Overview of the Finland's research system governance structure (Source: Research.fi)

Academy of Finland allocates research funding – in 2014 worth some 310 million euros - to leading-edge scientific research, promotes scientific research and research environments and the application of research results, supports international scientific cooperation and acts as an expert in science policy (Academy of Finland). At home, the key partners are the Finnish universities; globally, research funding agencies in the EU and in a number of countries around the world. The academy provides support for all stages of the research career.

Tekes grants annually around 550 million euros towards innovative projects aimed at generating new know-how and new kinds of products, processes, and service or business concepts (Tekes). Funding is also available for developing work organisations. Tekes facilitates collaboration and networking between small and large businesses, industry and academia, public and private sector and non-governmental organisations. Tekes's customers include companies, universities, research institutions, government organisations, local and regional authorities and other organisations operating in Finland. Tekes can also finance R&D projects undertaken by foreign-owned companies registered in Finland. International companies with R&D activities in Finland do not need to have a Finnish partner to be eligible for funding. The financed project should, however, contribute to the Finnish economy. To promote international R&D cooperation, Tekes funds collaborative research and development projects and facilitates researcher mobility.

The **Strategic Centres for Science, Technology and Innovation** (SHOKs) at the moment make up a main policy instrument in Finnish innovation policy. SHOKs form cooperation platforms for innovative companies and spearheading research. A not-for-profit limited company, the partners in which include key companies, universities and research institutes in a topic area, is responsible for running each SHOK. The SHOK's research strategy is drawn up and decisions on its implementation are made by the partners. Non-partner actors may also take part in research programmes and projects.

The SHOKs carry out research in a virtual research organisation, which may consist of geographically dispersed units. **Research carried out by the SHOKs is strategic, pre-commercial, and as a rule not associated with short-term market goals**. As the time span of research usually is 5 - 10 years at minimum, competitors may take part in the same programmes.

Between 2008 and 2012 Tekes funded SHOK programmes with a total of 343 million Euros. An average of 40% of the research conducted in the SHOK programmes is **co-funded by the companies involved** (Ministry of Employment and the Economy 2013a). There are six SHOKs (two first ones are currently talking about merging with each other):

Energy and the environment CLEEN Ltd
Bioeconomy FIBIC Ltd
Metal products and mechanical engineering FIMECC Ltd
Built environment innovations RYM Ltd
Health and wellbeing SalWe Ltd
Information and communication industry and services DIGILE

The **Finnish Innovation Fund Sitra** promotes and stimulates new business models that aim for sustainable well-being. As a public fund, Sitra reports directly to the Finnish parliament. Sitra provides funds for surveys, forward-thinking activities, experiments, and shared strategy processes that promote well-being and are ecologically and socially sustainable. Project funding must be related to Sitra's themes or key areas. At the moment, operations are targeted at two current themes:

Through the Empowered individual and social structures theme, Sitra encourages people to assume more responsibility for their own well-being and for that of their loved ones. Sitra aims

at creating means and incentives that help people promote the common good and look after loved ones.
The Ecologial sustainability theme aims at affecting the ways of living and the use of natural resources with the purpose of creating a social environment that supports the idea of ecological sustainability.
Sitra does not provide funds for academic research projects, dissertations, or commercial research and development projects.

2. Overall Research and Innovation strategy

2.1 Economic context

Finland's GDP growth forecast for 2015 is 0.3%. In 2016 and 2017, GDP growth is expected to pick up to 1.4% (Ministry of Finance 2015a). Sensitivity to the global environment is connected to the export structure; 80 % of exports consist of capital goods and intermediate goods for which demand is typically more volatile and influenced by the business cycle. Fiscal consolidation is on-going and the government has proclaimed the reduction of the debt ratio by 2015 as one of its most important goals.

The Finnish economy is similar to other western economies. Services account for more than two thirds of production (68.5 %) whereas the share of agriculture is small (3 %). Industrial production still plays a key role especially to exports although its overall share of production (28.5 %) is decreasing slowly (Statistics Finland). Important sectors in the Finnish economy are electronics and electricity, machine and metals industry, chemistry as well as pulp and paper. Within services significant branches are retail and business services, logistics and wholesale. **Life sciences, health and well-being, clean technologies as well as creative industries/services are expected to become strong sectors in the future**, which is reflected for instance in the Tekes strategy.

Since the recession of early 1990s Finland has been a **forerunner in technology-based product and process innovations** and is home to well-known telecommunications corporation – Nokia. There are other ground breaking businesses in Finland as well, including the elevator company Kone, the mobile game companies Supercell and Rovio, and several others such as Metso (forestry), Wärtsilä (mechanical engineering), and Suunto and Polar Electro (manufacturing) amongst others. Indeed, the share of services and especially knowledge intensive services has been lower in Finland than in other leading countries (for instance Denmark, Sweden and Belgium). This fact lead to a general challenge: compared with high level R&D investments and business R&D, relatively little world class advanced services or goods originate from Finnish innovations or Finnish entrepreneurial firms.

Figure 3. Supercell Corporate HQ in 2010; in 2014, Supercell profits were 515 million euros (Source: Supercell)

A great majority of business R&D is still conducted by Nokia. All in all, the **private sector is an important knowledge provider in Finland** with 4.6b euros R&D expenditures in 2013 (about 69% of the total R&D spending), however, 365 million euros less than in the record year 2011. **Private sector R&D is concentrated** (more than 80% in 2010) in large businesses with over 250 employees. Moreover, the ten largest businesses account for 56% of all the private sector R&D (Ministry of Employment and the Economy).

Table 1. Basic indicators for R&D investments

Indicator	Finland	OECD Total	Year
Gross domestic expenditure on R&D (GERD) [Mio. USD*]	7.176	1.128.468	2013
GERD Growth rate compared to previous year [Percent]	-3,6	3,8	2013
Gross domestic expenditure on R&D (GERD) as a percentage of GDP [Percent]	3,3	2,4	2013
Government-financed GERD as a percentage of GDP [Percent]	0,9	0,7	2013
Industry-financed GERD as a percentage of GDP [Percent]	2	1,4	2013
Business enterprise expenditure on R&D (BERD) [Mio. USD*]	4.941	768.910	2013
Percentage of BERD financed by government [only direct funding, Percent]	2,8	6,6	2013
Percentage of BERD financed by abroad [Percent]	11,7	6,5	2012
Higher education expenditure on R&D (HERD) [Mio. USD*]	1.544	205.193	2013
Percentage of HERD financed by industry [Percent]	5	5,9	2013

Government intramural expenditure on R&D (GOVERD) [Mio. USD*]	640	127.355	2013
Percentage of GOVERD financed by industry [Percent]	9,9	3,8	2013
Total researchers in full-time equivalent	39.196	4.403.168	2013/2012
Total researchers in full-time equivalent per thousand total employment	15,7	7,8	2013/2012
Business enterprise researchers as a percentage of national total [Percent]	56,8	60	2013/2012
Patents with foreign co-inventors as a percentage of patent applications filed under the Patent Cooperation Treaty (PCT) [Percent](1)	19,3	7,2	2011/2012

Source: OECD Main Science and Technology Indicators, 2015/1; (1)OECD Patents Statistics

* at current prices and Purchase Power Parities (PPPs)

The **Finnish economy faces strong headwinds from the ageing population**. The working-age population has started to shrink. Productivity and living standards rank high among the developed countries, but erstwhile strong industries such as electronics and forestry are in difficulty and, in general, the share of manufacturing in GDP is declining. Although Finnish labour productivity has traditionally been high in manufacturing, this is less the case in the services sector.

2.2 Research and Innovation policy

The **Finnish National Reform Programme** (2012) identified the **most important substantive reforms of the research and innovation policy** to be the creation and introduction of new means and models to strengthen innovation activity, the establishment of attractive clusters of expertise, internationalisation, structural development of higher education, reform of research institutes ad research funding, and organisation of infrastructure policy and the tenure track system. Overall, the number and scale of reforms taking place signal the continuous commitment to a broad and ambitious R&I policy.

The Innovation Union Scoreboard 2014 positions **Finland among other innovation leaders** including Sweden, Germany and Denmark, which show a performance well above that of the EU average. The relative strengths of Finland are in Human resources and Finance and support. Growth for Knowledge-intensive services was the highest off all Member States. Growth

performance in Intellectual assets and Innovators is well above average and in Firm investments and Linkages & entrepreneurship well below average.

2.3 R&D funding

2.3.1 Funding flows

The recent Europe 2020 target for Finland is to have 4 % expenditure to R&D as a proportion of GDP by 2020. However, GERD declined between 2009 and 2013 from 3.94% to 3.31%. In Finland the private sector share of R&D funding decreased from 65% of 2011 to 61% of GERD in 2013. Respectively, the share of the government increased from 23% to 26% of GERD in 2013. Also the share of funding from abroad increased from 6% to 11% of GERD (Eurostat). The government funds around 27% of all R&D activity. From this amount 65% is directed to the higher education sector, around 26% goes to public research organisations (mainly sectorial research institutes) and approximately 8% to the private sector (Eurostat). Most of the university funding comes from various government sources, especially from the Ministry of Education and Culture but also from the main public R&D funders, the Academy of Finland and Tekes.

Although private sector participates in the funding of research carried out by the higher education and public sector, most of their funding goes to private R&D. Public research organisations perform about 9 % and the higher education around 22 % of all R&D activities. In 2012, 61% of funding from abroad was directed to the private sector. Around 24% of the foreign funding went to universities and 12% to the public research organisations. Funding to basic research and research infrastructures has grown more slowly than funding to applied research and innovation. Recent budgetary cuts have further exacerbated this trend (Statistics Finland).

2.3.2 Funding mechanisms

Table 2 details the Government budget appropriation or outlays for R&D in 2014. 42.8% of the R&D funding is allocated to Tekes and Academy of Finland, which both operate within a competitive funding framework. "Other R&D funding" of 11.6% entail competitive funding practices of ministries and agencies. Furthermore, the recent reforms of the R&I system has moved institutional funding to be decided on a more competitive basis and some recent changes. These indicate further budget shifts from government research institutes to the Academy of Finland.

Table 2. Government budget appropriations or outlays for R&D (GBAORD) in 2014 (Source: Statistics Finland)

	R&D funding € million	Share of R&D funding, %	Real change from 2013, %
Universities	578.9	29.6	-0.7
Tekes	513.3	26.3	-6.8

Academy of Finland	322.7	16.5	-3.6
Government research institutes	282.2	14.4	-7.2
Other R&D funding	226.7	11.6	1.0
University central hospitals	31.3	1.6	-0.6

With regard to the practices determining the core funding, Research and Innovation Policy Guidelines for 2011–2015 states that the **independence and international scope of evaluations are strengthened**. Evaluation results are more closely linked to the development and decision making of organisations and functions (Research and Innovation Council of Finland, 2010).

In 2012, the Government approved the decrees related to the **revision of the university funding model**. Government appropriations will be directed especially on the basis of completed qualifications and credits as well as scientific publications and competed research funding. Funding of universities of applied sciences will be revised to better support educational targets, such as improvement of the quality of teaching and research.

In September 2013, the Finnish Government approved a resolution that specifies a package of measures for the **reform of research institutes and research funding** (Government Resolution on Comprehensive Reform of State Research Institutes and Research Funding). Through the funding reform, research and analysis work in support of decision making by the government and its ministries will be strengthened by gathering together research funding for deployment in line with government policy (Ministry of Education and Culture, 2013).

Research and analysis activities supporting societal decision making by the government will also be strengthened, by accumulating funding in stages from state research institutes' budget-funded research appropriations and placing it at the disposal of the government and its ministries. This will be accomplished between 2014–2016, making available 5 million euros in 2014, 7.5 million euros in 2015, and 12.5 million euros in 2016 in non-earmarked funds, for research, assessment and analysis activities meeting the immediate information needs of the Government and its ministries. To be placed at the general disposal of the Government, such funds will be allocated to common and horizontal projects and research and analysis projects supporting decision making within the ministries' administrative branches. Projects will be designed and coordinated through a plan for research in support of Government decision making. A joint-research commissioning group, under the leadership of the Prime Minister's Office, will be in charge of preparing this plan (Government Communications).

Project-based funding by the Academy of Finland is allocated on a competitive basis and in line with the principles of peer review. The new overall reform of research funding will also affect the activities of the Academy of Finland. Through the reform, some 22 per cent of direct

government budget-funded research appropriations will be assembled and subjected to competition. The objective is to make 70 million euros available for strategic research funding in 2017. Such funding will be assembled in stages between 2015–2017, from the state research institutes' research appropriations (52.5 million euros), from the Academy of Finland's research funding (7.5 million euros) and from the Finnish Funding Agency for Technology and Innovation Tekes' innovation funding (10 million euros). The Strategic Research Council, which will manage these funds, will be based at the Academy of Finland. The council will fund long-term projects. Its decisions will be based on a review of both scientific quality and societal relevance (Government Communications).

2.4 Strengthening the knowledge base

2.4.1 Education and skills development

Finland had the **highest number of R&D personnel as a proportion of the total employment in Europe**. The same result was found in an examination of R&D personnel employed in the higher education sector and the government sector, for instance in government research institutes. In 2013, 16 persons per 1,000 employed persons worked in R&D position in Finland. Seven of them worked in the higher education sector and three elsewhere in the government sector (Academy of Finland 2014a). According to the State of the Union Country Report 2014, Finland has strong innovation performance overall and outperforms its reference group in terms of highly skilled human resources. However, the share of new doctoral graduates was lower in Finland than in the reference group in 2012. Finland performs below the EU average in the share of foreign doctoral students and participation in EU excellence–driven funding programmes.

2.4.2 Young people's scientific education

The **scientific education taught in Finnish schools** is generally at a good level, which is also evident in the international PISA student assessments. There is discussion on the educational curricula on the state of natural sciences but there have not been any recent major changes in the educational curricula.

The Ministry of Education and Culture aims to ensure the appropriate mix of skills among the population by continuously monitoring the supply and demand of various fields of study. Especially the vocational qualification has been designed to respond to labour market needs. Specific bodies, such as the Finnish Education Evaluation Council and the Higher Education Evaluation Council assist in this task. There is a specific organisation, the **national LUMA** (LU stands for "luonnontieteet", natural science in Finnish, and MA for mathematics) **centre, which works as an umbrella organisation for the cooperation of schools, universities, business and industry to support and promote the teaching and learning of science, mathematics and technology**, at all levels. There are also some specific measures such as Science Circus, a travelling science education event at schools provided by the Finnish Science Centre. Some other smaller projects have been also carried out in Finland. However, as a whole there has not been any dedicated science education in the curricula.

Figure 4. LUMA Centre Finland was established in November 2013 as an umbrella organization for the collaboration of schools, universities and the business sector, with the aim to promote and support life-long learning, studying and teaching of STEM subjects on all levels of education. (Source: LUMA Centre Finland)

According to Eurostat, in 2012, 27.6% of the students participating in tertiary education were in the fields of science, mathematics and computing, engineering, manufacturing and construction, which was above the EU average (22.6%). The **general attainment in scientific education** has been rather high but when looking at the applications it is clear that other fields of study are generally more popular.

2.4.3 Human resources for research

The **amount of scientists and engineers in Finland** has risen from 64,000 (2005) to 252,000 (2014) and their number of the labour force was 9.4% in 2014. The latter figure was about 40% higher than the estimated EU-28 average of 6.7% (Eurostat).

The **National Guidelines for the Development of Doctoral Training** (2011) have been prepared for the universities. Since 2011, all Finnish universities have started the reform of the doctoral training system in line with the principles of innovative doctoral training.

The large number of researchers and doctoral degrees is partly explained by the **Finnish graduate school system**. In 2010, the system comprised 110 graduate schools. The schools had about 1,600 graduate students who were paid for working full-time on their doctoral dissertations. The goal is that the students complete their doctoral dissertations in four years. All of Finland's 16 universities house one or more graduate schools, often in collaboration with other universities or research institutes. However, the current form of graduate school system will end in 2015 (Academy of Finland).

The recent economic downturns and structural reforms in HEI have led to a **growing number of high educated unemployed**. Some unemployed academics establish companies of their own; others go to re-education if they regard perspectives in the job market hopeless in terms of their background. Still, there is simultaneously a need to attract more qualified researchers and other labour in order to support and sustain the relatively high level of Finnish research and innovation system, especially since private sector has also increasingly employed PhDs (Sainio, 2010). The amount of researchers has risen during the past few years. This has not, however,

been reflected in the share of foreign researchers or in the mobility of either students or staff at Finnish HEIs. There are rules and practices to help foreign researchers to work in Finland. Information is fragmented however and there has not been a dedicated programme to facilitate the immigration of foreign experts. Partly due to above challenges, the private sector has recruited relatively low numbers of foreign researchers except the few international businesses.

2.4.4 Women in research

In 2014, the **share of female scientists and engineers (headcount) was 29.8% in Finland**. This was slightly below the EU-28 average (40.1%) (Eurostat). The Finnish figure has remained almost the same for several years, but the EU-28 average has increased steadily. In 2011, the Ombudsman for Equality made a study on equality in the management of universities and the result was that equality is realised quite well in the Finnish universities.

In addition to the Equality Act which supports gender equality in HEIs and PROs, **Finland has also adopted measures to support gender equality** when decisions on research positions and research funding are made (Government Action Plan for Gender Equality 2012-2015 and Academy of Finland's Criteria for research funding decisions). As part of the steering of HEIs process and the 2012 agreement between national authorities and HEIs, the latter are required to report on the implementation of their gender equality strategies.

2.5 Research Infrastructures

Based on the recommendations of the Science and Technology Policy Council in 2006, a Committee was appointed to prepare a proposal that identifies important **research infrastructure**, a system of funding for research infrastructures and procedures for identifying and evaluating the need for establishing new infrastructures. The work of the Committee resulted in two roadmaps with proposals for organising a national research infrastructure policy in the future (Academy of Finland 2014b). The Committee formulated a vision as part of the research infrastructure strategy: *By 2020, Finland will have gained recognition for its internationally competitive science and high-quality research infrastructures, which enable the renewal of learning, society and the business sector*. The strategy includes five sets of measures necessary to realize this vision: 1) Long-term development of all research infrastructures, 2) Improvements of access to and collaborative use of research infrastructures, 3) Shoring up of the funding base of research infrastructures, 4) Provision of a firm basis, by the roadmap, for the methodical development of research infrastructures, and 5) Evaluation of the impact and significance of research infrastructures. Specific recommendations have been included in relation to each measure.

	National research infrastructures of the Roadmap (no)	Partnerships of Finnish actors in ESFRI projects (no)	International research infrastructures which Finland has joined through state or other agreements (no)	The total estimated annual costs for Finland (€)*
Social Sciences and Humanities	7	3	0	80 000 000**
Environmental Sciences	6	7	4	50 000 000
Energy	-	1	3	1 000 000
Biological and Medical Sciences	10	8	2	45 000 000
Material Sciences and Analytics	3	2	1	15 000 000
Natural Sciences and Technology	4	3	5	60 000 000
E-Science and Mathematics	3	1	2	12 000 000
Others	-	-	1	650 000
In total	**33**	**25**	**18**	**183 650 000**

* Information is based on the estimated annual costs between the years 2014-2018
** Several of the infrastructures in the field of humanities provide services to researchers from all disciplines

Figure 5. Estimated national funding requirement for research infrastructures, by discipline (Source: Finnish Research Infrastructures Roadmap)

The same roadmap estimates **annual budgets for the development of research infrastructures**. It is estimated that the additional costs of implementing the roadmap will total approximately 30 million euros per year, while the costs of current national and international research infrastructures are around 160 million euros a year. Funding will also be needed for local research infrastructures. The present project reiterates the proposals of earlier working groups concerning the need for an organ at the national level, a research infrastructure council, to prepare and implement research infrastructure policy and its funding.

3. New initiatives/emerging technology fields

3.1 Recent policy developments

3.1.1 Reform of national research and innovation system

The National Reform Programme 2015 intends to diversify the business structure, in particular by hastening the introduction of planned measures to broaden the innovation base. In particular, the programme notes that in **order to accelerate economic growth, a tax incentive for research and development activities** will be continued and extended to private persons, who invest in starting companies. During the year 2013, the tax incentive was used by over 600 companies, 80 per cent of which were SMEs. In 2012, ICT 2015 working group was appointed to prepare a strategy to mitigate the effects of the sudden structural change in the ICT sector as well as to reform the information and communications technology sector and to increase its competitiveness. The working group proposes, for instance, a ten-year research, development and innovation programme and a new financing programme to ensure sufficient funds for startups and companies in the growth phase.

The Commission's analysis of the National Reform Programme leads it to conclude that whilst investment in research, development and innovation continues to be high, a critical issue remains the **efficiency with which this research is translated into innovations and new high- growth companies**, which can penetrate fast growing export markets and strengthen international competitiveness. In the short term, Finland should implement recently adopted policies and measures to improve the research and innovation system such as the 2012 action plan, and propose further reforms, where relevant, based upon existing evaluations and foresight work.

Once during each electoral period, the Government submits to Parliament a foresight report on long-term perspectives. The focus of each report is on a defined set of strategically significant issues that will impact the Government's key policies over the coming 10-20 years. The foresight report gives the Government's view on the chosen issues and associated policies (Finnish Government 2013). Several different types of **foresight activities** have also been carried out for instance by the Committee for the Future, one of the 15 standing committees of the Parliament of Finland, by the ministries, Tekes and the Academy of Finland as well as research institutes and universities. Foresight studies have often been organised in association with research programmes of the Academy of Finland or Tekes programmes and their focus has been rather narrow.

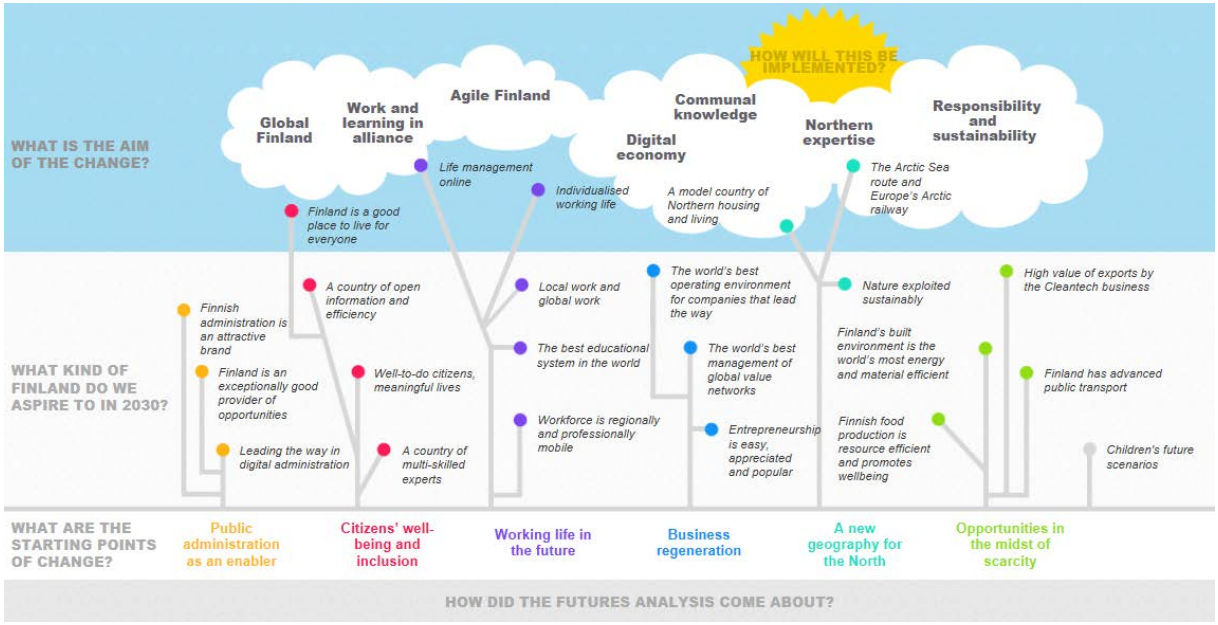

Figure 6. Front-page of the Finnish [Foresight 2030] online report

According to the roadmap, the steps towards the goal "Entrepreneurship is easy, appreciated and popular" are as follows, for example

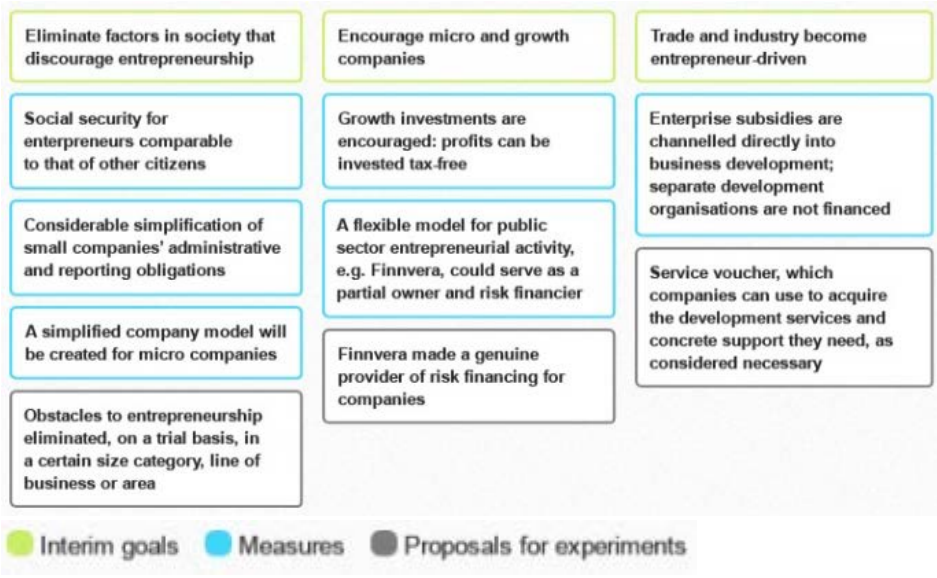

Figure 7. Roadmap towards the 2030 objective "[Entrepreneurship is easy, appreciated and popular]"

In May 2015, a new Center Party -led government started its reign. In its [strategic programme], the new government states that Finland's competitiveness is built on high expertise, sustainable development and open-minded innovations based on experimentation and digitalisation. The government will launch a reform programme to achieve the strategic objectives of the government term. By the end of 2018, **1.6 billion euros will be invested on a one-off basis in key government projects and to reduce the repair debt**. Key government projects include reforming basic education with the aid of digital learning environments, a customer-oriented reform programme in child and family services, developing home care for the elderly,

promoting the bioeconomy and clean solutions, reforming employment service activities, facilitating funding for SMEs, and promoting domestic and foreign investment.

The Research and Innovation Policy Guidelines for 2011-2015 (Research and Innovation Council) and the Growth through expertise, Action plan for research and innovation policy (MEC and MEE 2012) are two **key policy documents which set out at national level the policy guidelines** on the required measures and funding and detail out the actions required for the implementation of the government's research and innovation policy.

According to the international evaluation of the Finnish research and innovation system (MEE & MEC 2009) the **Finnish higher education and public research system is fragmented**, which makes it more difficult to focus resources and to provide high-level research. According to the evaluation the system can be seen as fragmented in three dimensions. Firstly, resources are scattered in three different types of organisations with overlapping tasks: universities, polytechnics and public research organisations (PROs). Secondly, these institutions are scattered around the country with several rather small units. Thirdly, the universities have been internally fragmented in several rather small units.

The Research and Innovation Policy Guidelines state that developing the Finnish innovation system requires that:

structures are reformed and organisational, operational and regional fragmentation will be reduced
the co-ordination and steering of policy actions will be strengthened at government level
the prioritisation and selection of subject matters and contents will be undertaken
the exploitation of education, research and innovation (ERI) activities will be promoted extensively
universities, polytechnics and public R&D institutes are supported in raising their profiles and specialising in their fields of strength; the quality of research will be improved
multi-lateral cooperation will be enhanced and the division of labour between HEIs, public R&D institutes and enterprises clarified
steering systems, incentives and the regulatory environment will be developed
the efficiency and effectiveness of the business and innovation service system will be improved
the position of the SME sector within the innovation system will be strengthened
a long-term infrastructure policy will be created and the wide use of public data enhanced
evaluation expertise and the exploitation of evaluation data will be strengthened
the funding base for research and innovation will be diversified
the internationalisation of ERI activities of the entire innovation system will be enhanced
the means for monitoring policies will be improved.

The Government budget for 2013 included, for the first time, two **tax incentives aimed at growth seeking businesses**. The Tax Incentive for Private Investors targets business angels investing equity in SMEs. The incentive provides a possibility to postpone paying capital gains taxes as long as those gains are re-invested in qualifying businesses. The R&D Tax Credit for SMEs is a deduction from corporate income taxes tied to the wage costs of R&D personnel in Finland. Presumably the R&D tax incentive supplements rather than replaces the current R&D subsidies. These incentives are then continued (see, e.g. Finnish Business Angels Network's summary of the measures).

Moreover, government decision on central government spending limits for 2014 – 2017 (MoF 2013) stated that:

A new research, development and innovation programme will be launched with Academy of Finland funding to support the programme and **implementation of the ICT 2015 programme**, the Academy of Finland's annual funding authority will be increased by 10 million euros from 2014.
The Government will launch a major growth funding programme in order to strengthen the capital investment market and to **support SME growth**. The programme will be financed through both government and private investment. Taken together, investment in these funds may run into billions of euros.
During the budget planning period annual capitalisations of 30 million euros will be made into Finnish Industry Investment in order to start a **new growth fund for growth-stage businesses**.
In 2014–2017, capital investments in Finnvera will be increased by 5 million euros in order to **support the growth of startup businesses through direct investment**. During the planning period annual investments of EUR 20 million will be made from the Finnish
Funding Agency for Technology and Innovation (Tekes) lending authority to capitalise seed companies: From 2014, as part of the growth funding programme, Tekes will gradually take over responsibility for the provision of early-stage public development subsidies, including capital investment activities.

3.1.2 Innovation policy focus areas

According to the Ministry of Employment and the Economy government's **recent innovation policy focus areas** include environmental business, the mining industry and the forest and bioeconomy sectors. In addition to industry, the Government is placing a greater emphasis on the service sectors as sources of growth. Public funding for research, development and innovation activity is being targeted accordingly.

As stipulated in a decision issued by the Research and Innovation Council in autumn 2011, the Ministry of Education and Culture (MEC) and the Ministry of Employment and the Economy (MEE) drafted an **action plan for research and innovation policy** by the end of 2012 as part of the government's strategy process (MEC and MEE 2012). The aim of the action plan was to concretise and enhance the implementation of the government's research and innovation policies and document central development measures and adjustments required for the years 2012 - 2015.

Proposals for measures by the government to increase the attractiveness of Finland and enhance the internationalisation of the RDI system:

1. Research, development and innovation (RDI) activities by **polytechnics** are strengthened using special fixed-term funding.
2. The Universities Act is amended setting the target period for the completion of **doctoral studies** at four years, and universities will revise the requirements for doctoral degrees in science and the arts to make sure they correspond with this timeframe.
3. Appropriations for the budget line item on **research infrastructure** will be confirmed for 2014 to 2017.

4. Opportunities for long-term research are strengthened by introducing a targeted **10-year funding scheme** offered by the Academy of Finland.
5. **Arctic research** and expertise are strengthened, and foundation for arctic business is constructed.
6. Actions proposed by the **ICT 2015** Group appointed to respond to the challenges brought on by the structural change in the field of ICT and the national action programme in health technology and pharmaceutical research to be created as a pilot are utilised to attract international RDI investments to Finland.
7. A national programme to ensure the best possible **utilisation of EU's research and innovation activities, such as the Horizon 2020** programme, is created. The national support and advisory service for the applicants of EU funding is renewed accordingly.
8. The utilisation of immaterial property rights is improved by updating and implementing the **national IPR strategy**. IPR tax incentives are adopted to improve the opportunities of Finland to utilise investments in research and innovation from both Finland and abroad.

A research and innovation system with better quality and more flexibility

9. The utilisation of **research and the institutions' interaction with society** are accounted for when developing funding models for higher education institutions.
10. The structural development of universities is speeded up by, for example, supporting the identification and enhancing of their **core competences** using competed special funding in 2014 to 2016.
11. The INKA (**Innovative Cities**) programme and the negotiation procedure of innovation clusters are used to challenge the most significant urban regions.
12. Public funding instruments are used to ensure that the number of high-quality development **platforms for growth companies**.
13. The model of **Strategic Centres for Science, Technology and Innovation will be reformed** based on an evaluation completed in February 2013.
14. The activities, role and tasks of **the Research and Innovation Council will be evaluated** by the end of 2013.

Increasing effectiveness by expanding the scope of innovation activities and increasing experimentation

15. Measures required to **increase experimentation** and the preparedness to take risks in the promotion of innovation are determined in cooperation with central actors in the field of innovation.
16. The ministries will incorporate plans regarding the methods of **promoting research and innovation** in their respective administrative branches.
17. An operating model is created for **establishing lead market areas** and implementing measures particularly in the areas of cleantech and bioeconomy and in fields such as intelligent construction and security.
18. A target level is set to directing one per cent of **public procurement towards purchasing of new solutions in the cleantech field**.
19. The generation and diffusion of innovations is promoted by setting a **target percentage (such as 2 or 3 per cent) for public procurement**.

20. To support the programme on the **opening of public data** and measures to promote business use of public sector information, education and training, advisory, networking and other support services are compiled into a single entity.

Greater value and new competitive advantages through intangible investments

21. Shared use of information and openness are promoted by investing in the information infrastructure of managing, distributing and storing **digital data** related to research and innovation.
22. Intangible investments by companies are encouraged by promoting **service innovations** and enhancing business activities in the creative sector, among others.
23. The government's energy and climate strategy incorporates new business opportunities and measures emerging from the demand for **clean energy** and outlines measures to support this.

3.2 Research and innovation system changes

3.2.1 Education

The most significant structural change in recent years has been the **university reform** (with the new University Act in 2010) that has addressed the issue of universities to have more flexibility to promote high-level research, internationalisation and focusing of resources. The act has also enlarged the autonomy of universities, making them autonomous legal entities. This has been followed by mergers of several universities decreasing the amount of universities to 16. Also a new university funding model and reform came into force in January 2013. The aim of this model is a better, more efficient international university system with stronger impact and a better-defined profile. One key change proposed by the committee to the model used in 2010–2012 is greater emphasis on quality. Funding will no longer be allocated on the basis of target number of degrees, and the relative weight of scientific publications is expected to grow. Universities have also introduced a tenure track as the core academic career system to offer well-supported career path based on the principle of commitment from university and individual to academic career; it has clearly defined expectations, incentives, and assistance in personal development (see more, for instance on the tenure track of Aalto University).

Also, the **admission of students** at higher education institutions was reformed in 2011-2014. The aim of the reform is to make the access to higher education more seamless and the main options for student choices are reserved for applicants with no prior degree or equivalent level of education. At the same time the electronic application and selection system was developed.

In parallel, the **polytechnic reform** started in September 2011. According to the Government Programme, the responsibility for polytechnic funding as a whole is transferred to the government, and polytechnics will be made independent legal persons. The objective is to **strengthen the role of polytechnics as increasingly independent and responsible educators of experts**, reformers of working life and builders of the competitiveness of the regions. The reform is implemented via changes in legislation and the renewal of operating permits.

The university and polytechnic reform including new financial model has profound implications on the teaching and research staff and on the preconditions of Finnish research. This is

happening in parallel with the reductions in higher education spending. As a consequence **many degree programmes may face closing down** in the near future. The cuts hit polytechnics in sparsely populated areas hardest but also many universities have laid off their personnel. Universities are allowed and even encouraged to attract private money from the business sector. With the exception of Aalto University, they have not been particularly successful. The reforms will have long standing impacts on the HEIs future developments. Depending on whether a HEI reaches or surpasses its targets, it will be rewarded by more financial resources or face reduced funding. If a university needs to demonstrate efficiency by rapidly producing a lot of completed degrees, it may get tempted to relax its requirements.

The Ministry is simultaneously putting pressure to a**ccelerate mergers or at least enhanced collaboration between provincial universities and polytechnics** which will modify the HEI landscape. The ultimate goal is to reduce universities' and polytechnics' total number. At present, alliances have emerged, for instance, FUAS Federation of three Universities of Applied Sciences in South Finland, namely HAMK, LAMK and Laurea.

3.2.2. Research

The 2014 report on the review of the state of research in Finland evaluates Finnish research as relatively good and stable; however, what remains a concern is that the number of researchers at the very top of their field remains low in Finland. Fi**nland needs more high-quality, leading edge research**. In 2009–2012, more than 28,000 publications were written by Finnish researchers. The number of publications has increased most in universities. However, compared to leading international universities, all of the discipline units in Finnish universities are small and unable to cover even all major research areas. The current size of disciplines in different universities is the result of implicit or explicit choices. Reviewed by discipline (54 disciplines), the Finnish university landscape is still rather fragmented. Twenty-seven of the disciplines are represented in six or more universities; in 21 of these, the median value of the professorial full-time equivalents was less than 10 in 2012, that is, they are very small. Measured with bibliometric methods, not one of these 27 disciplines was clearly above the world average in the period 2009–2012 (Academy of Finland 2014a).

In September 2013, the Finnish Government approved a resolution that specifies three packages of measures for the **reform of research institutes and research funding** and identifies the ministry responsible in each case. These three sets of measures comprise structural reforms, research funding reforms, and the implementation and follow-up of the reforms. The overall reform will be implemented in 2014–2017. The objective of the overall reform is to strengthen multidisciplinary, high-level research of social significance. It will also seek to free up resources from research support services and fixed structures for redeployment in research activity and to organise research institutes into larger and stronger wholes.

The aim of this is creating **stronger multidisciplinary research organisations**, capable of competing with other European research institutes for funding, and greater cooperation between research institutes and universities. Through the reform, Agrifood Research Finland, the Finnish Forest Research Institute and the Finnish Game and Fisheries Research Institute will be merged to form the natural resources institute Finland. The Finnish Geodetic Institute; issues related to the Inspire project and the development and promotion of joint use of geographic information under the National Land Survey of Finland; and the sector-dependent information

systems of the Information Centre of the Finnish Ministry of Agriculture and Forestry, along with the related system development, will be merged to form a research and development centre for geographic information. The VTT Technical Research Centre of Finland and the Centre for Metrology and Accreditation will be merged to form a multi-technological research and development centre; preparations will be launched to turn the new centre into a profit-based, fully state-owned company with a special assignment. In 2015, the National Consumer Research Centre and the National Research Institute for Legal Policy merged with the University of Helsinki to form institutes or units based on national special assignments.

In addition to the structural reform of research institutes, **deeper, network-based collaboration will be required**, crossing the boundaries of government agencies and public bodies. The activities begun under the framework of the Finnish Natural Resource and Environmental Research Consortium (LYNET) and the Consortium of Expert Institutions on Health and Welfare (SOTERKO) will be developed and expanded in order to improve the quality, productivity and impact of research and consultancy.

One part of the reform of research institutes and research funding is the establishment of the **strategic research funding instrument**. Research funding subject to competition, and disbursed in support of social policy and society's functions and services, will be assembled under this instrument in order to make 70 million euros available for strategic research funding in 2017. Research and analysis activities supporting societal decision-making by the Government will also be strengthened, by accumulating funding in stages from state research institutes' budget-funded research appropriations and placing it at the disposal of the government and its ministries. This will be accomplished between 2014-2016, making available 5 million euros in 2014, 7.5 million euros in 2015, and 12.5 million euros in 2016 in non-earmarked funds, for research, assessment and analysis activities meeting the immediate information needs of the Government and its ministries.

The issue of competitive versus institutional funding and the **effectiveness of research funding** were at the core of the recent international evaluations of the Academy of Finland and Tekes. These two evaluations took place in a context where reforms of the funding system for university and public research institutes are being implemented. Peer review practices have been fully integrated into research evaluations over a decade ago and are routinely used by the Academy of Finland for its project-based funding. Moreover, the independence and international components of peer review evaluation have been strengthened under the Research and Innovation Policy Guidelines. The peer review mechanism is not used for Tekes project-based funding, where the objective is to generate new business opportunities.

The evaluation of the Academy of Finland was concluded in 2013 (MEC 2013b). It considered the Academy successful in its mission to finance high-quality scientific research and that the portfolio of funding instruments meets the expressed needs of the Finnish research community. The evaluation panel recommends a more active role for the Academy in science policy. The evaluation recommends that the **Academy's role should be extended into strategic research funding**. The Ministry of Education and Culture is also encouraged to consider transferring budget funds from university core funding to the Academy in order to boost the volume of research funded by means of competitive bidding.

3.3 Emerging technology fields

The **Strategic Centres for Science, Technology and Innovation** (SHOKs) make up a main policy instrument in Finnish innovation policy at the moment. SHOKs form cooperation platforms for innovative companies and spearheading research. As the time span of research usually is 5 - 10 years at minimum, competitors may take part in the same programmes.

3.3.1 Biotechnologies/ Bioeconomy

Finnish Bioeconomy Cluster FIBIC is one of six Strategic Centers for science, technology and innovation in Finland (SHOK). The aim of FIBIC is to turn science and technology into sustainable bio-based solutions. The on-going research programs are related to the development of intelligent and resource-efficient processes, future biorefineries and bioenergy solutions.

The ACel programme addresses the opportunity which is created by the fact that both the use of materials and the request of sustainable renewable raw materials is growing globally. In Finland, the world leading competence in cellulose production and conversion enables the further development of wood–based cellulose materials to novel application markets. The programme is expected to have a major impact on the renewal of the forest cluster and generation of new Finnish networks in textile and composite value chains.

Sustainable Bioenergy Solutions for Tomorrow (BEST) is a public-private research programme launched in early 2013. BEST crosses traditional business area boundaries and joins the strengths of forest and energy sectors, complemented by the know-how of technology and consulting companies and research organizations. The programme partners consist of 21 companies and 13 universities or research institutes. The planned duration is four years (2013-2016) with an annual budget of roughly 4 million euros. The programme is coordinated jointly by CLEEN Ltd. (Cluster for Energy and Environment) and FIBIC Ltd. (Finnish Bioeconomy Cluster).

3.3.2 ICT

In a similar vein, another SHOK, DIGILE aims is to increase the pace of development of Finnish ICT and digital business. Nowadays, digital business is an essential part of all kinds of business as well as public services. There are currently four research programs:

- Internet of Things (IoT)
- Data to Intelligence (D2I)
- Digital Services (DS) and
- Need 4 Speed (N4s)

In addition to the research programmes, a desire to create both **business ecosystems and business concepts** is at the very heart of DIGILE's work. Business ecosystem creation programs increase the pace of development of products and services, and prepare markets for their arrival. They also make it possible to receive almost instantaneous feedback from the market, thus reducing the risk of commercial failure.

Since 2011, the **coordination of the international research community** has been an important part of DIGILE's company-driven services. DIGILE is currently coordinating the European Future Internet PPP programme (www.fi-ppp.eu). This 600 million euro project is constructing a technological environment for ICT-based service provision with many different areas of application – from city infrastructure to smart mobile solutions. China is currently DIGILE's main regional focus area. DIGILE is the Finnish coordinator of the China-Finland ICT Alliance that was launched in 2009. The main objective of the ICT Alliance is to advance an efficient and business-oriented collaboration between China and Finland in ICT and ICT enabled applications and services in society and industry. The initial joint RDI projects of the ICT Alliance focused on network technology, wireless solution and ICT-based services.

FORGE Service Lab is a development laboratory for digital services. The construction of FORGE's technical environment started in 2012. The laboratory began the full range of its operations in 2014. It aims to support the service-provision growth of other branches of industry, as well the efforts of public administration to provide better services. Through FORGE Service Lab, these other branches of industry will also be able to take full advantage of the latest results of DIGILE's ICT research programmes. DIGILE believes that FORGE will ensure that Finnish companies and public organisations are amongst the very first to both reap the benefits of the opportunities the digital age provides and create situation-specific innovations. As more and more services vital to society are provided online, we can see the information society increasingly becoming the service society.

In April 2012, Minister of Economic Affairs set up the **ICT 2015 working group**. The working group was tasked with preparing a strategy to alleviate the impacts of the sudden structural change experienced in the ICT industry, alongside reforming the information and communications technology industry and increasing its competitiveness. During its work, the group expanded its perspective and approach to cover broad-based application of ICT in all industries and within the public administration.

The ICT 2015 group submitted its report to Minister of Economic Affairs and Minister of Labour on 17 January 2013. As illustrated in the report, the "21 paths to a Friction-free Finland" establish a **roadmap for long-term efforts to make Finland a leader in information technology applications** over the next 10 years. New measures will be decided on over the coming years, taking account of the results achieved and changes in the world. The working group made the following crucial proposals for the initial stage (MEE 2013b):

Building a common national IT service architecture. Harnessing of this common architecture will enable easier creation of services across organisational boundaries.
A ten-year research, development and innovation programme, ICT 2023. This programme would bring together key actors in the sector, such as universities, research institutions, companies and funding agencies.
A new financing programme to ensure sufficient funds for startups and companies in the growth phase.

3.3.3 Health and well-being

There are three health-related SHOK research programmes that SalWe manages. SalWe applies scientific data to developing products, services and practices that maintain and improve personal health, and prevent and treat diseases with serious social impact.

Get it done: A programme of personalized diagnostics and care. GET IT DONE creates new technologies and practices for healthcare professionals to provide **more effective services for health and well-being**. ICT-based solutions promote the utilization of clinical data, such as genetic information, for effective disease prevention and treatment.
Intelligent Monitoring: Combining in vitro and in vivo methods for **measuring and evaluating individual medical data**. The programme for intelligent monitoring of health and well-being has developed innovative, intelligent and cost-effective tools for use in personal healthcare or by healthcare professionals.
Mind and Body: The programme has created a set of skills on which new solutions for the **management of obesity and brain disorders** can be based. Excess weight and related morbidity are major challenges to medicine, as are mental stress and progressive brain dysfunction. These diseases impair the well-being of people of working age, and they impose major healthcare costs.

3.3.4 Environment & Energy

The SHOK CLEEN facilitates and coordinates industry driven research in cleantech field. CLEEN is a wide and heterogeneous consortium which has 44 shareholders. CLEEN manages seven on-going environment and energy focused research programs:

The objective of the ARVI (Material Value Chains) research programme is to build a solid and broad competence background, i.e., an innovation platform, based on which the Finnish material recovery industry may extend their businesses and improve competitive positioning in the global markets. The programme creates data, assessment tools and concepts for the value chain management and processing of materials to enable Finnish companies to expand and deepen their knowhow and to find out new technologies, process solutions and services as well as new ways to combine them to meet the requirements of future markets.

Sustainable Bioenergy Solutions for Tomorrow (BEST), see section 3.4.1

The objective for the Carbon Capture and Storage Program (CCSP) is to develop CCS-related technologies and concepts, leading to essential pilots and demonstrations by the end of the program. A further objective is to create a strong scientific basis for the development of CCS technology, concepts and frameworks, and to establish active, international CCS co-operation.

The Distributed Energy Systems (DESY) programme consists of DESY Research made by research institutes and universities, DESY Joint Research connected to parallel projects of companies and DESY Demonstrations. Demonstration projects are under processing and they have their own timetable depending on investment decisions. A fully implemented DESY programme will raise the production of renewable energy and it will especially promote the use of hybrid energy technologies including energy storing to a new and higher level via optimal solutions.

Efficient Energy Use (EFEU) research programme develops system level energy efficiency solutions and services for fluid handling systems and regional energy systems. EFEU consortium consists of 11 industrial partners and 5 research organizations. The budget of the programme is 12 million euros.

The objective of the Future Combustion Engine Power Plant (FCEP) research programme is to ensure that Finnish combustion engine industry can maintain its leading position on global markets. Another objective of the programme is to support Finnish companies and research institutes through close cooperation to further develop their research facilities, know-how, technologies and products to meet the future market requirements, which are closely connected to the emissions legislations including green house gas emissions.

The Measurement, Monitoring and Environmental Efficiency Assessment (MMEA) research programme aims at groundbreaking developments in environmental monitoring technologies, tools and services. The focus is on 1) new on-line & remote sensing technologies, 2) interoperable environmental observation systems, 3) management systems for environmental efficiency - thus covering the whole value chain from sensors to environmental efficiency services. Further, the programme includes 4) testing and demonstrating the results in the MMEA Testbed, and 5) implementing pilots that integrate monitoring and environmental efficiency tools between the MMEA Work Packages and with other CLEEN programs, with the other Strategic Centres for Science, Technology and Innovation (SHOKs), and with international research collaborators.

3.3.5 Metal products and mechanical engineering

The Metal products and mechanical engineering SHOK, FIMECC, aims to innovation commercialisation on three areas
Agile and profitable business execution in the changing global markets
Leading concepts, technologies and material based solutions for effective differentiation
Novel digital production for addressing customers' production excellence sustainably

There are ten research programmes currently going on in FIMECC. These programmes typically have a budget of 30 – 40 million euros:

- The overall goal of the Breakthrough Steels and Applications (BSA) programme is to enable a renewal of the Finnish metal and engineering industries through major improvements in their offerings and global competitiveness brought about by the intelligent use of novel advanced steel products. Key emphasis is on end-users in selected business areas: bionergy, power generation, mining, lifting, handling and transport, offshore and marine, waste recycling, arctic technologies and processing industry.

- FutIS – Future Industrial services – research programme promotes the adoption and expansion of service business in technology-based industrial firms. The programme investigates the future of industrial services in metal and engineering industry in three major topics: service business mindset, integrated service development, and efficient service operations. The network includes 19 companies and 9 research groups and their international partners.
- The Hybrid Materials (HYBRIDS) programme's goal is to significantly increase the competitiveness of Finnish companies in the field of knowledge-intensive, value-added materials (VAMs) which show huge commercial potential. The programme is linked and will be run in close cooperation with FIMECC materials programme BSA.
- MANU, Future digital manufacturing technologies and systems, focus area is manufacturing technology and creating competence in the field of digitalization and its use in manufacturing.
- MemsCat is an ecosystem of Finnish Microsystems players. The core of the ecosystem is formed by the well-established sensors and microsystems industry present in Finland and the member base is currently under expansion.
- The REBUS programme aims at making scientific breakthroughs in the area of networks and business ecosystems. The programme challenges the participating firms to take major leaps in developing these practices as well as fundamentally change their underlying mindsets of managerial behaviour. The particular focus is on those relational business practices that are needed to act as a member in as well as to take advantage of various networks.
- Sensor technologies have enabled better, more precise and timely monitoring of different types of equipment while at the same time development of memory technologies, data communication capabilities, as well as computational power have made it possible to economically utilize the available data. The purpose of the S4Fleet programme is to research the variety of possibilities these technological breakthroughs enable in service business.
- The objective of the System Integrated Metals Processing – SIMP project is to improve the environmental footprint of the "Metals and metal products" in the Finnish industrial sector and to further increase its global competitiveness. The focus is specifically on digitalising complex process models and making them operable in real-time in a gate-to-gate systemic plant environment.
- Smart technologies for lifecycle performance S-STEP is positioned in the cross roads of two significant megatrends: 1) the growing importance of industrial service business, and 2) the remarkable emergence of industrial internet or cyber-physical systems. S-STEP aims to create the industrial internet technology that enables superior services for the Finnish industry. The total volume of the programme is 25.6 million euros and its intended duration is 4 years, starting at June 1, 2014. There are 21 industrial partners and 9 research or academic partners.
- User Experience & Usability in complex Systems (UXUS) Research Programme supports future knowledge creation and creates new interaction concepts and innovative practices in developing the user and customer experience excellence.

3.3.6 Built environment innovations

The core of the operations of RYM SHOK are the research programs based on the research strategy decided by the shareholders, which the companies implement jointly over a 3-6 year time horizon. There are two research programs underway:

- The goal of the Energizing Urban Ecosystems (EUE) research programme is to build solid foundations for the comprehensive understanding of the planning, design and management of the future urban areas and ecosystems, and turning this accumulating intellectual capital and know-how into successful, global business processes.
- The Indoor Environment programme creates solutions that promote productivity, comfort and health of space user in an ecologically sustainable way. The focus areas are user-centric spaces, energy efficient management, revenue models for good indoor environments, and design and implementation of inspiring learning environments.

3.3.7 Key research programmes in Academy of Finland

Academy Programmes are research programmes funded by the Academy of Finland with a view to directing research and allocating research funding to fields that are considered of key importance in terms of the regeneration of science and the foresighting of future research needs. A major emphasis in Academy Programmes is on multi- and transdisciplinarity approaches as well as international cooperation. The Academy Board decides on the startup of new Academy Programmes. An Academy Programme is a thematic, target-oriented and coordinated body of research projects that are provided with funding for at least four years. In 2015, the Academy funds 13 Academy Programmes.

- Arctic academy programme ARKTIKO (2014-2018) is designed to reinforce Finland's status as an internationally leading expert in Arctic issues
- Climate Change FICCA (2011-2014) respond to the scientific challenges posed by climate change on a broad front, that is, support the type of multidisciplinary research that addresses the social and environmental spheres side by side
- Computational Science LASTU (2010–2016) strives to unite the development of computational methods with research that addresses computationally intensive problems that are also fundamental issues in science and engineering; topical examples include climate change, energy issues, health and well-being, the security of global information networks, and management of the global economy
- Future of Living and Housing ASU-LIVE (2011-2015) approaches the future of living and housing as a substantive entity that comprises environmental issues from sustainable development to land use, logistics and services, and consumer issues from cultural needs through to health issues
- The aim of the Future of Learning, Knowledge and Skills TULOS (2014-2017) is to gain more in-depth and up-to-date research data about the mechanisms, preconditions, opportunities and threats to knowledge, skills and competencies in the global world. This will contribute to increasing our understanding of the new forms of learning and their distinctive characteristics, to developing more effective education solutions that make use of modern technologies, to shedding light on the role of the media in the individual's life and its different forms, and to

unravelling the changes that have happened in social and societal interaction with the development of electronic communications.

- The focus of Health and Welfare of Children and Young People SKIDI-KIDS (2010–2015) is on ways of promoting children's health and well-being as well as on children's health and welfare problems; the programme is also concerned to research health and welfare risks.
- Programmable materials OMA (2012-2016) aims to identify areas in which Finland could act in the forefront of materials science
- Research programme on the Human Mind MIND (2013-2016) involve basic research into the human mind and its neural mechanisms in different cultural and social contexts; the research will be applicable in tackling topical issues and challenges, such as learning, brain and mind development, ageing, health and sickness of the human mind, drugs and addictions, globalisation, refugee problems, cultural encounters and collisions as a result of conflicts, the electric media, and community planning
- Sustainable Governance of Aquatic Resources AKVA (2012-2016) expected to contribute to upgrading the scientific level of Finnish water research and achieving both national and international objectives of the Finnish water sector
- Synthetic Biology FinSynBio (2013 – 2017) integrates Finnish-based researchers into an internationally competitive scientific community that would exceed a critical mass and that would actively work to develop synthetic biology and apply the research knowledge from the community
- New Energy (2014 - 2017) will involve a search for solutions for managing the coming major transition in the energy sector

The Academy of Finland is also participating in the joint European Baltic Sea Research Programme (2010–2016).

4. University – industry collaboration and commercialization of university research

4.1 Facilitate partnerships and productive interactions

Knowledge circulation within the Finnish research system is relatively strong in international comparison and the interaction between public and private research has not been identified as a major issue of concern. The percentage of GOVERD financed by Finnish industry has been around 10%, which is much higher than the estimated OECD average of about 4% (OECD Main Science and Technology Indicators 2015). The figure implies that university-business R&D linkages and public research institute-business linkages are above average. The high percentage of GOVERD financed by industry is largely due to the business collaboration of one research institute, VTT. In 2013, the share of external funding for VTT was 68%, which was likewise 66% of total external funding received by the Finnish research institutes. About 40% of the external funding of VTT was provided by domestic or foreign business. For the majority of other research institutes, the share of external funding is notably smaller (VTT).

There are several policy measures in Finland **facilitating the partnerships and interactions between the private sector and research institutions**. The most established instruments are the Tekes programmes and Tekes project funding, where collaborative research and networking are encouraged. The more recent instruments are the strategic centres for science, technology and innovation (SHOKs), where the private sector is not only a shareholder in the SHOKs but is also involved in planning the strategic research agenda for the research programmes coordinated by these SHOKs.

However, the **external evaluation of the strategic centres for science, technology and innovation (SHOKs)** in 2013 provides insights and critical perspectives on one of the main industry-driven instruments of Finnish innovation policy. For instance, despite major advances SHOKs also face important challenges that include i) multiple and often internally contradictory objectives, ii) tensions between short and long-term perspectives and iii) lack of international activities (MEE 2013a). Indeed, In May 2015, a new Center Party -led government stated in its strategic programme that the SHOKs will gradually be closed down (Finnish Government 2015). In practice, this means that Tekes has halted the 2015 application round for new SHOK Research programmes. In addition, the phase funding of SHOK Research programmes currently underway will be reviewed. The most promising and smoothly progressing themes can be pursued by directing the SHOK funding still available for this year at key targets. This will provide a transition period for the planning of new operating models and funding channels. For example, Tekes advises SHOKs to explore options such as the EU's Horizon 2020 programme. Moreover, many SHOK companies operate in the spearhead areas identified in the Government Programme, such as the bioeconomy, cleantech solutions, digitalisation and wellbeing. Realising these spearhead projects could provide a new way of using the work done and networks built by SHOK programmes.

Tekes, the Finnish Funding Agency for Innovation, facilitates collaboration and networking between industry and academia and is the main support provider for R&D activities in Finnish SMEs. In 2014, more than 63% of Tekes funding was allocated to SMEs. The

share of funding targeted for SMEs has been increasing for the past 10 years. Although much of the support goes directly to the support of in-house R&D it is also typical that the support goes for collaborative projects between universities and SMEs or that an SME buys research services from HEIs or PROs.

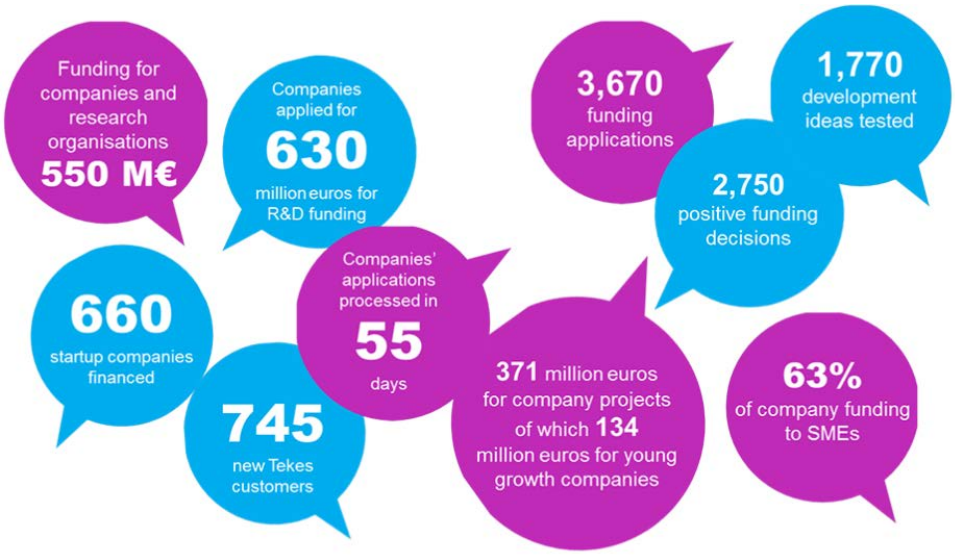

Figure 8. Tekes funding 2014 (Source: Tekes)

The **Finnish IPR strategy** was published in 2009 and it identifies four trends in the field of intellectual property rights (IPR): globalisation, digitalisation and convergence, politicisation of intellectual property rights, and expansion in scope. The strategy states that the operating environment for intellectual property rights should be improved especially in relation to competence, efficiency of rights, competition law and the functionality of the markets as well as efficiency of administration. Development of financial analysis related to IPR has also been discussed.

Public-private co-operation also takes place in various incubators activities (such as business development and networking services as well as programme and project co-operation) mainly maintained by various local and regional Science parks and Technology Centres. As opposed to some other countries the incubators have gathered their financing from various sources on project basis and **there has not been a centralised funding model for the incubators** although the regional ELY-centres (Centres for Economic Development, Transport and the Environment) are a key supporter of incubator activities. Some incubators were also co-financed by the European Social Fund. In the European Regional Development Fund (ERDF) -programmes one key policy line was to support for cooperation and networking of innovation actors and SMEs, the improvement of the availability and efficiency of innovation services, the development of business incubators, the development of special knowledge in areas, the development of activities that support R&D, the development of electronic advisory and customer service systems and the utilisation of applied research. The second main line of ERDF was dedicated for promoting innovation and networking, and strengthening competence structures.

4.2 Knowledge circulation between the universities, PROs and business sectors

According to the Community Innovation Survey (CIS) coordinated by Eurostat, in 2012 almost 30 per cent **of innovative companies in Finland collaborate with universities** and almost 25 per cent with research institutes. Obviously the main reason for this is the role of Tekes in Finnish innovation system. Besides being a public R&D financier, Tekes is also a network creator as it enables and encourages collaboration, especially between industry and research. The technology programmes are established in strategically important R&D areas that Tekes has identified jointly with the business sector and researcher community. Half of the Tekes funding is channelled through these programmes.

Since 1993, special programmes have been dedicated to supporting commercialisation of research and academic spin-offs. These **TULI (Research into Business) programmes** aimed at supporting commercialisation of publicly funded research results, developing commercialisation services in universities, polytechnics and research institutes, promoting cooperation between research organisations and companies, as well as creating viable businesses through startups, spin-offs and technology transfer. Projects funded by the programme were run by 40 universities, polytechnics and research institutes. In the 2008 -2013 period, the programme budget was approximately 50 million euros. During the 2008–2013 period, TULI funding was granted to 1,839 projects in universities and research institutes and 875 projects in universities of applied sciences. Over the same period of time, a total of 135 spin-off companies were created from university and research institute ideas and 52 from university of applied science ideas.

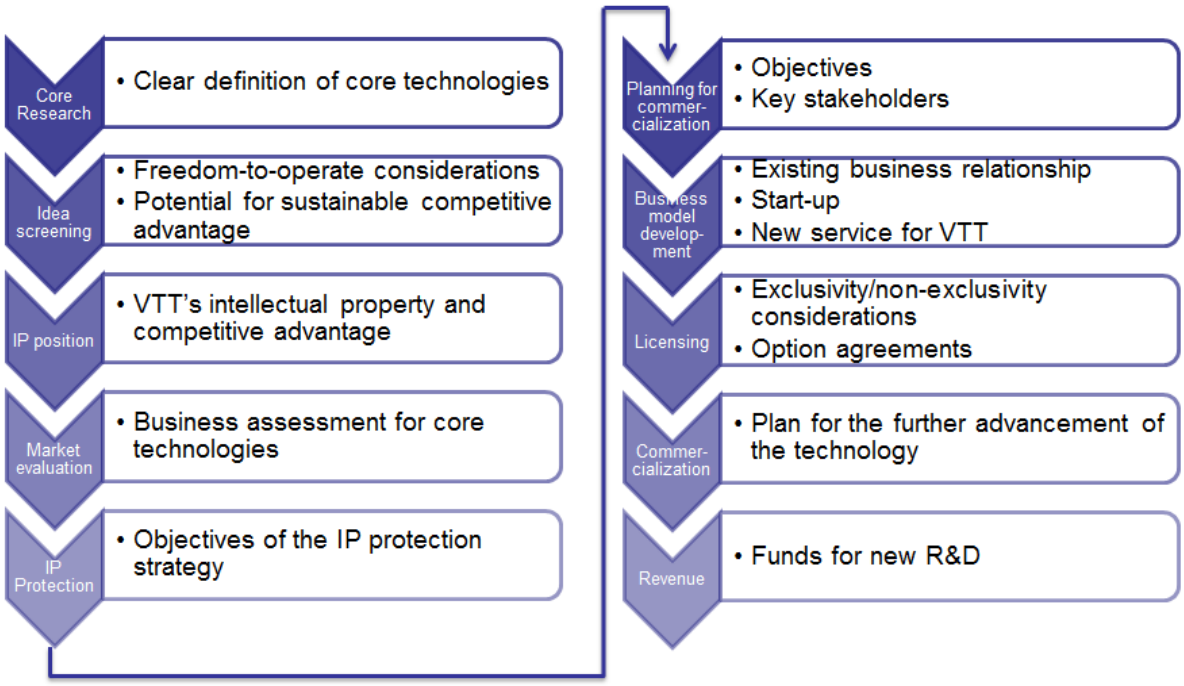

Figure 9. TULI process at VTT Technical Research Centre of Finland (Source: VTT)

The **operational model of the TULI programme** was based on localized implementation, formed from eight regional TULI centres. Local project managers searched for and identified ideas and inventions, organised the evaluation of their commercial potential and arranged consulting services to advance commercialisation for those which were approved as projects.

The role of the national coordination was to organise the activities of the network and produce useful tools for the project managers.

The **law on university inventions** entered into force on 1 January 2007. The Act aims to promote the identification, protection and recovery of inventions born in Finnish universities. The Act applies to inventions made by the staff of the universities. The Act also applies to the Academy of Finland's researchers working on universities. The Act divides research into open and contract research. The inventor is required to report a discovery, if it falls within the scope of the Act. If the university takes the right to the invention, the inventor is entitled to reasonable compensation. In contract research the university can take the right to the invention within six months of notification of the invention. The HEI can take right to the invention during contract period, even if the inventor announces willingness to exploit the invention.

Universities and research institutes have established limited companies for **licensing and commercialization of IPR**. For example VTT Ventures Ltd manages portfolio of VTT (Technical Research Centre of Finland) spin-offs. Companies based on VTT's technology are built on the most promising technologies of VTT. Spin-off companies utilize the results of VTT's research and development as well as VTT's IPR in their business. VTT is usually a minority shareholder in these startup companies and VTT staff, especially the inventors, can join the newly established companies. At the moment there exist 16 spin-off companies varying from the development of superconducting sensors and readout electronics to biomarkers and molecular lipid quantification.

5. Partnership models to encourage clustering and precompetitive research

5.1 Public-private knowledge transfer

The private sector is increasingly involved in the governance of Finnish HEIs. According to the new Universities Act, **external stakeholders will be afforded a much greater role in the university governance** but still a great minority of board members come from the private sector. The private sector has a substantial representation of the PROs also. In the biggest PRO in Finland, VTT, a majority of the board members are from the private sector. In other PROs the role of the private sector is smaller but nevertheless a notable one. Typical for the boards is that representatives of various stakeholders are present. These include universities, the responsible ministry, companies and key interest groups or associations relevant to the field.

In 2006, the Academy of Finland founded a programme supporting PhD mobility between the academia and private sector. A researcher could apply for a project that is accomplished outside home organisation by **moving from academia to a firm or vice versa**. When the programme was launched, it did not attract researchers' attention and half of the funding remained unused. This was an abnormal situation in the Finnish research funding system in which hard competition among applicants is a general rule. The instrument is currently run with a private funding from a number of organisations and foundations under the name PoDoCo, Post Docs in Companies. PoDoCo is a matchmaking programme supporting long term competitiveness and strategic renewal of companies and employment of young doctors in the private sector. Indeed, inter-sectoral mobility is increasingly typical in Finland.

5.2 Regional innovation strategies

In Finland, the **institutional role of the regions in the research and innovation policy used to be small** and most policy decisions were made at the national level. Regional concerns have an effect on the national policy in some respects, however. One mechanism is through Regional Councils that are appointed by the municipalities and are therefore politically representing the local governments. Planning for a region includes a strategic regional plan, a regional plan and a regional development programme and its implementation plan. A strategic regional plan is the basis for regional development. All the other plans and programmes regarding regional development, including implementing EU Structural Fund Programmes are derived from the three documents listed above. The regional actors together with the national government and HEIs have jointly contributed to the establishment of six regional university centres in several non-university towns. The university centres gather the operations of several universities in one location in these towns. One of the HEI reform's targets aims to clarify the division of labour between universities and polytechnics by further differentiating their profiles. Polytechnics should primarily serve the practical needs of regional enterprises.

Regional concerns have an effect on the national policy in some respects also. For instance, the Ministry of Education and Culture reconciled the objectives of the national research policy and the regional policy in a strategy document entitled "Regional strategy for accomplishing education and research policies until 2013". The targets of regional development have been

drawn up in special programmes, recently in Centre of Expertise Programme (OSKE) and currently in **INKA** (Innovative Cities) programme that was launched at the beginning of 2014. The **programme** encourages major urban areas in Finland **to choose strategic focus areas and generate competence-driven business** with the help of new kinds of development environments and lead markets. The aim is to use investments in development made by the state and the urban regions in order to generate openings that are based on international competence and also provide international visibility. Resources from structural funds from the period 2014–2020 are directed to comparable projects in innovation clusters. Major land use, housing and traffic infrastructure projects implemented in cities will be used as new types of development and testing environments for innovations. A region-specific negotiation procedure will be created for the most significant innovation clusters, with participation from national financiers, such as Tekes, the Ministry of Employment and the Economy and, where necessary, the Ministry of Education and Culture and other ministries. The growth agreement, also coordinated by the Ministry of Employment and the Economy, requires cities making choices in accordance with the Smart Specialisation Strategies of the European Union.

6. Cross-border institutions and arrangements

6.1 International scientific co-operation

The 2012 government action plan for research and innovation policy recognises that **Finland has not utilised the opportunities offered by European and other international research funding to a sufficient degree**: "Finnish researchers' knowledge of the application process, their objectives and activity with reference to the research programmes of the European Union are not at a sufficient level. Increasingly systematic utilisation of international research funding strengthens the preconditions for research and innovation activities and helps Finland develop its scientific expertise. A national programme to ensure the best possible utilisation of EU's research and innovation activities, such as the Horizon 2020 programme, is created as part of the efforts to promote the internationalisation of the research and innovation system. The national support and advisory service for the applicants of EU funding is renewed accordingly."

6.1.1 European research infrastructures

Finland has not had the funds for major investments in research infrastructures which have resulted in a **long tradition of utilising the infrastructures and experimental arrangements of other countries** (MEE & MEC 2009). The planning of the development of the national research infrastructures is aimed to accommodate to the European developments. Finnish memberships in European research infrastructures include:
European Organization for Nuclear Research CERN
European Molecular Biology Laboratory EMBL
European Space Agency ESA
European Southern Observatory ESO
European Synchrotron Radiation Facility ESRF.
There is no dedicated hard or soft law governing funding organisations' or research performers' participation in bilateral or multilateral research programmes. However, ministries, agencies have established their own practices and programmes that increasingly **allow cross-border access to research infrastructures.** Most recently also means for higher education institutions have been improved to allow cross-border access to research infrastructures.

The Finnish research infrastructures roadmap includes a total of 31 research infrastructures as well as two projects with potential to become significant infrastructures. The research infrastructures were selected in a two-stage international review using three main criteria: the project's significance to the Finnish scientific community as well as to the research strategy of the host organisations; the quality and scope of the potential user community; and the commitment by the participating organisations to the project. Most of the Finnish research infrastructures are associated with **European Strategy Forum on Research Infrastructures (ESFRI) roadmap** projects integrating the European dimension in the roadmap.

6.1.2 International knowledge circulation

In Finland, there are not any specific policies promoting international knowledge circulation, although **publications especially in international journals are increasingly encouraged**. In the university funding model, knowledge circulation and international research is included in the funding criteria. In this model, a total of 13% of the funding is based on publications of which

international, cited publications cover 10% and other scientific publications 3%. The model reflects somewhat the model used for instance in Denmark and Norway.

Finnish researcher mobility, however, has decreased steadily throughout the 2000s. Students' interest to undertake studies abroad has also declined. One reason behind this trend may have been the increasing competitiveness of the Finnish research system. On the other hand, the forms of international research activities have changed. Short-term visits and continuous cooperation through the internet may have reduced longer-term researcher mobility.

The Academy of Finland has expressed a **commitment to promoting the internationalisation of Finnish science and research**. The Academy provides funding for the Finnish Centres for Excellences (CoE) in order to support international cooperation in research. It has also been stated that the Academy will create strategic partnerships with foreign funding organisations in order to create opportunities for researchers to engage in joint projects as well as enhance the impact of international activities. In concrete terms, the Academy has established bilateral agreements with 26 countries and regions as well as with 42 foreign organisations. Although most of the agreements deal with mobility, there is also joint research activity. Discussions on international funding cooperation have resulted in an agreement with Chile, China, Denmark, Estonia, Germany, Iceland, Norway and Sweden.

Similar to the Academy, Tekes has **collaborative partnerships with several countries**, such as the USA, Japan, China and European countries. Important tools for international cooperation are centres in China, India, Japan, Russian and the USA. These belong to Team Finland network that promotes Finland and boosts Finnish enterprises abroad. The network brings together all services offered by state-funded actors which work for the internationalisation of Finnish enterprises, advance investment in Finland and promote Finland's country brand.

Tekes has also **developed the international dimension of its programmes**. Many of the programmes are open to foreign participants (although not typically funding) and international cooperation within research projects is actively encouraged. Truly open initiatives with open funding opportunities for foreign participants do not exist at the moment. Instead the joint innovation policy initiatives have been carried out by active participation in EU level instruments, such as ERANETs.

Furthermore, **foreign companies with R&D activities in Finland do not need to have a Finnish partner to be eligible for funding**. Tekes can finance R&D projects undertaken by foreign-owned companies registered in Finland. The funded project is however expected to contribute to the Finnish economy. Tekes funding for researchers becomes available for foreign researchers if they team up with a Finnish research group or a company to carry out internationally challenging research project. Tekes can fund the Finnish partner in joint projects.

6.2 Optimal transnational co-operation and competition

There is no overarching legislation governing Finland's participation in joint initiatives. Given that Finland is a relatively small country, **participating in cross-border joint initiatives has typically ranked high on the R&I agenda**. Consequently, Finland is well represented in the European research landscape, being a member of all major European research organisations (European Organisation for Nuclear Research, European Molecular Biology Laboratory, European

Space Agency, European Organisation for Astronomical Research in the Southern Hemisphere, European Synchrotron Radiation Facility).

Recent examples of international collaboration in research programmes include the international BONUS programme which was launched at the beginning of 2009. BONUS is funded by its members, the national research funding institutions in the eight EU member states around the Baltic Sea and the European Union's Seventh Programme for research, technological development and demonstration by a total of 100 million euros for the years 2011-2017.

Strong research alliances exist with other Nordic countries, expanding into the Baltic region. Recent developments in the research cooperation in the Nordic countries include the graduate schools and CoE Programmes. The programmes are funded by the Nordic Research Councils, the Nordic Council of Ministers and NordForsk. This Nordic support supplements the basic funding of the Nordic Centres of Excellence (NCoEs), which comes from national sources, among them the Academy of Finland. The Finnish participation has been active also in other instruments such as the ERA-NET schemes.

A specific organisation – **NordForsk** (established in 2005) - is a Nordic research board operating under the Nordic Council of Ministers for Education and Research and responsible for Nordic collaboration in research and research training. The objective of NordForsk is to support co-operation in the fields of scientific research and science policy.

6.3 An open labour market for researchers

Internationalisation of science has been a policy objective in Finland for quite some time, but so far the results of the policy measures have been modest. According to report on the state of scientific research in Finland 2014 only 14% of the researchers in Finnish universities were foreigners. The same report though notes that co-publishing with foreign researchers has increased considerably since 1990; during the years 2012-2013, 37% of scientific publications were co-published with foreign researchers. The share of foreign R&D-investment as a share of private R&D in Finland was 7% in 2010, which is low in international comparison (OECD, 2012).

The strategy for the Internationalisation of Higher Education Institutions in Finland 2009-2015 implements the principles of open, transparent and merit-based recruitment (MEC 2009a). Moreover, the steering of HEI s process and the 2012 agreement between national authorities and HEIs support the latter to prioritise and focus on improving research careers. Twelve Finnish organisations are actively engaged in the Commission's Human Resources Strategy for Researchers of which three have received the 'HR Excellence in Research' logo for their progress in implementing the Charter and Code. Also, soft law measures (e.g. Research and Innovation Policy Guidelines for 2011-2015 and the FiDiPro programme) further **contribute to the opening up of the recruitment system with a view to attracting foreign researchers**. Additionally Joint Degree Programmes have been initiated in Finnish universities to target foreign students aiming at Master's Degree level. So far the actions taken have not improved the situation and therefore other policies or measures should be considered.

Figure 10. FiDiPro provides competitive grants to projects recruiting highly merited scientists, who are able to commit to long-term cooperation with a Finnish university or research institute. Finnish universities and research institutes may propose FiDiPro Professors and FiDiPro Fellows from all disciplines. (Source: FiDiPro)

Noki and Kovanen have identified **several weaknesses in the Finnish research system for attracting researchers from abroad**. These include for example, limited career opportunities for researchers with few permanent positions and therefore a dependence on short term funding. The remuneration level also has been lower than in many other European countries (Ministry of Education and Culture 2008). In some studies it has been noted that often the families and especially spouses have had difficulties in getting a job. Additionally the administration has proved to be a challenge. Basically there are rules and practices to help foreign researchers to work in Finland but information is fragmented and there has not been a dedicated programme to facilitate the immigration of foreign experts. The private sector has also not been very keen to recruit foreign researchers except for the few international companies. The administrative limitations at the universities have also made it more difficult to compete internationally (such as salaries).

7. Public support mechanisms to stimulate innovation

7.1 Government direct and indirect R&D funding

In Finland government support to research and innovation has mainly been channelled through direct funding, whereas indirect funding measures have emerged in the recent policy formulations. Government indirect R&D funding includes tax incentives such as R&D tax credits, R&D allowances, reductions in R&D workers' wage taxes and social security contributions, and accelerated depreciation of R&D capital. Two **tax incentives** aimed at growth seeking businesses were introduced to the government budget in 2013.

The Tax Incentive for Private Investors targets business angels investing equity in SMEs. The incentive provides a possibility to postpone paying capital gains taxes as long as those gains are re-invested in qualifying businesses.
The R&D Tax Credit for SMEs is a deduction from corporate income taxes tied to the wage costs of R&D personnel in Finland.
Several **instruments supporting new R&D performing firms** have existed in Finland for some time. One of them is the R&D project funding of Tekes that consists of grants and loans and plays an important role in the policy-mix. In the projects Tekes is responsible for half of the funding. One relevant shift is the increased fraction of R&D-funding allocated to SHOKs. This increase mirrors the efforts of focusing national strengths and top know-how to some key areas that are hoped to be competitive in global networks.

Tekes has now reformed its strategies and instruments aimed at **better supporting new growth enterprises**. In particular, project funding for businesses, according to the new strategy, is channelled through different operating methods, which are:

- around 40% for customer initiatives based on demand;
- around 20% for research programmes of the Strategic Centres for; Science, Technology and Innovation (SHOK)
- around 25% to focus areas through Tekes programmes;
- around 15% to other strategic choices.

Alongside Tekes, the Growth Company Service of EnterpriseFinland provides **funding instruments to support SMEs**. Additionally Finnvera (a specialised financing company owned by the State of Finland), Finnish Industry Investment and regional ELY-centres (Centres for Economic Development, Transport and the Environment) all have instruments that support innovative startups. Most of these instruments are related to general funding support for businesses but in many cases these also target (innovative) startups.

Public sector financing support has also been directed towards **seed-financing and loans.** Finnvera, Sitra and Tekes represent public financing on equity terms. Tekes has a wide range of funding instruments to support innovation in businesses. It provides for instance, funding for start- up businesses through the "Young Innovative Companies -programme". Innovation is one of the key criteria for funding, as the firms operations have to be based on an innovative business idea based on specific expertise or new technology. Another instrument launched by Tekes is the funding for the purchase of innovation services that aims at promoting business development of innovative SMEs.

The Ministry of Employment and the Economy has established a **Growth Enterprises group** within the Enterprise and Innovation Department, which bears responsibility for structuring, developing and implementing the growth enterprise policy, as part of the broad-based innovation and industrial policy. The emphasis on growth enterprises has led to the establishment of the VIGO accelerator programme designed to complement the Finnish innovation ecosystem by bridging gaps between early stage technology firms and international venture funding. Through VIGO, target enterprises can gain access to both private and public funding sources. The programme is coordinated by Tekes. Other notable incubators aimed at supporting growth enterprises are, for example, Startup Sauna, the Spinno Enterprise Center and the Aalto Startup Center. There are various innovation platforms and incubators in many towns and cities around the country. Demola in Tampere is perhaps one of the best known. Hämeenlinna's counterpart is called Konseptori.

Figure 11. The Vigo portfolio companies have raised more than 355 million euros by the end of 2014. Vigo-programme seeks to provide high quality internationally focused companies for investors by providing individual attention from the most experienced Finnish entrepreneurs. (Source: Vigo)

Aaltoes (**Aalto Entrepreneurship Society**) was founded in spring 2009 by a group of students, who saw that the entrepreneurial climate in Finnish universities did not support students or researchers who wanted to start companies and aim for international markets and high growth. At first, Aaltoes started bringing forth entrepreneurial role models to inspire and encourage students to become entrepreneurs, soon expanding to organizing pitching evenings, hackathons, workshops and other events, where students and researchers could experiment, look for co-founders and learn by doing. In late 2009, as Aalto University was starting to gain its form, Aaltoes made a pitch for a space for young entrepreneurs to work on their companies at, ultimately gaining premises and a budget from the University for a 1,500 square meter industry hall on the university's campus in Otaniemi, Espoo. The co-working space would later become known as Aalto Venture Garage, nowadays known as Startup Sauna. Aaltoes was one of the

main reasons for Aalto University to become the first official European partner of Stanford University's Technology Ventures Program (STVP) in 2011.

The Aaltoes' main pitching event Slush has grown from a 300-person event to become one of the leading events of its kind in the world. In November 2014, Slush brought together over 14,000 attendees and more than 3,500 companies for the two-day event. More than 750 investors came to Helsinki to meet startups in nearly 3,800 pre-booked meetings.

News, 4/30/2015

Slush in Tokyo

The largest Slush event organised outside of Finland, Slush Asia raised an enormous amount of interest and gathered 3 000 eager participants together in Tokyo on 24th of April. The main goal of the sold out event is to create a new kind of startup culture to Japan with strong ties to Finland.

The sunny weather in Tokyo resembled anything but the gray November weather of Helsinki, but otherwise Slush Asia, held on Friday 24th April, resembled a lot the main event held in the capital of Finland. Gorgeous lasers lit the tents, technology products of a possible future were on display and thousands of enthusiastic guests and volunteers created an atmosphere similar to a rock festival.

The artificial island of Odaiba in Tokyo gathered up to 3 000 eager participants to Slush Asia that is known to be Japan's biggest and most international startup event held in English. So far the largest Slush event outside of Finland raised an enormous amount of interest and all tickets were sold out well in advance.

Figure 12. The CEO of Slush Asia, Antti Sonninen, moved to Japan a couple years ago to open up Rovio's Tokyo office. According to his experience, Japanese startup events are usually commercial, invitational and carried out in Japanese only. Slush Asia aims to create a new kind of startup-culture that is based on open and international networks. (source. Team Finland)

The Nordic Growth Entrepreneurship Review 2012 reports that Finland nurtured 92 young growth enterprises in 2006–2009, whereas both Norway and Sweden were able to support over twice as many. The young growth company birth rate is 0.56% in Finland and 0.70% in Sweden. On the bright side, it seems that the Finnish growth enterprises grow faster and become larger than their Nordic peers. The same review also states that in the course of 2012–2013 Nokia, and to a lesser extent some other established businesses in the Finnish ICT sector, released some ten thousand highly skilled individuals to the local labour market (Nordic Innovation 2012). Nokia has been very active in supporting the entrepreneurial efforts of those that leave the company. Depending on the case, it may offer to pay the individual's wage in excess of one year, even if the work continues at a start- up. Additionally it may provide tens of thousands of euros per company in direct support and loan guarantees. It may donate or sell patents and other forms of intellectual property to startups with plans to exploit them. The Ministry of Employment and the Economy and other public organizations also have measures that are directly targeted at former Nokia employees. Those have helped employees start over 100 new companies with over 1,000 employees in Finland (an early presentation of Nokia Innovation Mill concept is here). Spinverse acquired the Innovation Mill concept from Technopolis in 2013.

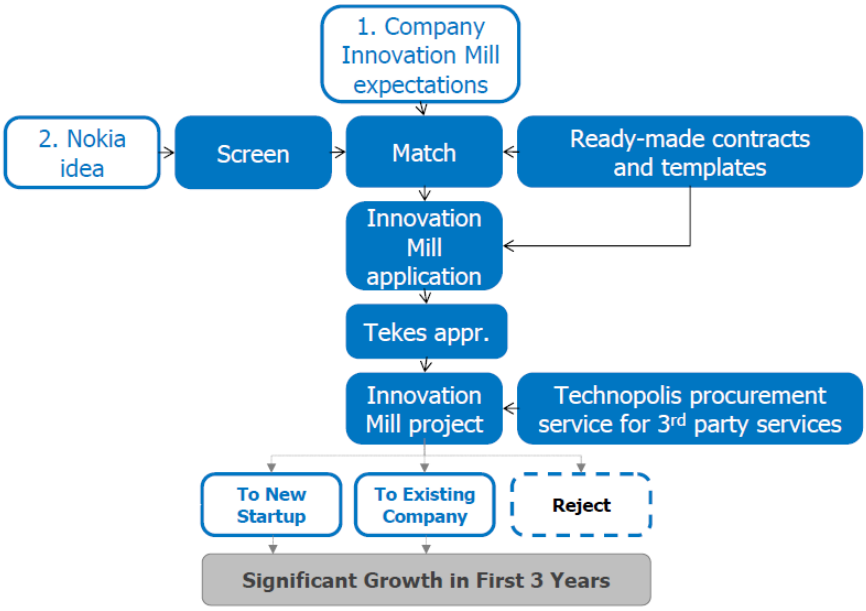

Figure 13. Innovation mill process to match Nokia IP with external business interest (Source: Technopolis)

7.2 Public procurement and enhanced public-private interaction

Prior to 2009 the role of innovation oriented public procurement was quite modest in Finland but the development of **public procurement in research and innovation policies is underway and high on the political agenda**. For instance the Research and Innovation Policy Guidelines for 2011–2015 places emphasis on public procurement by referring to it as one of the key tools of demand driven innovation policy. The development of public procurement is also one of the key themes in the action plan and policy framework for demand and user-driven innovation. The main key barriers in implementing demand-side policies in Finland are the small domestic markets and to some extent the dispersed local government sector. As a result, active participation of Finnish organisations to the EU Lead Market is seen as a very important

approach in the action plan by the MEE. On the other hand the small markets can possibly work as an efficient pilot market for global innovations.

One of the Tekes programmes also targets innovative public procurement. Its main aim is to encourage businesses to develop new innovations, renew public services, increase productivity, and to create new markets. An additional aim of the programme is to promote the use of public procurement as a tool for innovation policy as well as to develop good practices.

The Action plan for research and innovation policy discusses also possible new policy instruments related to innovation enhancing public procurements. The action plan refers also to the reform of the Act on Public Contracts, so that public procurements pay greater attention to innovation activity perspectives. A t**arget level is set to directing one per cent of public procurement towards purchasing of new solutions in the cleantech field**. The generation and diffusion of innovations is promoted by setting a target percentage (such as 2 or 3 per cent) for public procurement that enhances research, development and innovation activities. Expertise in procurement is enhanced by strengthening and developing comprehensive support and advisory services in matters of public procurement related to innovation. Financial and other incentives for procurement related to innovation are developed as part of the Effectiveness and Productivity Programme of central government and the productivity (Ministry of Employment and the Economy 2010).

The 2012 government action plan for research and innovation policy identifies the following action points in view of research and innovation information management.

The public data resources may function as a raw material for research and innovation much more effectively than has been the case so far.
The Ministry of Finance is about to launch an Open Data programme by which the public sector will expedite the opening and availability of data as concerns its own data resources.
The action plan further notice that effective utilisation of public sector data in innovation activities requires the expedition of application and service development projects implemented by businesses, the strengthening of research, education and training and advisory services concerning the opening and utilisation of the data as well as new support services that can be used, among other things, to strengthen the innovation activities of communities utilising the open data and the development of data resources to be implemented in cooperation between public authorities and users.

8. Summary

Finland's competitive position is facing challenges and its large export businesses have suffered. Considering its high level of R&D inputs, the country has a relatively low contribution of high-tech and medium-high-tech goods to the trade balance. Within the past few years, the decline of the important electronics (telecommunications) sector in particular has created pressure for structural change in Finland. The decline of this sector is reflected in a decrease in business R&D investments – dominated by Nokia. Consequently, as part of the Europe 2020 strategy, the Council recommended that Finland continues efforts to diversify its business structure, in particular by hastening the introduction of planned R&I measures to broaden the innovation base in order to strengthen productivity growth and external competitiveness. The **extent to which the business and public sectors will be capable of absorbing new innovations from the ICT sector – and more concretely the available highly-skilled human resources – is considered a determinant for new growth.**

The action plan for research and innovation policy presents four major themes where Finnish research and innovation policy needs to improve itself (MEC and MEE 2012):

(1) Increasing the attractiveness of Finland **and enhancing the internationalisation of the RDI system**: Given that Finland is a relatively small country, internationalisation and participating in cross-border joint initiatives (e.g. Team Finland centres, Nordforsk and Baltic research alliances) have typically ranked high on the R&I agenda. Increased collaboration and coordination of public agencies and opening up (e.g. foreign-established companies eligible for the Tekes funding, opening up of programmes and attracting international students and researchers, the FiDiPro-programme) and streamlining of instruments (e.g. revision of university funding model) provide more comprehensive support for internationalisation of R&I system.

(2) A research and innovation system with **better quality and more flexibility:** Structural reforms of funding agencies, research institutes and universities have advanced creating relevant mergers and further coordination that are expected to improve, together with more excellence driven funding models, the quality of scientific research. The measures include the new University Act (2010); reforms of doctoral education and tenure track systems (starting 2010); University funding model (2013); structural development scheme for polytechnics (2014); reform of research institutes and research funding (2013); Strategic Centres for Science, Technology and Innovation (SHOKs) evaluation (2013); and evaluation of and broader role for the Academy of Finland (2013). However, diverging views exist of the benefits of the reforms.

(3) Increasing effectiveness by expanding the scope of innovation activities and increasing experimentation and (4) Greater value and new competitive advantages through intangible investments. Finland's innovation policy and measures in general are geared towards **speeding up the development, commercialisation and take-up of new technologies**. The focus of public RDI funding has been shifted to growth-oriented SMEs which, as it is hoped, will then create jobs and successfully establish international business. The measures include the Tekes programme for funding young, innovative companies, and more generally, the new Tekes strategy with emphasis on growth companies; renewal of Finnvera's export guarantees schemes; expansion of the Vigo Accelerator Programme; Tax Incentive for Private Investors investing

equity in SMEs; R&D Tax Credit for SMEs of the wage costs of R&D personnel. There was a special ICT 2015 working group that prepared a strategy to mitigate the effects of the sudden structural change.

In May 2015, a new Center Party -led government started its reign. In its strategic programme, the new government states that Finland's competitiveness is built on high expertise, sustainable development and open-minded innovations based on experimentation and digitalisation. The government will launch a reform programme to achieve the strategic objectives of the government term. By the end of 2**018, 1.6 billion euros will be invested on a one-off basis in key government projects and to reduce the repair debt**. Key government projects include reforming basic education with the aid of digital learning environments, a customer-oriented reform programme in child and family services, developing home care for the elderly, promoting the bioeconomy and clean solutions, reforming employment service activities, facilitating funding for SMEs, and promoting domestic and foreign investment.

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French Research and Innovation Landscape

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Abstract

The French research and innovation has overcome major changes in the last decades and is now rather complex. This report aims to explain in a simplified way how the French research and innovation system is organized as well as the last strategic changes which led to the last changes in practices of the French research and innovation landscape.

First of all, the report provides an overview of the French research and innovation system with the main actors involved in research and innovation functions (orientation, programming, executive research and evaluation). The French system involves many stakeholders. However, the last decades saw the emergence or the strengthening of the role of some key actors in the past decade:

- The government - via the French Ministry of National Education, Higher Education and Research (MENESR) - in the strategic steering (National research strategy / Investment for the future Programme (PIA));
- The French National Research Agency (ANR) and BPI France in the funding of research and innovation activities (on a project basis);
- The High Council for the Evaluation of Research and Higher Education (HCERES) as an independent evaluation bodies;
- Universities in the conduction of research activities.

Secondly, the report introduces the key last changes in the French research and innovation system since the end of the 1990s which aim to:

- Grant greater autonomy to universities, increase their role in research activities and make them more attractive at the national, European and international levels (Communities of Universities and Institutions) (2007 and 2013 Laws);
- Build regional clusters with universities and research organizations to increase cooperation among actors, share tools, knowledge and workforce and increase interactions with other local actors (industry, competitiveness cluster, etc.) (2013 Law);
- Implementation of an French national research strategy *(Stratégie Nationale de Recherche* -SNR) with a multiannual programming, consistent with the EU Framework Programme for Research and Innovation, H2020.

- Implementation of the Investment for the future Programme (*Plan d'Investissements d'Avenir* - PIA) (35 billion euros) which aims to be invested in higher education and research, industrial field and SMEs in priority thematic areas
- Define a plan for French Industrial recovery (*Nouvelle France Industrielle*) on priority sectors (set of actions to be undertaken and funds to be allocated)

Those last changes in the French science, technology and innovation strategy have led to major changes in practices of the French research and innovation landscape:

- The public research saw the increase of the competitive funding and project financing, the creation of Communities of Universities and Institutions (CUE) with higher international visibility. Coordination of research actors has been increased in 5 key fields (environment / Life sciences and health / Human and Social Sciences / Energy / Digital sciences and technology).
- New instruments were implemented to strengthen knowledge and technology transfer such as:
    - Carnot Institute all over the French territory to develop public-private partnerships
    - Competitiveness Clusters to bring together on the same geographical place companies, public and private research laboratories, higher education institutions to develop synergies around specific challenges.
    - Companies for the Acceleration of Technology Transfer (SATT) to federate the exploitation of public research outcomes at a local level
- A greater support to innovative companies with tax advantages (Crédit Impôt Recherche, CIR), the creation of a dedicated funding agency (BPI France) for innovation, creation of public incubators for innovative SMEs, etc.

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Quick guide to French Innovation System

	Name	Description	Link
Institutions	The Agency for Environment and Energy Management Agence de l'Environnement et de la Maîtrise de l'Energie	ADEME is a public agency, created in 1991, to support and fund partnerships aiming at protecting the environment and improving energy savings.	www.ademe.fr
	French National Research Agency Agence Nationale de la Recherche	Main funding agency for public research established in 2005 in order to finance research projects, based on competitive schemes through public/public and public/private partnerships. It covers basic research, applied research, innovation and technology transfer.	www.anr.fr
	Alternative Energies and Atomic Energy Commissariat à l'énergie atomique et aux énergies alternatives	The Alternative Energies and Atomic Energy Commission performs research in the fields of energy, technologies of information and health, defence and technologies.	www.cea.fr
	The National Center for Scientific Research Centre National de la Recherche Scientifique	CNRS is the largest research performing organisation in France and Europe. It operates in all disciplinary fields and is one of the 8 EPSTs in France. In addition it is a founding member of the 5 Alliances.	www.cnrs.fr
	High Council for the Evaluation of Research and Higher Education Haut Conseil de l'évaluation de la recherche et de l'enseignement supérieur	Organization in charge of research evaluation (research organizations, HEIs, foundations, funding agencies, research activities), which was created in 2013 and replaced AERES (Evaluation Agency for Research and Higher Education).	www.hceres.fr

National Institute for Agricultural Research Institut National de la Recherche Agronomique	INRA is one of the 8 EPSTs in France. It is responsible for the organization of agricultural research (sustainable production, diet & nutrition, food safety, ecology, regional development & landscape management).	www.inra.fr
National Institute for Health and Medical Research Institut National de la Santé et de la Recherche Médicale	INSERM is one of the 8 EPSTs in France. It conducts research on medical biology and health of populations. It is the only French public research organization dedicated to human health.	www.inserm.fr
French Ministry of National Education, Higher Education and Research Ministère de l'Education nationale, de l'Enseignement supérieur et de la Recherche	The research and innovation policy is led by the French Ministry of National Education, Higher Education and Research.	www.enseignementsup-recherche.gouv.fr/
Research and Higher Education Interministerial Mission Mission interministérielle Recherche et Enseignement supérieur	MIRES gathers all the funds devoted to the research and higher education expenses of MENESR, the Ministry of Economy, Industry and Digital Affairs, as well as of several other ministries. MENESR is the leading ministry within the MIRES and is responsible for implementing the agreed budget plan.	No website as it is under the authority of MENESR
Public Investment Bank Banque Publique d'Investissement	BPI France, previously OSEO, is the public investment bank created in 2012. It provides support for R&D and innovation projects to businesses, especially SMEs. BPI France aims to promote and support the industrial development & SMEs' growth through innovation and to promote technology transfer.	www.bpifrance.fr/

Strategic Research Council Conseil Stratégique de la Recherche	Council placed under the authority of the French Prime Minister and assisting the MENESR in R&I policies. It proposes the main orientations of the Strategic Agenda for Research, Transfer and Innovation, contributes to its monitoring and evaluation.	It is not really an institution but rather council gathering stakeholders from different institutions. Therefore it does not have a website
Ministry for Economy, Industry and Digital Affairs	This ministry plays a specific role in relation to private sector research and innovation and industrial research. Innovation policies are mainly under its responsibility, together with MENESR.	http://www.economie.gouv.fr/
Public Scientific & Technical Research Establishments Etablissements publics à caractère scientifique et technologique	There are 8 EPSTs (status of private law) in France, who are responsible for 33% of public research. They include: CNRS; INRA, INSERM, INRIA, IRD, IRSTEA, IFSTTAR, INED.	It is a legal status of an institution. CNRS is for instance an EPCST. No website
Public Research Bodies of an Industrial and Commercial Character Établissements publics à caractère industriel et commercial	There are 12 EPICs (status of public law) in France, who are responsible for 24% of public research activities. The most important are: CEA, CNES, IFPEN, BRGM; IFREMER, CIRAD, ONERA.	It is a legal status of an institution. CEA is for instance an EPIC. No website
The Alliances	The 5 Alliances created between 2009 and 2010 are key actors in the French R&D initiatives. They aim to strengthen the position of the French research worldwide through collaborative programming between the different actors, but also to enhance synergies between public research organizations, as well as with private and industrial partners in key sectors.	
AllEnvi	Environment (food/climate/water/territories)	http://www.allenvi.fr/

	ATHENA	Human and Social Sciences	http://www.allianceathena.fr/
	Aviesan	Life sciences and Health	http://www.aviesan.fr/
	ANCRE	Energy	http://www.allianceenergie.fr/
	ALLISTENE	Digital sciences and technology	https://www.allistene.fr/
	Institut Curie	Foundation of public interest, which combines one of the largest European oncology research centers and two state-of-the-art hospitals	http://curie.fr/
	Institut Pasteur	Foundation contributing to the prevention and treatment of infectious diseases through research, teaching and public health initiatives.	http://www.pasteur.fr/
	French National Institute of Intellectual Property Institut Nationale de la Propriété Intellectuelle		http://www.inpi.fr/fr/accueil.html
Policy Papers	The National Research Strategy Stratégie Nationale de recherche	As part of the 2013 Law on Higher Education and Research the 2014-2020 SNR replaced the SNRI. It shall be revised every 5 years. The SNR was determined by the Strategic Agenda for Research, Transfer and Innovation "France Europe 2020".	http://cache.media.enseignementsup-recherche.gouv.fr/file/Strategie_Recherche/26/9/strategie_nationale_recherche_397269.pdf
	National Research and Innovation Strategy	First French multi-annual RDI strategy launched in 2009 for a four-year period by a working group led by MENESR. Replaced by SNR in 2013.	https://www.google.de/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CCIQFjAAahUKEwivpdP-t-DIAhVIjSwKHc5iC0w&url=http%3A%2F%2Fwww.ambafrance-uk.org%2FIMG%2Fpdf_Rapport_general_de_la_SNRI_engl.pdf%3F3442%2F6770905a56e7b78fb876573e7c7efcfe638247da&usg=AFQjCNGRGiDxhbg4

			Xts8MC_UxjnR6m7LKg&bvm=bv.105841590,d.bGg
	Strategic Agenda for Research, Transfer and Innovation "France Europe 2020"	"France Europe 2020" shall prepare French research to tackle the great scientific, technological, economical and societal challenges of the future. It has been the framework for the SNR. Main objectives of the agenda include to establish national priorities, simplify the organization and restructure the evaluation and the indicators of research; to optimize coordination with European programs; to face the societal, scientific and technological challenges, and tackle the competitiveness challenges; to establish collectively priority axes for knowledge and technology progress and prepare their implementation	http://cache.media.enseignementsup-recherche.gouv.fr/file/France-Europe_2020/18/3/AgendaStategique02-07-2013-EnglishLight_262183.pdf
Laws	1999 Law on Innovation and Research LOI N° 99-587 du 12 juillet 1999 sur l'innovation et la recherche	This law created knowledge transfer units within universities, public incubators, measures to facilitate mobility of public research staff, etc.	www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000000759583&dateTexte=&categorieLien=id
	2007 Law on the Freedoms and Responsibilities of Universities LOI n° 2007-1199 du 10 août 2007 relative aux libertés et responsabilités des universités	This law sets the conditions for the universities autonomy to make universities more attractive, change their governance for better efficiency and give more visibility to universities' research.	www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000000824315&dateTexte=&categorieLien=id
	2013 Law on Higher Education and Research LOI n° 2013-660 du 22 juillet	The main objectives of this law included to motivate researchesr to tackle global challenges, to overcome research framentation, to increase the qualiffication of studetns and to reinforce the opening of the French	www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000027735009

	2013 relative à l'enseignement supérieur et à la recherche	higher edcuation and research system to international partnerhsips. These goals should be implemented with the help of site strategies and a national research strategy. In addition the law included a provision whereby Communities of Universities and Institutions (CUEs) were created.	
Programmes / Projects	Investments for the Future Programme Plan d'investissements d'avenir	Following the implementation of the SNRI in 2009, the government implemented PIA with about 35 billion euros to be invested in higher education and research, industrial field and SMEs as well as in sustainable development and digital technology over 10 years (2010-2020). These targeted investments are unprecedented in France and aim at improving the French capacity to compete in a world of knowledge-based economy. Several programmes were set with different kind of funding (loan, equity, and subsidies) and with different approaches per thematic areas. The main operators involved are: ANR, BPI France, ADEME and the Deposits and Consignments Fund. A second programme (PIA2) was launchend in 2013 and mainly aims at increasing comeptitiveness and ecological transition.	http://www.enseignementsup-recherche.gouv.fr/pid24578/investissements-d-avenir.html
	R&D tax credit crédit d'impôt recherche	The CIR is the most significant public instrument to stimulate private research. It is an indirect funding, supporting research development and enterprises innovation in all fields, for industrial, commercial, agricultural and textile firms, as well as SMEs.	http://www.enseignementsup-recherche.gouv.fr/cid87439/guide-credit-impot-recherche-2015.html
	Companies for the Acceleration of Technology Transfer	SATTs belong to PIA. SATTs aim to federate the exploitation of public research outcomes of higher education institutions and public research organisations at a local level. Located at the crossroads of the world of research and business, SATT are new players which aim to increase the efficiency of the French system of research exploitation,	www.satt.fr/wordpress/que-sont-les-satt/

	including accelerating the transfer to and use by industry.	
Technological Research Institutes Institut de recherche technologique	Part of PIA with the overall objective of reinforcing the landscapes created by competitiveness clusters with public – private strategic partnership in research, training and innovation.	http://competitivite.gouv.fr/les-investissements-d-avenir-une-opportunite-pour-les-poles-de-competitivite/les-instituts-de-recherche-technologique-irt-campus-d-innovation-654.html
Institutes for Energy Transition Instituts pour la transition énergétique	Part of PIA with the overall objective of reinforcing the landscapes created by competitiveness clusters with public – private strategic partnership in research, training and innovation.	http://competitivite.gouv.fr/les-investissements-d-avenir-une-opportunite-pour-les-poles-de-competitivite/les-instituts-pour-la-transition-energetique-ite-660.html
Mixed Research Units Unités Mixtes de Recherche	Research units consisting of members of higher education instititions and public research organizations.	
Nouvelle France Industrielle	Nouvelle France Industrielle is a plan for French industrial recovery, announced by the French government 2013.	www.economie.gouv.fr/presentation-nouvelle-france-industrielle
Deposits and Consignments Fund Caisse des dépôts et consignations		http://www.caissedesdepots.fr/
Strategic Equipment	This programme aims to support large-scale scientific infrastructures and mid-size equipment (from 1 to 20 million euros). 88 projects were selected in all fields of research.	
Laboratories of Excellence	The Strategic laboratories have been created to select research teams of excellence and strengthen their role and their international visibility to	http://www.labex-whoami.org/en/who-am-i/laboratory-of-

	compete with international research counterparts, attract internationally recognised scientists and perform high level research and education programmes. A total of 171 strategic lab projects have been selected.	excellence
Excellence Inititaives Initiative d'excellence	The National Investment Plan has brought together research and higher education public organizations, in order to create 8 multidisciplinary campuses of excellence to be flagships for the entire French research and education system.	http://www.agence-nationale-recherche.fr/investissements-d-avenir/appels-a-projets/2014/initiatives-dexcellence-idex-initiatives-science-innovation-territoires-economie-i-site/
National Competition to support the Creation of Innovative Technological SMEs	The National Competition to support the Creation of Innovative Technological SMEs detects and supports projects to create innovative technology SMEs in all sectors.	
Young innovative companies Jeunes entreprises innovantes	JEI is a status created in 2004. Young companies classified as JEIs receive help doing research and development, with exemptions on taxes and employer contribution (researchers, technicians, R&D project managers, IP specialists, personnel in charge of pre-competitive tests).	http://www.enseignementsup-recherche.gouv.fr/cid5738/le-statut-de-la-jeune-entreprise-innovante-jei.html
The industrial Contract for Training through Research	CIFRE is the French flagship instrument for encouraging knowledge and technology transfer. It was implemented in 1981 to promote mobility between public research laboratories and the socio-economic actors, to contribute to employ PhD candidates in enterprises. A CIFRE brings together three partners: an enterprise, a PhD candidate and a public laboratory.	http://www.anrt.asso.fr/fr/pdf/plaquette_cifre_complete_avril2009_GB.pdf
Carnot Institutes	Founded in 2006, the Carnot Label was designed to develop partnership-based research, meaning research efforts conducted by public laboratories in partnership with socio-economic stakeholders, primarily enterprises, to serve their needs. The	www.instituts-carnot.eu/

		Carnot Label is granted for a five-year renewable period to public research structures, Carnot institutes, which concurrently conduct upstream research capable of renewing their scientific and technological skills, along with an ambitious partnership research policy to the benefit of the socio-economic world.	
Clusters	competitiveness clusters	The competitiveness clusters bring together companies, public and private research laboratories, training centres and education institutions, to develop synergies and cooperation around specific thematic areas and encourage greater R&D investment by companies.	competitivite.gouv.fr/home-903.html
	Research and Higher Education Cluster Pôle de recherche et d'enseignement supérieur	The PRES were created in order to reshape the academic landscape and increase efficiency at a regional level. The clusters were also meant to raise the international profile and attractiveness of the French research and higher education system. From 2006-2012 26 PRES were created gathering around 60 universities and diverse HEIs. In 2013 the PRES have been replaced by CUEs.	http://www.enseignementsup-recherche.gouv.fr/pid25100/poles-de-recherche-et-d-enseignement-superieur.html
	Communities of Universities and Institutions	CUEs aim at bringing together all local players involved in higher education and research around a shared scientific priority statement. Replacing the PRES, 25 clusters should be established from which 20 are under the CUE instrument and 5 have association status.	http://www.cpu.fr/actualite/regroupements-universitaires-25-grands-ensembles-pour-viser-lexcellence/
	Genopole	Created in 1998, Genopole is France's leading bio cluster for biotechnologies and research in genomics and genetics which gathers 80 biotech companies and 19 academic research laboratories. They share facilities (21 shared-access technology platforms) at a single place in the south of Paris (Evry).	http://www.genopole.fr/?lang=en

	Sofia Antipolis	Founded in 1969, it is the biggest technology park (near Nice) in France and in Europe. This competitiveness cluster houses 1,414 enterprises, 5,000 students, 4,000 researchers from the public sectors and 30,000 employees (2008).	http://www.sophia-antipolis.org/

1. The research and innovation system in France1

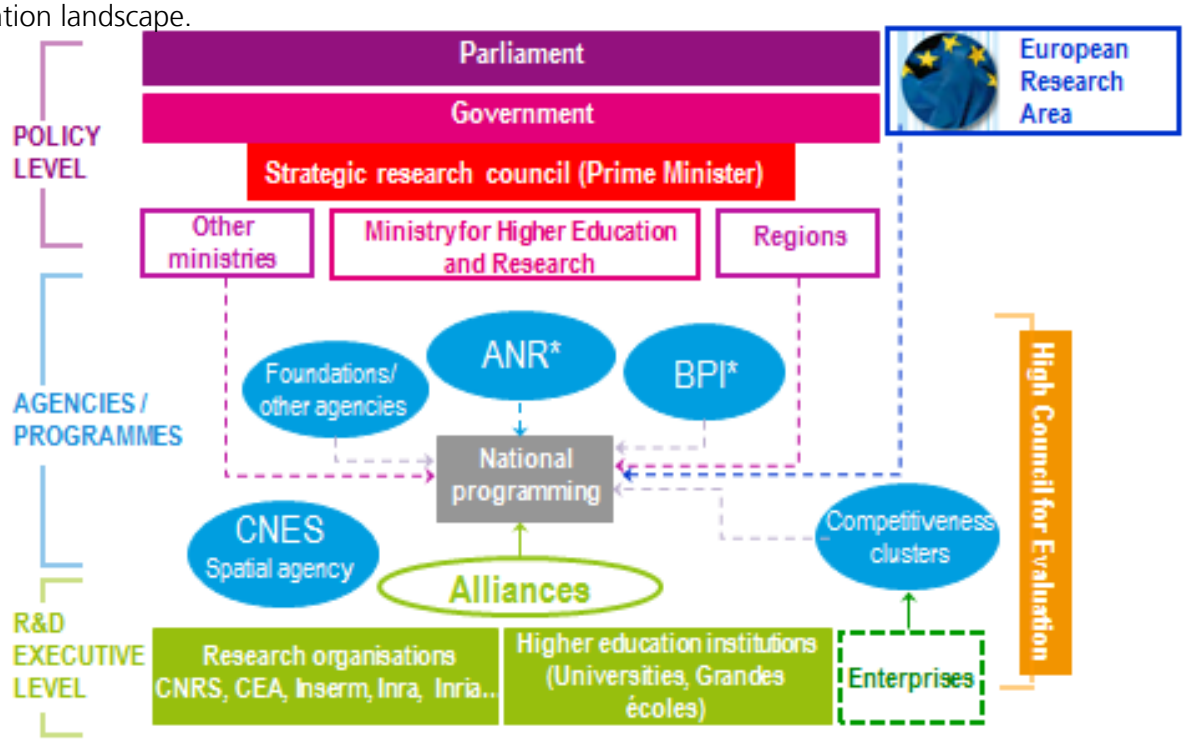
The research and innovation policy is led by the French Ministry of National Education, Higher Education and Research (MENESR). Activities are carried out either in higher education institutions and public research organisations, or within enterprises for private research. 412,000 people (full time equivalent) work within the research field in France (42% in public research organisations & 58% in enterprises) (MENESR, September 2014).

The French research and innovation system has undergone profound reforms during the last decade. The present chapter will give an overview on the French research and innovation system at present time while the following chapters will further develop on the last decades' changes of the research, knowledge & technology transfer and innovation landscapes on the policy and operational levels.

The French research and innovation system is organised around four main functions:

1.1 Orientation: definition of research and innovation policy, its general objectives and budget
1.2 Programming: formulation of thematic priorities by sector and allocation of resources
1.3 Executive research: conduction of research activities
1.4 Evaluation

The following figures (Figure 1 & 2) introduce the main actors involved in research and innovation activities and their interactions as well as some key facts on the French research and innovation landscape.



* ANR: French National Research Agency
* BPI: Public Investment Bank

Figure 1: The French research, higher education and innovation system (Source: MENESR-website, Système français de recherche)

[1] As of July 2014. There have been no major changes in the system since then.

A few figures

- France Gross domestic Expenditure on R&D (GERD) : 47.16 billion euros (2013)
- GERD (Gross Domestic Expenditure on R&D) to GDP (Gross Domestic Product) ratio: 2.2%
- France ranks 11th in the Innovation Union Scoreboard 2014
- 412,000 people participate in research activities in France (full time equivalent, 2014) (MENESR, 2014)
- 30% of women amongst French researchers (MENESR, 2014)

Figure 2: A few figures on the French research, higher education & innovation system

1.1 Orientation of the research and innovation policy

The French Ministry of National Education, Higher Education and Research (MENESR) is a key actor in the orientation of the research and innovation policy with the assistance of the **Strategic Research Council**.
The latter proposes the main orientations of the **Strategic Agenda for Research, Transfer and Innovation** (Chapter 2), contributes to its monitoring and evaluation. This council, placed under the authority of the French Prime Minister, is composed of French and international high level scientists and experts as well as policy makers and socio-economic major players.

The **Ministry for Economy, Industry and Digital Affairs** plays a specific role in relation to private sector research and innovation and industrial research. Innovation policies are mainly under its responsibility, together with the MENESR.

The Research and Higher Education Interministerial Mission (MIRES) gathers all the funds (26.06 billion euros in 2014) devoted to the research and higher education expenses of the MENESR, the Ministry of Economy, Industry and Digital Affairs, as well as of several other ministries (Defense, Culture and Communication, Ecology, Energy, Sustainable Development and Sea, Food and Agriculture and Fishing). The MENESR is the leading ministry within the MIRES and is responsible for implementing the agreed budget plan.

1.2 Programming

Funding agencies (the French National Research Agency (ANR), the Agency for Environment and Energy Management (ADEME) and the Public Investment Bank (BPI France)) together with the Alliances are the main actors which formulate the thematic priorities by sectors and allocate the financial resources.

1.2.1. Funding agencies

ANR – The French National Research Agency

ANR is a research funding organization, established in 2005 in order to finance research projects, based on competitive schemes through public/public and public/private partnerships. It covers basic research, applied research, innovation and technology transfer.

ANR actions aim to foster the emergence of young talents, to target new fields of research to be more explored, develop public-private partnerships and to ease international cooperation with French teams. Different kinds of instruments have been implemented to meet these objectives:

instruments targeting individuals, instruments targeting cooperative research and instruments fostering the development of new projects.

ANR is also the central organization in the implementation of the Investments for the Future Programme (See Chapter 2).

The following figure (Figure 3) presents the main aspects of ANR's funding since its creation.

A few figures

- ANR budget (2013): 656 M€
  - Budget dedicate to the funding of research projects: 432.5 M€
  - Between 318,000 & 888,000 euros are granted to the selected projects
- More than 12,000 projects have been funded since ANR creation in 2005
- 20% of the funded projects are collaborative projects associating teams from the public and private sectors (2013)
- 1,040 international projects were co-financed by ANR between 2006 and 2013 within the framework of bilateral and multilateral agreements for a global amount of 300 M€

Figure 3: A few figures about ANR (ANR Annual Report 2013)

ADEME – The Agency for Environment and Energy Management

ADEME is a public agency, created in 1991, to support and fund partnerships aiming at protecting the environment and improving energy savings.
ADEME supports and funds partnerships in the following main fields:

- Waste management,
- Polluted soils,
- Energy and climate,
- Air and noise,
- Transversal actions (sustainable territories and cities, international actions).

A few figures

- ADEME budget (2013): 570M€
  - 373.5 M€ dedicated to investments and functioning grants
- 19 ongoing international cooperation agreements
- 55 new thesis projects

Figure 4: A few figures about ADEME (ADEME Annual Report 2013)

BPI France (Public Investment Bank)

BPI France, previously OSEO, is the public investment bank created on December 31st, 2012. It provides support for R&D and innovation projects to businesses, especially SMEs. BPI France aims to promote and support the industrial development & SMEs' growth through innovation. BPI France also aims to promote technology transfer.

A few figures

- 21 B€ endowment in 2013
  - 747 M€ to support innovation (funding & loans)
- 3,650 innovative projects funded
- 1,680 projects including international development funded
- 78,400 companies have directly benefited from guarantees, loans, and/or equity
- 17,400 companies supported by co-financing their investments alongside with banks

Figure 5: A few figures about BPI France (BPI France Annual Report 2013)

1.2.2 Alliances

The Alliances are key actors in the programming. They aim to strengthen the position of the French research worldwide, in each area, through collaborative programming between the different actors, but also to enhance synergies between public research organizations, as well as with private and industrial partners in key sectors such as energy, social sciences or life sciences.

The 5 Alliances contribute to the elaboration of the National Research Strategy and thematic roadmaps, coordinate and design R&D initiatives for cooperation and partnership in accordance with the national strategy. In addition, the Alliances support the coordination of public research efforts at the European and international level.

The National Center for Scientific Research (CNRS), the largest research performing organisation in France and Europe, is a founding member of the 5 Alliances created between April 2009 and June 2010.

Name	Field of research	Date of creation	Website
Aviesan	Life sciences & health	April 2009	http://www.aviesan.fr/
ANCRE	Energy	July 2009	http://www.allianceenergie.fr/
ALLISTENE	Digital sciences and technologies	December 2009	https://www.allistene.fr/
AllEnvi	Environment	February 2010	http://www.allenvi.fr/
ATHENA	Humanities & Social Sciences	June 2010	http://www.allianceathena.fr/

1.2.3 How is research funded?

Public research

Public research is mainly funded under two main mechanisms:

- ***Institutional funding:*** the **higher education institutions** and **public research organisations (PROs)** receive an allowance which they should manage. This budget can be a lump sum or can depend on results.
- ***Competitive funding (on project basis):*** each project is evaluated by the specific funding agency, which will decide whether the funding will be granted and on which amount. In most of the cases, the selection is done via a call for proposals. Project funding is however quite limited: 12% for higher education institutions and 10% for the PROs (ANRT-FutuRIS, 2012). The main funding agency in France for public research is **ANR**.
  PROs and higher education institutions also benefit from grants from French regions, charity societies, industries and the European Union (H2020).

Private research

Private research is mainly funded by **enterprises'** own resources. Business expenditures on R&D (BERD) in France have steadily increased since 2003 and reached 30.1 billion euros in 2012 (MENESR, 2015).

Private research is also stimulated by public funding via two main kinds of instruments:

- ***Direct funding (grants):*** the French **government** and **BPI France** are the main actors of direct funding (endowment from the government and competitive funding from BPI France) in targeted fields.
- ***Indirect/Fiscal funding:*** The most significant public instrument (fiscal funding) is the **R&D tax credit** (*CIR*), with a particular increase from 2004 onwards. Almost 20,000 enterprises benefited from the CIR in 2011 (CIR, Rapport Développement et impact du

crédit d'impôt recherche 1983-2011). The CIR represents between 5 and 6 billion euros per year. CIR is an indirect funding, supporting research development and enterprises innovation in all fields, for industrial, commercial, agricultural and textile firms, as well as SMEs.

The following figures (Figure 6 & 7) sum up the different kinds of funding and the main funders.

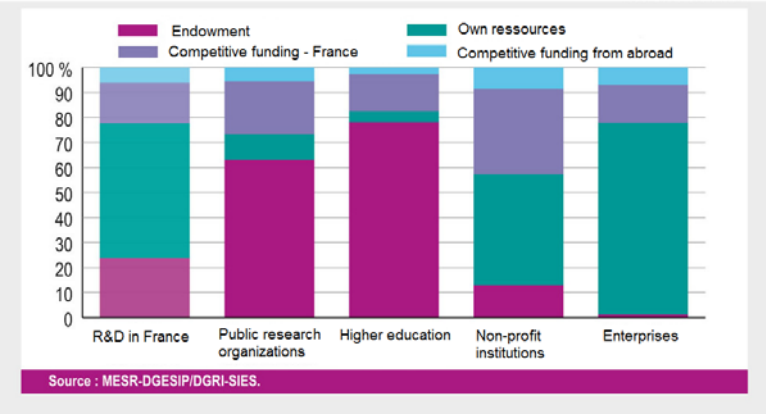


Figure 6: Origin of the resources for R&D expenditures by sector of performances (Source: MENESR)

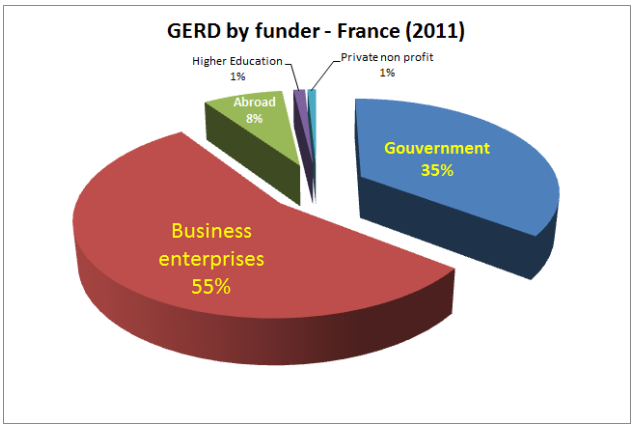


Figure 7: GERD by funder – Source: Erawatch France Page, Funding Flow

1.3 Executive research: where are research activities conducted?

Research activities take place within the public sector (36%), mainly higher education institutions and public research organizations and within private enterprises (64%).

1.3.1 Public research activities

Public research activities are implemented under the authority of the MENESR. Public research is conducted by public research organizations (57%), higher education institutions (39%), associations (3%) and other organizations such as ministries (1%). (MENESR, 2014)

Higher education institutions

The French higher education system is rather complex and higher education institutions have a great variety of status despite attempts of simplification (see Chapter 2 and 3). The system is composed of the following types of organizations: **public universities, "*grandes écoles*"** - selection of the students before admission via "concours" (yearly competitions), **higher engineering school & private higher education**.

Efforts have been made to reinforce the coordination between universities. 25 **Communities of Universities and Institutions (CUE)** have therefore been created to coordinate the institutions' efforts (see chapter 3).

There were about 2,387,000 students in higher education in 2012 (including the overseas departments) and the total number of researchers working in HEIs was of 52,270 (MENESR: L'état de la recherche et de l'enseignement supérieur en France (2014)).

A large part of the research in higher education institutions (grandes ecoles and universities)[2] is shared with public research organizations (PROs) with more than 3,000 teams: **Mixed Research Units** – *(UMR).*

Public Research Organizations (PROs)

About 30 research organizations develop either multidisciplinary or targeted research, as shows the non-exhaustive list below. Two foundations, the Pasteur and Curie Institutes, can also be added to the list[3]. These research organizations also contribute to policy implementation. 70,000 people work in PROs; half of them work at CNRS and 1/5 at CEA.

Eight **Public Scientific & Technical Research establishments** (EPSTs) exist in France, implementing 33% of public research:

CNRS – The National Centre for Scientific Research operates in all disciplinary fields.

INRA – The National Institute for Agricultural Research is dedicated to the organization of agricultural research (sustainable production, diet & nutrition, food safety, ecology, regional development & landscape management).

INSERM – The National Institute for Health and Medical Research conducts research on medical biology and health of populations. This is the only French public research organization dedicated to human health.

INRIA – The National Institute for Research in Computer Science & Control is dedicated to fundamental and applied research in information and communication science and technology.

IRD – The Institute of Research for Development conducts interdisciplinary research with a focus on the development of southern countries.

IRSTEA – The National Research Institute of Science and Technology for Environment and Agriculture leads scientific and technological research in the areas of developing sustainable land management, especially agricultural and natural land, and their resources.

IFSTTAR – The French institute of science and technology for transport, spatial planning, development and networks.

INED – The French institute of demographic studies.

12 French **public research bodies of an industrial and commercial character** (EPICs) implement 24% of the public research activities. The main EPICs are as followed:

CEA – The Alternative Energies and Atomic Energy Commission performs research in the fields of energy, technologies of information and health, defense and technologies.

CNES – The French Space Agency is responsible for shaping and implementing France's space policy in Europe.

IFPEN – IFP New Energy is public-sector research, innovation and training centre active in the fields of energy, transport and the environment.

[2] The full list of HEI is available here : http://www.enseignementsup-recherche.gouv.fr/cid49705/etablissements-enseignement-superieur-recherche.html

[3] For further information on main research organizations: http://www.enseignementsup-recherche.gouv.fr/pid24575-cid49677/principaux-etablissements-publics-de-recherche-et-d-enseignement-superieur.html

BRGM – The Bureau of Geological and Mining Research is the leading public institution in Earth science application.

IFREMER – The French Research Institute for Exploration of the Sea contributes to the development of the knowledge of oceans and their resources, monitoring of marine and coastal environments.

CIRAD – The Agricultural Research Centre for International Development works with developing countries to tackle international agricultural and development issues.

ONERA – The Aeronautics and Space Research Center is the French aeronautics, space and defence research laboratory.

Foundations:

Institut Curie – Foundation of public interest, which combines one of the largest European oncology research centres and two state-of-the-art hospitals.

Institut Pasteur – Foundation contributing to the prevention and treatment of infectious diseases through research, teaching and public health initiatives.

1.3.2 Private enterprises

Enterprises employed 148,300 researchers in 2011. Six main sectors concentrate half of the R&D potential in France: automotive industry (16%), pharmaceutical industry(11%), manufacture of aircraft and spacecraft (10%), IT activities and information services (6%) and chemical industry (5(MENESR, 2014)

In the 2013 ranking published by the IPO, private enterprises are the entities which own most of the patents; the first French company being Alcatel Lucent (61th - 648 patents issued in 2013), followed by Thomson Licensing (Technicolor) (102th - 367 patents), CEA (114th - 309 patents), Sanofi Aventis (137th - 238 patents) and Thales (144th – 226 patents) (IPO: Top 300 Organizations Granted; U.S. Patents in 2013).

Of the 20 entities that filed most of the patents (2013) at the **French National Institute of Intellectual Property (INPI)**, are included mainly large French industrial groups (PSA Peugeot-Citroën, Safran Group, Renault, Valeo , L'Oréal) but also three research organizations (CEA, CNRS and IFPEN). The first depositors remain the automotive companies, followed by the main industrial sectors: cosmetics, aerospace, telecommunications, electronics, chemistry and energy, highlights the INPI (2015 statistics).

The interactions with public research institutions have been increasing over the last decades. Those changes will be later described in Chapter 3.

1.4 Evaluation

The High Council for the Evaluation of Research and Higher Education (HCERES) is the organization in charge of research evaluation. This institution was created by the 2013 Law on Higher Education and Research, therefore replacing the AERES, Evaluation Agency for Research and Higher Education.

The latter was created in 2007 in order to evaluate the research system independently, in conformity with the international standards. Its objective was to enlighten decisions and improve the system's global performance, giving to research professionals, ministries and funding agencies data of quality, with objectivity and transparency.

AERES evaluated:

- Research organizations
- Higher education institutions
- Scientific cooperation foundations, as well as funding agencies (ANR),
- Research activities
- Higher education trainings and diploma.

HCERES share the same characteristics as AERES, but with more flexible evaluation criteria.

2. The key latest changes in the French STI Strategy

Since the end of the 1990s, successive reforms have been directed towards a new distribution of tasks between different actors:

- The Government provides strategic guidelines – the **National Research Strategy** (SNR) & the **Investments for the Future Programme** (PIA);
- The **French National Research agency** (ANR) and the **Public Investment Bank** (BPI France) for project funding;
- The **High Council for the Evaluation of Research and Higher Education** (HCERES) as an independent evaluation body;
- **Universities** with a greater role in the conduction of research activities.

The main strategic changes introduced by the successive government in the last decade will be described in the present Chapter.

2.1 The 2007 Law on the Freedoms and Responsibilities of Universities

This law sets the conditions for the universities autonomy with several goals:

- Make universities more attractive at the national, European and international levels;
- Change the governance for better efficiency;
- Give more visibility worldwide to universities' research.

This new legislation therefore aims to grant three kinds of autonomy:

- **Administrative autonomy:** the university is led by a President, elected among researchers, lecturers or professors;
- **Financial autonomy:** the university received an endowment from the State to perform its tasks (financial resources, human resources management, etc.);
- **Pedagogical and scientific autonomy:** the university decides the programmes, the content, methods and teaching equipment with respect to the national framework.

The universities have been encouraged to form clusters with other higher education and research institutions to pool resources, offer joint programmes and collaborate in research (See 3.1.2).

2.2 The 2013 Law on Higher Education and Research

The four main objectives were to:

- Give a new ambition for research in order to tackle global economic and social challenges and to develop technology research and transfer;
- Overcome research fragmentation;
- Increase the qualification of students to facilitate their integration into a job position;
- Reinforce the opening of the French higher education and research system to European and international partnerships.

This is to be implemented through:

- A Regional approach with a **site strategy** which builds local academic clusters with universities and research organizations at the regional level to :
    - Define joint research and innovation strategy;
    - Increase cooperation among actors;
    - Share tools, knowledge and workforce;
    - Increase interaction with regions, local industry and competitiveness clusters.

- Definition of a national research strategy with a multiannual programming, developed and revised every 5 years.

The 2013 Law on Higher Education and Research included a provision whereby **Communities of Universities and Institutions (CUEs)** were created.
The CUEs' governance consists of a board of directors, an academic council and board members. Based on a shared project, the higher education institutions and the research organizations coordinate their training offer and their research and technology transfer strategy. A single contract per site is to be signed with the Minister. This shall greatly simplify implementation

2.3 The French National Research Strategy

France launched its first multi-annual national RDI strategy in 2009, called the **National Research and Innovation Strategy** (SNRI), elaborated by working groups led by the MENESR. The SNRI was established for a four-year period (2009-2013), involving various stakeholders communities (research, business and civil society).

The SNRI has been replaced by the **National Research Strategy** (SNR), included in the 2013 Law on Higher Education and Research. The SNR will be defined and revised every 5 years.

The SNR is elaborated by the Strategic Research Council via its operational body, the Operational Committee composed of:

- The ministries dealing with research activities (defense, industry, health, agriculture, and foreign affairs)
- The main interdepartmental structures
- The Alliances, ANR, CNRS, CEA, clusters, associations, enterprises, etc.

The framework for the new SNR (2014-2020) was determined by **the Strategic Agenda for Research, Transfer and Innovation** "France Europe 2020"), launched on May 21st 2013, for a three-year period.It has been designed in coherence with the EU Framework Programme for Research and Innovation H2020.

2.3.1 "France Europe 2020": the framework for the new SNR (2014-2020)

"**France Europe 2020**", the Strategic Agenda for Research, Transfer and Innovation, aims to prepare French research to tackle the great scientific, technological, economical and societal challenges of the future.

The main objectives of the strategic Agenda "France Europe 2020" are to:

- Establish national priorities, simplify the organization, restructure the evaluation and the indicators of research;
- Optimize coordination with European programs, thanks to an increased coherence and a better involvement;
- Face the societal, scientific and technological challenges, and tackle the competitiveness challenges;
- Establish collectively priority axes for knowledge and technology progress and prepare their implementation.

The 9 proposals for the Agenda "France Europe 2020" are the followings:

- Mobilize actors on major societal challenges in coherence with the Horizon 2020 societal challenges:
    - Sustainable resources management and adaptation to climate change
    - Secure, clean and efficient energy
    - Industrial leadership
    - Health and wellbeing
    - Food security and demographic challenges
    - Mobility and sustainable urban systems
    - Information and communication society
    - Inclusive, innovative and adaptive societies
    - Space ambition for Europe
    - Freedom and Security for Europe, its citizens and inhabitants;
- Reinforce coordination of the French research system;
- Promote technological research;
- Develop digital trainings and infrastructures;
- Foster innovation and technological transfer;
- Increase dissemination of the scientific culture;
- Develop research programme along strategic priorities;
- Strengthen regional coordination through "site policy";
- Increase French research presence at the European and international level.

2.3.2 The implementation of the SNR

2 main instruments will frame the implementation of the SNR:

- Multiannual contracts between the State and HEIs and PROs. A certain amount is granted to these organizations for the multiannual period;
- Annual work plan of the funding agencies' programming, including ANR and all other kinds of public research funding.

The following figure (Figure 8) recalls how the National Strategy of research is implemented.

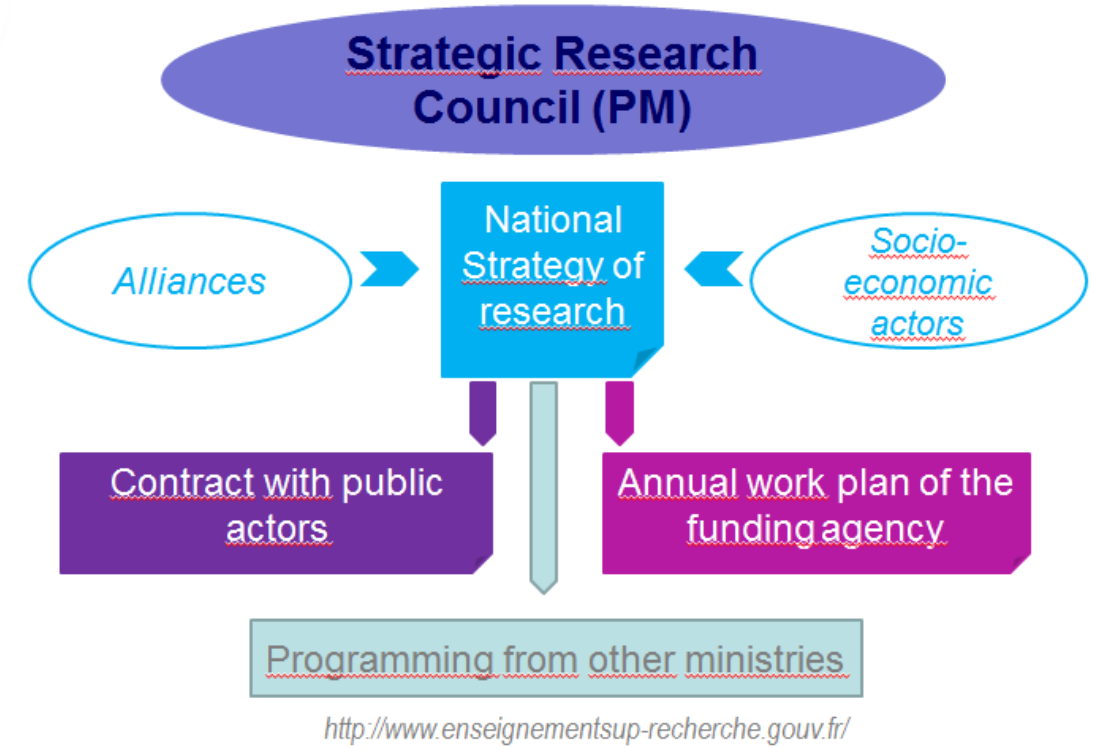


Figure 8: Implementation of the French National Research Strategy (Source: http://www.enseignementsup-recherche.gouv.fr/)

2.4 Investments for the future Programme

Following the implementation of the SNRI in 2009, the government announced in June 2010 the implementation of a "Investments for the future Programme" (PIA) with about **35 billion euros** to be invested in higher education and research, industrial field and SMEs as well as in sustainable development and digital technology over 10 years (2010-2020):

- Research (7.1 B€)
- Higher education (11 B€)
- Digital technology (4.5 B€)
- Sustainable development (5.1 B€)
- Industrial field and SMEs (6.5 B€).

In each of these fields, several programmes were set with different kind of funding (loan, equity, and subsidies) and with different approaches per thematic areas. The main operators involved in the distribution of funds are: **ANR**, **BPI France**, **ADEME** and the **Deposits and Consignments Fund** (Caisse des dépôts et consignations).

The funding is part of an economic stimulus package over 10 years – the "Big loan" (*Grand Emprunt*), launched in 2009 which was renamed **Investments for the future**. These targeted investments are unprecedented in France and they aim at improving the French capacity to compete in a world of knowledge-based economy. They seek to restore industrial competitiveness through investment in innovative and industrial projects, and financial support for institutional reform of the French national innovation system.

17.9 B€ were made available through competitive calls from 2010 to 2012 (to select (see ANR):

- strategic equipment (Equipex)
- laboratories of excellence (Labex)
- health and biotechnology innovative projects (including University-Hospital Institutes – IHU, pre-industrial demonstrators, cohorts, national infrastructures, bio information technologies, Nano biotechnologies…)
- technology Transfer Acceleration companies (SATT)
- institutes of excellence in the field of carbon-free energies (IEED)
- technological research institutes (IRT)
- training and learning innovative projects (IDEFI)
- excellence initiatives (IDEX).

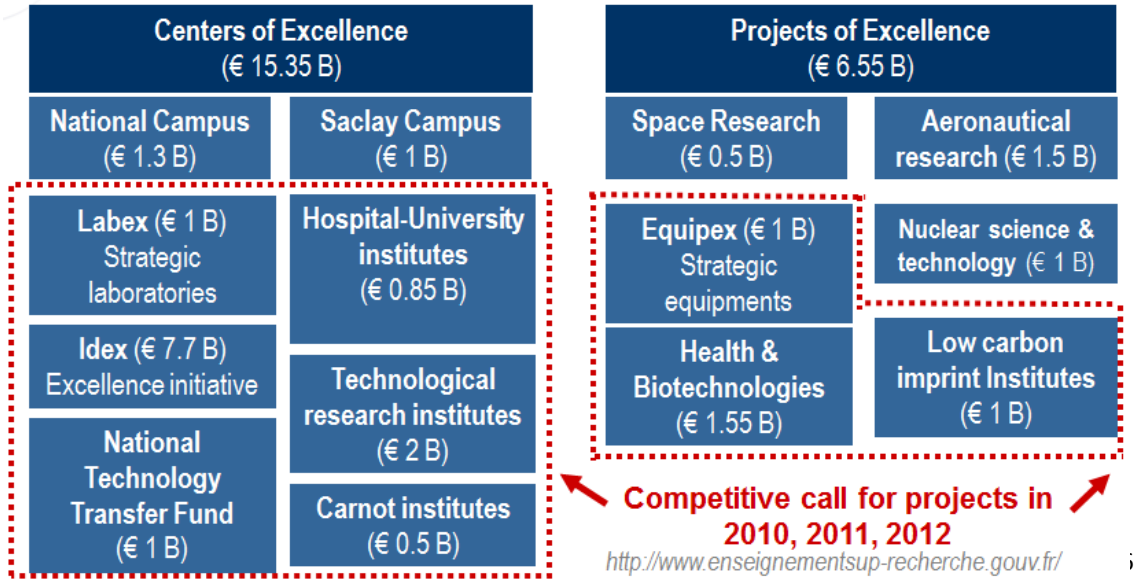


Figure 9: Investments for the future Programme (PIA1) (Source: http://www.enseignementsup-recherche.gouv.fr/)

A second programme (PIA2) of 12 B€ was announced by the French Prime Minister on July 9th 2013, which is distributed as follows:

- Universities and research: 3.65 B€
- Energy transition: 2.3 B€
- Industry innovation: 1.7 B€
- Technology innovation for defense industry: 1.5 B€
- Aeronautics and space: 1.3 B€
- Digital economy: 0.6 B€
- Youth, training and modernization of the state: 0.55 B€
- Heath: 0.4B €.

This new programme aims to increase **competitiveness and ecological transition**. One of its characteristic is a stronger proportion of equity financing loans (less than 1/3 of the credits will be distributed in the form of direct subsidy). Besides, the PIA2 will support priorities of the **French industrial policy** within the framework of "Nouvelle France Industrielle" (NFI).

2.5 "Nouvelle France Industrielle"

"Nouvelle France Industrielle" is a plan for French industrial recovery, which was announced by the French President and government on September 12th, 2013. This plan aims to create a new momentum among French industrials, better integrating digital technology and international development.

After a 18-month period of consultations and studies on 34 sectors, the French government decided to focus the "Nouvelle France Industrielle" plan on 9 priority sectors:

- New resources (bio-based and recycled materials)
- Sustainable cities
- Green mobility (urban mobility/ electric vehicle)
- Transport of the future (high-speed trains/ ships/ aircraft)- towards more ecological and more competitive transports
- Medecine of the future (digital health, biotechnologies)
- Data management (big data, cloud computing)
- Smart objects/ Robots
- Digital confidence (cybersecurity, etc.)
- Safe, healthy, sustainable and exportable food

Within this priority sectors, actions will be undertaken and funds allocated to the development of the technological offer, to support companies for their future development, to train employees, to give a greater visibility to these sectors of the future and to reinforce the European and international cooperation.

3. The recent changes in practices in the French research and innovation system

Since 2005, the French research and innovation system has been the subject of far reaching reforms with, among others, the creation of competitiveness clusters in 2005, the National Agency for Research (ANR) in 2005, the 2007 Law on the autonomy of Universities (today around 100% of French Universities are autonomous)[4], combined with the development of Research and Higher Education clusters (PRES) since 2006 and all the measures deriving from the 'Investments for the Future' programme.

The objectives of these reforms are:

- To put the universities in a central position,
- To mutualize existing structures and means, reduce fragmentation of research,
- To support excellence and add value to research,
- To increase the interfacing between research and innovation, bridge the gap between academic research and industrial involvement,
- To increase international visibility and attractiveness.

Different complementary instruments have been created, in order to cover the whole spectrum, from basic research to technology transfer (Figure 10).

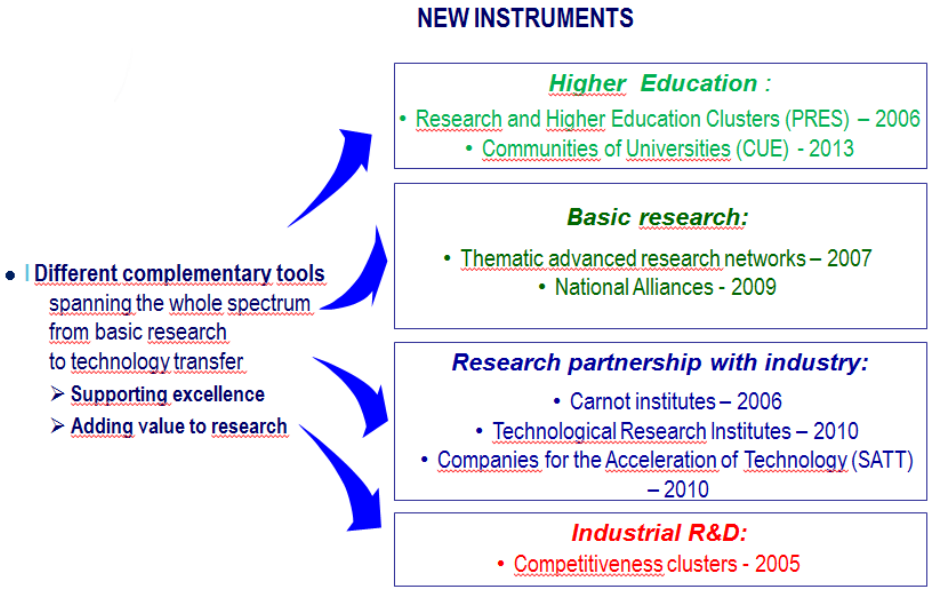


Figure 10: New instruments implemented in the French Higher Education, Research and Innovation system (Chantal Khan-Malek, 2014)

3.1 Public research

Since the end of the 1990s, successive French governments have been willing to reinforce scientific excellence and to direct public research towards social, economic and environmental objectives. Within that perspective, a certain number of the reforms mentioned in the previous chapter brought some new mechanisms and actors.

Reforms have been undertaken on several complementary levels:

[4] The most updated map can be found on the Ministry website : http://www.enseignementsup-recherche.gouv.fr/cid55933/presentation-autonomie-des-universites.html

- Development of closer ties between universities and public research organizations
- Development of competitive research funding and on a project basis
- Strengthening of universities' autonomy
- Coordination between PROs through thematic alliances

3.1.1 Development of competitive research funding and project financing

Competitive funding of public research has risen since the establishment of the ANR, the National Research Agency in 2005; from 7.4% in 2009 to about 11% - 12% in 2012 (Source: ANRT-FutuRIS estimation).

The ANR has become an important source of funding for PROs and universities. ANR had a budget of 423.5 million euros dedicated to calls for proposals in 2013. 1,068 projects were funded in 2013 out of which 17% were international projects co-financed with foreign agencies. The average funding granted per project was 400,000 euros (ANR 2013 Annual Report).

Besides, the development of competitive funding is also explained by the mechanisms introduced by the following instruments of the **Investment of the future Programme** launched in 2010.

Excellence initiative (IDEX – Initiative d'excellence)
The National Investment Plan, with 6.35 billion euros, has brought together research and higher education public organizations, in order to create five to ten multidisciplinary campuses of excellence to be flagships for the entire French research and education system.

The first call launched in 2010 resulted in the selection of 3 IDEXs, out of 17 projects:
- Idex Bordeaux - http://www.idex-univ-bordeaux.fr/,
- Unistra (Strasbourg) - http://www.unistra.fr/index.php?id=accueil,
- Paris Sciences and Humanities (PSL) - http://www.univ-psl.fr/default/EN/all/psl_fr/index.htm.

The second call launched in 2011 resulted in the selection of 5 IDEXs:
- A*MIDEX (Aix-Marseille) - http://amidex.univ-amu.fr/
- UNITI (Toulouse) - http://www.univ-toulouse.fr/universite/investissements-d-avenir/idex-uniti-concertation.
- Université Paris-Saclay - http://www.campus-paris-saclay.fr/Idex-Paris-Saclay,
- SUPER (Paris) - http://www.sorbonne-universites.fr/idex-super-de-nouvelles-etapes-franchies
- Université Sorbonne Paris Cité - http://www.sorbonne-paris-cite.fr/

The eight projects have each received from 700 to 900 million euros.(MENESR, 2012)

Strategic laboratories (LABEX)
The Strategic laboratories have been created to select research teams of excellence and strengthen their role and their international visibility to compete with international research counterparts, attract internationnally recognised scientists and perform high level research and education programmes. With the two Calls already implemented (2010 & 2011), a total of 171 strategic lab projects have been selected out of 356 submitted, for a total budget of 1.94 billion euros.

The selected ones are in the following fields:

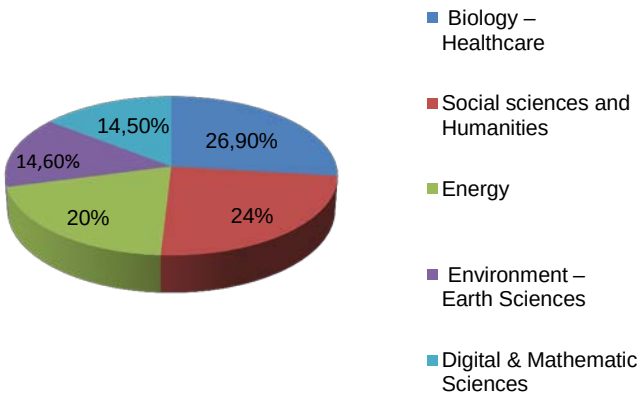


Figure 11: Distribution of Labex per field (Source: MENESR 2012: Laboratoires d'excellence)

Strategic equipment (EQUIPEX)

This programme aims to support large-scale scientific infrastructures and mid-size equipment (from 1 to 20 million euros). From the 2 calls launched in 2011 and 2012, 88 projects were selected in all fields of research.

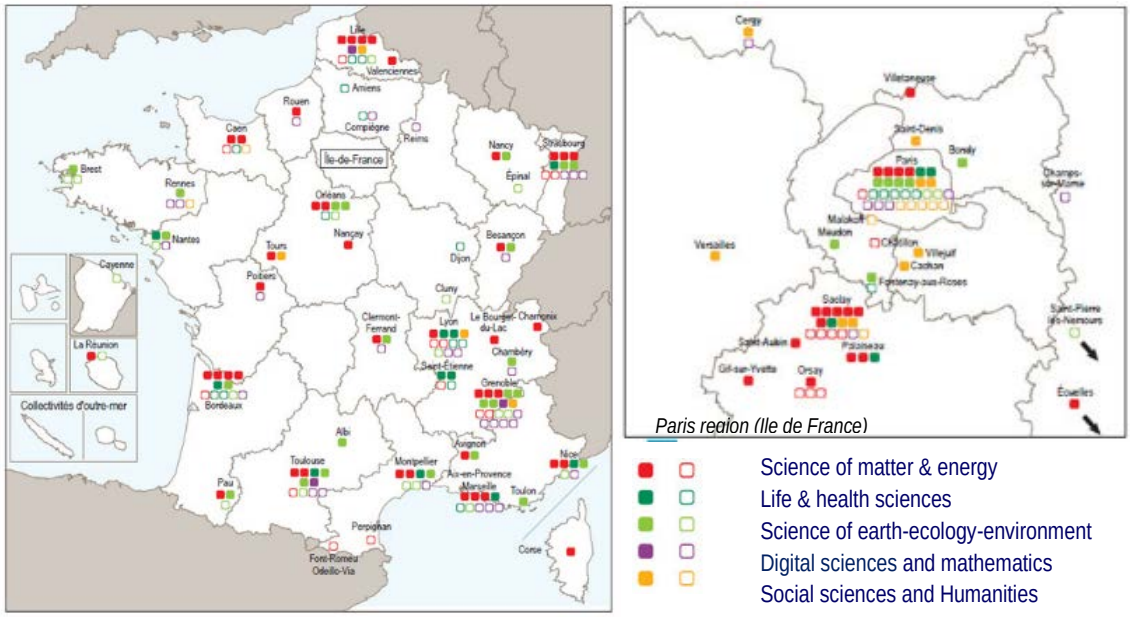
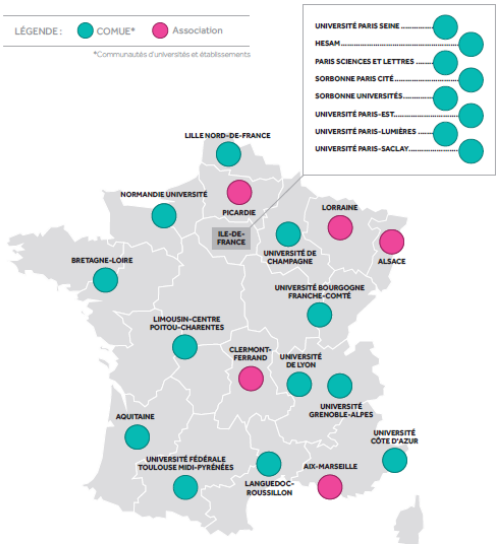


Figure 12: Geographical and thematic distribution of EQUIPEX (MENESR, 2011)

3.1.2 Towards university clusters with higher international visibility

The first universities clusters were created in 2006 under the research and higher education clusters (PRES) instrument. 26 PRES were therefore created between 2006 and 2012, gathering around 60 universities and diverse HEIs such as engineering and business schools, "Grandes Ecoles", research organizations, hospitals, etc. The PRES were created in order to reshape the academic landscape and increase efficiency at a regional level. These clusters were also meant to raise the international profile and attractiveness of the French research and higher education system. The PRES have been replaced by the new Law on Higher Education and Research by

CUEs. This instrument of the "**site policy**" aims to bring together all of the local players involved in higher education and research around a shared scientific priority statement. In July 2014, it was agreed that 25 clusters should be established from which 20 belong to the CUE instrument and 5 have association status. (Source: ***MENESR, 2014)***



http://www.enseignementsup-recherche.gouv.fr

Figure 13: Geographical distribution of CUEs (MENESR, 2014)

3.1.3 Towards Thematic Alliances and joint programming

Created in 2009 and 2010, the Alliances bring together research actors and reinforce coordination of research programming in some key fields (life sciences, energy or social sciences).

Their missions are to:

- Enhance synergies between public research organizations, and with private and industrial partners;
- Contribute to the elaboration of the national research strategy and thematic roadmaps;
- Participate in the National Research Strategy and its implementation;
- Contribute to the annual work programme of the National Agency for Research (ANR);
- Support and enhance European and international collaborations.

Five multi-organizations Alliances have been created:

Figure 15: The Five Alliances and their logos

At the European level, the Alliances participate in coordinated actions and joint programming initiatives, in the specific fields of relevance.

3.2 Knowledge and technology transfer between public and private research

3.2.1 The knowledge and technology transfer framework

Knowledge and technology transfer between public research and enterprises have been a priority of the French research and innovation policy for the last fifteen years. Several new tools have been implemented, carried out by an increasing number of actors and specialized institutions.

The industrial Contract for Training through Research (CIFRE)

Knowledge and technology transfer has been encouraged for several decades. The flagship instrument is **the Industrial Contract for Training through Research** (CIFRE). The latter was implemented in 1981 to promote mobility between public research laboratories and the socio-economic actors, to contribute to employ PhD candidates in enterprises. A CIFRE brings together three partners: an enterprise, a PhD candidate and a public laboratory.

Enterprises receive funding to hire a young doctoral fellow on a research project which will be the topic of the PhD candidate's thesis. **Since 1981, CIFRE have brought together more than 21,000 doctoral students, 7,500 enterprises and 4,000 laboratories.** 96% of the CIFRE PhDs find a job within a year, 70% in less than three months.[5].

Knowledge and technology transfer by the Public Research Organizations

Public Research Organizations have conducted knowledge and technology transfer activities as well. Some of them have dedicated bodies in charge of knowledge and technology transfer activities.

Examples:

- **CNRS** with **"France Innovation Scientifique et Transfert"[6] (FIST SA)** founded in 1992

  FIST SA is a public limited company, now a subsidiary of CNRS at 70% and 30% BPI France. Its main mission is to transfer innovative technologies, mainly originating from CNRS to the industry.

  Its action extends from the receipt of projects to the granting of exploitation rights through consulting in intellectual property strategies, participation in the filing of patent applications, search of industrial partners, negotiating and drafting of exploitation contracts, and management of patent portfolios.

  Besides, 1026 enterprises have been created since 1999 by CNRS laboratories and their academic partners. 80% of the startups associated to CNRS laboratories are still running; the 5-year survival rate of enterprises created by CNRS affiliated laboratories was of 90% between 1999 and 2009 (the average rate being 52.6%).[7] (CNRS, 2014)

[5] For further information, please refer to the CIFRE leaflet : http://www.anrt.asso.fr/fr/pdf/plaquette_cifre_complete_avril2009_GB.pdf
[6] Website: http://www.fist.fr/en/
[7] CNRS Communiqué, 10 Decembre 2014

- **CEA** with **CEA Tech**[8]

  CEA Tech is the CEA's (the French Atomic Energy and Alternative Energy Commission) technology research unit. CEA Tech's three divisions — LETI, LITEN, and LIST[9] —develop a broad portfolio of technologies for ICTs, energy, and healthcare.

  CEA Tech leverages a unique innovation-driven culture and unrivalled expertise to develop and disseminate new technologies for industry, effectively bridging the gap between the worlds of research and business. CEA Tech also provides businesses with access to key enabling technologies developed by other CEA operating divisions.

- **INSERM** with **INSERM Transfert**[10] created in 2000.

- **INRA** with **INRA Transfert**[11]**.**

Public-Private joint laboratories

Public-private joint laboratories represent the most advanced instrument of the public-private partnership. They aim to decompartmentalize public and private spheres. They rely on the pooling of human and materials resources.

The 214 identified laboratories (in 2009) gather 79 PROs; the first one is the CNRS which is participating in 55 public-private joint laboratories.

The creation of public-private joint laboratories has been reinforced by the programme LabCom. The latter, monitored by the ANR, has a dedicated budget of 20 million euros to encourage cooperation between SMES or an intermediate-sized enterprise and a public research laboratory. 38 projects were selected for funding in 2014 (ANR, 2015)[12]

Clusters/ technology parks

Clusters have been created on the initiative of public actors including the state, regions and departments. Two of the most important ones are the following:

1- Sofia Antipolis[13]**:** Founded in 1969, it is the biggest technology park (near Nice) in France and in Europe. This competitiveness cluster houses 1,414 enterprises, 5,000 students, 4,000 researchers from the public sectors and 30,000 employees (2008). Research is conducted mainly in the following areas:

- Computing, Electronics, Networks and Communications (25% of the entreprises and about 50% of employment).
- Health, Fine Chemicals and Biotechnologies
- Earth Sciences and Environment.

[8] Website: http://www.cea.fr/cea-tech

[9] LETI: Laboratoire d'électronique et de technologie de l'information ; LITEN : Laboratoire d'Innovation pour les Technologies des Energies Nouvelles et les nanomatériaux ; LIST : Laboratoire d'Intégration de Systèmes et des technologies.

[10] Website: http://www.inserm-transfert.fr/en/

[11] Website: http://www.inra-transfert.fr/fr/

[12] For further information, please refer to the following link: http://www.agence-nationale-recherche.fr/en/funding-opportunities/documents/aap-en/joint-laboratories-between-research-organizations-and-smes-or-intermediate-sized-enterprises-eti-labcom-2014/nc/

13 http://www.sophia-antipolis.org/

2- Genopole[14]: Created in 1998, Genopole is France's leading bio cluster for biotechnologies and research in genomics and genetics which gathers 80 biotech companies and 19 academic research laboratories. They share facilities (21 shared-access technology platforms) at a single place in the south of Paris (Evry).

3.2.2 New instruments to strengthen knowledge and technology transfers

New instruments to strengthen knowledge and technology transfers between public and private research have been implemented during the last 15 years following 3 main reforms:

- **The 1999 Law on Innovation and Research** with the creation of knowledge transfer unit (Services d'activités industrielles et commerciales) within universities, creation of public incubators, measures to facilitate mobility of public research staff, etc.

- **2005 / 2006:** establishment of **Carnot institutes**, **competitiveness clusters**, call for proposals from the ANR, etc.

- **The 2010 Investment for the Future Plan** with the **Companies for the Acceleration of Technology Transfer (**SATT), thematic or regional organisms in charge of the commercialization of intellectual property rights;
  In addition, **Technological Research Institutes** ("Institut de recherche technologique", IRT) and **Institutes for Energy Transition** ("Instituts pour la transition énergétique", ITE), were created to support the ecosystem created by competitiveness clusters.

The main new instruments will be described below.

The Carnot Institutes

Founded in 2006, the Carnot Label was designed to develop partnership-based research, meaning research efforts conducted by public laboratories in partnership with socio-economic stakeholders, primarily enterprises (from SMEs to large corporations), to serve their needs.
The Carnot Label is granted for a five-year renewable period to public research structures, Carnot institutes, which concurrently conduct upstream research capable of renewing their scientific and technological skills, along with an ambitious partnership research policy to the benefit of the socio-economic world.

In total, 34 research structures are labeled (2014) for their ability to cooperate with companies. Carnot institutes bring together scientific and technology competences in 6 sectors:

- Mechanics, materials and processes
- Energy and transport
- ICT, micro and nano-technologies
- Construction, civil engineering, urban planning
- Environment, natural resources, chemistry
- Health, technologies for health, nutrition

[14] http://www.genopole.fr/

A few figures regarding Carnot Institutes:

- 15% of the public research employees in the whole country
- 420 million euros of research contracts directly funded by enterprises
- 50 million euros of income form intellectual property rights
- 65 startups created

Figure 14: A few figures on the Carnot Institutes. Source: http://www.instituts-carnot.eu/

Figure 15: Geographical distribution of Carnot Institutes (MENESR, 2011)

The competitiveness clusters

The competitiveness clusters bring together companies, public and private research laboratories, training centers and education institutions, to develop synergies and cooperation around specific thematic areas and encourage greater R&D investment by companies. National and local public actors are also closely associated to competitiveness clusters. Contrary to the other research fields, they are under the authority of the Ministry of Economy. Within the frame of the Government's economic policy, the competitiveness clusters aim at developing the competitiveness of the French economy and at encouraging employment in promising markets.

A total of 71 clusters have been selected, with three types of partners: companies, public research institutions and higher education institutions. They aim at developing synergies and collaborative efforts and to foster innovative projects and products. Indeed, 1465 collaborative R&D projects have received 2.5 billion euros public funding, involving more than 15,000 researchers (MENESR, 2015).

Figure 16: Map of the 71 competitiveness clusters (updated in October 2014)
Source : http://competitivite.gouv.fr/documents/commun/Documentation_poles/cartes-poles/carte.pdf

Those competitiveness clusters were labeled in 3 different categories:

- Worldwide Clusters (leaders in their field)
- Competitiveness Clusters with a worldwide vocation (vocation to become one of the worldwide leaders in their field)
- National Clusters (national scope)

World Class Competitiveness Clusters:

- Worldwide clusters (7)

	Aerospace Valley	Aeronautics / Space ICT
	Finance Innovation	Engineering / Services
	Lyonbiopôle	Biotechnologies / Health
	Medicen Paris Region	Biotechnologies / Health
	Minalogic	ICT Microtechnology / Mechanics
	Solutions communicantes sécurisées	ICT
	Systematic Paris-Region	ICT

- Clusters with a worldwide vocation (11)

	Alsace BioValley	Biotechnologies / Health
	Axelera	Chemistry Eco-technologies / environment
	Cap Digital Paris Region	ICT
	EAU	Eco-technologies / environment
	i-Trans	Transportation
	Images et Réseaux	ICT
	Industries et Agro-Ressources	Bio-resources Energy Materials
	Mer Bretagne	Energy ICT Transportation
	Mer PACA	Energy ICT Transportation
	Mov'eo	Transportation
	Végépolys	Agriculture / Agri-food

The opening to other international clusters is also very important, in order to obtain the missing technological bricks and increase the international visibility. To do so, the involvement of foreign companies and foreign R&D centers in clusters needs to be reinforced, as well as the agreements between BPI France and similar foreign agencies, aiming to support innovative bilateral projects.

3.2.3 The main devices of the Investments for the future Plan

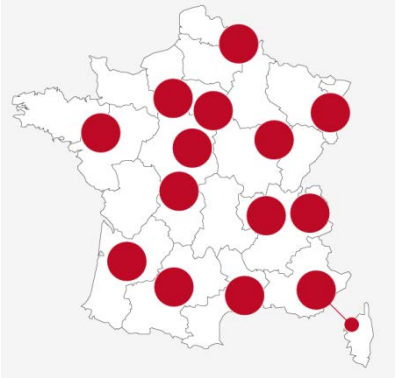
Companies for the Acceleration of Technology Transfer (SATT)

SATTs aim to federate the exploitation of public research outcomes of higher education institutions and public research organisations at a local level. Located at the crossroads of the world of research and business, SATT are new players which aim to increase the efficiency of the French system of research exploitation, including accelerating the transfer to and use by industry.

The SATTs are structures specialised in the exploitation of public research outcomes at a local level. They act as an interface between enterprises and public research, and provide a large range of services related to technology transfer and commercialization activities. One of their missions is to finance the maturing period of projects that is supporting technology "proof-of-concept" (prototyping, transnational research) for innovative applications as well as sustainability on the long term. The SATTs act as local offices, replacing the multiple existing technology transfer structures. The aim is to improve the services for researchers and companies, reduce the current fragmentation on a same site, and develop synergies between the local and national actors working on the same subject.

900 million euros have been dedicated to the creation of 14 SATTs. The map below (Figure 17) shows their geographical distribution. The full list can be found on the website dedicated to the SATT structures.

Figure 17: Geographical distribution of the SATTs (Source: SATT-website)



Technological research Institutes (IRT) and Institutes for energy transition (ITE)
The overall objective of the IRT and ITE is to reinforce the landscapes created by competitiveness clusters with public – private strategic partnership in research, training and innovation.

Eight **IRT** have been chosen after the first Call in 2010. 2 billion euros have been dedicated to their funding. Source: http://competitivite.gouv.fr/les-investissements-d-avenir-une-opportunite-pour-les-poles-de-competitivite/les-instituts-de-recherche-technologique-irt-campus-d-innovation-654.html

- NANOELEC in Grenoble – nanoelectronics
  Competitiveness cluster involved: Minalogic
  16 other partners: CNRS, INRIA, Bouygues, CEA, Schneider Electric, SOITEC, etc.
- IRT Saint Exupéry in Toulouse – aeronautics and space
  Competitiveness cluster involved: Aerospace Valley
  15 other partners involved: Airbus, EADS, Safran, Thales, CNRS, etc.
- BIOASTER in Lyon and Paris – infectiology
  Competitiveness cluster involved: Lyonbiopôle
  7 other partners involved: Institut Pasteur, Danone, Sanofi, CNRS, INSERM, CEA, etc.
- IRT M2P in Metz, Belfort-Montbéliard &Troyes materials, metalworking industry and
  Competitiveness clusters involved: Materalia, Véhicule du future, Microtechniques, Fibres Enseignement supérieur et recherche
  50 industrial partners (Air Liquide, Alstom, AREVA, etc), 11 academic partners (CNRS, ONERA, etc)
- Railenium in Valenciennes & Villeneuve d'Ascq –railway equipment
  Competitiveness cluster involved: I-Trans
  24 other partners involved: IFSTTAR, SNCF, Réseau Ferré de France (RFF), Alstom, etc)
- IRT Jules Verne in Nantes – composite materials
  Competitiveness cluster involved: EM2C
  33 other partners involved: Airbus, Alstom, CNRS, IFSTTAR, CEA, AREVA, etc.
- SystemX in Saclay – digital system engineering, ARE
  Competitiveness cluster involved: Systematic
  62 other partners involved: Airbus, Alcatel-Lucent, Alstom, Campus Paris Saclay, CEA, IFSTTAR, Orange, Renault, etc).
- B-COM in Rennes – networks and digital infrastructures
  Competitiveness cluster involved: Images et réseaux
  38 other partners involved: Orange, Thomson Video Networks, INRIA, INSERM, etc.

ITE are Institutes for Energy Transition. They are interdisciplinary platforms, gathering industry and public research competencies. Their goal is the same as that of the IRTs; however they are focused on the thematic field of energy transition. 1 billion euros have been dedicated to their funding.

The results of the first and second calls in June 2011 and June 2012 have seen seven selected institutes:
Source: http://competitivite.gouv.fr/les-investissements-d-avenir-une-opportunite-pour-les-poles-de-competitivite/les-instituts-pour-la-transition-energetique-ite-660.html

- **National Institute for the development of ecotechnologies and carbon-free energy (Institut national pour le développement des écotechnologies et des énergies décarbonées, INDEED)** in Lyon
  Competitiveness clusters involved: Axelera, Tenerrdis, Plastipolis, Trimatec, LUTB & Viaméca
  10 other partners involved: Arkema, GDF Suez, PEP, Rhodia, CNRS, IFP Energies nouvelles, etc.
- **Picardie Innovations Végétales, Enseignements et Recherches Technologiques (PIVERT)**
  Competitiveness cluster involved: Industries & Agro-Ressources (Pôle de compétitivité à vocation mondiale Industries & Agro-Ressources, IAR).
  9 other partners involved: CNRS, INRA, Solvay etc.
- **France Energies Marines (FEM)** in Brest – renewed sea energies
  Competitiveness clusters involved: Mer Bretagne and Mer PACA
  23 other partners involved: CNRS, IFREMER, IFP Energies Nouvelles, CEA, EDF, Alstom Wind, Areva Renouvelables, etc.
- **Greenstars** – bio-seaweeds labeled by the clusters
  Competitiveness clusters involved: Pôle mer PACA, Trimatec, IAR
  42 other partners involved: INRA, INRIA, IRD, CNRS, Ifremer, CEA, Air Liquide, CEA, etc.
- **Institut Français des Matériaux Agrosourcés (IFMAS)** in Villeneuve d'Ascq – agro-based materials
  Competitiveness cluster involved: pôle MAUD
  10 other partners involved: INRA, CNRS, Université de Lille, etc.
- **Institut Photovoltaïque d'Île-de-France in Saclay**
  Competitiveness cluster involved: Advancity
  7 other partners involved: EDF, Total, CNRS, Air Liquide, etc.
- **SuperGrid Institute** in Villeurbanne –electric powered transports
  Competitiveness cluster involved: Tenerrdis
  17 other partners involved: CNRS, Alstom, EDF, etc.

All the instruments described in this section aim to reinforce public-private technology but also to stimulate knowledge and technology transfer. Instruments to encourage innovation in the private sector have also been implemented and will further be described in the following section.

3.3 Investments for innovative companies

Innovation companies can be in particular supported by the Research tax credit (see Chapter 1) or the Public Investment Bank. Since its creation in the beginning of 2013, BPI France has occupied a prominent role in supporting innovation. Indeed BPI France's main objective is to federate the innovation ecosystem and to catalyze public policy in favor of the innovation in public organizations and in enterprises.

3.3.1 The increasing role of BPI France in supporting innovation in enterprises

To strengthen its actions, in November 2013 BPI France launched the **Nova Plan with an additional billion euros**, which main objectives are:

- To simplify and fasten the procedures, to facilitate applications for funding and to speed up the decision process in particular within the framework of the programmes for the creation of collaborative projects (involving enterprises and laboratories) led by an enterprise (for a funding comprised between 3 and 10 M€) .

- To bring assistance:

    - To develop the innovation ecosystem: 200 M€ dedicated to investment to boost innovation and speed up the creation of innovation enterprises (French Tech)
    - To help enterprise to settle e.g. in the US market with an acceleration programme in San Francisco for 8 innovative startups or in Paris with the creation of a co-working areas to welcome startups for a maximum duration of 6 months with an incubator offer (assistance on funding and fund raising, a business mentoring and networking with BPI France partners)

- To ensure a funding continuum (at each development step)
    - Creation of the Large Venture Fund (500 M€) which targets enterprises with a strong capital need in the following thematic priorities: health, digital technologies and environment
    - New funding devices with the creation of a seed capital fund for enterprises to boost fund raising (between 100,000 and 500,000 €), creation of a new innovation loan to fund the industrial and commercial launch of an innovation for a maximum amount of 3 M€.
    - Opening of funding to non-technological innovation
      (Source: OECD, 2014 http://www.oecd.org/fr/sti/inno/innovation-france-ocde.pdf)

3.3.2 Other initiatives implemented by the government to support innovative companies

Public incubators for innovative SMEs

To support innovative SMEs, public incubators for innovative SMEs have been created within the frame of the 1999 Law on Innovation and Research. They are bringing support to innovative SMEs by hosting them, providing training and assisting them in fund raising. Their objective is to promote the transfer of technologies, which have been developed in public research laboratories, to the private sector, via the creation of companies. The public incubators have been created at a regional level, on the initiative of the higher education school and research organizations.

In 2014, 28 incubators[15] were still active. Most of them are multisectoral.
However, three incubators are specialized: 2 in heath (Paris Biotech Santé in Paris and Eurasanté near Lille) and 1 in the digital sector (Marseille).

[15] Please refer to the following link to see the all incubators list : http://cache.media.enseignementsup-recherche.gouv.fr/file/Creation_et_developpement/06/0/incubateurs24425_54060.pdf

Between 2000 and 2014, public incubators hosted almost 4,000 projects of innovative enterprises. Figure 18 shows the thematic distribution of the hosted project (MENESR, 2015). On the same period, those projects ended up in the creation of 2,700 innovative enterprises.

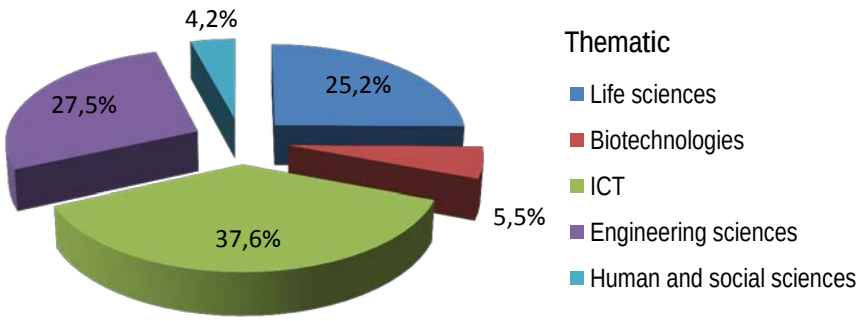


Figure 18: Thematic distribution of the hosted project (MENESR, 2015)

Priority is given to projects of innovative enterprises from or linked to public research. The incubators are located within or near a scientific site in order to maintain close relationships with laboratories.

National Competition to support the Creation of Innovative Technological SMEs

The National Competition to support the Creation of Innovative Technological SMEs detects and supports projects to create innovative technology SMEs in all sectors. This label also enables selected projects to more easily find complementary funding.
Between its creation in 1999 and 2014, more than 1,600 SMES were created; 69% of them are still active and half of them are originally from public research (MENESR, 2015).
In 2014, the national competition to support the creation of innovative technological SMEs has been renamed "i-LAB" with 2 new measures:

- Creation of a new prize "PEPITE – Tremplin Entrepreunariat Innovation" which aims at encouraging the creation of enterprises by students and young graduates
- Nomination of 5 "Grand Prizes" to be awarded for the most innovative projects. The selected projects fit within one of the 10 societal challenges defined by the H2020 French Strategic Agenda (see section 2).

Among the 171 projects selected in 2014, 35% are in the sector of biotechnologies and medical technologies and 25% in the digital sector. 54% of the projects promote the results of public research. Beyond the financial support, training instruments have been implemented to help the laureates in their development. (MENESR, 2014)

Young innovative companies (JEI) programme

Young innovative companies ("Jeunes entreprises innovantes", JEI) is a status created in 2004. It helps young companies doing research and development, with exemptions on taxes and employer contribution (researchers, technicians, R&D project managers, IP specialists, personnel in charge of pre-competitive tests). The conditions to be labeled JEI are to be an SME (European definition of an SME) created for less than eight years, to be independent and to have R&D expenses below or equal to 15% of taxes. In 2011, 2,810 SMEs were labeled as JEI for a total amount of 89 million euros. (MENESR, 2014)

Conclusion

On the basis of the French research and innovation system as described in the document, a coherent set of complementary tools has been established in the past decades in France, to:

- support excellence,
- reinforce local synergies,
- foster a culture of partnership in R&D,
- Increase international visibility and attractiveness.

The recent changes out of which the new French research system is evolving, result in a move towards more thematic research and competitive project-based funding, and a larger role of the universities, as well as changes in the association of research organizations based on more autonomous universities.

There have also been efforts to tackle the long-standing barriers relating to the weakness of knowledge circulation and transfer. Examples for such measures are the development of instruments aimed at increasing the diffusion of academic knowledge and developing public-private partnerships (Competitiveness Clusters, Carnot Institutes, IRT, SATT) as well as encouraging a culture of innovation.

Finally, France has increasingly focused on incentivizing private research and to this end has developed a set of measures to stimulate greater private R&D investments, in particular through the research tax credit scheme, competitiveness clusters and the Young Innovative Companies programme.

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FRIENZ Facilitating research and innovation cooperation between Europe and New Zealand

German Research and Innovation Landscape

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Abstract

Germany has the largest innovation system of the European Union. In 2012 Germany spent 2.98% of its GDP on R&D. The share of public and business expenditures on R&D is 0.96% and 2.02% of GDP, respectively, in 2012. These figures are both well above the OECD average, owing to the government's focus on R&D and to Germany's specialisation in R&D-intensive industries.
The success of Germany´s innovation system draws on a long history of science carried out by well-qualified scientists, researchers, technicians and laboratory staff. They work in a highly efficient & highly differentiated science and research system in higher education institutions, public research organizations or industry which increasingly collaborate with international partners. For future oriented core themes, people in these entities are connected and interact within clusters, such as the leading edge clusters, thus combine the strength of each participating organization to a higher impact. Following long-term oriented strategies, such as the New High-Tech Strategy 2020, Germany continuously improves its innovation system.

Table of Contents

Quick guide to German Innovation System

	Name	Description	Link
Institutions	Federal Ministry of Education and Research (BMBF)	The promotion of education, science and research by the Federal Ministry of Education and Research represents an important contribution to securing the prosperity of Germany.	https://www.bmbf.de/en/
	Federal Ministry of Economy and Technology (BMWI)	The central task of the Ministry for Economic Affairs and Energy is to reinvigorate the social market economy, stay innovative in the long term and strengthen the social fabric in Germany.	http://www.bmwi.de/EN/root.html
	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)	The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) is responsible for a range of government policies which are reflected in the name of the ministry itself. For more than 25 years the Ministry has worked to protect the public from environmental toxins and radiation and establish an intelligent and efficient use of raw materials; it has advanced climate action and promoted a use of natural resources that conserves biodiversity and secures habitats.	http://www.bmub.bund.de/en/
	Federal Ministry of Food, Agriculture and Consumer Protection (BMELV)	The BMELV is competent for structuring German food and agricultural policy. BMEL research is closely linked to the future-centric topics climate protection, renewable resources and feeding the global population. One of the main goals is to protect the natural environment through sustainable agricultural production. At the same time, perspectives are to be created for rural areas. Last but not least food safety and a healthy diet are other important research topics.	https://www.bmel.de/EN/Homepage/homepage_node.html
	Federal Ministry of Health (BMG)	The Federal Ministry of Health is responsible for a variety of policy areas, whereby its activities focus predominantly on the drafting of bills, ordinances and administrative regulations. Moreover, by means of prevention campaigns, the Federal Ministry of Health seeks to improve the population's health. All in all, the	http://www.bmg.bund.de/en.html

		sphere of activities pursued by the Federal Ministry of Health can be condensed into the areas of health, prevention and long-term care.	
	Federal Ministry of Defense (BMVg)	As the supreme federal authority in the field of defence - and, as such, being neither an armed forces command nor a defence administration agency – the Federal Ministry of Defence is responsible for the ministerial control of the entire Bundeswehr.	http://www.bmvg.de/portal/a/bmvg/en
	Stifterverband	The Stifterverband is a business community initiative advocating long-term improvement of the German education and research landscape. In order to achieve this goal, the Stifterverband provides funding for universities and research institutes, supports talents, analyses the higher education system, and devises recommendations for policymakers and business. The Stifterverband covers 3,000 businesses, trade associations, foundations and private individuals. Together, they form one of Germany's biggest private academic patrons. Virtually all major German corporate groups are involved on the executive board and other committees – as are SME-owners and representatives from scientific institutions.	http://stifterverband.info/index.php
	Max-Planck-Society (MPG)	Germany's most successful research organization.	https://www.mpg.de/en
	Fraunhofer Society (FhG)	Largest European organization for applied research.	https://www.fraunhofer.de/en.html
	Helmholtz Association (HGF)	The Association is dedicated to pursuing the long-term research goals of state and society, and to maintaining and improving the livelihoods of the population.	http://www.helmholtz.de/en/home/
	Leibniz Association (WGL)	The Association focuses on application oriented and basic research and providing scientific infrastructure.	http://www.leibniz-gemeinschaft.de/en/home/
	Federal Institute of geosciences and natural	The central geoscientific authority in Germany providing advice to the German Federal Government in all geo-relevant questions.	http://www.bgr.bund.de/EN/Home/homepage_node_en.html

	resources (BGR)		
	Physikalisch-Technische Bundesanstalt (PTB)	Germany's national metrology institute is Germany's highest authority when it comes to correct and reliable measurements.	https://www.ptb.de/cms/en.html
	Deutsche Forschungsgemeinschaft (DFG)	The main task of the DFG is to select the best projects by researchers at universities and research institutions on a competitive basis and to finance these projects.	http://www.dfg.de/en/index.jsp
	Federal Statistical Office	Destatis indicators about Germany.	https://www.destatis.de/EN/Homepage.html
Policy Papers	OECD Science, Technology and Industry Outlook (2014)	STI Country Profiles: Germany.	https://innovationpolicyplatform.org/system/files/sti-outlook-2014-germany.pdf
	The Commission of Experts for Research and Innovation Report (2015)	Research, innovation and technological in Germany.	http://www.e-fi.de/fileadmin/Gutachten_2015/EFI_Report_2015.pdf
	The German Council of Science and Humanities	The German Council of Science and Humanities (Wissenschaftsrat) provides advice to the German Federal Government and the State (Länder) Governments on the structure and development of higher education and research.	http://www.wissenschaftsrat.de/en/home.html
	The German Academy of Natural Scientists Leopoldina	The German Academy of Natural Scientists Leopoldina – National Academy of Sciences – represents scientists from Germany in international committees and is also involved in providing science based advice from science and innovation to the society and politics.	http://www.leopoldina.org/en/home/
	The New High-Tech Strategy for Germany (HTS)	The new High-Tech Strategy stands for the aim of moving Germany forward on its way to becoming a worldwide innovation leader. The goal is for good ideas to be translated quickly into innovative products and services.	http://www.hightech-strategie.de/de/The-new-High-Tech-Strategy-390.php
	Strategy of the Federal Government for the	The Strategy for the Internationalisation of Science and Research is the Federal Government's basis for action in this field. It was	https://www.bmbf.de/pub/Internationalisierungsstrategie.pdf

	Internationalization of Science and Research	adopted under the title "Strengthening Germany's role in the global knowledge society" in 2008 and has been developed further by the Federal Ministry of Education and Research (BMBF) with the "International Cooperation" action plan issued in 2014.	
Programmes / Projects	Research Explorer	The Research Explorer contains over 23,000 institutes at German universities and non-university research institutions, searchable by geographic location, subject and other structural criteria.	http://www.research-explorer.de/research_explorer.en.html?
	Innovation Dialogue	High ranking representatives from science and business discuss new strategic approaches in innovation policy with the Chancellor and the Federal Ministers of Research and Economics.	http://innovationsdialog.acatech.de/
	Industry-Science Research Alliance	The Industry-Science Research Alliance plays a decisive role in the implementation and the further development of the High Tech Strategy 2020. It consists of 28 high ranking members from science and business and forms the forum for an intensive exchange between business, science and politics.	http://forschungsunion.de/
	BMBF Foresight	BMBF Foresight is a strategic instrument of the Federal Ministry of Education and Research (BMBF) that provides technology foresight and the determination of future societal needs in terms of research and development.	https://www.bmbf.de/en/background-to-bmbf-foresight-1445.html
	Forward looking projects	The forward-looking projects provide a means of looking beyond the relevant research itself, in order to shape the necessary framework and to plan steps for effective implementation. The projects are being jointly implemented by the industry, science and policy-making sectors, and they are open for broad participation by all relevant players.	http://www.hightech-strategie.de/_dpsearch/highlight/searchresult.php?URL=http://www.hightech-strategie.de/de/Zukunftsprojekte-der-Bundesregierung-972.php&QUERY=Zukunftsprojekt
	The Higher Education Pact 2020	The Higher Education Pact 2020 aims to equip the German higher education system for the challenges of the future.	http://www.research-in-germany.org/en/research-landscape/r-and-d-policy-

			framework/higher-education-pact.html
	The Joint Initiative for Research and Innovation	The Joint Initiative for Research and Innovation aims at strengthening and accelerating the dynamic development in the non-university research field.	http://www.pakt-fuer-forschung.de/
	Excellence Initiative	The Excellence Initiative aims to promote top-level research and to improve the quality of German universities and research institution.	http://www.dfg.de/download/pdf/dfg_im_profil/geschaeftsstelle/publikationen/exin_broschuere_en.pdf
	International Cooperation - Action Plan of the Federal Ministry of Education and Research (BMBF)	The Action Plan highlights the ways in which BMBF will need to shape international cooperation in the coming years in order to strengthen education, science, research and innovation in Germany and to successfully protect Germany's competitiveness in the global market. At the same time, it also reflects the fact that worldwide cooperation in science and research is a key to sustainable and peaceful development.	https://www.bmbf.de/pub/International_Cooperatin_Action_Plan.pdf
	Forschungscampus ("research campus") funding initiative	Forschungscampus ("research campus") funding initiative supports medium- to long-term public-private partnerships which bring their partners together in one place.	https://www.bmbf.de/pub/Forschungscampus_2014_bf.pdf
	EXIST		http://www.exist.de/EN/Home/home_node.html;jsessionid=F66AE5EF249D13E27825383D63F953D2
	The High Tech Gründerfonds	The High Tech Gründerfonds (High Tech set-up fund – HGTF) provides venture capital for new technology company startups.	http://high-tech-gruenderfonds.de/en/#title
Clusters	Networks of Competence	The Kompetenznetze Deutschland initiative of the Federal Ministry of Economics and Technology (BMWi) brings together the best-performing innovation clusters in Germany. The initiative ended on April 30, 2012.	http://www.bmwi.de/EN/Service/publications,did=167252.html
	Leading Edge Cluster Competition	The Leading-Edge Cluster Competition intends to strategically expand the technological competence of regional partners from science and industry and	https://www.bmbf.de/pub/Deutschlands_Spitzencluster.pdf

	implement this competence in internationally competitive innovations.	
Internationalization of Leading Edge Clusters in Germany	The promotion of the internationalization of leading edge clusters helps bundling competences through strategic international cooperation to gain and profit from additional know-how and innovation. An announcement by the BMBF in 2014 followed up by further announcements in 2015, 2016, aims to further link German R&D clusters with worldwide networks of knowledge and competence in order to increase the potential for innovations and competitiveness within companies.	https://www.bmbf.de/de/cluster-netzwerke-international-547.html
The leading-edge cluster Forum Organic Electronics	The Leading-Edge Cluster Forum Organic Electronics in the Rhine-Neckar metropolitan region combines scientific excellence with economic power, in order to make use of the potential for innovation and growth in the future technology printed electronics. It is a cooperative network which currently consists of fifteen international corporations, among them three DAX-listed companies, four mid-sized companies and ten research institutes and universities. The partners from science and business work closely together along the entire length of the value chain, from the research and development of new materials, to the conception of devices and systems, and the marketing of applications and services.	http://www.innovationlab.de/en/cluster-foe/leading-edge-cluster-forum-organic-electronics/
The leading-edge cluster Cool Silicion Valley	The aim of the Leading-Edge Cluster "Cool Silicon" is to build the technology basis for a massive increase of energy efficiency in the information and communications technology (ICT) sector.	https://www.cool-silicon.de/Home/About-us.html
Go Cluster program	The "go-cluster" program provides a stimulus to improve cluster management and help turn German clusters into highly effective international clusters. The initiative provides support for innovative	http://www.clusterplattform.de/CLUSTER/Redaktion/EN/Standardartikel/go-cluster.html

	services and raises the international visibility of innovation clusters. Members of the "go-cluster" programme can obtain funding for novel solutions.	
Research Cluster model of the technical university in Aachen	With RWTH Aachen Campus, RWTH Aachen intends to develop itself into one of the leading technical universities worldwide. Industrial companies and university institutes work on defined research focuses under a new quality of collaboration and interdisciplinary exchange here.	http://www.rwth-aachen.de/cms/root/Wirtschaft/~ekt/Campusprojekt/lidx/1/
Innovation Alliance of the universities in North Rhine-Westphalia (NRW)	Innovation Alliance of the universities in North Rhine-Westphalia (NRW) is a registered alliance of more than 20 member universities, universities of applied sciences and university spin-off organizations in NRW.	http://www.innovationsallianz.nrw.de/archiv/innovationsallianz.nrw.de/indexd97e.html?id=1&L=1
Knowledge and Innovation Communities (KICs)	KICs are the results of the European Institute of Innovation & Technology (EIT) mission to fully integrate all three sides of the "knowledge triangle" consisting of higher education, research and businesses.	http://eit.europa.eu/activities/innovation-communities
BioRN	About 80 companies from the field of red biotechnology develop drugs, technology platforms and diagnostics at the Biotech Cluster Rhine-Neckar (BioRN).	www.biorn.org
CLIB2021	International open innovation cluster in biotechnology and the bioeconomy.	www.clib2021.de:
Cluster Leistungselektronik im ECPE e.V.	Next generation of electronics.	www.clusterle.de
Hamburg Aviation	Aviation industry cluster	http://www.hamburg-aviation.de/en/start.html
Institute of Plastics Processing (IKV) and the Skilled Crafts at RWTH Aachen University	Europe-wide the biggest research and education institute engaged in the field of plastics processing enjoying outstanding reputation	http://www.ikv-aachen.de/en/

	Innovations for the Plastics Industry	CAP - Development of coatings and particles for the plastic industry	http://www.kunststoff-institut.de/inhalte/en/startseite.php
	Medical Valley EMN	Development of an international innovation system in medical devices and health care	http://en.medical-valley-emn.de/
	Merge	Technologies for Multifunctional Lightweight Structures	https://www.tu-chemnitz.de/MERGE/index.php
	OptoNet e.V	Photonic network	http://www.optonet-jena.de/startseite/
	Organic Electronics Saxony	Organic Electronics	http://www.oes-net.de/en/home.html
	Software-Cluster	Enterprise Solutions	http://www.software-cluster.org/en/

1. General features of the STI system

Germany has the largest innovation system of the European Union. Research and innovation activities are carried out either in higher education institutions, public research organizations or industry. In 2012 Germany spent 2.98% of its GDP on R&D up from 2.53% in 2007. The share of public and business expenditures on R&D is 0.96% and 2.02% of GDP, respectively, in 2012. These figures are both well above the OECD average, owing to the government's focus on R&D and to Germany's specialisation in R&D-intensive industries (OECD Science, Technology and Industry Outlook, 2014). However, according to the Commission of Experts for Research and Innovation (EFI), expenditures for internal R&D in relation to GDP decreased from 2.98% in 2012 to 2.85% in 2013 partially due to slow growth in the business sector but largely due to purely statistical effects. As a consequence, the EFI suggests a more ambitious target of 3.5% of GDP for R&D by 2020 in order to close the gap on leading innovative nations (EFI 2015a).

Table 1: Basic indicators for R&D investment (OECD, 2015).

Indicator	Germany	OECD Total	Year
Gross domestic expenditure on R&D (GERD) [Mio. USD*]	100.991	1.128.468	2013
GERD Growth rate compared to previous year [%]	0,3	3,8	2013
Gross domestic expenditure on R&D (GERD) as a percentage of GDP [%]	2,9	2,4	2013
Government-financed GERD as a percentage of GDP [%]	0,8	0,7	2013
Industry-financed GERD as a percentage of GDP [%]	1,9	1,4	2013
Business enterprise expenditure on R&D (BERD) [Mio. USD*]	67.569	768.910	2013
Percentage of BERD financed by government [only direct funding, %]	4,3	6,6	2013
Percentage of BERD financed by abroad [Percent]	4	6,5	2013/2012
Higher education expenditure on R&D (HERD) [Mio. USD*]	18.179	205.193	2013
Percentage of HERD financed by industry [Percent]	14,2	5,9	2013
Government intramural expenditure on R&D (GOVERD) [Mio. USD*]	15.243	127.355	2013
Percentage of GOVERD financed by industry [%]	10,1	3,8	2013
Total researchers in full-time equivalent	360.365	4.403.168	2013/2012
Total researchers in full-time equivalent per thousand total employment	8,5	7,8	2013/2012
Business enterprise researchers as a percentage of national total [%]	56,4	60	2013/2012
Patents with foreign co-inventors as a percentage of patent applications filed under the Patent Cooperation Treaty (PCT) [%][(1)]	15,7	7,2	2012

* at current prices and Purchase Power Parities (PPPs)
[(1)]OECD Patents Statistics

Figure 1 indicates the various public and private institutions where research and development is carried out in Germany and their interrelationships.

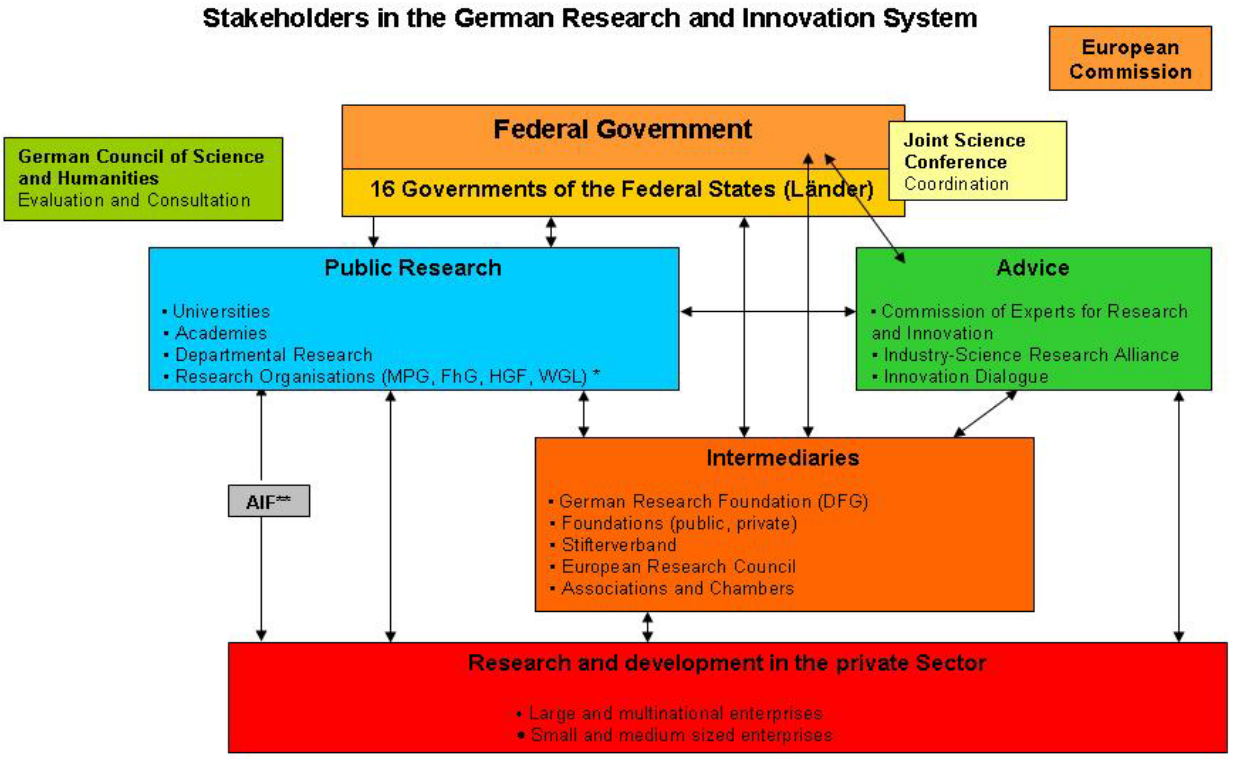

Figure 1: Stakeholders in the German research and innovation system (BMBF, 2014a).

1.1 Public Institutions, private non-profit institutions

Public facilities are primarily the universities – 108 universities and 210 universities of applied science. Whilst university research is characterized by its thematic and methodological breadth, the universities of applied science tend to concentrate on application oriented research. One of the main tasks of both types of universities is to train junior scientists. The overall R&D budget of the universities lay in the range of 14 billion euro in 2012 (BMBF, 2014a).

In addition to research carried out in universities there is also a wide range of non-university research carried out by private non-profit institutes. Besides the various academies, foundations etc., there are four research organizations with different profiles and focal points that play a key role:

a) The 82 institutes of the **Max-Planck-Society (MPG)** concentrate on free basic research in innovative fields. The focal areas lie in the biological-medical, physical-chemical, social sciences and humanities fields. The MPG considers itself as the most successful research organization in Germany. Since its establishment in 1948 18 Nobel laureates have emerged from the ranks of its scientists. MPG currently employs more than 17.000 staff of whom 5.654 are scientists (39.6% were foreign nationals). In addition, another roughly 4.700 junior and visiting scientists worked at MPG institutes (55,5 % came from abroad). The

annual budget lies in the range of 1.7 billion euro out of which 80% are basic or institutional funding (Max-Planck-Society 2015).

b) The **Fraunhofer Society (FhG)** is the largest European organization for applied research in health, security, communication, energy and the environment. In its 67 institutes and research units it carries out in particular research for industry, service companies and public organizations. Its annual budget is currently about 2 billion euro out of which more than 70% originate from industry contracts and almost 30% from the public sector. FhG currently has a total staff of nearly 24.000 (Fraunhofer Society 2015).

c) The **Helmholtz Association (HGF)** comprises 18 natural sciences, technical and biological-medical research centres. It contributes to solving grand challenges which face society, science and industry by performing top-rate research in strategic programmes in the fields of aeronautics, space and transport, earth and environment, energy, health, key technologies as well as structure of matters. It aims at researching systems of great complexity with its large-scale facilities and scientific infrastructure, cooperating closely with national and international partners. HGF currently has a total staff of more than 38.000 employees with an annual budget of more than €4 billion (Helmholtz Association 2015).

d) The **Leibniz Association (WGL)** currently comprises 89 institutions including 8 research museums focusing on application oriented and basic research and providing scientific infrastructure. The institutions are divided up into five Sections with differing focus areas: Section A - Humanities and Educational Research; Section B - Economics, Social Sciences, Spatial Research; Section C - Life Sciences; Section D - Mathematics, Natural Sciences, Engineering; Section E - Environmental Research. In 2014, The Leibniz Association employed more than 18.100 persons (9.217 Scientists of which 2.042 were foreigners) and has an annual budget of 1.64 billion euro (Leibniz Association 2015).

In addition to the aforementioned institutes there are another 46 federal and state funded departmental research institutions which work closely with the departments to create the in-depth scientific base for political decisions. In addition departmental research provides, in part statutory, research-based services for society and commerce in the fields of testing, approval, and drafting of regulations and monitoring. They also run national, international and supranational expert systems and databases as well as science-based measuring networks. Examples are the Federal Institute of geosciences and natural resources (BGR) which is subordinate to the Federal Ministry of Economy and Technology or the Physikalisch-Technische Bundesanstalt (PTB), the national metrology institute of Germany.

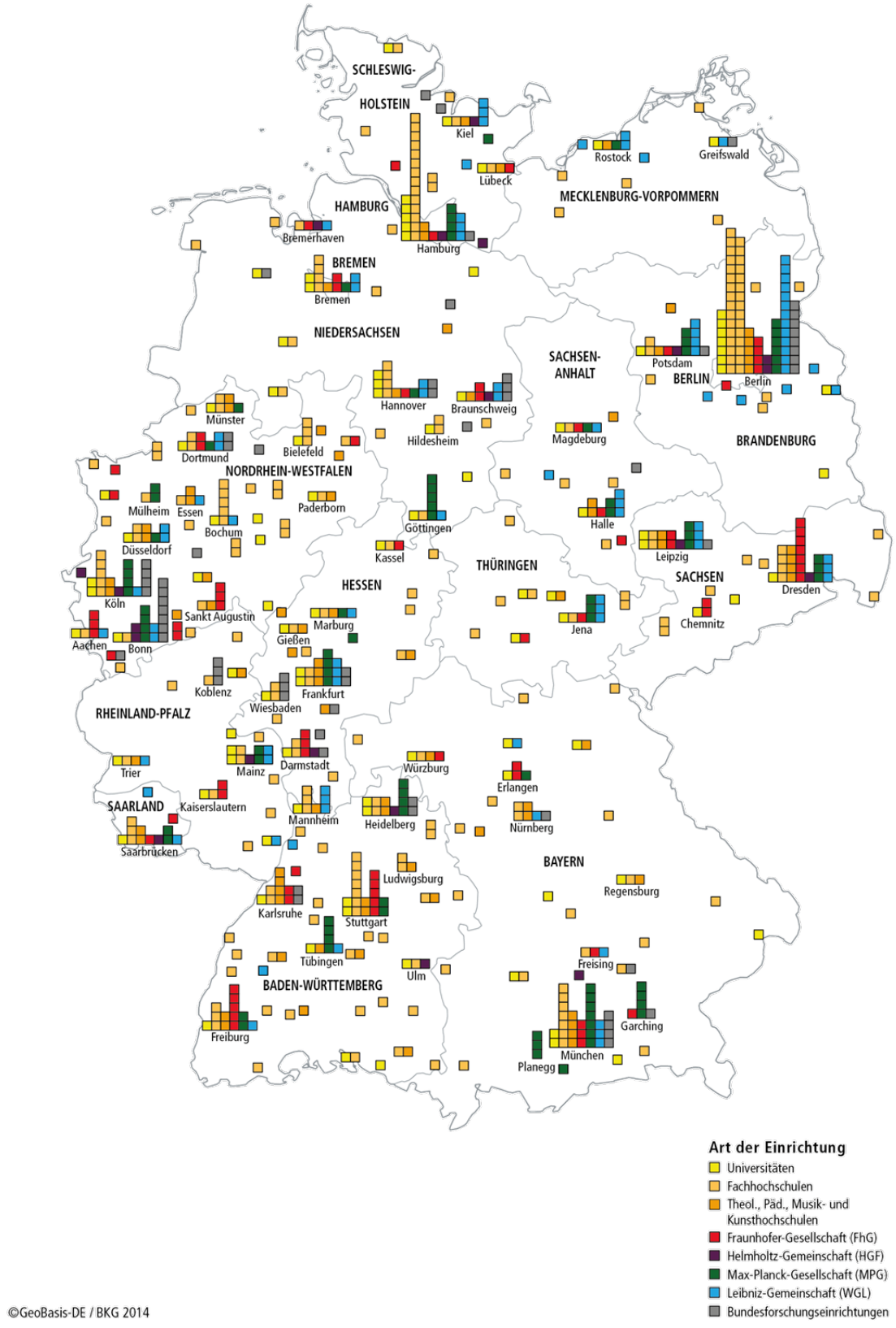

Figure 2: Locations of research institutions in Germany (DFG, 2015)

Figure 2 provides an overview of the location of research institutions in Germany. The map indicates the areas with high agglomerations of research institutions such as in Berlin, Munich Cologne/Bonn, Frankfurt, Stuttgart, and Hamburg as well as regions with less

developed publicly funded R&D infrastructure. The figure shows the locations of 427 higher education institutions (107 universities, 217 universities of applied science, 103 universities and colleges of theology, music and art as well as public administration) as well as of the institutes belonging to the four research organisations listed above (Federal Statistical Office, 2015). These organisations have institutes at about 250 locations in Germany.

Research is also conducted at some 60 federal research institutions, which are also shown on the map. A number of other publicly funded research institutions have been omitted from the map for the sake of readability. Among the institutions to be mentioned in this regard there are more than 200 state research institutions as well as libraries, archives and collections, and the Academies of Sciences and Humanities.
The Research Explorer information system provides more detailed information on Germany's "centres of research". It contains over 23,000 institutes at German universities and non-university research institutions, searchable by geographic location, subject and other structural criteria.

1.2 Private Sector

The business sector plays an important role in the German research landscape. Around two thirds of the total research & development funds are provided by the private sector. These funds are used for research in the individual companies and also for joint projects with science partners. The research is strongly application oriented and specifically designed to produce results that can be directly exploited. The internal R&D expenditure by the business sector totalled 58.8 billion euro in 2015[1] (Stifterverband für die Deutsche Wissenschaft, 2015). An evaluation of the sector revealed significant differences: around 37% of the internal R&D expenditure was invested in automotive engineering. Around 16% was used for electrical engineering R&D. This was followed by mechanical engineering with approx. 10%, the pharmaceutical industry with approx. 8% and the chemical industry with approx. 7%.
Increasingly, the business sector carries out research with partners from business and science. In 2013, around 22% of the R&D expenditure was spent on external research projects with and at other companies, universities and public research organisations (Stifterverband für die Deutsche Wissenschaft, 2015).

1.3 Government funding for research and innovation

The main constitutional regulations governing the joint funding of science and research by the federal and state governments are laid down in article 91b of the constitution. According to these regulations and based on agreements the federal government and the state governments can work together to fund

- Institutions and research projects outside universities
- Science and research projects at universities
- Research buildings at universities including large facilities

In addition the federal government has financing competencies for major research projects (e.g. aviation, aerospace, marine and nuclear research).

[1] Planned data based on basis data from 2013.

The federal governments funding instruments comprise:

a) **Project funding** – in particular by the Federal Ministry of Education and Research (BMBF), The Federal Ministry of Economics and Technology (BMWi), The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV), the Federal Ministry of Health (BMG) and the Federal Ministry of Defence (BMVg) – is distributed via funding and special programmes based on applications and fixed term projects. In addition to individual projects, combined projects with several partners may be financed. The project funding of the Federal Government totalled to 5.972 billion euro in 2013. The biggest share came from BMBF with 3.157 billion Euro, followed by BMVg with 940 million Euro and BMWi with 840 million euro. The other ministries contributed 870 million Euro together. Another increasingly important source for competitive funding are the EU framework programmes. So far, the mean value in FP 7 is at 724 million Euro (as per 2011) (BMBF, 2014a).

b) **Institutional funding** not only refers to individual research projects but also to the overall operation of and investments in research institutes that are funded for longer periods by the federal government or jointly by the federal and state governments. This secures the research infrastructure, competence and strategic direction of the German research landscape. Important examples of this are the payments made by the federal and state governments to the research organisations HGF, MPG, FhG and WGL.

c) **Departmental research** – as part of the federal administration the institutional core of departmental research lies with those institutions with research and developments assignments. They are assigned to a division of a specific federal ministry that also finances them. In 2010, there was approx. 830 million Euro available for institutions with research and development assignments. Parts of these funds are used for placing, monitoring and analysing external R&D projects (extramural processing of R&D projects) undertaken by institutions of the science system.

Figure 3 presents the regions that proved to be especially active in acquiring funds from the federal government's direct project funding programme and the thematic priorities that were set by these regions.
The figure presents a combined view of funding programmes for scientific institutions and for private enterprise. The Stuttgart, Munich and Berlin regions received especially large amounts of funding. Compared with the previous Funding Ranking (for 2005–2007), the federal government provided increased funding for the humanities and social sciences, the impact of which was seen especially for Berlin.
Both Berlin and Stuttgart give priority to research in information and communication technologies as well as to energy research and technology. In the Munich region, much of the funding acquired from the federal government is allotted to aviation and space research, which also plays a major role in Hamburg. In this region, substantial amounts of funding are accounted for by the German Electron Synchrotron (DESY) project, which is classified as major instrumentation for basic research.

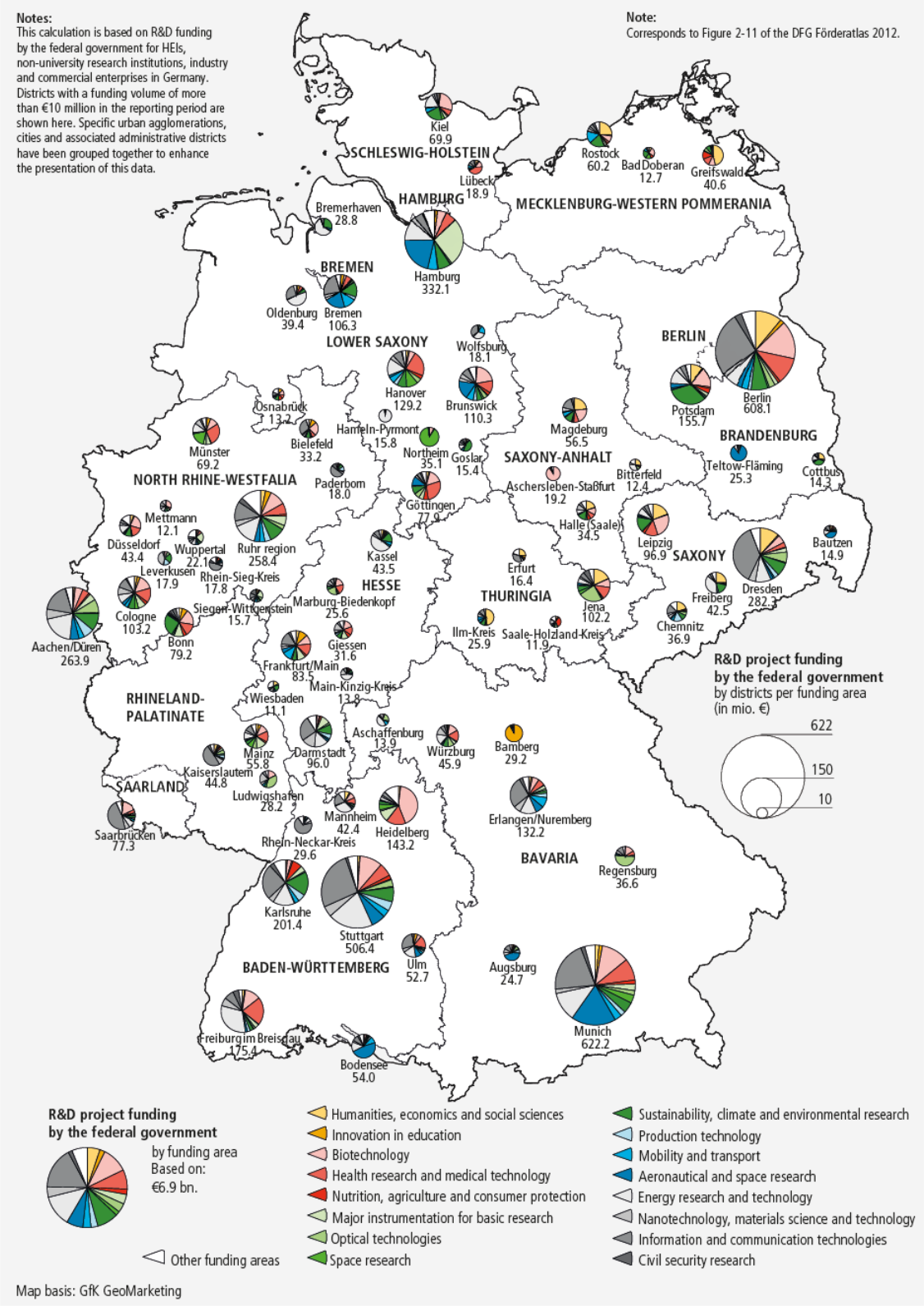

Figure 3: Regional distribution of R&D project funding by the federal government 2008 to 2010 by funding areas (DFG, 2012)

1.4 Research and innovation advisory services

In the **Innovation Dialogue**, high ranking representatives from science and business discuss new strategic approaches in innovation policy with the Chancellor and the Federal Ministers of Research and Economics. Since 2010 topics of innovation financing, cluster and network funding as well as technologies with a high potential for value creation have been addressed (Forschungsunion, 2015).

The **Commission of Experts for Research and Innovation** (EFI) advises the federal government in research, innovation and technology policy issues. The independent experts analyse the strengths and weaknesses of the German innovation system in their annual report (EFI 2015).

The **Industry-Science Research Alliance** plays a decisive role in the implementation and the further development of the High Tech Strategy 2020. It consists of 28 high ranking members from science and business and forms the forum for an intensive exchange between business, science and politics. While focusing on the 5 demand fields of the High Tech Strategy and developing future projects and initiatives for their implementation, it identifies drivers of as well as barriers to innovation (Forschungsunion, 2015).

The **German Council of Science and Humanities** has the task of advising the federal government as well as the federal state governments about questions relating to the content and structural development of universities, science and research. A special aspect of the council is that it acts as a mediator between science and politics. In addition to evaluating individual research organisations, facilities and universities and accrediting private universities it also looks at interdisciplinary subjects such as current topics and developments from the science world (Wissenschaftsrat, 2015).

Science academies: **The German Academy of Natural Scientists Leopoldina** – National Academy of Sciences – represents scientists from Germany in international committees and is also involved in providing science based advice from science and innovation to the society and politics (Leopoldina, 2015). It works closely with the **National Academy of Sciences and Engineering** which also promotes the dialogue between science, business, politics and society and advises and informs politics as well as society about engineering related future issues (Acatech, 2015).

Technology foresight: BMBF started the second cycle of its **Foresight** process to obtain renewed insight into the next 10 – 15 years. In an intensive two-year search phase, social trends and technological developments are recorded, analysed and linked to scenarios to allow early reference knowledge to be collated for future research and innovation policy (BMBF, 2015a).

2. Overall STI strategy

Education, research and innovation are seen as the key to sustainable growth. They are essential features of a high quality, long term growth strategy forming one of the principles of policies aiming for sustainability. New technical solutions and innovations are required not only to maintain Germany´s ability to compete in the global market but also to develop it further.

In order to develop Germany´s ability towards this goal, the German Federal Government launched the High-Tech Strategy in 2006, the first coherent strategy to foster research and innovation at national level. As the first of its kind, the policy strategy cuts across policy areas. This initial strategy was primarily focused on key enabling technologies and lead markets whilst also considering horizontal policy areas.

Since its launch, the High-Tech Strategy has been developed further in close co-operation with representatives from industry and science. In 2014, the **New High-Tech Strategy 2020** **(HTS 2020)** was launched representing a comprehensive and inter-departmental innovation strategy. The revised strategy is based on a broader concept of innovation encompassing social innovation. Moreover, the new High-Tech Strategy will place greater emphasis on transparency and participatory processes.

This represents the first comprehensive national innovation strategy with which the existing scientific-technical competences are summarized and specifically expanded. The **New High-Tech Strategy 2020** **(HTS 2020)** focuses on current and future challenges in Germany and across the world and identifies five demand fields:

- Climate/energy
- Health/nutrition
- Mobility
- Security
- Communication

The new High-Tech Strategy comprises five key elements for strategic re-orientation:

(1) Priority tasks relating to future prosperity and the quality of life

This element focusses on technology areas, such as the digital economy and society, sustainable economy and energy, the innovative workplace, healthy living, intelligent mobility and civil security.

(2) Improved networking and knowledge transfer

This element involves strengthening the cooperation between companies, universities and research institutions as well as strategically expanding universities' options for cooperation with industry and society. It also focusses on closing gaps in commercialisation and on advancing internationalisation of leading-edge clusters, core projects and other comparable networks.

(3) Creating more dynamic innovation processes in industry

The German government is committed to unleashing the potential of innovation processes in industry, particularly by promoting small- and medium-sized companies and technology-based startups and improving their potential for innovation.

(4) Creating favourable framework conditions for innovation

The focus of this element is on creating favourable framework conditions for Germany's innovation system concerning access to a highly-skilled workforce, access to innovation finance and the creation of other social, technical and legal framework conditions for innovation.

(5) Transparency and participation

This element involves the development of a more active dialogue through the involvement of civil society, enhancing society's openness towards technology, and supporting participation of the general public in social innovation.

3. New initiatives/emerging technology fields

There are a number of projects and initiatives currently being carried out with the aim to promote education, research and innovation in Germany. Four of the most important pillars will be listed here.

3.1 Promoting the High Tech strategy (HTS) 2020 for Germany

The High-Tech-Strategy aims to create underlying conditions favourable for funding innovation, allowing ideas to become innovations more quickly by, for example, facilitating the funding of innovations - in particular for small and medium sized enterprises (SME) – and by improving the conditions for setting up innovation-oriented companies (BMBF, 2014b).

The funding of important **key technologies** is targeted toward the progress in the five demand areas because key technologies such as biotechnology and nanotechnology, micro- and nanoelectronics, optical technologies, microsystems technology, advanced materials and production technologies, energy technologies, aerospace technologies and information and communication technologies are seen as prime drivers of innovation and form the basis of new products, procedures and services. The critical issue is to transfer them into commercial applications. Therefore, the focus of funding is placed on application oriented fields.

A central concern of the **HTS 2020** is aligning the research and innovation policy to central missions. Increasingly, socially and commercially relevant advances in innovation take place at the interfaces between technologies and disciplines. Also, central challenges require systematic approaches involving various technologies in order for complex solutions to be devised. Innovation policy therefore also needs to go beyond research and include realization and implementation steps. This is the background against which the federal government has developed ten mission-oriented **forward-looking projects** through which systematic solutions are devised to counter urgent social challenges while at the same time contributing to the competitiveness of the German economy. The ten forward-looking projects are:

- CO2-neutral, energy efficient and climate adapted cities
- Renewable biomaterials as an alternative to oil
- Intelligent restructuring of energy supply
- Treating diseases more effectively with the help of personalized medicine
- Better health through targeted prevention and an optimized diet
- Living an independent life well into old age
- Sustainable mobility
- Web-based services for business
- Industry 4.0
- Secure identities

Building a bridge between science and business is one of the core elements of the High Tech Strategy. Scientific institutes and companies already work hand in hand. 58% of companies that enter into research cooperation in Germany also work with universities, around 28% with non-university research institutes (BMBF, 2014b).

To further tap the existing potential, BMBF launched the **Leading Edge Cluster Competition** in 2007 to consolidate and expand the link between science and business. After the selection of the third and final round in January 2012, **15 Leading Edge Clusters** were named. The spatial distribution is shown in Figure 4. The clusters are involved in a diverse and forward thinking

range of areas and make important contributions to the forward-looking projects. Up to 350 partners from universities, research institutes, companies in a region as well as representatives from the region work together on a joint strategy. The government funding is 40 million Euros per cluster and year over a period of 5 years, i.e. a total of 600 million Euros per year. This is matched by funds from the participating companies, coming to a total of around 1.2 billion Euros per year (BMBF, 2015b). Two examples for leading edge clusters are outlined in the following.

Examples:
The **Leading Edge Cluster "Forum Organic Electronics"** in the Rhine Neckar region wants to use the flexibility and transparency of construction elements based in organic electronics to open up new application fields for lights, solar energy production and the mass production of electronic parts. The cluster has more than 20 members that cover the entire value chain from researching new materials, designing construction parts, through to marketing applications.

The Leading Edge Cluster Cool Silicon Valley with more than 100 companies and research institutes is a pioneer in the field of highly energy-efficient micro-electronics. Semiconductors for computer systems and broadband radio systems and also wireless and energy self-sufficient sensor nodes are developed, e.g. a self-sufficient sensor node for monitoring aircraft structures made or carbon fiber reinforced plastics (CFK). Younger scientists are also targeted, for example through the newly launched English language Masters study course "Nano-electronic Systems".

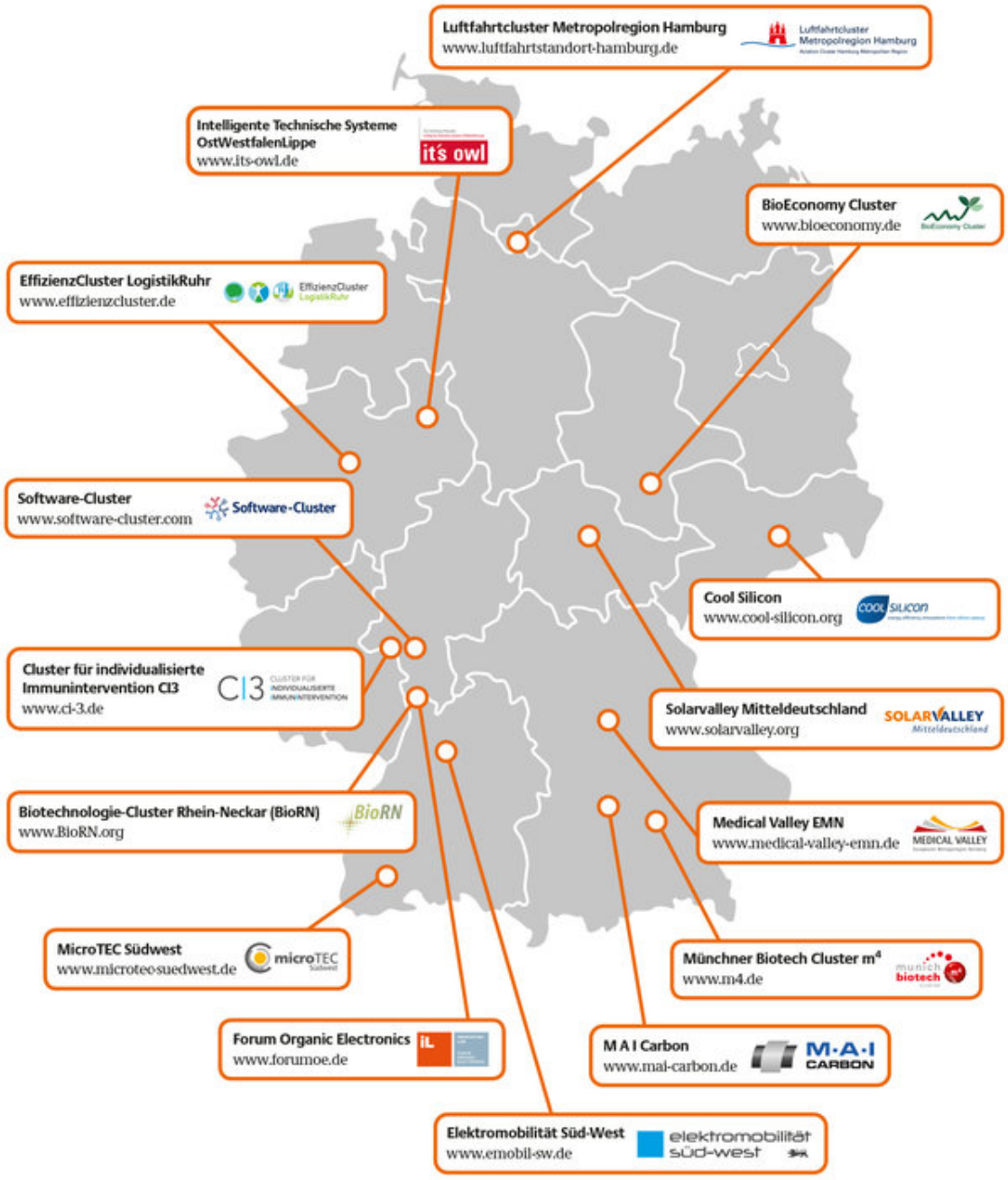

Figure 4: The Leading Edge Clusters in Germany (BMBF, 2015)

3.1.1 Internationalization of Leading Edge Clusters in Germany

During times of increasing globalization it is necessary to connect innovation with international partners in science and industry. The promotion of the internationalization of leading edge clusters represents an important part of this process. It helps bundling competences through strategic international cooperation to gain and profit from additional know-how. Therefore, an announcement by the BMBF in 2014 aims to further link German R&D with worldwide networks of knowledge and competence in order to increase the potential for innovations and competitiveness within companies.

In leading edge clusters, science and industries already cooperate well on a national level producing new technologies, products and solutions in multiple business branches. Doing so, participating companies and institutions were able to become leading actors and to receive international reputation. This is where the new BMBF measure sets in: Outstanding cluster and networks within worldwide leading ranks are embedded into long-term global knowledge processes via the development of strategic cooperation with leading innovative regions. Especially SMEs will profit from becoming part of networks consisting of large companies, universities and research institutions. As part of this process, leading edge clusters and successful networks are creating new innovation impulses and bridging the gap towards international cooperation.

This measure is planned to be carried out from June 2015 onwards in two phases. First, during a maximum of two years, a conception phase will be developed as a basis for further cooperation with international partners. Second, an up to three years lasting phase of implementation seeks to realize up to three internationalization projects with equal contribution of involved players. Two further cluster internationalization calls are planned for the subsequent years (BMBF, 2015c).

3.1.2 Promoting Networks of Competence

In the **BMWi** supported initiative **Networks of Competence** more than 100 technology networks in 9 branches and 30 regions were established which have a combined total of 9.000 members, among them some 6.000 SMEs (Figure 5). As the initiative ended on April 30, 2012 BMWi has been offering in its **Go Cluster program** targeted support for the cluster managers aimed at professionalizing their work. One of the goals of BMWi is to continue developing the national innovation clusters to turn them into excellently managed clusters as specified by the European quality criteria. "go-cluster" offers needs-oriented services to all target groups: cluster managers, cluster players or representatives from government, science and business.
The objective is to: support the transformation of the most efficient national innovation clusters into international clusters of excellence; promote new cluster services to stimulate cluster managers to offer new services; increase international visibility of participating innovation clusters; analyse trends of international cluster policy to work out recommendations for the German perspective.

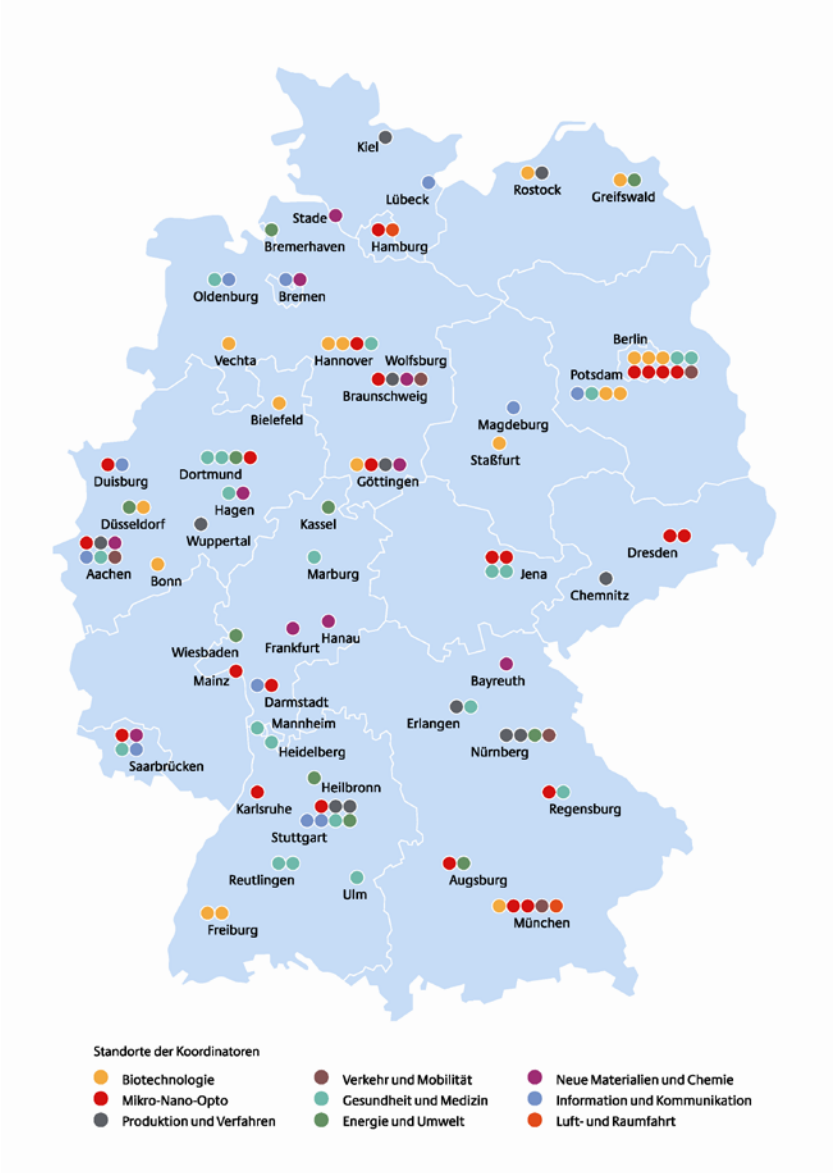

Figure 5: Networks of Competence in Germany (BMWI, 2006)

3.2 Strengthening Science

As the science system is one of the top priorities of the federal government and the state governments, the federal government is also striving to expand the cooperation with the state governments in this area.
Three major reform initiatives by the federal and state governments have been brought on the way:

The Higher Education Pact 2020 aims to equip the German higher education system for the challenges of the future. The number of young people eligible to study in higher education will continue to increase significantly in coming years. Furthermore, international competition requires a further improvement in universities' profile in research. That is why the Federal Government and the Länder agreed to create a financial framework for stronger and internationally more visible universities and to support universities in expanding their study

programmes. After all, Germany has a steadily increasing need for highly qualified people in demanding occupations and there is an especially high demand for graduates in the so-called MINT subjects (mathematics, informatics, natural sciences and technology). Furthermore, the pact is also intended to promote equal opportunities for women.

The Federal Government will support the Higher Education Pact 2020 with more than 7 billion euros in funding between 2011 and 2015. The Länder will provide comparable additional financial support and secure overall funding. A further 2.7 billion euros will be made available by the Federal Government for the second phase of funding until 2018 (BMBF, 2014a).

The **Higher Education Pact** has three major pillars:

(1) The creation of a needs based range of study programs ensuring the quantitative expansion of the academic training. Between 2007 and 2010 185.000 new college places were created. In the second phase (2011 – 2015) another 320.000 to 335.000 additional college places will be created. The federal government will provide at least 4.7 billion Euros for the second phase.

(2) The federal and state governments also decided to participate in the overhead financing as part of the various project funding schemes, namely the research funding programme by the German Research Foundation (DFG). Universities can receive a lump sum which totals 20% of the direct project funds. Until 2015 the federal government will bear these costs in the order of 1.7 billion Euros alone.

(3) The Teaching Quality Pact (2011-2020) supports 186 universities from all 16 states by helping them to improve their study conditions. Until 2020 the federal government will invest around 2 billion Euros for this purpose (BMBF, 2011, 2014c).

The **Joint Initiative for Research and Innovation** aims at strengthening and accelerating the dynamic development in the non-university research field. The non-university research institutes HGF, MPG, FhG, WGL and the DFG as the funding organization of university research can secure their position in the long term. Between 2011 and 2015 the institutional funding of these organizations will increase by 5% each year.

The **Excellence Initiative** for Cutting Edge Research at Institutions of Higher Education aims at promoting innovative cutting edge research at German universities to make them more competitive and internationally more visible. In the first two selection rounds 2006 and 2007

- 39 graduate schools, where junior scientists are promoted and work is performed in cross faculty and interdisciplinary teams,
- 37 excellence clusters, in which cutting edge research takes place and which usually integrate at least two specialist fields,
- Nine universities which will implement new institutional concepts to position themselves among the top universities worldwide (Example: in Karlsruhe the Technical University merged with a non-university public research institute of the Helmholtz Association to the Karlsruhe Institute of Technology – KIT) were granted solely on the basis of scientific evaluation with a funding volume of approx. 1.9 billion Euros. In 2009 the continuation of this programme until 2017 was decided along with an increase of the available funding by another 2.4 billion Euros (BMBF, 2015d)

In the third and last round in June 2012, the Grants Committee selected a total of 39 universities from 13 states: 45 graduate schools and 43 clusters of excellence made it through the science-based selection process, while the institutional strategies of the FU Berlin, HU Berlin, Bremen, Dresden, Köln, LMU München, TU München, Konstanz, Heidelberg, RWTH Aachen, and Tübingen won over the Committee in the third funding line. The new projects started in November 2012 and have a duration of 5 years each (DFG, 2013).

3.3 Further training within the science community for enhancing the innovation capability

Against the background of demographic change securing a good skilled labour basis – in particular concerning highly qualified personnel – is seen as essential for maintaining and further expansion of Germany´s high-performance science system and thereby the innovation capability and competitiveness of the country. The majority of forecasts come to the conclusion that there will be a shortage of skilled workers in Germany due to demographic change meaning that the population of Germany is both shrinking and ageing. This is the reason why the federal government devised a **skilled labour concept** which is directed at all target groups in the labour market. It comprises both the training of young people as well as the qualification of older people. Education, with the exception of vocational training, lies in the responsibility of the federal states. Therefore the federal government and the federal states work hand in hand. Along with the intended increase of the R&D budget to 3% of the GDP in 2015 the expenditure for education shall raise from 6.8% in 2009 to 7% of the gross domestic product.

In addition measures are being taken to promote language skills at an early age, to introduce children in day care centres science and technical topics via the "**Little Scientists House**", to reduce the number of school drop outs, to educationally disadvantaged children and teenagers with extracurricular activities in the framework of the Education Alliance programme and to attract at least 40% of an age cohort to start a degree at an institution of higher education.

The utilization and funding of domestic potential alone will not balance the effect of the demographic change. Therefore, the federal government wants to facilitate the immigration of qualified personnel by implementing the EU highly qualified persons directive (Blue Card) and to improve the legal residence rights and prospects of foreign graduates of German universities.

3.4 Intensification of European and International cooperation

Research and education are of growing importance in the field of international cooperation in terms of the overriding goals of foreign policy, be it in the areas of business, security, European integration or global cooperation for finding solutions to global challenges such as climate change, health, migration or demographic change.

The federal government´s research and innovation policy objectives, along with Europe´s declared intention to become the world´s most competitive science based economy calls for a better exploitation of the opportunities offered by international cooperation. The federal government has responded to these challenges by formulating the **Strategy of the Federal Government for the Internationalization of Science and Research** in 2008. This strategy has four designated priority fields:

- **Strengthen cooperation with the world´s best** – Germany wants to further develop the quality of its education and research landscape to achieve the very highest level. All efforts here focus on strengthening national excellence by further developing and intensifying the cooperation with the world´s best scientists, experts and institutes.

- **Developing innovation potential at an international level** – Help is provided to companies, research institutes and universities when developing their international innovation potential allowing them to improve their position in the global competition. The two key focuses are to use global knowledge for own research driven innovation and facilitating the access of German innovative products to the international markets.

- **Strengthening the cooperation in education and research with developing countries in the long term** – the internationalization strategy aims to give a new quality to the cooperation with developing countries in the fields of education, science and research by further expanding vocational training, tertiary education, science and research and thereby creating the necessary basis for addressing joint solutions to global issues.

- **Assuming international responsibility and coping with global challenges –** at the start of the 21st century mankind faces immense challenges like resource consumption, climate change etc. The supply with safe, environmentally-friendly energy, food and other resources has become a systemic transformation task. These challenges cannot be solved by just one country. Germany with its highly developed research and innovation capacities can make significant contributions toward finding evidence based solutions to global challenges (BMBF, 2008).

In 2014, "**The BMBF's International Cooperation Action Plan**" connects with the Federal Government's BMBF-led strategy for the Internationalization of Science and Research ("Strengthening Germany's Role in the Global Knowledge Society", 2008). The Action Plan has the following key areas:

- Outlining the analytical principles for strategically placing the international instruments and projects on a sound evidence base;
- Pooling the various BMBF strategies in order to establish a standard frame of reference;
- Using the new frame of reference for future specialist, regional and country strategies;
- Increasing the impact of the various BMBF activities through stronger goal orientation and coordination;
- Establishing a basis for stronger networking activities between stakeholders in the fields of research and education policy with a view to ensuring a more coherent international presence;
- Identifying and implementing projects which can serve as examples for further measure with regard to their structural approach, networking and impact (so-called "beacons") and
- Increasing the visibility of Germany's excellent education, research and innovation scene.

The plan draws five central conclusions which are the key to Germany's future success as an attractive site for education, research and innovation in the face of international competition:

1. More mobile: Germany must continue to increase the mobility of trainees, students and scientists both to and from Germany in order, among other things, to meet the future demand for skilled staff.

2. More effective: Cooperation and funding procedures are to be made as easy as possible; obstacles to bilateral and multilateral cooperation must be reduced.

3. More efficient: Germany must improve its networking activities and promote networking at all levels as well as between all stakeholders, both national and international.

4. More focused: Germany must focus even more consistently on quality and excellence in its global relations to the benefit of all concerned.

5. More site-aware: Germany must define its interests more closely and consider international collaborations from the aspect of strengthening the competitiveness of German industry (opening up markets) and science.

The BMBF will adopt the following measures in compliance with the Coalition Agreement

- strengthen research cooperation with the world's best
- tap international potential for innovation and among other things
- strengthen cooperation with the emerging and developing countries lastingly and among other things
- contribute towards tackling global challenges and among other thing
- create prospects for both people and industry through training and among other things
- present a strategy for cooperation with the OECD;
- strengthen the UN Campus in Bonn;
- Establish a comprehensive monitoring system. This monitoring system will cover the internationalization of the German research landscape as well as the opportunities for cooperation and international developments of important partner countries (BMBF 2014d).

4. Description of mechanisms and assessment of best practices for strengthening the University – industry collaboration and supporting the commercialization of university research

There are numerous attempts in Germany to accelerate the transfer from research output to application in form of products or research based services. This requires strengthening the interaction between universities and non-university research institutes and the private sector. An important step was the change of the patenting regulations at universities in 2002 through which inventions now are owned by the university rather than by the inventor himself. This led to the installation of technology transfer units at universities which also advise the researchers in all questions of patenting. Mainly the technical universities have always had closer ties to the private sector.

One example of how universities link up with industry is the Research Cluster model of the technical university in Aachen. Research clusters are thematic research networks which provide businesses and university departments with the opportunity to conduct joint projects and develop new processes and products collaboratively. Simultaneously, employees of the research partners are included in education and further training on the Campus. Up to 19 clusters will take shape on the RWTH Aachen Campus, complete with office, testing, and laboratory facilities, in which industry companies and university institutes can work defined research focuses taking collaboration and exchange to a whole new level (RWTH Aachen 2015).

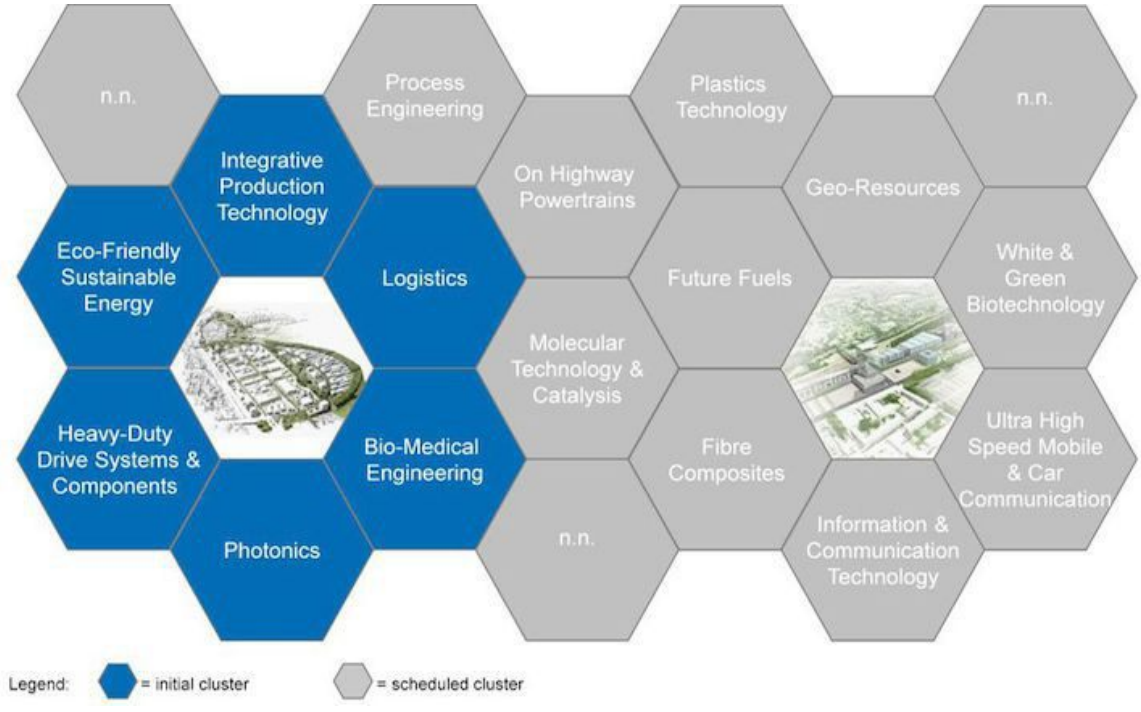

Figure 6: Research Cluster model of the RWTH Aachen (RWTH Aachen Campus GmbH, 2015).

There are also numerous regional initiatives. One of the largest in Germany is the Innovation Alliance of the universities in North Rhine-Westphalia (NRW), a registered alliance of more than 20 member universities, universities of applied sciences and university spin-off [transfer]

organizations in NRW. It has the aim of increasing public awareness and practical application of its members' scientific competence and experience in research and creating a common platform for collaboration with business partners. By acting together, members of the alliance realize key competitive advantages. The NRW Innovation Alliance supports the promotion of research and knowledge transfer at participating universities by, among others, offering services for these universities, brokering cooperation between researchers and businesses, and its continuous proactive public relations activities. Jointly defined quality standards apply for all participating universities and partners (InnovationsAllianz, 2015).

4.1 The Research Campus initiative

The challenges of the future can only be met if science and industry cooperate with one another more intensively and at a much earlier stage. In view of this, the **Forschungscampus ("research campus") funding initiative** supports medium- to long-term public-private partnerships which bring their partners together in one place. Apart from establishing long-term, binding and equal partnerships under one roof the aim of the programme is also to support very complex research fields with a high research risk and special potential for breakthrough innovations.

Nine public-private partnerships were awarded the title Research Campus (BMBF, 2015e). Each selected Research Campus will receive funding of 1 to 2 million Euros per year as an orientation framework for a maximum of 15 years. Thus a medium-term partnership lasting ten years could receive up to 20 million Euros from the BMBF for joint research activities. The partners involved will also contribute significant resources. The winners are:

- ARENA 2036 - Active Research Environment for the Next Generation of Automobiles, Stuttgart
- Digital Photonic Production, Aachen
- Future electric grids, Aachen
- EUREF-Forschungscampus: Sustainable Development of Energy and Mobility by Coupling Intelligent Grids and Electromobility - "Mobility2Grid ", Berlin
- InfectoGnostics, Jena
- Mannheim Molecular Intervention Environment (M2OLIE), Mannheim
- Mathematical Optimization and Data Analysis Laboratory - MODAL AG, Berlin
- Open Hybrid LabFactory, Wolfsburg
- STIMULATE - Solution Centre for Image Guided Local Therapies, Magdeburg.

Figure 7 shows the location of each of the winners in Germany.

Figure7: Regional distribution of winning research campuses (BMBF, 2015e).

4.2 EXIST

For university based business startups BMWi runs the so called **EXIST** - programme. The programme aims at improving the entrepreneurial environment at universities and research institutions and at increasing the number of technology and knowledge based business startups. The EXIST programme is part of the German government's "Hightech Strategy for Germany" and is co-financed by funding of the European Social Fund (ESF) (EXIST, 2015).

The EXIST programme includes three programme lines:

1. The EXIST programme line "Culture of Entrepreneurship" supports projects at universities to build up an infrastructure for providing skills and support for technology and knowledge-based innovative ventures. In support of these activities, universities receive an allowance from the German Federal Ministry of Economics and Technology over a three-year period.

2. EXIST Business Startup Grant supports the preparation of innovative business startup projects at universities and research institutions.

3. EXIST Transfer of Research promotes technology-based business startup projects in the pre-startup and the startup stage. EXIST Transfer of Research complements the broadly targeted EXIST Business Startup Grants with an excellence-oriented measure for high-tech startups.

4.3 High Tech Gründerfonds

The **High Tech Gründerfonds** (High Tech set-up fund – HGTF) provides venture capital for new technology company startups. The HGTF has been financing young technology companies as well as providing management support with a thematic focus on life sciences, advanced materials and informatics. Since 2005 over 400 startup companies have been launched successfully. Next to the 576 Mio. € originating from HTGF I and HTGF II funds, so far, more than 940 Mio. € of additional capital have been raised into the portfolio in about 785 follow-on rounds of financing. Moreover, HGTF successfully exited 53 portfolio companies in that same timeframe (HGTF 2015).

5. Description of partnership models utilized by government and related agencies to encourage clustering and precompetitive research between firms and assessment of best practices

There are a number of programmes initiated by the German government to support companies in their clustering and research activities. One of the most important one is the Central Innovation Program SME (ZIM) which will be presented as a positive example of how to successfully connect companies with research, education and innovation.

5.1 The Central Innovation Program SME (ZIM)

ZIM is a funding programme for small and medium sized enterprises (SME) with business operations in Germany that want to develop new or significantly improve existing products, processes or technical services. As the cooperation partner of an SME, public and private non-profit research and technology organisations (RTO) are also eligible. The programme is open to all branches and technological sectors. ZIM provides a reliable source of support for innovation efforts since 2008. The aim of ZIM is to sustainably increase the innovative capacity and competitiveness of SMEs including craft businesses and independent professions and in doing so contribute to their growth and the generation of new jobs.

ZIM offers multiple funding variants for custom-fit funding, possibilities for continuous application and quick decision processes. Funding options are available for individual or cooperation projects as well as for cooperation networks. Furthermore, funding is provided for services and consultation related to marketing activities. Within ZIM there are different possibilities for cooperation with international partners. German companies working with foreign partners in a ZIM project receive a bonus of 5% on top of the normal funding rates (BMWI, 2015).

5.2 Knowledge and Innovation Communities (KICs)

KICs are the results of the European Institute of Innovation & Technology (EIT) mission to fully integrate all three sides of the "knowledge triangle" consisting of higher education, research and businesses. By bringing together leading players from all these dimensions to cooperate within the KICs, the EIT is able to promote innovation in Europe (EIT 2015).

KICs are characterized by the following features:

- **High degree of integration:** each KIC is organized around an independent legal entity, gathering world-class KIC partners from all the innovation dimensions. The specificity of the KICs is to integrate, education and entrepreneurship with research and innovation at the EU level to deliver incremental and disruptive results.

- **Long-term perspective:** each KIC is set up for a minimum of seven years to contribute to overcoming fragmentation via world-class, long-term, integrated partnerships. This

enables partners to commit to a strategic initiative for a longer time than in traditional innovation policy initiatives.

- **Efficient governance:** each KIC is driven by a CEO and KIC partners are represented by single legal entities for more streamlined decision-making. KICs must produce annual business plans with clear targets and deliverables looking for both market and societal impact.

- **The co-location model:** each KIC consists of five or six world-class innovation hotspots, building and leveraging on existing European capacities. A co-location centre brings together diverse teams of individuals from across the Knowledge Triangle in one physical place, acting as a hub for many activities and combining competences and skills developed in different areas of specialization (EIT 2015a).

KICs carry out a whole range of activities, covering the entire innovation chain including training and education programmes, reinforcing the journey from research to the market, innovation projects and business incubators. They have been conceived so that they are able to react in an effective and flexible way to new challenges and changing environments.

The KICs are driven by a pursuit of excellence in all of their activities and are established with the aim of reaching the necessary critical mass to achieve systemic impact, including the creation of new businesses and new jobs as well as the promotion of new skills and entrepreneurial talent in the economy.
The EIT's first three KICs were launched in 2010:

- **Climate-KIC:** addressing climate change mitigation and adaptation
- **EIT ICT Labs:** addressing information and Communication Technologies
- **KIC InnoEnergy:** addressing sustainable energy

And a further two in 2014:

- **EIT Health:** addressing healthy living and active ageing
- **EIT Raw Materials:** addressing sustainable exploration, extraction, processing, recycling and substitution (EIT 2015)

5.2.1 German Participation in KICs

German activities are present and of high importance in almost all KICs that have been launched since 2010. German core partners and offices in each of the KICs are listed below:

- **Climate-KIC:** Bayer Technology Services, Forschungszentrum Jülich, German Research Centre for Geosciences, Potsdam Institute for Climate Impact Research, TU Berlin

- **EIT ICT Labs:** Leadership members from the Deutsche Telekom AG and DFKI; TU München, TU Berlin, FhG, Siemens as core, affiliate and associate partners

- **KIC InnoEnergy:** Offices in Berlin, Karsruhe, Munich and Stuttgart;

- **EIT Health:** Co-location Centre in Heidelberg; headquarters based in Munich

- **EIT Raw Materials:** Key coordinating partner from Helmholtz-Zentrum in Dresden; headquarters based in Berlin

5.2.2 EIT Health and EIT Raw Materials in detail

Germany managed to become head leaders in both EIT Health and EIT Raw Materials. Until 2020, up to €540 million have been provided by the EU to realize the KICs ambitious goals. Playing a major part in both KICs highlights Germany's role as a leading player in competitive research and innovation within Europe. Besides universities and research institutes it will be the leading edge clusters that will profit from this coordination on a European level.

For the EIT Health, the consortium "InnoLife", consisting of 144 partners from 16 European countries, was chosen to be the leading actor. Other partners involved in EIT Health are the MPG, Roche Diagnostics, RWTH Aachen, Siemens Healthcare and TU Munich. The aim of this KIC is to maintain health and promote active ageing via innovative products and services.

For the EIT Raw Materials, the KIC "RawMatTERS", consisting of 116 partners from 22 countries, was selected to play a crucial role. This project is led by the HGF in Dresden and coordinated from Berlin. Further participators are several Fraunhofer Institutes, BASF, Varta Microbattery, CUTEC, RWTH Aachen and TU Freiberg. Here, the aim is improve resource efficiency and the processing of metallic products. Furthermore, recycling along the material chain are to be optimized and resources substituted (BMBF, 2015f).

6. Design principles and parameters of arrangements for institutions that have a role in delivering value for the private sector

There are many different principles for cross-border collaboration of institutions and clusters. Two important ones are highlighted in the following.

6.1 Fraunhofer – largest European applied research organisation

The **Fraunhofer Society (FhG)** as largest European organization for applied research is of crucial importance and a good example of how to connect research with industry, service companies and public organizations. They see innovations as the basis for success in economy and within companies, especially in industries where product life cycles are constantly getting shorter due to global competition and continuing technological development.

It is the close cooperation with industry partners that tailors FhG research to the challenges of companies. The efficient style of collaboration ensures customers to get the agreed solution on time and ready to put into practice. Customers often make a direct approach to Fraunhofer as a first contact. Then, the company is invited to an initial consultation. The goal of this initial discussion is to establish what the objectives would be for a potential cooperative venture and how the budget and schedule might look. This is followed by contract negotiations, the signing of an agreement, and commencement of the research and development work. The scope and scale of cooperation with Fraunhofer is flexible, with the institutes catering to the specific needs of each particular client. Fraunhofer only starts charging for its R&D work once the scope of the cooperation has been defined and the corresponding agreements have been finalized.

Thanks to their broad customer base, FhG researchers also have plenty of experience in how companies think and work. FhG works for businesses and helps customers transform knowledge into profit. To a certain degree Fraunhofer can inject its own funds into future-relevant projects through the Fraunhofer-Zukunftsstiftung (Fraunhofer Future Foundation). The fact that many of the cooperation projects in which Fraunhofer plays a major part receive funding from the German state or the EU is most interesting to customers.

FhG applies the same principle of confidentiality internationally as it does nationally and ensures that all international research activities offer clear advantages to customers and sponsors. Working in international teams and dealing with global market requirements in projects abroad provides researchers with invaluable experience benefiting domestic customers, too.

Finally, Fraunhofer helps its customers by improving products, moving from product development to short-run production as well as market analysis and innovation consulting services. Further help is provided via incorporating new technologies, acquiring licenses, optimizing existing processes and organizational structures as well as characterization, testing and certification. Fraunhofer is highly regarded by the professional and business communities and by buyers of finished products to the satisfaction of many companies that their development work was carried out in collaboration with a Fraunhofer Institute (FhG 2011).
Fraunhofer has furthermore research sites in Canada (Project Center for Composites Research), USA (Fraunhofer USA, Inc., and further devevelopment centers), Brasil (two Project Centers), Chie (Fundación Fraunhofer Chile Research).

6.2 Cross-border collaboration of German clusters

There have been 10 leading edge clusters of Germany which succeeded in the competition to internationalize their collaboration with cross-border partners (BMBF, 2015c).

Cluster	Region / International Partners	Description	Link
BioRN	Rhine-Neckar Metropolitan Region / Israel	About 80 companies from the field of red biotechnology develop drugs, technology platforms and diagnostics at the Biotech Cluster Rhine-Neckar (BioRN).	www.biorn.org
CLIB2021	Bio-Innovation Growth mega-Cluster / Belgium, The Netherlands	International open innovation cluster in biotechnology and the bioeconomy.	www.clib2021.de:
Cluster Leistungselektronik im ECPE e.V.	Bavaria / Europe	Next generation of electronics.	www.clusterle.de
Hamburg Aviation	Hamburg Metropolitan Region / France	Aviation industry cluster	http://www.hamburg-aviation.de/en/start.html
Institute of Plastics Processing (IKV) and the Skilled Crafts at RWTH Aachen University	Aachen / globally	Europe-wide the biggest research and education institute engaged in the field of plastics processing enjoying outstanding reputation	http://www.ikv-aachen.de/en/
Innovations for the Plastics Industry	Lüdenscheid / Europe	CAP - Development of coatings and particles for the plastic industry	http://www.kunststoff-institut.de/inhalte/en/startseite.php
Medical Valley EMN	Nürnberg / Globally	Development of an international innovation system in medical devices and health care	http://en.medical-valley-emn.de/
Merge	Chemnitz / Europe	Technologies for Multifunctional	https://www.tu-chemnitz.de/MERGE/ind

		Lightweight Structures	ex.php
OptoNet e.V	Thüringen / Europe	Photonic network	http://www.optonet-jena.de/startseite/
Organic Electronics Saxony	Saxony / Europe	Organic Electronics	http://www.oes-net.de/en/home.html
Software-Cluster	Southwest of Germany / Europe	Enterprise Solutions	http://www.software-cluster.org/en/

7. Analysis of public support mechanisms to stimulate innovation that are not R&D-based

7.1 Knowledge transfer networks

The transfer of knowledge and technology as the so-called "Third Mission" of universities is central to most higher education facilities in addition to teaching and research. The transfer of knowledge and technology aims at bridging the gap between invention and innovation and utilizing newly acquired scientific knowledge and new technologies in both a systematic and structured way, thereby realizing their market potential (University Koblenz-Landau 2015). Examples of knowledge transfer networks in Germany are:

The knowledge transfer network Rhineland-Palatinate is an association of the knowledge and technology transfer centres of 11 universities of applied science providing advice to the business community on establishing cooperation agreements and other links between universities and enterprises. As a partner in innovation processes, this network provides possibilities within the science community in Rhineland-Palatinate offering information on current research results and access to modern research facilities. The network further helps finding common development goals, connects highly qualified young academics as well as it debates personal requirements competently to find the best solution for cooperation (Transfernetz Rhineland-Palatinate 2015).

The **German Association of Innovation, Technology and Business Incubation Centres (ADT)** as part of the German Center for Research and Innovation (GCRI), represents another important facility supporting its member centres in fulfilling their task on initiating and overseeing innovative technology-oriented startups. By pursuing this approach, the ADT fosters the growth of small and medium-sized enterprise economy as well as innovation-oriented structural change in all regions of Germany. The goal of the ADT is to promote technology transfer and innovation as well as business startups and enterprise development. It also seeks to further develop the importance and competence of the Innovation Centres in order to support innovative entrepreneurs and to present them appropriately in the public domain. The ADT represents the interests of the Innovation Centres and startup companies thus also, in public areas such as politics, industry, science and the media (GCRI 2015).

The **ATI Westmecklenburg GmbH (Agency for Technology Transfer and Furtherance of Innovations)** is a regional development agency in West Mecklenburg in the German state of Mecklenburg-Vorpommern. The company performs the search for new technological products, procedures and services, concepts and their realization as well as technology transfer between

scientific institutes and entrepreneurs. The aim is to professionalize and promote technology transfer between the R&D at universities and businesses as well as support business startups and entrepreneurs. For these purposes, the company offers consulting, coaching and management services for founders and entrepreneurs in the early stages of their development as well as for growth and stabilization; information and contact procurement; event offers for the purpose of furthering education and cooperation promotion (GCRI 2015a).

There are many more important centres of innovation forward-thinking institutions in Germany listed here. They provide information and support in a variety of areas, including innovation management and business planning, technology transfer and commercialization of patents, innovation marketing, and technology assessment.

7.2 Incubators

Incubators support startups with venture capital, foundation experience, know-how and physical office space. In Germany, a number of incubators support young professionals to launch their own companies via financial and intellectual advice. They offer mentoring services and workshops for all kinds of possible questions concerning business foundation. Besides incubators, there are so-called accelerator and company builder doing similar work to promote company establishment (DS 2015; Für Gründer 2015). Examples of Incubators are:

German Accelerator: This growth acceleration programme launched by the BMWi in 2011 supports German startups from ICT related sectors to enter the U.S. market. It provides startups with hand-on mentoring and assists them in their pursuit of becoming category leaders with lasting competitiveness and success in the global marketplace. Since its foundation, German Accelerator has established a remarkable network of dedicated mentors, experienced investors, and other professionals and experts. Out of approximately 250 applicants, over 40 companies have already been accepted into the programme. Supported by a venture development firm, German Accelerator will further strengthen its role in supporting German startups in the U.S. It also serves as a permanent facilitator for transatlantic startups, as well as provides inspiration, demand, innovation, research, and development in Germany (German Accelerator 2015).

Rocket Internet: The Berlin-based e-commerce startup incubator has built a unique platform allowing it to take internet business models to over 100 countries and thus bringing basic goods and services a diverse customer base. Founded in 2007, Rocket Internet was created to establish e-commerce and online retailing companies in places that were seen as underserved markets. Often mimicking the business models and designs of American companies, Rocket has established more than 75 firms from Brazil to India that garnered more than $900 million in revenue in 2013. Recently, the company has framed itself not only as an incubator but also as an internet platform hosting meetings with plenty of potential investors (Forbes 2015).

7.3 Innovation Hubs

Innovation hubs are defined as a location where the development and marketing of innovation occurs due to the spatially concentrated interaction of science, education and economy in combination with adequate living conditions including shopping, culture and leisure time facilities. The aim of developing such location is to stimulate a competitive regional environment. This environment is characterized by multiple interactions between actors, the suspension of borders between physical, digital, economic, social and cultural space, a creative community

with a density of scientists seeking an equally high living standard in terms of environmental, social and cultural diversity as well as physical accessibility (Hartmann et al. 2012).

Thus, innovation hubs are different to abovementioned public support mechanisms in the sense of being a part within regional developing plans and spatial contexts. They rely on an existing innovation potential nearby larger cities and must be integrated in infrastructural conditions on a high level of competence. Examples of Innovation Hubs are:

The Bayern Innovative GmbH is one of the major hubs for innovation and cooperation in Europe. It was founded in Nuremberg in 1995 with the mission to promote innovation and knowledge transfer by the Free State of Bavaria conjointly with representatives from industry and science. New developments are initiated by intensifying the interdisciplinary collaboration between companies and the transfer of research results from scientific institutes. Organizing various dedicated congresses, cooperation fora and joint stands on high-tech exhibitions, Bayern Innovative has succeeded in setting up internationally oriented networks in 10 technologies and sectors, supported by a professional, multimedia-based information and knowledge transfer. The networks of Bayern Innovative GmbH comprise 55,000 companies and 500 institutes in 50 countries. Since 2006, Bayern Innovative GmbH is managing clusters of the Bavarian Cluster Offensive (GCRI 2015b).

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Italian Research and Innovation Landscape

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Abstract

The aim of this report is to provide overall information on the Italian research and innovation (R&I) system with a focus on the most recent challenges and changes.
The Italian R&I system has been heavily affected by the economic crisis. The crisis, followed by austerity policies and budget cuts, had a significant impact on the resources, both public and private, available for research and innovation in the country.
Thus, Italy's R&I performance are declining and the gap with the EU's leading countries for research and innovation is widening. In particular, the investment in R&D remains low, with a gross domestic expenditure on R&D representing 1.3% of the Italian GDP as opposed to the EU average of 2.01% and OECD average (2.4%).
Moreover, Italy is facing a series of structural challenges that hinder the effectiveness of its R&I system:

- Insufficient resources for higher education and research
- Growing territorial inequalities
- Low share of skilled human capital
- Business system dominated by very small farms, with low R&D intensity

In spite of this difficult socio-economic context, the most recent policy measures adopted by the government are addressing these challenges and aim at strengthening the Italian R&I system. In particular, the new national strategy for research (National Research Programme 2014-2020) seeks to increase the attractiveness and openness of the Italian R&I system to include it better in the European Research Area. Other major reforms impacted the recruitment of researchers and professors, the doctoral training as well as the evaluation of public research.
Several measures have also been implemented to strengthen the link between public research and business and favouring the emergence of innovative start-ups by:

- Supporting the emergence of public-private partnerships and national technological clusters
- Reforming indirect incentives for innovative firms
- Facilitating the access to finance and support services for start-ups

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Quick guide to Italian Innovation System

	Name	Description	Link
Institutions	Ministero dell'Istruzione, dell'Università e della Ricerca	The Ministry of Education, University and Research is the main institutional actor of Italian R&I system. The MIUR coordinates national and international scientific activities, supervises the national academic systems, distributes funding to universities and research organisations and establishes the tools and means for supporting public and private research.	http://www.istruzione.it/
	Ministero dello Sviluppo Economico	The Ministry of Economic Development is responsible for a wide variety of policies, including economic development and cohesion, energy and mineral resources, telecommunications, internationalisation and business incentives. It also plays an important role in the definition and implementation of programmes for STI in partnership with MIUR.	http://www.sviluppoeconomico.gov.it/index.php/it/
	Agenzia Nazionale di Valutazione del Sistema Universitario e della Ricerca	The National Agency for the Evaluation of the University and Research System is a public body in charge of the evaluation of the quality of public research.	http://www.anvur.org/index.php?lang=it
	Consiglio Nazionale delle Ricerche	The National Research Council is a multidisciplinary research organisation and the largest in Italy.	http://cnr.it/sitocnr/home.html
	Agenzia Nazionale per le nuove tecnologie, l'energi e lo sviluppo economico sostenibile	The Italian National Agency for New Technologies, Energy and Sustainable Economic Development is a PRO which has the mission to develop R&D in the field of energy efficiency, renewable energy sources and nuclear energy.	http://www.enea.it/it
	Council of Ministers	The Council of Ministers has a top role in the Italian R&I system. It defines priorities and outlines policies in the National Research Programme	

	(PNR).	
Comitato interministeriale per la programmazione economica	The Committee for the Economic Planning (CIPE), created in 1967, plays a key role for the coordination of the science and technology policy within the government. The CIPE is chaired by the Italian President of the Council of Ministers and gathers all Ministries with competencies in the field of economic growth thus including higher education and research. The CIPE is involved in the preparation and revision of the National Research Programme and contributes to the discussions related to the EU Framework Programme for Research and Innovation.	http://www.programmazioneeconomica.gov.it/
Consiglio Universitario Nazionale (National Committee for Universities)	Represents Italy's University system. Gives advice and makes recommendations to the Ministry of Education, University and Research	https://www.cun.it/cun/about-us/
Agenzia Nazionale per le nuove tecnologie, l'energi e lo sviluppo economico sostenibile (Italian National Agency for New Technologies, Energy and Sustainable Economic Development)	Research and innovation activities on energy efficiency, renewable energy sources and nuclear energy. Other fields of interest are cultural heritage conservation, agro-food, health, and the environment	http://www.enea.it/it
Istituto Nazionale di Fisica Nucleare (Italian Institute for Nuclear Physics)	Conducts research on subnuclear, nuclear and astroparticle physics under the supervision of the Ministry of Education, Universities and Research	http://www.infn.it/index.php?lang=en

	Istituto Nazionale di Statistica (Italian National Institute of Statistics)	Public research organisation and main producer of official statistics for Italy	http://www.istat.it/en/about-istat
	Comitato di Esperti per la Politica della Ricerca	Committee of Experts on Research Policy	http://www.cepr.it/
Policy Papers	Horizon 2020 Italia	Document on the R&I strategy in Italy for the period 2014-2020. Aims at identifying Italy's strengths and weaknesses and drawing up recommendations for a major and better inclusion of Italy in the European research area.	http://hubmiur.pubblica.istruzione.it/web/ministero/focus190313
	Agenda Digitale Italiana	The primary objective of the "Italian Digital Agenda" is to promote the spreading of new technologies, including the digitalization of the public administration, the diffusion of broadband all over the territory, implementation of programmes to reduce the digital divide etc.	http://www.agid.gov.it/
	Programma Nazionale di Ricerca 2014-2020	The National Research Programme defines the objectives and modes of implementation of specific interventions in priority areas and projects. The goal is to ensure the coordination of research with other European and national policies.	http://www.istruzione.it/allegati/2014/PNR_online_21feb14.pdf
	Valutazione della Qualità della Ricerca 2004-2010	Evaluation report of the quality of public research in Italy for the period 2004-2010	http://www.anvur.org/rapporto/main.php?page=intro
Programmes / Projects	Programma Operativo Nazionale "Ricerca e Competitività"	National Operational Programme Research and Competitiveness aiming at supporting R&I performance in the 4 convergence regions (Sicilia, Calabria, Campania, Puglia).	http://www.ponrec.it/
	Fondo per gli Investimenti della Ricerca di	The Basic Research Investment Fund is responsible for the funding of basic research performed by universities,	http://futuroinricerca.miur.it/

	Base	research organisations, firms etc.	
	Progetti di ricerca di interesse nazionale	The National Interest Research Programme funds basic research of universities and public research organisations.	http://prin.miur.it/
	Fondo per le agevolazioni alla ricerca	The Fund for the Promotion of Research supports applied research projects supported by firms in collaboration with universities.	http://hubmiur.pubblica.istruzione.it/web/ricerca/far
	Premio Nazionale per l'Innovazione	National Prize for Innovation awarded each year to the best business ideas.	http://pnicube.it/pni-2/
	Italian Master Startup Award	Awarded each year to the start-ups with the best results on the market.	http://pnicube.it/category/italian-master-startup-award-2015/
	Programma Montalcini	Competitive calls to attract young researchers in Italian universities.	http://hubmiur.pubblica.istruzione.it/web/ministero/cs301214
	Programma Messaggeri	Calls for short stays of foreign researchers in Italian universities.	https://messaggeri.cineca.it/
Clusters	Cluster Tecnologico Nazionale Fabbrica Intelligente	National Technology Cluster on Intelligent Factories	http://www.fabbricaintelligente.it/
	Trasporti Italia 2020	National Technology Cluster on Surface and Marine Mobility and Transport	
	Cluster Agrifood Nazionale	National Technology Cluster on Agrifood	http://www.clusteragrifood.it/
	Smart Communities Tech	National Technology Cluster on Smart Communities Technology	http://smartcommunitiestech.it/
	Smart Living Technologies	National Technology Cluster on Technologies for ambient assisted living	http://www.smartlivingtech.it/en

	Cluster Tecnologico Nazionale Aerospazio	National Technology Cluster on Aerospace	http://www.ctna.it/ITA/
	Sustainable Processes and Resources for Innovation and National Growth	National Technology Cluster on Green chemistry	http://www.clusterspring.it/home-en/
	Advanced life sciences in Italy	National Technology Cluster on Life Sciences	http://www.clusteralisei.it/

1. General features of the STI system

1.1. Basic characterization

1.1.1. Main indicators

Table 1 – Main S&T indicators for Italy

Indicator	Italy	OECD Total	Year
Gross domestic expenditure on R&D (GERD) [Mio. USD*]	26.520	1.128.468	2013
GERD Growth rate compared to previous year [Percent]	-1,2	3,8	2013
Gross domestic expenditure on R&D (GERD) as a percentage of GDP [Percent]	1,3	2,4	2013
Government-financed GERD as a percentage of GDP [Percent]	0,5	0,7	2012/2013
Industry-financed GERD as a percentage of GDP [Percent]	0,6	1,4	2012/2013
Business enterprise expenditure on R&D (BERD) [Mio. USD*]	14.316	768.910	2013
Percentage of BERD financed by government [only direct funding, Percent]	7,1	6,6	2012/2013
Percentage of BERD financed by abroad [Percent]	13	6,5	2012
Higher education expenditure on R&D (HERD) [Mio. USD*]	7.482	205.193	2013
Percentage of HERD financed by industry [Percent]	1,1	5,9	2012/2013
Government intramural expenditure on R&D (GOVERD) [Mio. USD*]	3.957	127.355	2013
Percentage of GOVERD financed by industry [Percent]	5,3	3,8	2012/2013
Total researchers in full-time equivalent	117.973	4.403.168	2013/2012
Total researchers in full-time equivalent per thousand total employment	4,9	7,8	2013/2012
Business enterprise researchers as a percentage of national total [Percent]	40,5	60	2013/2012
Patents with foreign co-inventors as a percentage of patent applications filed under the PCT [Percent]	14,3	7,2	2012

Source: OECD Main Science and Technology Indicators, 2015/1; OECD Patents Statistics

*** at current prices and Purchase Power Parities**

Low overall performance of the Italian R&I system

Italy is the fourth largest economy in the European Union with a population representing 12% of the total EU population. Italy also produces about 12% of the total EU28 GDP (Eurostat, 2013).

However, Italy's research and innovation performance is lagging behind that of the EU 28 and the innovation gap keeps widening as a result of the prolonged economic crisis.

Some key indicators show the poor R&D growth performance in Italy. First, the investment in R&D remains low, with a gross domestic expenditure on R&D representing 1.3% of the Italian GDP as opposed to the EU average of 2.01% and OECD average (2.4%).

When focusing on business funded R&D, in 2013, the R&D expenditure in the business sector as % of GDP in Italy was 0.67% compared to an EU average of 1.28% and OECD average (1.4%). Similarly, in Italy in 2014, 2.02 Patent Cooperation Treaty (PCT) patents applications were registered per billion GDP compared to an EU average of 3.78 (Innovation Union Scoreboard, 2015).

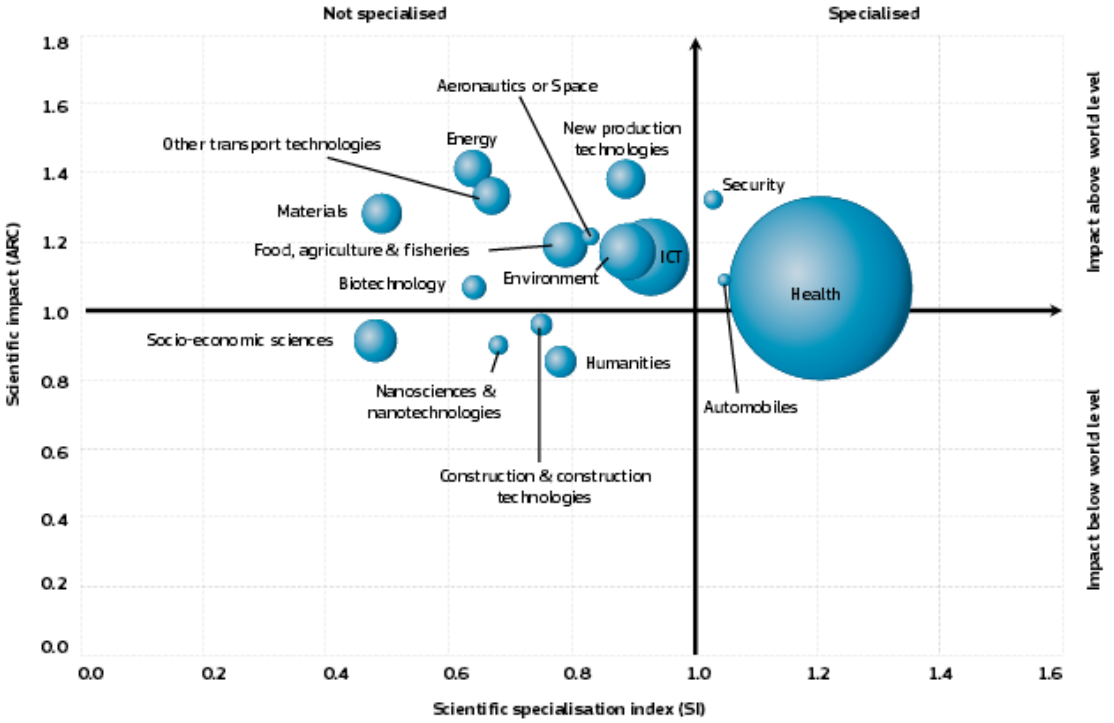
Strength of the Italian R&I system: scientific publications and international cooperation

The ANVUR Report on the quality of Italian research over the period 2004-2010 underlines that the growth of the share of Italian publications is one of the fastest in Europe, above the EU average (ANVUR, 2013). Italy, with a total number of about 852.000 publications, ranks 8th among the top 20 countries per number of scientific publications issued between 1996 and 2011 (HIT 2020, 2013).

Regarding quality, the share of Italian scientific publications, which are among the most cited publications worldwide, is above the world average (ANVUR, 2013). Scientific articles issued by Italian researchers were cited 15 times on average between 1996 and 2011 which is close to the results of some of the main European countries as France (15.6) and Germany (16.2). Thus, regarding productivity and quality of publications by both universities and public research organisations, Italy ranks among the best-performing countries in Europe.

This is confirmed by the graph below which shows that the quality of Italian publications is above the world average in almost all scientific fields. Health, automobile and security are three thematic fields in which Italy shows clear technological advantage.

Figure 1 - Italy – Positional analysis of publications in Scopus, 2000–2010



Source: European Commission, R&I performance in the EU, 2014, DG Research and Innovation – Unit for the Analysis and Monitoring of National Research Policies

A strong performance is also found for cooperation with foreign institutions for co-publications: in 2014 in Italy 574 international scientific co-publications per 1 million inhabitants were issued, whereas the EU average was 363 (Innovation Union Scoreboard, 2015).

A similar pattern can be observed for patents. In 2012, the share of patents filed in cooperation with foreign partners was far above the OECD average; with 14.3% for Italy compared to an OECD average of 7.2% (OECD, 2015).

1.1.1. Socio-economic context and challenges

Economic crisis and budget cuts

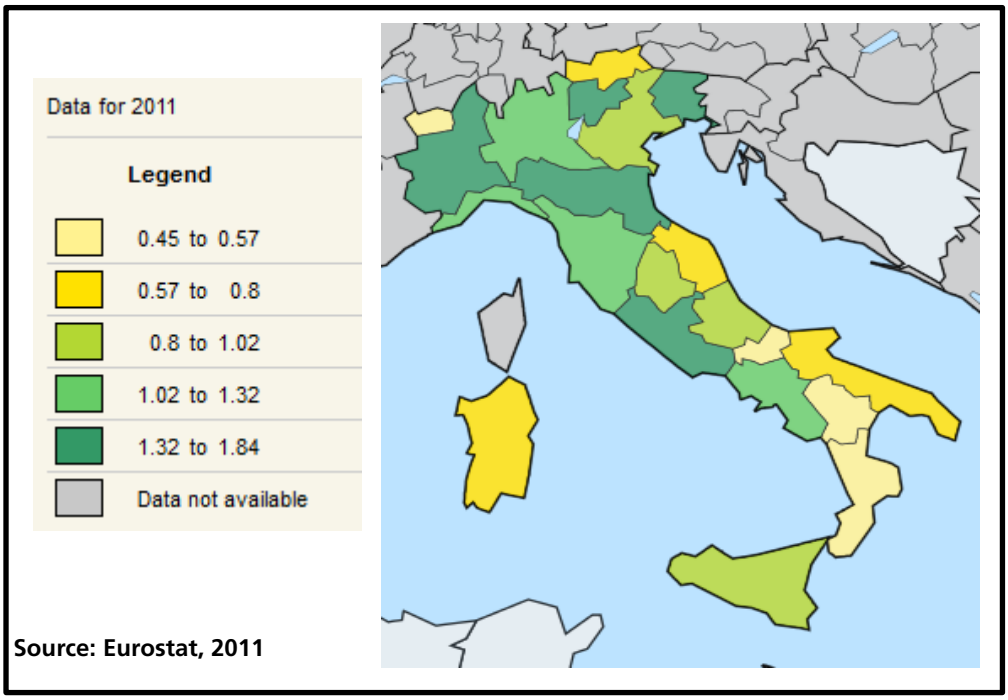
Italy's GDP contracted in 2009 by 5,5% and followed the same pattern until 2013 (-1,8% in 2013). Since the beginning of the crisis in 2008, Italy's industrial production fell by about 25%, weakening the investment capacity of industries (ERAWATCH, 2014).
The economic crisis deeply affected the Italian research and innovation system, reducing the budget available and limiting the possibility to hire new research staff.

Indeed, Italy's current budgetary policy aims at reducing and controlling the public expenditure, with consequences on the funding of the R&D system. Public R&D funds in 2012 fell from €9,2 million to €8,8 million (ISTAT, 2014).

Territorial inequalities

Territorial inequalities in the distribution of R&D expenditure are a traditional feature of the Italian R&D system. In particular, it is characterized by a high concentration of R&D expenditure in Northern and Central Italy (Lombardy, Piedmont, Emilia Romagna, Veneto and Lazio). The Northern regions of Italy concentrate 60.6% of the national R&D expenditure while the southern regions represent only 16.1% (ISTAT, 2014).

Figure 2 - Total intramural R&D expenditure (GERD) as % of Italian regions' GDP



Source: Eurostat, 2011

In particular, business R&D activities are highly polarized between regions while, thanks to public policy and public investment in Southern regions, the localization of public higher education institutions and research organisations is well balanced. However, in a context of austerity budget and cuts in the public funding of research, the role of business becomes more and more relevant and is likely to deepen territorial inequalities in the near future.

The adoption and implementation of the National Operational Programme Research and Competitiveness (PONREC) aim at reducing these territorial inequalities, targeting in particular the four convergence regions[1] (Sicilia, Campania, Calabria, Puglia). This is a seven-year programme, managed jointly by the MISE and the MIUR. PONREC granted funds for € 4,832 million to 3,315 projects in the period 2007-2013 (PONREC, 2015).

Low share of skilled human capital

According to the Innovation Union Scoreboard (IUS) 2013, in Italy the proportion of people aged 30-34 with tertiary education was 20.3% in 2011 and thereby well below the EU average of 34.6%. This is considered to be a traditional weakness of the Italian STI system and this issue is likely to worsen as the budget of universities is facing budgetary cuts. Indeed, the number of new students enrolled in Italian universities keeps falling and in 2011-2012 universities reported 280,144 new students, which represents a decrease of more than 58,000 students compared to the year 2003-2004 (ERAWATCH, 2013).

[1] Convergence regions are defined by the European Commission as those regions having per capita GDP less than 75% of the average GDP of the EU.

1.2. Structure of the R&I system

1.1.1. Political level

The Council of Ministers has a top role in the Italian R&I system. It defines priorities and outlines policies in the National Research Programme (PNR), the main government document for R&D planning.
The Committee for the Economic Planning (CIPE), created in 1967, plays a key role for the coordination of the science and technology policy within the government. The CIPE is chaired by the Italian President of the Council of Ministers and gathers all Ministries with competencies in the field of economic growth thus including higher education and research. The CIPE is involved in the preparation and revision of the National Research Programme and contributes to the discussions related to the EU Framework Programme for Research and Innovation.

1.1.2. Operational level

At a more operational level, the main actor of the Italian R&I system is the Ministry of Education University and Research (MIUR). The MIUR coordinates national and international scientific activities, supervises the national academic systems, distributes funding to universities and research organisations and establishes the tools and means for supporting public and private research. The MIUR is also responsible for the preparation of the three years National Research Programme.
The Ministry for economic development (MISE) plays an important role related to innovation. MISE is in charge of technological innovation and is responsible for industrial policy, energy policy and policies for SMEs. The MISE is also in charge of the planning, coordination and management of the structural funds.

Other ministries (e.g. Health, Defence, Agriculture etc.) can fund research in their respective fields.

Regions also play a significant role in the design of science policy and implementation of R&D initiatives. In particular, regions have recently gained significant competencies in the field of R&D, enabling them to adopt S&T policies and fund R&D initiatives. Many regions have created Regional Innovation Agencies with the role to fund and implement innovation policy measures.

1.1.3. Science Policy Advice

The main advisory bodies for the MIUR are:

- The National Committee for Universities (CUN), which is an elected body representing the Italian University system. It serves as an independent source of advice and recommendations to the MIUR on matters considered as relevant to the University System, such as national programs, policies and administrative practices, classification and definition of academic fields and disciplines, teaching and research, funding issues, etc.

- The Committee of Experts on Research Policy (CEPR) which operates as advisory body for the MIUR on all subjects related to R&D policy. The CEPR is chaired by the MIUR and is composed of 9 members, selected by the MIUR among high-level personalities of the scientific community and civil society. CEPR carries out consultancy and analysis activities on issues concerning the policy and state of the art of Italian research, also with reference to the international context. The final objective is to identify actions needed to promote scientific excellence as well as to support Italy's competitiveness in the European and international contexts.

1.1.4. Research performers

Higher education institutions (HEIs)

This category includes all universities, polytechnics and other higher education institutions, regardless of their sources of funding or status as well as all research institutes, experimental facilities and clinics operating in association with, directly controlled by, or under the administration of, higher education institutions.
In 2015, 96 universities are active, 67 of which are public universities. All universities have a relevant commitment in research and each university conducts a wide range of research activities based on their own strategy, objectives and specialization.

Despite the deep budget cuts, Italian HEIs are recording excellent performance in research. The growth of the share of Italian scientific publications is one of the fastest in Europe, with a strong performance in cooperation with foreign institutions and regarding the impact of the publications (ANVUR, 2013).

According to the ranking list established by ANVUR (2013) in its "Valutazione della Qualità della Ricerca 2004-2010", the 5 main Italian universities in terms of size and scientific excellence are the following:

1. University of Padova
2. University of Milan Bicocca
3. University of Verona
4. University of Bologna
5. University of Pavia

In 2012, universities employed 45,223 researchers (ISTAT, 2014) which makes universities the second largest employers of researchers after businesses. In the academic year 2011-2012, more than 34,300 students attended doctoral courses; among them 3,859 foreign students (Erawatch, 2013).

In 2013, the Higher Education expenditure on R&D (HERD) in Italy amounted to €5,700 million, being equal to 0.35% of GDP, which is a bit below EU28 average (0.49%) (Eurostat, 2013).

Public research organisations (PROs)

MIUR has the supervision of 13 PROs.The 4 largest Italian public research organisations are:

- The CNR (National Research Council) is a multidisciplinary research organisation and the largest in Italy. Its activities are divided into macro areas of interdisciplinary scientific and technological research, concerning several sectors: biotechnology, medicine, materials, environment, ICT, advanced system of production, SSH. CNR employs 8,112 persons; among which about 4,000 researchers are active in almost 100 Institutes distributed all over the territory. CNR is mainly funded by the Italian Government, but also receives funds from the EC and other national and international organisations through participation in public R&D projects calls;

- ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) which has the mission to develop R&D in the field of energy efficiency, renewable energy sources and nuclear energy. ENEA hosts over 2,700 staff, distributed in its 9 research centres all over the national territory. ENEA is not under the supervision of the MIUR but of the MISE;

- ISTAT (Italian National Institute of Statistics). ISTAT is a public research organisation operating since 1926. ISTAT is the main producer of official statistics;

- INFN (Italian Institute for Nuclear Physics) which conducts theoretical and experimental research in the fields of subnuclear, nuclear and astroparticle physics.

Business enterprises

Private investments on R&D in Italy are considerably lower than the OECD average: 0.6% of the GDP compared to the OECD average of 1.4% (OECD, 2015). However, this indicator differs based on the size of firms. Indeed, investments in R&D of large and medium-size Italian enterprises are similar to the results of their main international competitors.

Almost 75% of the business R&D expenditures are covered by firms with at least 250 employees confirming the minor role of SMEs in research funding. In the period 2010-2012, 69.2% of firms with 250 employees or more were innovating firms, whilst the proportion is only 54.8% for enterprises with 50 to 249 employees and 32.7% for enterprises with 10 to 49 employees (ISTAT, 2014). But, with small and micro enterprises representing more than 99% of the total number of enterprises in Italy[2], this aspect is clearly a challenge for Italy's R&I system.

The Italian companies that made most investment in research and development in 2011 included Fiat in the automotive sector, Finmeccanica in aerospace and military research, Telecom Italia in telecommunications and two banks, Intesa San Paolo and Unicredit (EU Industrial R&D Investment Scoreboard, 2012).

1.1.5. Assessment of the quality of education and research

In Italy two bodies have been established to assess the quality of education and research:

1) The National Committee of Guarantors for Research (CNGR)

CNGR is a consultative body to the MIUR, tasked to promote the quality of research and ensure proper functioning of peer reviews.
The committee composed of seven high-level researchers, from Italy and abroad, is responsible for:

- Defining general criteria for evaluation of research projects, taking into account recommendations emerging from international organisms;
- Appointing members to selection committees and coordinate their activities to evaluate research projects.

The CNGR also releases an annual report on activities in the field of the evaluation of Italian research.

2) The National Agency for the Evaluation of the University and Research System (ANVUR)

To be aligned with the EU policy, Italy created the ANVUR in 2010, a public body which reports to the MIUR and works to ensure the quality of higher education and research in Italy. The main activities of the ANVUR are:

- Evaluating the quality of the processes, outcomes and products of education and research activities, including technology transfer, in universities and research institutes;

[2] Around 4.1 million of the 4.5 million firms have 1 to 9 staff.

- Defining criteria and methods for evaluating the structure of universities and research institutes, and the courses offered by universities (including doctorates, master's degrees and specialist colleges);
- Drawing up reference parameters to ensure the correct allocation of resources;
- Evaluating the efficiency and efficacy of public funding programmes and providing incentives for activities directed at education, innovation and research;
- Publishing a two-year report on the state of the university system and research.

The first evaluation document released by ANVUR in 2013 is entitled "Valutazione della Qualità della Ricerca" and covers the period 2004-2010. Its objective is to draft, for each scientific area, a ranking of Italian universities and research institutes based on the following parameters: scientific quality and impact of the publications, ability to attract funding, number of international collaborations and of patents registered, etc.

ANVUR's evaluation determines the allocation of public funding to universities and research institutes. Thus, in 2013, for the first time, 13.5% of institutional funding was distributed on the basis of the results of this evaluation (HIT 2020; 2013).

2. Overall STI strategy

2.1. Definition of the National Research Programme

The priorities and areas of intervention of the R&I system in Italy are determined at the government level. Every three years, the MIUR draws up a National Research Programme (PNR) which is approved by the CIPE in the light of the objectives set in the more general Economic and Financial Planning Document (DEF).

The National Research Programme defines the objectives and modes of implementation of specific interventions in priority areas and projects. The goal is to ensure the coordination of research with other European and national policies.

2.2. Recent developments

2.2.1. Horizon 2020 Italia and the National Research Programme 2014-2020

In March 2013, the MIUR released **Horizon 2020 Italia** (HIT 2020), a document on the R&I strategy in Italy for the period 2014-2020. HIT2020 anticipates the National Research Programme (NRP) 2014-2020. It aims at identifying Italy's strengths and weaknesses and drawing up recommendations for a major and better inclusion of Italy in the European research area.

The new **National Research Programme (NRP) 2014-2020**, presented in January 2014 to the Italian Council of Ministers, is based on this strategy. The duration of the NRP was extended from 3 to 7 years to align with the EU Framework Programme for Research and Innovation (Horizon 2020).

The NRP 2014-2020 builds upon three main pillars:

1. Develop and attract highly skilled talents;
2. Identify a small number of key thematic projects likely to have high societal impact;
3. Boosting the innovative capacity and competitiveness of the business sector, in particular SMEs.

The NRP 2014-2020 will also list a number of national priority topics/challenges, consistent with the priorities identified in Horizon 2020 and in the smart specialization strategies of the regions. These thematic priorities are currently being defined and are expected to be published soon.

The MIUR committed a total yearly investment of € 900 million to implement the measures included in the NRP 2014-2020.

2.2.2. Italian Digital Agenda

Established in March 2012 by the MISE, in agreement with the Minister for Public Administration and Simplification, the Minister for Territorial Cohesion, the MIUR and the Minister of Economy and Finance, the **Italian Digital Agenda (ADI)** aims at transferring the strategy and principles outlined by the Digital Agenda for Europe to the Italian

context.

The primary objective of the ADI is to promote and lead in the country the wide spread of new technologies, including the digitalization of the public administration, the diffusion of broadband all over the territory, implementation of programmes to reduce the digital divide etc.

In line with the Digital Agenda for Europe, the operational interventions outlined in the ADI are distributed in six main topic areas:

- Infrastructures and Security
- Digital identities
- Public data and sharing
- Digital skills
- Digital administration
- Smart communities

The Italian Digital Agenda is implemented by the **Digital Italy Agency**.

2.2.3. Reforms for a more open and attractive research system

Doctoral training

In February 2013, the MIUR released a new regulation (D.M 8/02/2013 n.94) introducing the reform of the Italian doctoral training system. This regulation was implemented for the first time in the academic year 2014-2015 with the aim to creating attractive and competitive doctoral schools in Italy. Multidisciplinary courses are allowed and PhD courses can include interdisciplinary training. Partnerships with foreign universities as well as cooperation with industries are also encouraged. Training of PhD students should include courses dedicated to international research, management of research and IPR.

Recruitment in universities

In 2013, the government announced that it will dedicate additional funds for the recruitment of new professors.

Moreover, candidates to the positions of full and associate professors are now required to pass a habilitation test (D.M. 7/06/2012 n.76)in which they are evaluated by an independent scientific committee. This system has been implemented to guarantee transparent and merit-based recruitment.

2.3. R&D funding

2.3.1. Flows

Public funding

Since 2012, austerity policies affected the public expenditure in R&I and the effects of the economic crisis limited the investment capacity of businesses. In 2012, it is estimated that the total R&D expenditure was down 1.5% compared to the previous year.
In terms of funding, business accounted in 2011 for 45.1% of the total R&D expenditure whereas the public funding accounted for 41.9% (ERAWATCH, 2013).

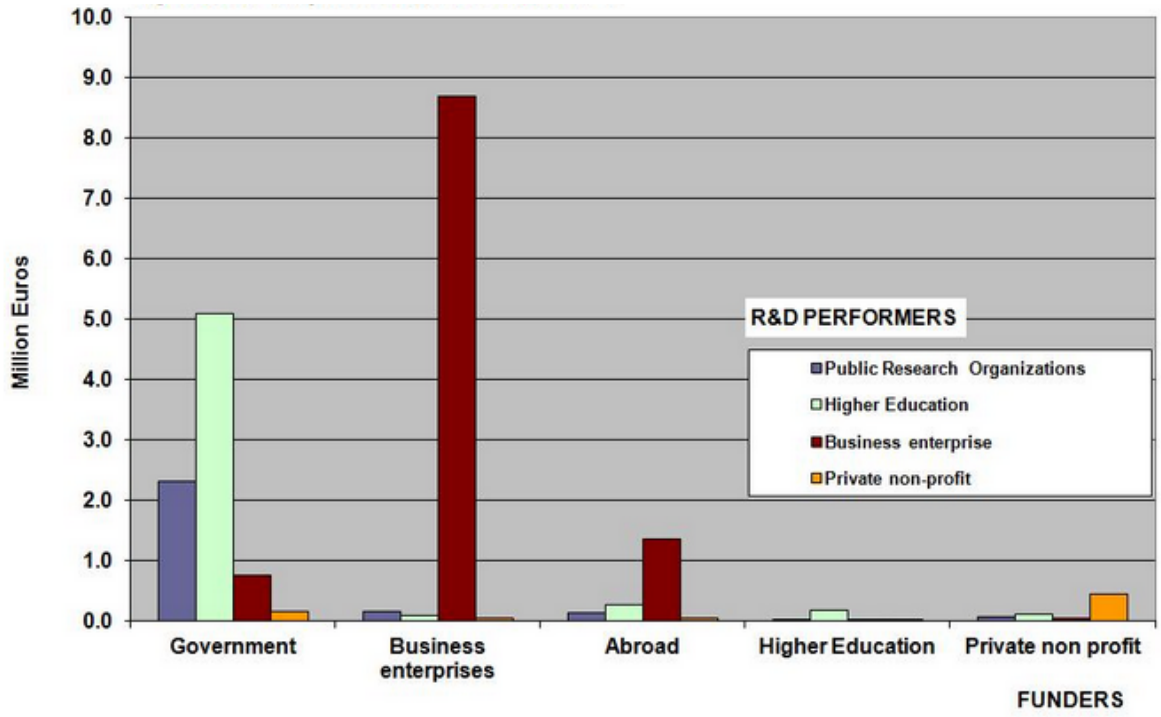
European funds are also an important source of funding. Italy is the 4th biggest beneficiary in terms of FP7 funding and Italian R&I organisations have received more than € 3 billion through this channel. Structural funds, with € 27.9 billion allocated to Italy over the period 200-2013, is also an important source of funding, in particular for the 4 convergence regions (Calabria, Campania, Puglia, Sicilia) (Innovation Union progress at country level, 2014).

Public funding for R&D is mainly thematic funding, in line with the thematic priorities defined in the NRP.

Funding from the business sector

The distribution of R&D funded by the business sector by type of research performers shows that the investments of business in R&D aim mainly at financing research performed in the enterprises. This shows the low propensity of the business sector to commit resources for the collaboration with public organisations.

Figure 3 – Italy's GERD by source of fund and by R&D performer. Year 2011



Source : Erawatch, Country Fiche, Italy

2.3.2. Mechanisms

Institutional funding

The MIUR is the main responsible institution for the financing of the Italian R&I system. Public research organisations and universities are mainly funded through institutional funding:

- Ordinary fund for Higher Education (FFO) for both private and public universities
- Ordinary fund for R&D (FOE) for public research organisations

A growing share of this institutional funding (13% for FFO and 7% for FOE in 2012) is allocated based on the performance of each organisation as outlined in the evaluation report released by ANVUR. For the FFO, the government plans to increase this share up to 30% in 2016 (HIT 2020, 2013).

Competitive funding

Public R&D funding is also allocated through competitive project funding. The MIUR manages three main programmes:

- National Interest Research Programme (PRIN) which funds basic research of universities and public research organisations.

- Fund for the Promotion of Research (FAR) for supporting applied research projects performed by firms in collaboration with universities.
- Basic Research Investment Fund (FIRB) for the funding of basic research performed by universities, research organisations, firms etc.

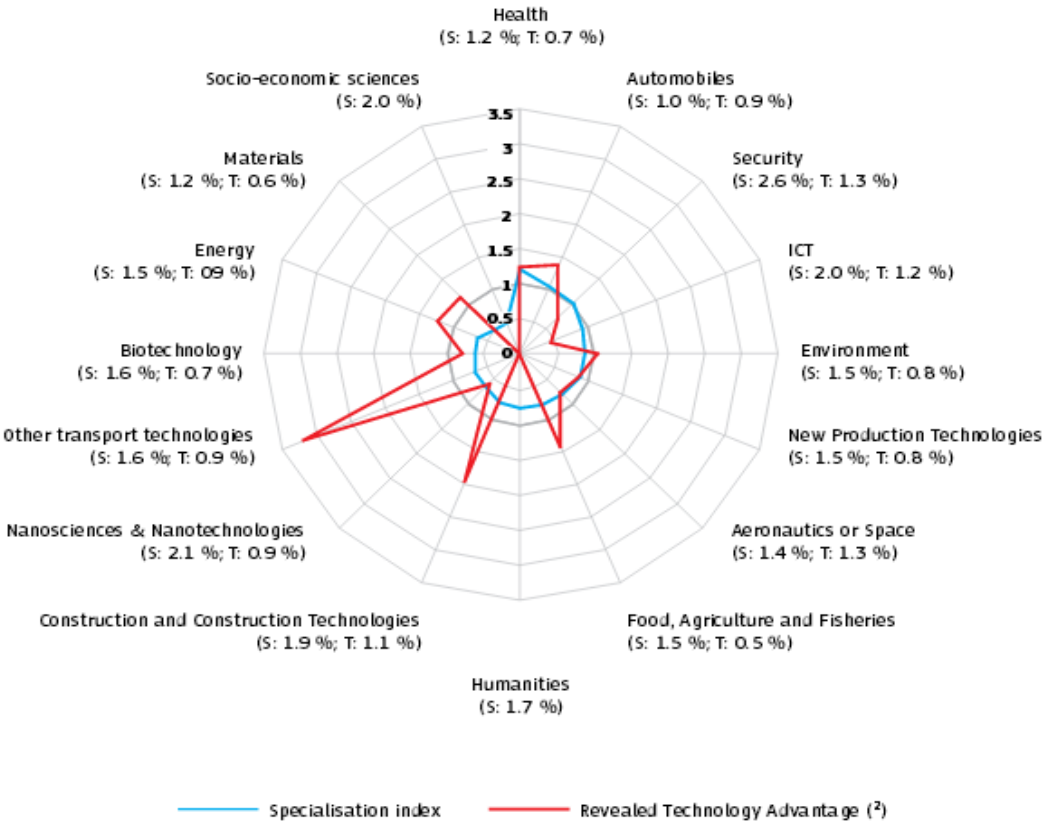
Since 2013, funds available for these competitive programmes have suffered large budget cuts. Resources for the PRIN decreased respectively from €100m in 2009 to €38.2m in 2012 (ERAWATCH, 2013).

3. Emerging technology fields

3.1. Science and technological specialisation

The graph below shows the science and technological specialization of Italy based on the country's number of publications and number of patents. Italy reveals a clear technology advantage in the fields of Health; Automobiles; Food, Agriculture and Fisheries; Construction; Transport; Energy and Materials. However, specialization in publications is only reflected for the first two thematic fields of this list which shows a mismatch between the science base and the industrial structure.

Figure 4 - Italy – S&T National Specialisation in thematic priorities, 2000–2010[3]



Source: European Commission, R&I performance in the EU, 2014, DG Research and Innovation – Unit for the Analysis and Monitoring of National Research Policies

[3] Notes about Figure 4: (1) Values over 1 show specialisation; values under 1 show a lack of specialisation.

(2) The Revealed Technology Advantage (RTA) is calculated based on the data corresponding to the WIPO-PCT number of patent applications by country of inventors. For the thematic priorities with fewer than 5 patent applications over 2000–2010, the RTA is not taken into account. Patent applications in 'Aeronautics or Space' refer only to 'Aeronautics' data.

(3) The growth rate index of the publications (S) refers to the periods 2000–2004 and 2005–2009.

(4) The growth rate in number of patents (T) refers to the periods 2000–2002 and 2003–2006

3.2. National Research Programme thematic priorities

Under the NRP 2011-2013, the MIUR targeted the following thematic priorities:

- Climate and the environment
- Energy
- Health
- Cultural heritage
- Security
- Urban areas

Alongside these areas, the MIUR also targets a set of cross-disciplinary challenges:

- Develop enabling technologies, i.e. technology which can improve the country's industrial competitiveness;
- Favour the clustering of projects, reducing the fragmentation of investment and promoting the creation of hubs where action, resources and skills can integrate;
- Contribute to the development of a digital agenda, to promote innovation, transparency and efficiency in the public sector, exploiting to the full the potential of information and communication technologies.

The set of thematic priorities is currently being updated by the MIUR within the framework of the new NRP 2014-2020. The new NRP defines 11 grand challenges for the R&I system:

- Scientific and cultural progress
- Health, demographic change and wellbeing
- European Bio-economy Challenges
- Secure, clean and efficient energy
- Smart, green and integrated transport
- Climate action, resource efficiency and raw materials
- Europe in a changing world - inclusive, innovative and reflective societies
- Space and astronomy
- Secure societies - protecting freedom and security of Europe and its citizens
- Restoring, preserving, valuing & managing the European Cultural Heritage, Creativity
- Digital Agenda

These grand challenges will be translated into more targeted research and innovation topics. These topics are currently being defined by the MIUR, in consultation with the scientific and socio-economic communities.

4. Description of mechanisms for strengthening the University – Industry collaboration and supporting the commercialization of university research

Italy is facing a lack of cooperation between public research and the industrial sector. Only 12.1% of innovative enterprises do cooperate with other organisations, which is the lowest value in Europe. Similarly, only 29.7 articles per million inhabitants are published with co-authorship between public and private organisations compared to the EU-28 average of 50.3 articles (Innovation Union Scoreboard 2015).

Since 2002, universities, in cooperation with the MIUR, have started to address this challenge by implementing strategies to increase cooperation with industries and technology transfer.

In particular, universities have opened up their governance to business and local actors. Moreover, in the last years many universities promoted the development of technology transfer offices as well as spin off to strengthen the linkages with the market.

According to the Italian Network for research valorisation (Netval), in the last 10 years, almost all Italian universities and public research organisations have created their own technology transfer offices. 47.5% of these technology transfer offices work in partnership with a scientific park and 50.8% are involved in incubators (Netval, 2014). The main activities of these technology transfer offices are the following:

- IPR management,
- Support for the creation of spin-offs,
- Licensing,
- Management of university-business collaborations.

Regarding spin-offs, 1,123 active spin-offs are currently registered in the database Spin-off Italia[4]. The number of spin-offs created in 2012 reached 140, the highest value ever registered in Italy (Netval, 2014). Spin-offs created in Italy are mainly active in the sectors of ICT (26.8% of the total number of spin-offs) followed by services for innovation (17.2%), energy and environment (16.3%) and life sciences (15.8%) (Netval, 2014).

38 universities and incubators are also part of the association PNICube. This association, created in 2004, aims at supporting the development of university spin-offs through two main initiatives:

- National Prize for Innovation (PNI) awarded to the best business ideas,
- Italian Master Start-up Award that recognizes the start-ups with the best results on the market.

[4] http://www.spinoffricerca.it/

5. Description of partnership models utilized by government and related agencies to encourage clustering and precompetitive research between firms

5.1. High-technology public-private districts and joint labs

To foster interactions between research, education and innovation in the four convergence regions (Sicilia, Campania, Puglia, Calabria) the MIUR is funding a number of public-private districts and labs. Within this framework, 90 projects received € 900 million. The aim is to foster a stronger competitiveness of the existing productive areas by revitalizing them through excellent research and development activities on key technologies, enabling product and process innovations.

5.2. National Technology clusters

In 2012, the MIUR launched a national call to support national technology clusters. As a result of this call, the MIUR assigned € 266 million to 30 projects, grouped in 8 clusters (MIUR Ufficio Stampa, 2013):

- CFI: Intelligent Factories
- SPRING: Green Chemistry
- ALISEI: Life Sciences
- Trasporti Italia 2020: Surface and Marine Mobility and Transport
- CL.A.N.: Agrifood
- CTNA: Aerospace
- Smart Communities Tech: Smart Communities Technology
- Smart Living Technologies: Technologies for ambient assisted living

Two of the main criteria for the selection of projects were the quality of cooperation between the public and private sectors and the high-level of internationalization.

Each cluster is a wide and inclusive network of Italian excellent organisations. The 30 projects gather 456 partners: 112 belonging to the research field and 344 to the industrial field (i.e. 140 big companies and 204 SMEs). Out of the € 266 million, € 170 million will be delivered as contribution to expenses and € 96 million as credit facility (MIUR Ufficio Stampa, 2013).

On the longer term, the National Technology Clusters will have to implement strategies to attract further public and private investments aimed at developing R&I projects and employing qualified human capital with the final purpose of increasing the quality of research products and their impact on enterprises, on the market and on the development of specific local areas.

5.3. Science and Technology Parks

Over 30 science and technology parks exist in Italy, spread all over the territory. They act as integrators at the local level between business needs, with a focus on small and very small enterprises, and the knowledge produced by the research centres and universities.

The first science park created in Italy was AREA Science Park in 1978 in Trieste. However, the vast majority of science parks were created quite late, in the 1990's. The fact that almost all science parks have a public or public-private ownership shows that policy makers were willing to support the development of these structures.

Many of these science parks (31) are members of APSTI (Association for Italian Science and Technology Parks). The missions of APSTI are the following:

- To promote best practices amongst its members;
- To support the development of organisations committed to fostering the R&I development at the local level;
- To represent its members and disseminate information on the role and importance of science parks.

6. Cross-border initiatives

6.1. International cooperation

Bilateral and multilateral agreements

Trans-national research collaborations are managed jointly by the MIUR and Ministry of Foreign Affairs (MAE) on the basis of bilateral and multilateral agreements.

Bilateral agreements have a long tradition as schemes to share research facilities, both public and private, knowledge, human resources and laboratories in the frame of overall strategies to improve research coordination of Italian and foreign scientific organizations.

In 2012, Italy was participating in 56 bilateral agreements, 9 multilateral entities and 1 multilateral cooperative programme (COST) (ERAWATCH Country fiche Italy).

Openness and attractiveness for foreign researchers

The inflow of foreign researchers in Italy is lower than in other large EU countries.

Recently, the government adopted a series of strategic measures aimed at increasing the attractiveness of the Italian R&I system:

- Launch of competitive calls to attract foreign researchers in Italian universities ("Rita Levi Montalcini" calls for young researchers and "Messaggeri" calls for short stays of researchers).
- Participation of international evaluators in the system of R&I evaluation and selection of professors to increase the transparency and international openness of the Italian R&I system.
- Reform of the doctoral training and increase of the number of courses available in English.

6.2. Research infrastructures

In 2009, the MIUR launched a public consultation to map research infrastructures projects based in Italy and with a potential pan-European interest. This process is part of a larger process launched at the European level by the European Commission and the European Strategy Forum on Research Infrastructures (ESFRI). The aim is to allow countries to set national priorities regarding research infrastructures and to earmark funds for their development and participation in pan-European research infrastructure activities.

Out of the 220 Italian research infrastructures projects which answered to the public consultation, the MIUR identified 50 "mature" research infrastructures projects that were included in a Roadmap (MIUR, 2011). The selected projects cover the following fields:

- Social sciences and humanities,
- Environmental science,
- Energy,
- Biology and medicine,
- Materials science and analysis facilities,
- Physics and astronomy,
- E-Infrastructures.

7. Analysis of public support mechanisms to stimulate innovation

7.1. Direct funding available for enterprises

Enterprises can benefit from a number of programmes to finance their R&I projects:

- Fund for the Promotion of Research (FAR) for supporting applied research projects supported by firms in collaboration with universities;
- Basic Research Investment Fund (FIRB) for the funding of basic research;
- Fund for Sustainable Growth which supports business R&D with significant potential to affect national competitiveness. This Fund is managed by the MISE which allocated € 600 million to the programme in 2013 (ERAWATCH, 2013).

7.2. Indirect incentives

In March 2013, the MISE reformed the system of indirect incentives with the aim to favour business R&D. The former tax credit has been replaced by two measures:

- The tax credit for businesses financing university or public research organisations R&I projects;
- The tax credit for firms employing high skilled workers in innovation and research.

Moreover, the MISE recently adopted a new legislation on innovative start-ups aiming at reducing the burden of administrative management for innovative SMEs and facilitating access to finance:

- Exemption from fees normally due to the Chamber of Commerce;
- Possibility to remunerate workers and consultants through stock options and work for equity schemes which are tax deductible;
- Possibility to raise capital in exchange for shares through equity crowdfunding portals;
- Tax incentives up to 27% on seed and early-stage investment amounting up to €1.8 million;
- Streamlined, free-of-charge access to public guarantees by 80% on bank loans amounting up to €2.5 million.

8. Summary and conclusion

Since 2013, the Italian R&I system is evolving quickly to tackle structural challenges as well as to adapt to a difficult socio-economic context.

In particular, the Italian R&I system is evolving toward a more transparent and open system:

- Higher share of competitive and performance-based funding
- More transparent selection process for researchers and professors
- Reform of the doctoral training
- Inclusion of international experts in the evaluation of national research

Since 2010, efforts have also been made to strengthen knowledge transfer and support the development of public-private partnership. In particular, the MIUR is now supporting a number of technological clusters and districts while universities are developing the competencies and expertise of their knowledge technology transfer offices.

Finally, a set of measures have been implemented to encourage innovative firms, in particular through tax incentives, direct funding for applied research and dedicated measures for start-ups.

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Dutch Research and Innovation Landscape

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Abstract

The Netherlands are one of the ten most innovation nations in the world. Its innovation capacity is continuously rising. The Dutch research landscape is very transparent and open for scientists from all around the world. Public-private cooperation makes up an important driving force for further development of the Dutch research and innovation system. However its innovative power is to certain degree hindered by the still low innovative performance of Dutch enterprises, especially SMEs.
Overall money invested into R&D by enterprises in the Netherlands is to a large amount spend by large multinationals. Thereby the private contribution to R&D expenditure is comparably low in the Netherlands. To improve this situation and encourage SMEs to spend more money on R&D and innovation the Dutch government introduced the Small Business Innovation Research (SBIR) Programme. It is hoped that innovation made in the Netherlands can be stimulated by this and other measures.

Table of Contents

Quick guide to Dutch Innovation System

	Name	Description	Link
Institutions	Ministry of Education, Culture and Science, OCW	OCW is responsible for higher education, science and basic research. It has broad political-administrative and financial responsibility for public-sector research. The ministry finances part of the major research organizations, coordinates science policy of the national government and contributes to the international science policy.	https://www.government.nl/ministries/ministry-of-education-culture-and-science
	Ministry of Economic Affairs Agriculture and Innovation, EZ	EZ is responsible for application oriented research and innovation and plays a growing role in central governance of national innovation policy and in the allocation of research funding.	https://www.government.nl/ministries/ministry-of-economic-affairs
	Netherlands Bureau for Economic Policy Analysis, CPB	CPB works at the crossroads of the economic sciences and public policy. Its goal is to contribute to the economic decision-making process of politicians and policymakers.	http://www.cpb.nl/en
	Netherlands Organization for Applied Research, TNO	TNO is an important funding agency. The focal point of their activities lies in socially and economically relevant subjects as well as current innovations and concrete applications. TNO in particular supports small and medium-sized enterprises (SMEs).	https://www.tno.nl/en/
	Netherlands Organisation for Scientific Research, NWO	NWO's main task is to fund scientific research at public research institutions, especially universities. It focuses on all scientific disciplines and fields of research. The funds are allocated by means of a national competition. NWO also maintains own research institutes engaged in basic research. Overall it actively contributes to various elements of the Dutch science and innovation landscape.	http://www.nwo.nl/en
	Royal Netherlands Academy of Arts and Sciences, KNAW	KNAW serves as a forum for the scientific community of the Netherlands and as an umbrella organization for research institutes in the area of humanities and social sciences as well as life sciences. KNAW also funds national and international research cooperation. In addition it has an advisory role.	https://www.knaw.nl/en?set_language=en
	Netherlands Enterprise Agency, RVO	NL Agency falls under the Dutch Ministry of Economic Affairs (EZ). It acts as an intermediary between the national	http://english.rvo.nl/

	(formerly NL Agency)	government on the one hand and companies, knowledge institutes and local governments on the other hand. The division NL Innovation is responsible for funding innovative activities (i.e. by credit facilities and innovation subsidies).	
	Advisory Council for Science, Technology and Innovation, AWTI	AWTI advises the government and parliament on policy relating to scientific research, technology development and innovation in both at national and international context.	http://www.awti.nl/english/about-us/item159
	Research Council for Technical Sciences, STW	STW was established as a foundation to serve the entire spectrum of technical sciences. The foundation's objective has been to realise knowledge transfer from excellent technical scientific research. Several years ago the emphasis in the mission was changed to knowledge transfer between the technical sciences and users so as to emphasize the role of the users in all STW projects.	http://www.stw.nl/en/
	Scientific Council for Government Policy, WRR	WRR is an independent advisory body for the Dutch government. The task of the WRR is to advise the government on issues that are of great importance for society. The reports of the WRR are not tied to one policy sector. Rather, its reports go beyond individual sectors; they are concerned with the direction of government policy for the longer term.	http://www.wrr.nl/en/home/
	Education Council of the Netherlands	The Education Council is an independent governmental advisory body which advises the Minister, Parliament and local authorities. The Council provides advice, both solicited and unsolicited, to the Minister of Education, Sciences and Cultural Affairs and the Minister of Economy.	https://www.onderwijsraad.nl/english/item34
Policy Papers	National Reform Programme 2015	All EU member states translate the overall EU objectives into national targets in their National Reform Programme – a document which presents the country's policies and measures to sustain growth and jobs and to reach the Europe 2020 targets.	http://ec.europa.eu/europe2020/pdf/csr2015/nrp2015_netherlands_en.pdf
	2025 Vision for Science – choices for the future	Important report about the plans of the government regarding science policy.	https://www.government.nl/documents/reports/2014/12/08/2025-vision-for-science-choices-for-the-future
	National Science Agenda	This Agenda, which is supposed to be published by autumn 2015 at latest, should connect the various agendas that have been diverging up so far. Scientists, the private sector, civil society	The document has not been available until the

		organisations and government should set it together.	end of October 2015.
	Strategy for the Top Sectors	The principal goal of this strategy is to promote closer cooperation between knowledge institutes, businesses and public authorities in the programming of fundamental and applied research, with special attention to the challenges facing society in the near future, including issues relating to sustainability.	https://www.government.nl/topics/entrepreneurship-and-innovation/contents/investing-in-top-sectors
	Quality in Diversity Strategic Agenda for Higher Education, Research and Science	This strategic agenda sketches a long-term perspective for higher education, research and science in 2025.	https://www.government.nl/documents/reports/2012/08/30/quality-in-diversity
Program / Project/ Clusters	Top Consortia for Knowledge and Innovation (TKIs)	In the course of 2012, the parties collaborating in the top sectors established 9 Top Consortiums for Knowledge and Innovation (TKIs), which have started to implement the research agendas in the Innovation Contracts.	No single homepage; important information can be found here: https://www.government.nl/binaries/government/documents/publications/2014/01/20/enterprise-policy-at-full-speed/ez-rapp-voortgangsrapp-ts-eng-dig.pdf
	Top Sectors Innovation Incentive for SMEs (MKB Innovatiestimulering Topsectoren - MIT	This scheme provides instruments that will enable companies to perform feasibility studies, carry out R&D-related collaborative projects or temporarily hire highly qualified employees.	http://www.rvo.nl/subsidies-regelingen/mkb-innovatiestimulering-regio-en-topsectoren-mit (only available in Dutch)
	Groot Technologisch Instituut (GTI)	These technology centres are working on applied research in the areas of airspace, energy, water and marine science.	No single homepage, an overview with links to the single GTIs is available here: https://nl.wikipedia.org/wiki/Groot_Technologisch_Instituut

1. General features of the STI system

1.1 Basic Characterization of the Dutch Research and Innovation Landscape

The Global Competiveness Report 2014-2015 classifies the Netherlands as one of the ten most competitive and innovative countries worldwide: this year's report places the Netherlands on rank 8 – steadying it at the same position as last year's report. "Overall, the country continues to depict a set of important competitiveness strengths that allow its economy to remain highly productive." The report says and continues as follows: "An excellent education and training system (3rd), coupled with a strong adoption of technology (9th), including ICTs (8th), and an excellent innovation capacity (8th) result in highly sophisticated businesses (5th) that manage to compete at the very high end of international value chains. In addition, efficient institutions (10th), world- class infrastructure (4th), and highly competitive (5th) and open products markets (6th) complete the impressive list of the country's assets." (World Economic Forum, 2015).

According to the Innovation Union Scoreboard 2015, the Netherlands belongs to the group of 'innovation followers', with innovation performance to be found below the 'innovation leaders' but above the 'moderate innovators' and overall well above EU-average. The Netherlands replaced Luxembourg as the most innovative 'innovation follower' and is thus now leading this group. With an average annual growth rate of 1.8% the Netherlands also belongs to the growth leaders of the 'innovation followers': their innovation performance has been improving second strongest of the group of all 'innovation followers'. Seen on the long run, the Netherlands performance has been improving steadily up until 2011, then increased strongly in 2012, after which it has continued to increase at a modest pace. The Netherlands is performing at or above EU average for most dimensions. It has relative strengths in 'International scientific co-publications', 'License and patent revenues from abroad' and 'Public-private co-publications'. Its relative weaknesses are found in 'Non-R&D innovation expenditures' and 'Exports in knowledge-intensive services'. (European Commission, 2015)

The following table gives an overview of major R&D-indicators for the Netherlands, compared to the OECD Total.

Table 1 Basic indicators for R&D investment (OECD, 2015).

Indicator	Netherlands	OECD Total	Year
Gross domestic expenditure on R&D (GERD) [Mio. USD*]	15.377	1.128.468	2013
GERD Growth rate compared to previous year [Percent]	2,0	3,8	2013
Gross domestic expenditure on R&D (GERD) as a percentage of GDP [Percent]	2,0	2,4	2013
Government-financed GERD as a percentage of GDP [Percent]	0,7	0,7	2013
Industry-financed GERD as a percentage of GDP [Percent]	1,0	1,4	2013
Business enterprise expenditure on R&D (BERD) [Mio. USD*]	8.561	768.910	2013
Percentage of BERD financed by government [only direct funding, Percent]	2,0	6,6	2013

Percentage of BERD financed by abroad [Percent]	13,5	6,5	2013/2012
Higher education expenditure on R&D (HERD) [Mio. USD*]	4.935	205.193	2013
Percentage of HERD financed by industry [Percent]	7,6	5,9	2013
Government intramural expenditure on R&D (GOVERD) [Mio. USD*]	1.881	127.355	2013
Percentage of GOVERD financed by industry [Percent]	16,6	3,8	2013
Total researchers in full-time equivalent	76.815	4.403.168	2013/2012
Total researchers in full-time equivalent per thousand total employment	8,8	7,8	2013/2012
Business enterprise researchers as a percentage of national total [Percent]	61,2	60	2013/2012
Patents with foreign co-inventors as a percentage of patent applications filed under the Patent Cooperation Treaty (PCT) [Percent][(1)]	18,3	7,2	2012

*at current prices and Purchase Power Parities (PPPs)
[(1)]OECD Patents Statistics

Regarding investments in R&D and compared to other European countries the Netherlands can be placed somewhere in the middle. The gross domestic expenditure on R&D (GERD) as a percentage of GDP amounted to 2.0% in 2013, which is slightly below the OECD Total of 2.4% (OECD, 2015). According to the National Reform Programme 2015, this number should reach 2.5% by 2020 (Ministry of Economic Affairs, 2015).

The same document shows a moderate increase in the 2011-2013 period for both, the privately and the publicly financed share of R&D spending (Ministry of Economic Affairs, 2015).The Dutch industry is the most important funder of research in the Netherlands (in 2013 51% of R&D expenses in the Netherlands are financed by industry, compared to 61% financed by industry in OECD Total), followed by the state as the second largest financing source (in 2013 33% of R&D expenses in the Netherlands financed by state, compared to 28% financed by state in OECD Total). During the last few years especially the amount of research being financed from abroad has grown significantly. (Source: OECD, 2015)

Regarding the distribution of R&D expenditure on implementing sectors (compared to OECD Total), Dutch businesses' share accounted for 56% in 2013, which is well below the OECD total of close to 68% of research being performed by the business sector. Universities' share of research performance on the other hand made up 32% in the same year, which is much higher than the OECD Total of 18%. In addition, when comparing government intramural expenditure (GOVERD) and Higher Education Expenditure on R&D (HERD), it can be noticed that implementation of research in the Netherlands is more strongly focused on universities than on public research institutions. So in general universities play a comparably important role in the implementation of research in the Netherlands. (Source: OECD, 2015)

1.2 Major Players and Structure of the Dutch Research and Innovation System

The structure of the Dutch research system can be divided into three levels: The first level includes all political institutions, which are responsible for research and innovation policies and their advisory bodies. The second level is comprised of important funding organisations. Actors implementing research and innovation (universities, research institutions etc.) make up the third

level. For more detailed information on the different institutions also see: Erawatch, 2014 (*Structure of the research system*).

1.2.1 Political institutions responsible for research policies and their advisory bodies

On the level of political institutions responsible for research, innovation and education policies the two main ministries and thereby the main actors in the Dutch research and innovation system and its governance are the Ministry of Education, Culture and Science (OCW) and the Ministry of Economic Affairs (EZ). In broad terms, OCW is responsible for higher education, science and basic research, while EZ is responsible for application oriented research and innovation and plays a stronger role in central governance of national innovation policy.

The OCW has broad political-administrative and financial responsibility for public-sector research in the Netherlands. Most of its budget is used for institutional or basic funding. The ministry finances part of the major research organizations, coordinates science policy of the national government and contributes to the international science policy.

The EZ focuses on innovation policy by making fixed contributions to a number of institutes. A large number of the ministry's projects and programmes are implemented by intermediary organizations such as RVO (former NL Agency, see 1.2.2), Netherlands Organization for Scientific Research (NWO) and Research Council for Technical Sciences (STW) – for more information on these see 1.2.2. The Ministry of Economic Affairs recently has established a stronger say in the allocation of research funding by NWO and KNAW (Royal Netherlands Academy of Arts and Sciences, see below) as policy budgets for the TNO (Netherlands Organization for Applied Research, see 1.2.2) and the large technological institutes active in aerospace, energy, water management and hydraulic engineering and maritime research, have been transferred to EZ.

The operational level of the Dutch governance system for research and education is complemented by several advisory bodies that are involved in policy analysis and evaluation. The main bodies to be mentioned here are the Advisory Council for Science, Technology and Innovation (AWTI), the Royal Netherlands Academy of Arts and Sciences (KNAW), the Netherlands Bureau for Economic Policy Analysis (CPB), the Scientific Council for Government Policy (WRR) and the Education Council of the Netherlands.

AWTI is an independent body set up to advice the government and parliament on policy relating to scientific research, technology development and innovation at national and international level.

KNAW is to advise the government, either on request or at its own initiative, on matters in the field of scientific endeavour.

CPB works at the crossroads of the economic sciences and public policy. Its goal is to contribute to the economic decision-making process of politicians and policymakers.

WRR is an independent advisory body for the Dutch government. Its task is to advise the government on issues that are of great importance for society. The reports of WRR are not tied to one policy sector. Rather, its reports go beyond individual sectors; they are concerned with the direction of government policy for the long run.

The Education Council is an independent governmental advisory body which advises the Minister of Education, Sciences and Cultural Affairs and the Minister of Economy and to both chambers of parliament on education, policy and legislation. It also operates as a think tank that provides analyses of current issues and formulates solutions to help develop new policy.

In addition to these formal advisory institutions several years ago (after some debate on the research and advisory role in government), almost all ministries established a Knowledge Forum, designed to strengthen interaction between senior civil servants and research institutions: The ministry sets out areas in which it needs to improve its knowledge, in connection with both present and future policy. The research institutions then indicate whether they are able to meet this demand. As such, the research institutions also reflect on policy development. This system also makes researchers and academic institutions aware of the questions current among policymakers, so that they can address them in research. (Source: Rathenau Instittuut, 2015)

1.2.2 Policy implementation with the help of intermediary organisations

Policy implementation is mainly done by four intermediary organizations: the KNAW, the NWO, the RVO and the STW.

KNAW is not only an advisory body for the government but also serves as a forum for the scientific community of the Netherlands and as an umbrella organization for 19 research institutes in the area of humanities and social sciences as well as life sciences. In addition, they also fund national and international research cooperation.

Another important funding agency is the Netherlands Organization for Scientific Research (NWO). It functions as an independent administrative body under the responsibility of the OCW. The NWO supports scientific quality and innovation in research and initiates new developments. It provides funds and supports the distribution of research results. It focuses mainly on research at universities. Aside from its role as a research funding agency, the NWO also maintains nine research institutes engaged in basic research and thereby is also part of the third level of the Dutch research system.

The Netherlands Enterprise Agency (RVO, formerly NL Agency) acts as an intermediary between the national government on the one hand and companies, knowledge institutes and local governments on the other hand. The division NL Innovation is responsible for funding innovative activities.

The Research Council for Technical Sciences (STW) supports and finances scientific-technological research projects and promotes utilization of results of research by third parties.

The Netherlands Organization for Applied Research (TNO) is another important funding agency. The focal point of the activities of TNO concentrates on socially and economically relevant subjects as well as current innovations and concrete applications for research results. Key topics e.g. comprise health, energy, mobility, security and environment. TNO in particular supports small and medium-sized enterprises (SMEs) as well as business starters.

The main bodies responsible for managing and implementing policies are NWO, STW, KNAW, and RVO.

1.2.3 Research Performers

The Netherlands has a large number of organizations that conduct research. They belong to three different sectors: universities, research institutes and enterprises.

Basic research is mainly done at universities and the research institutes of KNAW and NWO (see 1.2.2). Applied research is concentrated at other research institutes. Enterprises mainly work on the transfer of research results into applicable technologies.

Research institutes can be divided into the following groups:

- NWO and KNAW institutes which have certain similarities to university research institutes and concentrate on basic research;

- Netherlands Organization for Applied Research (TNO, also see 1.2.2) research institutes which are distributed over the whole country. They can be compared to research institutes of the German Fraunhofer Gesellschaft (see report on Germany).
- Technology centres, also called „Groot Technologisch Instituut" (GTI) also concentrate on applied research. They supply information on important technological developments for the Dutch government but also for the business sector. In addition they also develop new technologies on behalf of the government or enterprises. The main institutes with a status of a GTI are: the NLR (Nationaal Lucht- en Ruimtevaartlaboratorium) which is responsible for developing and applying advanced technological knowledge in the area of aerospace; the Energy research Centre of the Netherlands (ECN) which is the largest energy research institute in the Netherland, the Maritime Research Institute Netherlands (MARIN) and Deltares which is concentrating its research in the field of water and subsurface.

2. Overall STI strategy

The Netherlands aim to achieve the targets of the Europe 2020 strategy. The aim of the strategy is to promote smart, sustainable and inclusive economic growth in the EU. To this end five key targets, covering employment, research and innovation, sustainable energy and climate, education, and social inclusion have been formulated. Based on this strategy and the current situation, country-specific recommendations have been proposed by the European Commission in 2014. The main recommendations which have been adopted by the European Council for the Netherlands are the basis of the National Reform Programme 2015 of the Dutch Ministry of Economic Affairs.

The following table shows an overview of these targets for the Netherlands and the latest results as included in the National Reform Programme 2015 of the Dutch Ministry of Economic Affairs. R&D and Education-relevant targets and results are marked in red.

EU headline targets of the Europe 2020 Strategy	Target for the Netherlands	Result in 2013
Employment		
Increase in labour participation (20 to 64 years) from 69% to 75%[31]	80%	76.8%
R&D		
Increase in R&D spending from 1.9% to 3% of GDP	2.5%	1.98%
Sustainable energy and climate		
20% less CO_2 emissions		
Non-ETS sectors	*-16%*	*-19%*
ETS sectors	*N/A*	*N/A*
20% energy out of renewable sources	14%	4.5%
20% increase of energy efficiency	1.5% per year[32] (cumulative 480 PJ)	1.2% per year (average 2004-2012)
Education		
Reduction in percentage of early school leavers	< 8%	9.2%
Increase in percentage of 30 to 34-year-olds with post-secondary education	> 40%	43.1%
Social inclusion		
At least 20 million fewer people at risk of poverty and social exclusion	100,000 fewer jobless households	11,000 more than at the start of 2008

Overview of targets and results of the Europe 2020 Strategy (Source: Ministry of Economic Affairs, 2015)

As can be seen the Netherlands are not quite on track to reach its national Research and Development (R&D) 2.5% target, additional efforts will be needed to reach this (see first red marking). Therefore regarding government finances the European Council recommended the protection of expenditure in areas directly relevant for growth such as education, innovation and research. Regarding this recommendation the National Reform Programme states the following: "The government continues to pursue close cooperation with businesses, knowledge institutions and regional and local authorities to promote research and development (R&D) to strengthen the foundations for future economic growth. The government allocates part of the public funds to boost private investments in R&D. The efforts have resulted in a modest increase in investments in R&D by private parties over the past years. Moreover, the size of public-private partnership programmes of the Top Consortia for Knowledge and Innovation (TKIs) have increased" (Ministry of Economic Affairs, 2015). However looking at many other EU member states the Dutch objective of 2.5% is comparably low: many member states have set a national target of spending 3% of GDP on R&D. The lower Dutch target and the resulting strategy can be explained by the structure of the economy: R&D-intensive sectors, such as the automotive industry, so far represent a relative small share of the economy.

To improve this overall situation the National Reform Programme includes a long-term overview of public funds for innovation and research, which reads as follows:

	2013	2014	2015	2016	2017
Fundamental research	3,066.4	3,163.4	3,217.3	3,192.8	3,175.9
Applied research	449.8	428.3	364.0	345.6	333.8
Spending by ministries	1,443.8	1,518.0	1,335.3	1,206.9	1,140.0
Fiscal resources for R&D and innovation	1,628.1	1,693.6	1,667.6	1,570.7	1,555.6
Total	**6,588.2**	**6,803.3**	**6,584.2**	**6,315.9**	**6,205.3**

Overview of targets and results of the Europe 2020 Strategy (Source: Ministry of Economic Affairs, 2015)

The government is continuing the close collaboration with businesses, knowledge institutions and other levels of government with the aim of stimulating research and innovation. The 2025 Vision for Science and the Top Sector Policy (for more information on both strategies see below), with a generic and a specific track, are the most important policy strategies.

There has been good progress in the national education targets (see second red marking in the first table above) and it is likely that the national targets will be met (Ministry of Economic Affairs, 2015).

2.1 Important Strategy Documents

2.1.1 2025 Vision for Science – choices for future

"2025 Vision for Science – choices for future" is a publication of the Ministry of Education, Culture and Science of the Government of the Netherlands. This vision document, which gives the government a strategic framework for its new science policy, was produced with the assistance of many organisations and individuals, including young researchers, established scientists, university boards, private sector representatives and members of the public.

The government will pursue three aims for 2025 in order for Dutch science to maintain its leading international role:

- "Dutch science is of worldwide significance.
- Dutch science has even closer ties with society and the private sector; it has maximum impact.
- Dutch science continues to be a breeding ground for top talent." (Ministry of Education, Culture and Science, 2014)

Goal 1): World-class Dutch science

The government wants **Dutch science to consolidate its international standing**. Dutch research already is a world leader in many areas. However: "There must always be scope for creativity and innovation so that science can play an even bigger part in tackling social issues and strengthening economic growth." (Government of the Netherlands, 2014: Government science plans for 2015-2025)

Another important strategy to reach this goal is the **matching of European grants** by suitable funding of Dutch research institutions. The government wants to sustain Dutch research institutions' success in Europe and spur them on to win even more European project grants. As from 2015, government will provide an extra €50 million a year for scientists that receive European project grants. This will relieve the matching burden on institutions.

Another contribution to this goal shall be the publication of a **National Science Agenda**. This Agenda, which has been announced by the Cabinet and was supposed to be published by autumn 2015 at latest (however the document has not been available for the authors of this report until the end of October 2015), is supposed to connect the various agendas that have been diverging up until now. Scientists, the private sector, civil society organisations and government should set the National Science Agenda together. Its goal should be to challenge scientists to make ground-breaking advances. The Agenda will focus on the strengths of Dutch

science, while addressing social issues and economic opportunities.The National Science Agenda will respond to the challenges that offer the Netherlands important societal as well as scientific opportunities and will provide a source of inspiration for new research programming throughout the Netherlands. The government wants to promote collaboration between Dutch and foreign scientists. This will prevent fragmentation and strengthen the Netherlands' position and profile in international research teams. The National Science Agenda will therefore complement the European Horizon 2020 research programme and the strategy for the top sectors (see 1.3).

Another aspect concerns the **renewal of infrastructures**. Large-scale research infrastructure attracts scientists and innovative industries to the Netherlands. To retain this benefit, the ICT infrastructure must be renewed. The Netherlands Organisation for Scientific Research (NWO) will appoint a standing committee to deal with large-scale research infrastructure.

Goal 2): Stronger links with society and industry

To reach this goal, the government aims to secure open access to research, participatory science, confidence in science and integrity, closer ties between science and industry, encourage start-ups, better use of intellectual property, strengthening the knowledge function of higher professional education, better cooperation between public authorities and science. In more detail this means:

- "**Open access to research**: Sixty per cent of publicly-funded scientific articles in the Netherlands must be published in open access journals by 2016, and 100% by 2024. Publicly-funded research must be available to everyone, everywhere.
- **Participatory science**: Government actively supports communication with society about science. Science Weekend will be developed into an inspirational and popular national event. The government wants the general public to be more involved in science by 2025, for example by: participating in scientific research; asking questions of science; debating the possible social impact of new technology.
- **Confidence in science and integrity**: Science plays an important role in society. Science bears its own responsibilities but active policies on quality and integrity are also necessary. The government wants to promote replica research, meaning that research must be reproducible. It also wants to strengthen the position of the National Board for Research Integrity (LOWI).
- **Closer ties between science and industry**: Collaboration between science and industry can lead to scientific breakthroughs that create new social and economic opportunities.
- **Encourage start-ups**: Universities and higher education institutions must provide encouragement for graduates who want to start up their own business, for instance through the Valorisation Programme.
- **Better use of intellectual property**: Industry must make better use of the patents taken out on the results of scientific research.
- **Strengthening the knowledge function of higher professional education**: Institutions for higher professional education (HBO) must carry out more practical research and make their research activities more professional. They must also step up their cooperation with universities and make more use of European funding.
- B**etter cooperation between public authorities and science**: Guided by the National Science Agenda, public authorities must seek the assistance of scientists to solve pressing social issues." (Government of the Netherlands, 2014: Government science plans for 2015-2025)

Goal 3) science as a breeding ground for talent

To reach this goal the government goes different ways:

There should be **challenges for talented scientists.** Scientists must have the freedom to develop their talents. Together with the research institutions, the government wants to encourage scientists' development, in their roles as teachers, supervisors and managers, as well as in putting scientific knowledge and technology to practical use. From the governmental perspective too much emphasis is currently placed on publishing.

Another way to reach this goal is the **attraction of top international scientists**. Institutions must attract leading international high potentials. They must profile themselves as part of the Dutch scientific system. The Science Agenda's themes must also be recognised outside the Netherlands as strengths within Dutch science.

In addition the **number of PhD researchers in industry and government shall be increased**. The government will sign a Doctorate Agreement with industry on hiring several hundred PhD researchers in business and government. There must also be greater differentiation in the doctorate system.

Another goal is to get more out of **talented women researchers**. The ratio of men to women in science in the Netherlands should at least match the European average by 2025.

Overall **scientist should be given more time**. In the future, scientists should spend less time applying for grants. The NWO and universities are working on this. The pressure to publish must also be reduced. The new Standard Evaluation Protocol (SEP) will put greater emphasis on the overall quality of scientists' work. (Government of the Netherlands, 2014: Government science plans for 2015-2025)

2.1.2 Strategy for the top Sectors

The European Council recommended that the Netherlands should take measure to stimulate research and innovation. The Dutch government agrees with this recommendation. Research and innovation are seen as important drivers of long-term economic growth.

With its enterprise policy, the government is implementing the recommendation in association with the business sector, knowledge institutes and regional local authorities. This policy is a continuation of the **top sector approach** launched by the previous government.

The principal goal of the **Strategy for the Top Sectors** – in terms of innovation and research – is to promote closer cooperation between knowledge institutes, businesses and public authorities in the programming of fundamental and applied research, with special attention to the challenges facing society in the near future, including issues relating to sustainability. This will increase the applicability of scientific research for both commercial and social purposes and thus increase the return on the public funds devoted to research. That effect will be enhanced by the fact that the top sector approach incorporates elements of foreign policy, education policy and policies to reduce the administrative burden.

Another objective is to secure the active involvement of the ministries and of regional and local authorities in the strategy, not only financially but also by using their procurement policies.

The following top sectors have been identified: Agri-food, Horticulture and propagation materials, High Tech, Energy, Logistics, the Creative Industry, Life sciences, Chemicals and Water. These are the sectors in which the Netherlands excels globally and are a government priority. Another area of focus is head offices. Products and technologies produced by these top sectors contribute to finding solutions to societal issues. The first nine sectors were established in the 'To the top' policy document' (in Dutch). The head offices theme was added later. The establishment of head offices in the Netherlands helps sustain the country's strong economic profile, and it also creates jobs, which makes it important for all top sectors. More information

on the single sectors is available here: Government of the Netherlands, 2015: Investing in top sectors.

The continuation of the top sector approach is also mentioned as a goal in the National Reform Programme to reach the Europe 2020-Strategy goals. While the "2025 Vision for Science" mentioned above should help within the generic track of the Dutch government's innovation policy, the specific track consist of the top sector approach:

"Many results are visible. There are more public and private partnerships created and the (financial) contribution of private parties increases. Also involvement of SMEs increased. […] In the next years (SME) instruments will be simplified, regional clusters and ecosystems will be strengthened and special focus will be given to find solutions for societal challenges through public-private cooperation. Moreover, it is important to increase the amount of graduates in vocational-technical education (intermediate (preparatory) secondary vocational education). The Top Sectors Innovation Incentives for SMEs (MIT-scheme) stimulates innovation in the SME sector, in particular the involvement in the top sector approach. Applications for the MIT-scheme must fit within the innovation agendas of the top sectors. In 2015, the cooperation that began in 2014 with the provinces of Limburg and North Brabant will be expanded to all regions. The scheme will have a budget of €55 million in 2015 (was €30 million in 2014). In addition, a generic Innovation Performance Contracts (IPC) scheme will be published. The scheme stimulates SMEs to cooperate and to start together an innovation initiative." (Ministry of Economic Affairs, 2015)

2.1.3 Quality in Diversity – Strategic Agenda for Higher Education, Research and Science

The Ministry of Education, Culture and Science (OCW) and the Ministry of Economic Affairs, Agriculture and Science (EL&I) are responsible for the allocation of parts of the research funding and are therefore involved in this strategic agenda with the title Quality in Diversity.

This strategic agenda sketches a long-term perspective for higher education, research and science in 2025. After an analysis of the current situation, it is concluded that a change of course is necessary. Four main lines of action are identified:

- A more stringent and ambitious study climate
- Higher education institutes (HEIs) should develop stronger distinguishing profiles in education vis-à-vis other HEIs which should lead to more differentiation and specialization in education
- Stronger (public-private) collaboration in the triangle education-research-entrepreneurship
- HEIs should develop stronger distinguishing profiles in research vis-à-vis other HEIs, which should lead to more differentiation and specialization in research.

A new element is that performance agreements will be made between the OCW and HEIs to make them accountable for the achievements in these four areas. The performance agreements should result in a reduction of the number of study programmes, study programmes that are more relevant for the labour market, more focus and critical mass in research and more impacts of research.

Other concrete policy measure include: a reallocation of budgets for a 'quality impulse' in higher education; changes in the allocation system for higher education funding, with a large component for 'quality and profile'; and new laws and regulations to effectuate new policy measures for ensuring/guaranteeing the quality of diplomas, study success, teaching quality and intensity, selection of students, differentiation in supply of study programmes and funding of HEIs. To support the top sector approach, the valorization task of HEIs is better anchored (in the mission).

Like the top sector approach, OCW's Strategic Agenda for Higher Education, Research and Science has the same starting point: entrepreneurs, researchers, lecturers and students should be stimulated to excel. They should be given sufficient room to make their own decisions and to invest, and to dare to specialize. The cabinet wants to create the right conditions for entrepreneurship and science to perform at their best, increasingly in a joint effort, based on an excellent higher education system.

The key measures in this strategic agenda are:

- Government investments of a maximum of €230 million to improve the quality of the higher education system
- Changes in higher education funding
- Agreements with universities and universities of applied sciences about quality, profile and valorization
- Improve quality of higher education
- Support of the top sector approach (Erawatch, 2012).

2.2 Innovation and Research

2.2.1 Cooperation between knowledge institutes, the business sector and public authorities

As already mentioned above, the principal aim of the top sectors approach is to promote closer cooperation between knowledge institutes, businesses and public authorities in the programming of fundamental and applied research.

In the course of 2012, the parties collaborating in the top sectors established 9 **Top Consortiums for Knowledge and Innovation (TKIs),** which have started to implement the research agendas in the **Innovation Contracts**. In these contracts companies, researchers and the government have made agreements on how the resources earmarked for knowledge and innovation will be used in each top sector to build on existing scientific excellence and to meet the need for innovative solutions to societal problems. The TKI allowance, which is intended to spur private financing for TKI projects, took effect in 2013. Starting in 2014, the TKI allowance will be increased by 110 million euro to 200 million euro a year. Part of these funds will also be available to co-finance EU projects.

In 2013 the government made available approximately 22 million euro to stimulate the **involvement of SMEs in the top sectors**. The Top Sectors Innovation Incentive for SMEs (MKB Innovatiestimulering Topsectoren - MIT) scheme provides instruments that will enable companies to perform feasibility studies, carry out R&D-related collaborative projects or temporarily hire highly qualified employees. The actual themes have largely been determined and correspond closely with various flagship initiatives that serve as catalysts for achieving the Europe 2020 targets. In 2013 the top teams updated the Innovation Contracts for their own sectors for the period 2014-2015. The estimated private sector contribution to the TKIs in 2014-2015 is around 1billion euros per year. In updating the contracts the top sectors were asked to look explicitly at the association between the top sectors and European programmes for research and innovation. The Innovation Contracts described the importance of Horizon 2020 in particular, but also of programmes and initiatives like European Innovation Partnerships, Joint Programming Initiatives and European Technology Platforms. (Ministy of Economic Affairs, 2014)

2.2.2 Stimulating private R&D spending

Stimulating private spending on R&D is a primary aim within the generic track of the Dutch enterprise policy. Private R&D investments are being stimulated through the R&D Promotion Act

(WBSO), the R&D Allowance (RDA) and the Innovation Box tax credit scheme. An evaluation is under way to determine whether, starting in 2016, the RDA can be merged with the WBSO to create a single integrated tax credit scheme.

The structure of the SME+ Innovation Fund is being continued in the Future Fund. In this fund the solid foundation for financing innovative and fast-growing SMEs is being continued. In addition, a (start) capital of €200 million was appointed in 2014 to further increase access to risk capital for innovative SMEs (€100 million for the Dutch Venture Initiative II, possibly co-financed by the EIF) and to promote investments in fundamental and applied research (€100 million for large-scale research facilities and public-private cooperation projects aimed at societal challenges). At the European level, the framework programme Horizon 2020 promotes private and public R&D investments. The Dutch government is allocating resources for the co-financing and matching for Horizon 2020. (Ministry of Economic Affairs, 2015).

2.2.3 Investment in fundamental research

The importance of fundamental and applied research for innovation and for the Dutch economy and society is fully endorsed by politicians, the government, knowledge institutes and the business sector. The government has also decided to proceed with the Quality in Diversity Strategic Agenda, with its long-term perspective on higher education, research and science (see above).

2.2.4 The Netherlands and the European Research Area

Dutch research policy will also contribute to the development of the European Research Area (ERA). The goals formulated in the 2025 Vision for Science-Strategy (see above) will contribute to the ERA, which aims to ensure the free movement of researchers, knowledge and technology. In addition, the vision mentions:

- The direct funding opportunities for independent, curiosity-driven research will be maintained; the predictability and stability of university funding will be increased by working with three year averages and by reducing the promotion bonus;
- a permanent national commission for large-scale scientific infrastructure is to be established at the Dutch Organisation for Scientific Research (NWO) to ensure strategic, transparent, coordinated and integrated decision-making;
- it must be possible for scientists to pursue a broad career and the potential of women scientists has to be better utilized;
- the ambition concerning open access of publications and sharing research data was reaffirmed. The Netherlands is a frontrunner in Europe and aim to connect with like-minded Member States.
- the NWO is being asked to make an active contribution to the creation of the ERA, e.g. by means of the Joint Programming Initiatives, which seek to streamline and combine research expertise at the European level.

The partnership approach for the ERA is reflected by the involvement of, primarily, the Association of Dutch Universities (VSNU) and the NWO in the implementation of the policy measures from the Vision for Science and the contributions that they and other stakeholders involved have made. For example, since 2014, the VSNU has been part of a European consortium of employers that is guiding the establishment of a European pension fund for researchers, thereby improving mobility. The Dutch Network of Woman Professors (LNVH), the VSNU, the NWO and the department of OCW form a task force to better utilize the talent of women scientists, especially with respect to the submission and assessment of research proposals. (Ministry of Economic Affairs, 2015)

3. New Initiatives and Emerging Technology Fields

3.1 Top Sectors

The government has chosen nine 'top sectors', which are characterized by strong market and export positions, a good knowledge base, public-private collaborations and a potential to contribute to innovative solutions for societal challenges. Much of the policy measures are aimed at increasing the R&D-intensity of the Dutch business sector, especially in the following sectors:

- Agro-food
- Horticulture and propagating stock
- High-tech materials and systems
- Energy
- Logistics
- Creative industry
- Life sciences
- Chemicals
- Water

For each top sector a 'top team' of entrepreneurs and researchers has been formed. These have been asked by the cabinet to make concrete proposals for these policy agendas. The results of these proposals have made the Government to focus in tackling, over the next few years, mainly in administrative problems. These will involve improving professional education, removing obstacles to trade, strengthening the infrastructure, scrapping unnecessary rules and ensuring easier access for knowledge workers.

In May 2013, the new measure 'SME innovation support for top Sectors' (MIT) was launched. As from that moment, SMEs had the opportunity to submit proposals for participating in valorization initiatives.

The first biannual policy agenda's made by top teams date from 2011. In October 2013, the top sectors, knowledge institutions and the Dutch cabinet signed the Innovation Contracts for 2014/2015. The stakeholders promised an annual research investment of almost 2 billion euro (out of which about 970 million by the top sectors, and 1,06 billion public investments.

A progress report on the implementation of the Enterprise Policy was published in October 2013. The 'Voortgangsrapportage' was based on findings from the Top Sector Monitor, and addressed some of the issues raised in a preliminary evaluation by the AWTI.

In November 2013, the Scientific Council for Government Policy (WRR) published a report in which various elements of the existing innovation policy are criticized. The analyses in "Towards a learning economy investing in the Netherlands' earning capacity" question the choice for a sector-based strategy and provide suggestions for an alternative way to make the Dutch economy more resilient, adaptive, and proactive.

In order to ease access for SMEs and to reduce administrative barriers, Syntens and the Chambers of Commerce merged into 'Ondernemerspleinen' as of 2014. Also, NL Agency and the National Service for Implementation of Regulations became Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland, RVO) (Erawatch, 2015).

3.2 Examples for New Initiatives/Emerging Technology Fields

Leiden Bioscience Park: Life science hotspot of the Netherlands - The proximity of and interaction with other businesses, knowledge institutions and the active support of government bodies in a knowledge cluster are crucial. All these players are represented in the Leiden Bio Science Park cluster: dedicated life sciences companies, companies providing drug development and business services, knowledge institutions and supportive facilities. Around 85 companies and research institutes dedicated to red biotechnology or biomedical research are located at Leiden Bio Science Park. The biomedical clusters consist of drug developing companies, companies providing services in drug development and companies delivering business services. Apart from the biomedical cluster, there are also high tech companies working in the field of industrial biotech, green (food/plants) biotech, space, water management and research tools. A wide range of the knowledge institutions conduct research and provide education in life sciences at Leiden Bio Science Park, from vocational to academic level (Leiden BSP 2015).

Dutch Dairy Cluster: The dairy industry involves the production of raw milk and its processing into goods such as consumer milk, butter, cheese, yogurt, condensed milk, dried milk (milk powder), and ice cream using processes such as chilling, pasteurization, and homogenization. The dairy cluster includes cow farms producing milk as well as all downstream organizations processing it and distributing derivative products. The Netherlands has a long history of dairy production, with cheese production tracing its roots back to the Middle Ages when cheese was an important form of dairy trade because it had a longer shelf life than milk and similar products. A long history of many smallholder farmers specialized in dairy production meant that when middlemen started gaining power through economies of scale there was a rapid move to form cooperatives to keep bargaining power in the hands of the farmers. This resulted in the early formation of farmer cooperative groups that persist to this day. The cooperative structure resulted in increased specialization and investment in mechanization, moving production from farm to factory. Nowadays, dairy industries are highly involved in cooperation with universities such as the Wageningen Agricultural University, cluster development, network creation to maintain the status as the Netherlands' largest export cluster (Philippot et al. 2011). For more information on the Dutch Dairy Cluster please see the full document here.

Photonics Cluster Netherlands (PCN): PCN is the unique portal for Photonics in the Netherlands. Photnics is worldwide recognized as a key enabling technology for the 21st century and especially in Europe by the European Commission and also in the Netherlands by the High Tech Topsector. Their mission is to increase the level of awareness of the importance of Photonics for the economy and to increase the knowledge of Photonics at all levels of education, and as a result more industrial activities and more jobs in the field of Photonics (PCN 2015).

Dutch Aviation Solutions (DAS) cluster: DAS focuses on groups of Dutch companies involved into aviation sector, development of the airports and alike, complemented by specialized institutions, to enter the foreign markets together. DAS has a coordinated strategy which includes official trade missions, business meetings, trainings and inter-governmental cooperation to support companies with new opportunities (DAS 2015).

4. Description of mechanisms and assessment of best practices for strengthening the University – industry collaboration and supporting the commercialization of university research

In the Netherlands, a fundamental discussion exists about the way innovation should be stimulated. An Expert Evaluation Network has delivered a policy analysis on the performance of the Dutch cohesion policy between 2007 and 2013 (Chapter 4.1) There are many possible mechanisms that can be put in place to facilitate innovation, including mechanisms that reduce barriers to the movement of people between academia and firms, and incentives for university researchers to engage with business and to commercialize research. In the Netherlands, especially the concept of public-private partnerships (PPPs) raises new coordination challenges but also opportunities, due to the participation of heterogeneous set of actors with diverging interests and competencies (Chapter 4.2 and 4.3).

4.1 Expert Evaluation Network - Policy Analysis

The Dutch innovation policy is directed to establishing optimal conditions for innovation. It comprises general policy packages aimed at stimulating innovative activities in general and programmatic packages directed towards specific innovative industrial clusters. Likewise, regional economic policy is aimed at stimulating innovative activities in specific regional industrial clusters. The central problem of the Dutch innovation policy is what is called the Dutch Innovation Paradox: strong in production of scientific knowledge and patents, weak in application and commercialization. Recent proposals emphasize more transparency and openness. Several assessment reports of innovation progress and policy in the Netherlands distinguish possibilities for improvement in (i) stimulating innovative SMEs, (ii) the attractiveness of the Netherlands as a location for knowledge intensive activities, (iii) innovation through strong and internationally leading innovation clusters, and (iv) establishing an excellent climate for both learning and research.

The European Regional Development Fund (ERDF) is used as a means to co-finance the regional economic innovation policy. There are four regions administered by four management authorities. There is a good match between the ERDF-innovation policy guidelines and the regional priorities for enhancing and boosting innovation. Furthermore, the ERDF innovation measure fit quite well in both the national and regional agenda to stimulate industrial clusters and improve innovation in SMEs. According to the operational programs of the four regions, almost 45% of the total ERDF-funds are prioritized to innovation policy. This amount is equally allocated to the three lines of innovation: "boosting applied research", "knowledge transfers and poles" and "innovation friendly environment".

The information gathered from the four regions describes the situation until the end of 2009.

1. The total amount of money committed to innovation projects in the period 2007-2009 is €676 million. Of this amount 31% is financed by ERDF, 48% stems from regional and 22% from national sources.
2. Looking at the ERDF targets, "Boosting applied research" is most popular with 81% commitment in projects. This is for a major part related to the fact due to projects in FOI-code 9: "Other measures to stimulate research and innovation and Entrepreneurship in SMEs (124%) and in FOI-code 1: "R&TD activities in research centers" (92%). The commitment of projects in "knowledge transfer and poles" is with 72% on schedule. The measure most often used is code 3: "Technology transfer and improvement of

cooperation networks" (112%). The "Innovation friendly environment" is the least used so far with a total of 17% of committed projects by the end of 2009.

There are substantial differences between regions, but on the whole these general conclusions hold.

It is not possible at this moment to report results and outputs of the 2007-2013 Cohesion Fund program. Only on region reported some preliminary outputs, but this is too small to make general conclusions.

The main challenge that is reported by the regions has to do with the terms of demands of the European guidelines. These are strict and the bureaucracy sometimes deters organizations to file an application. Moreover, this bureaucracy argument also refers to one of the weaknesses of the innovation system in the Netherlands where large-scale projects rarely blossom (Experts Evaluation Network 2010).

4.2 The Infrastructure of Knowledge – Ongoing and completed projects

In the past twenty years Dutch science and research policy was highly successful. Nonetheless, there are questions about the functioning of the infrastructure of knowledge. The Rathenau Instituut is examining how it can be improved. Here, one ongoing project and one completed project will be presented as two examples of Dutch science and research policy.

Ongoing project: The future of Dutch universities

By 2025 universities will play a key role in an international knowledge-based society. And that society is changing rapidly. New education technologies are challenging universities to innovate. Urbanization, the rise of European research, education and innovation areas, and growing international mobility among knowledge workers will bring new opportunities. The optimists see boundless potential. At the same time, however, some paint doom scenarios, in which Dutch universities will lose out to the international competition, the rise of Asia and the financial crisis.

The future of the university depends to a large extent on external developments. This only increases the uncertainty and the importance of thinking strategically about the future. In February 2013, therefore, the Dutch universities' association VSNU and the Rathenau Institute launched a Future Strategy for Dutch Universities project. The aim is to develop a long-term vision of the position of the university, its knowledge and research function and its relationships with stakeholders. The project focuses on the question of how universities can fulfil their knowledge and research function to their full potential in the future.

The project has produced an interim product in the form of a publication that explores four possible scenarios. They are intended to structure the strategic dialogue between university administrators and their stakeholders. The scenarios are therefore a tool; they do not pretend to predict 'the' University of the Future, but merely serve as an invitation to consider all the possibilities.

In 2014 the project proceeded with scenario development and regional meetings. Audiovisual reports of the meetings will be made available. The process culminated with the Duin & Kruidberg conference in June 2014, at which stakeholders discussed the strategic vision and the various options (Rathenau Instituut 2015a).

Completed project: Coastal defences

Water has demanded the attention of the Dutch government since time immemorial. The Innovation Platform has designated water technology as one of the four key components of the Dutch economy, whereby water-related research must be structured as effectively and efficiently

as possible. The Rathenau Institute's Science System Assessment has made a significant contribution to the discussions.

Recent years have seen a shift in policy, as confirmed by the preliminary study conducted in 2005. The Dutch no longer attempt to control the water but to accommodate it. 'Living with water' and 'integrated water management' are now the key concepts. Given the form and structure of our country, it would be futile to attempt to control water completely. Rather, we must do everything possible to reduce the potential impact of flooding. There are various options, both in construction technology and spatial planning. Buildings can be designed to be water-resistant, or excess water can be redirected to areas in which it will cause least damage. Various other disciplines, including climate research, spatial planning and ecology, have therefore become more relevant to coastal defence research.

In these Science System Assessment projects, the key question was whether the research field itself changes under the influence of such developments and, if so, how? The first step was to identify the various parties involved in the field, the types of research in which they are engaged, and how that research is funded. In order to keep the project within manageable bounds in this method development stage, it focused on coastal defence research and specifically on:

- an inventory and classification of the Dutch research groups active in coastal defence research in the Netherlands. These include universities as well as other public sector research organizations.
- an analysis of how the research field is organized, and the way in which it can respond to developments both within and beyond the discipline itself. Coastal defence is a topic of extreme societal importance, and one which has a marked political dimension. How are the political and social agendas reflected in the research agenda? If government policy prioritizes certain aspects, does research follow suit?
- a quantitative bibliometric analysis of the international research field. Publications in academic journals can reveal the emergence of new research topics and new interdisciplinary partnerships (Rathenau Instituut 2015b).

5. Description of partnership models utilized by government and related agencies to encourage clustering and precompetitive research between firms and assessment of best practices

There are a number of programmes initiated by the Dutch government to support companies in their clustering and research activities. The most important ones, Knowledge and Innovation Communities (KICs), will be presented here as positive examples of how to successfully connect companies with research, education and innovation.

5.1 Knowledge and Innovation Communities

KICs are the results of the European Institute of Innovation & Technology (EIT) mission to fully integrate all three sides of the "knowledge triangle" consisting of higher education, research and businesses. By bringing together leading players from all these dimensions to cooperate within the KICs, the EIT is able to promote innovation in Europe (EIT 2015).

KICs are characterized by the following features:

- High degree of integration: each KIC is organized around an independent legal entity, gathering world-class KIC partners from all the innovation dimensions. The specificity of the KICs is to integrate, education and entrepreneurship with research and innovation at the EU level to deliver incremental and disruptive results.
- Long-term perspective: each KIC is set up for a minimum of seven years to contribute to overcoming fragmentation via world-class, long-term, integrated partnerships. This enables partners to commit to a strategic initiative for a longer time than in traditional innovation policy initiatives.
- Efficient governance: each KIC is driven by a CEO and KIC partners are represented by single legal entities for more streamlined decision-making. KICs must produce annual business plans with clear targets and deliverables looking for both market and societal impact.
- The co-location model: each KIC consists of five or six world-class innovation hotspots, building and leveraging on existing European capacities. A co-location centre brings together diverse teams of individuals from across the Knowledge Triangle in one physical place, acting as a hub for many activities and combining competences and skills developed in different areas of specialization (EIT 2015a).

KICs carry out a whole range of activities, covering the entire innovation chain including training and education programmes, reinforcing the journey from research to the market, innovation projects and business incubators. They have been conceived so that they are able to react in an effective and flexible way to new challenges and changing environments.

The KICs are driven by a pursuit of excellence in all of their activities and are established with the aim of reaching the necessary critical mass to achieve systemic impact, including the creation of new businesses and new jobs as well as the promotion of new skills and entrepreneurial talent in the economy.

The EIT's first three KICs were launched in 2010:

- Climate-KIC: addressing climate change mitigation and adaptation
- EIT ICT Labs: addressing information and Communication Technologies
- KIC InnoEnergy: addressing sustainable energy

And a further two in 2014:

- EIT Health: addressing healthy living and active ageing
- EIT Raw Materials: addressing sustainable exploration, extraction, processing, recycling and substitution (EIT 2015)

5.2 Dutch Participation in KICs

Dutch activities are present and of high importance in almost all KICs that have been launched since 2010. Dutch core partners and offices in each of the KICs are listed below:

- Climate-KIC: Amsterdam Airport Schiphol, KLM, TNO, Delft University of Technology, Utrecht University, Wageningen University & Research Center
- EIT ICT Labs: Co-location Centre in Eindhoven, key cooperating partners: Philips, University of Twente, University of Utrecht, Thales Nederland, High Tech NL
- KIC InnoEnergy: Offices in Amsterdam, Eindhoven; partners: Eindhoven University of Technology
- EIT Health: Co-location Centre in Rotterdam
- EIT Raw Materials: Leiden University, TNO, Stichting Katholieke Universiteit, Delft University of Technology

For more information please see each KIC's website available via the EIT website.

5.3 Climate-KIC and InnoEnergy-KIC in Detail

The Netherlands are actively involved in both, the Climate-KIC and the InnoEnergy-KIC.

The **Netherlands Climate-KIC** consists of partners from industry, research institutes, public organizations and a growing number of SMEs. Each academic partner has an incubator with a strong track record in creating new businesses and is connected to entrepreneurship activities. The partners have world leading expertise in climate mitigation and adaptation and form a strong innovation ecosystem in the Netherlands. They work together to initiate large projects in the areas of sustainable cities, land & water management and bio-economy and are committed to educate, innovate and accelerate on a local and international level (Climate-KIC 2015).

The activities within Climate-KIC are driven by eight climate change themes:

- Greenhouse gas monitoring
- Adaptation services
- Making transitions happen
- Sustainable cities
- The built environment
- Land and water engineering for adaptation
- Resource efficiency
- Developing a bio-economy

Wageningen UR is core member of Climate-KIC, and is represented in the Board of the Dutch CLC, the General Assembly and the Governing Board. In these capacities Wageningen UR is directly involved in the governance of the community. It has a strong participation in the themes Land and Water engineering for adaptation, bio-economy and adaptation services, but also participates in most of the other strategic lines. Furthermore, large companies such as DSM, Schiphol, KLM and Arcadis as well as TU Delft, Utrecht University and TNO are taking part in the project (Wageningen UR 2015).

As part of the programme, the Netherlands acts as an accelerator and supports entrepreneurs to develop from climate innovation into a clean-tech business. It helps to accelerate start-ups until they are ready for launching customers or investors within 18 months. Training, dedicated business coaching and substantial financial support (up to 85.000€) are also part of the programme. Accepted Climate-KIC start-ups will have access to extensive in-depth business coaching throughout their stay in the programme and are urged to participate in a series of Master Classes. Entrepreneurs also get access to the exclusive European Climate-KIC community, which includes investors, potential clients, experts, mentors and other start-ups (EIT 2015b).

The **KIC InnoEnergy** is the European company dedicated to promoting innovation, entrepreneurship and education in the sustainable energy field by bringing together academics, businesses and research institutes. The goal is to make a positive impact on sustainable energy in Europe by creating future game changers with a different mind-set, and bringing innovative products, services and successful companies to life. With the headquarters being in the Netherlands, activities are developed across a network of offices located in seven European countries. In total, 27 shareholders including top ranking industries, research centers and universities, all of which are key player in the energy field, are involved in the InnoEnergy-KIC. More than 150 additional partners contribute to activities to form a first class and dynamic network that is always open to new entrants.

The KIC InnoEnergy is committed to reduce costs in the energy value chain, increase security and reduce CO2 and other greenhouse gas emissions. To achieve this, the focus of activities lies around 8 technology areas:

- Clean Coal Technologies
- Energy from Chemical Fuels
- Energy Efficiency
- Electricity Storage
- Renewable Energies
- Smart and Efficient Buildings and Cities
- Sustainable Nuclear and Renewable Convergence
- Smart Electric Grid (KIC InnoEnergy 2015).

6. Analysis of public support mechanisms to stimulate innovation that are not R&D-based

6.1 Knowledge Transfer Networks

"In a nutshell, knowledge transfer (valorization) means putting academic knowledge to practical use." (Utrecht University 2015)

In addition to teaching and research, the transfer of knowledge and technology as the so-called "Third Mission" of universities is central to most higher education facilities. The transfer of knowledge and technology aims at bridging the gap between invention and innovation and utilizing newly acquired scientific knowledge and new technologies in both a systematic and structured way, thereby realizing their market potential (University Koblenz-Landau 2015).

Examples of knowledge transfer networks in the Netherlands

Utrecht Valorisation Center is an organization for employees at knowledge institutes, for businesses and students. For businesses it offers access to top-quality knowledge, learning and talent. Here, collaboration takes place on the basis of contract research and within projects and knowledge consortia. Knowledge transfer is aimed at converting this knowledge and learning into societal and commercial applications. The faculties provide advice and support for researchers who work with businesses and social institutions to acquire government and indirectly funded projects (Utrecht University 2015).

At **Wageningen University**, knowledge transfer in the Dutch horticultural system plays an important role. Internationally, the sector has a leading position in vegetables, fruits, ornamentals, flower bulbs and trees. Within these product groups, long-lasting experience in breeding and production is combined with extensive industrial activities in support, logistics and services. The strong position of the Dutch horticultural industry is founded on an intensive interaction between governmental research institutions and private companies. Over the past fifty years, the high quality of plant sciences has been continuous resource for innovations (Dons and Bino 2008).

The **Climate and Development Knowledge Network** (CDKN) supports decision-makers in designing and delivering climate compatible development by combining research, advisory services and knowledge management in support of locally owned and managed policy processes. The network works in partnership with decision-makers in the public, private and non-governmental sectors nationally, regionally and globally. The CDKN is able to provide support through its alliance organizations and procure the best services from around the world. It strives to deliver the highest quality technical advice, forge uniquely effective partnerships, and drive the latest and best thinking on climate compatible development.

Within the broad scope of climate compatible development, it works across four strategic themes:

- Climate compatible development strategies and plans
- Improving developing countries' access to climate finance
- Strengthening resilience through climate-related disaster risk management
- Supporting climate negtotiators from the least developed and most vulnerable countries (CDKN 2015).

Open Knowledge Netherlands is worldwide non-profit network of people passionate about openness, using advocacy, technology and training to unlock information and enable people to work with it to create and share knowledge. The network's goal is to help establish enlightened

societies around the world, where everyone has access to key information and the ability to use it to understand and shape their lives; where powerful institutions are comprehensible and accountable; and where vital research information that can help tackle challenges such as poverty and climate change is available to all (OKFN 2015).

NEMO Science Center is an interactive, informal learning environment where the general public comes into contact with science and technology. Visitors see, hear and experience how scientific phenomena and technology play an important part in their lives. As a science center, it stimulates, excites, is instructive and works closely with the fields of science and education. NEMO is responsible for a number of national activities and committed to make scientific knowledge accessible to everyone (NEMO 2015).

Many Dutch universities and public research organizations are members of knowledge transfer networks. Knowledge transfers represent an integral part of their organization and have traditionally been strong at the universities of technology and medical centers. This is reflected in the number of patents awarded in the early 21st century, where the Netherlands is listed on position five, following France, Germany, Japan and the United States of America.

Within higher education the development of programs for the stimulation of entrepreneurship is very common. In the centers, the Dutch research universities cooperate with universities of applied science and the business community to foster an entrepreneurial spirit in students and to promote cooperation between the business and education sectors. Over the past few years, the universities have intensified their partnerships with companies to create Public-Private Partnerships (Daniels 2011).

6.2 Incubators

"An incubator is an organization that helps start-ups develop in an accelerated fashion by providing them with a bundle of services, such as physical space, capital, culture, coaching, common services, and networking connections" (DIA 2015).

The Dutch Incubator Association (DIA) has been established to provide the Dutch incubators with a common platform on behalf of professionalization and positioning on a national, European, and international level. The goals of this association are:

- Professionalization of the incubation profession,
- Reinforcement of the incubator infrastructure and relations (synergy) on both national and European level
- Optimizing the information about incubation towards start-ups.

DIA is connected to the international incubation community and does what is in her power to contribute to the development of a high-performance professional industry in the Netherlands (DIA 2015).

Examples of Incubators in the Netherlands

A full list of business incubators in the Netherlands is available on the DIA website.

Geo Valley: Geo Valley is a European investment programme for companies inside Geomatics Business Park, aiming to further advance the employment of space travelborne satellite data in the development of useful environmental information. Under the name of Geo Valley, renowned geomatics companies and knowledge institutions (including several outside GBP) are working together to develop new innovations and applicability in the realm of geomatics. This way, the investment plan provides numerous product and service innovations in the field of water management, air quality and spatial quality. In addition, Geo Valley aims to improve the

availability and accessibility of geo-information, by developing internet-based facilities (Geo Valley 2015).

Yes!Delft: YES!Delft is the high tech entrepreneurs center with a clear mission: Building tomorrow's leading firms. It inspires students, professionals and scientists to make their first steps on the path to becoming an entrepreneur and offers them the necessary support to turn their venture into a success. YES!Delft focuses on entrepreneurs with concrete ideas for technical, innovative and scalable products or processes. It supports them in numerous ways. It starts by inspiring the future entrepreneurs to make their dream come true and introducing them to the opportunities out there and explain them the benefits and possibilities of being an entrepreneur. By means of education they help the students and young entrepreneurs with their development. With high quality training programs the entrepreneurs lay out a solid foundation for their own company. Offering them office space and many (technical) facilities, access to an interesting international network and optimal knowledge sharing circumstances to incubate, make these promising companies grow even further (YES!Delft 2015).

BiD Network: BiD Network aims to increase economic development in emerging markets through the mobilization of capital and knowledge to small and medium sized enterprises (SMEs). By offering customized matchmaking and support services to both financers and entrepreneurs it aims to grow the number of businesses that can start, grow and expand. Through its international network of local business centers, global business plan competitions and the use of an online entrepreneurial platform it locates businesses with a financing need of USD 10,000 to USD 500,000. BiD Network has experience in supporting entrepreneurs across multiple sectors, including clean energy, water and food & agriculture. Moreover, through 5 years of Women in Business competitions, BiD Network has built the network and the expertise to prepare women entrepreneurs from emerging markets for finance. Its investor matchmakers, with the support of our partners and a strong and dedicated network of coaches, prepare entrepreneurs for investment so BiD network can put together an attractive portfolio tailored to the interests of financiers, consisting of business angels, SME funds, private foundations and banks. Additionally, BiD network offers advisory services on how to set up deal flow sourcing, mentoring, investor services and business angel networks in emerging markets (BiD Network 2015).

BoP Innovation Center: The BoP Innovation Center offers business development services for growing economies in developing countries. It takes customers from opportunity scouting to finding investors and market introduction. Initially, the BoP Innovation Center scouts and assesses opportunities and best practices, organizes inspiration workshops and shares consumer insights. Doing so, it helps enterprises to scope the business and develop profitable business models and entry strategies. Furthermore, it designs business cases, brokers smart partnerships and organizes the pilots. After identification of appropriate innovations, the BoP Innovation Center engages Dutch and international enterprises and involves local partners. Finally, it links ventures to impact investors in its network, prepares business plans for investment and identifies potential investees. BoP Innovation Center is shareholder in the Inclusive Business Fund and introduces entrepreneurs to other impact investors with whom BopInc has a strong relationship (BoPInc 2015).

Erasmus Centre for Entrepreneurship (ECE): The ECE believes that the world is facing challenges and that we need entrepreneurial people who are able to solve them. Driven by the conviction that entrepreneurship is the primary condition for realizing progress, the ECE offers a learning environment where companies become better at entrepreneurship by gaining new insights and turning ideas into innovations. ECE supports startups, SMEs, as well as corporates in this process through a combination of a strong academic background and a community filled with experienced entrepreneurs. The ECE Campus is home to more than 50 innovative companies and the stage for many entrepreneurship events. This infrastructure helps to foster

ambitious entrepreneurship and empower a global community of 20.000 entrepreneurs who can solve worldwide challenges – creatively and effectively (ECE 2015).

6.3 Innovation Hubs

Innovation hubs are defined as a location where the development and marketing of innovation occurs due to the spatially concentrated interaction of science, education and economy in combination with adequate living conditions including shopping, culture and leisure time facilities. The aim of developing such location is to stimulate a competitive regional environment. This environment is characterized by multiple interactions between actors, the suspension of borders between physical, digital, economic, social and cultural space, a creative community with a density of scientists seeking an equally high living standard in terms of environmental, social and cultural diversity as well as physical accessibility (Hartmann et al. 2012).

Thus, innovation hubs are different to abovementioned public support mechanisms in the sense of being a part within regional developing plans and spatial contexts. They rely on an existing innovation potential nearby larger cities and must be integrated in infrastructural conditions on a high level of competence.

Examples of Innovation Hubs in the Netherlands

Enviu: Enviu kick-starts impact-driven companies aimed at creating environmental and social impact. Their products and services aim to improve the quality of life of as many people as possible in a sustainable way. Their vision is to maintain quality of life, end poverty and restore our planets eco-systems at the same time. Enviu believes that the world needs new models for production, distribution, education and business and sees kick-starting impact-driven ventures as a key to do this. Through Co-creation and Business Development, Enviu generates concepts together with its community of entrepreneurs and innovators (Enviu 2015).

Startup Juncture: This website is a central repository of links to all information one needs as a Dutch startup entrepreneur. It is the largest English language startup blog in the Netherlands and is dedicated to profiling Dutch startups and the vibrant Dutch startup scene at large, to a global audience. The website presents lists containing information about organizations, an overview of accelerators and incubators in the Netherlands, job boards, overview pages, meetings and events, office space, funding processes and documentation (Startup Juncture 2013).

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FRIENZ Facilitating research and innovation cooperation between Europe and New Zealand

Swedish Research and Innovation Landscape

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Abstract

The paramount document formulating and compiling Swedish national research and innovation policy is the quadrennial research and innovation bill, which has two main functions. First, it lays out the framework for investments and priorities for the coming four years. The second goal is to formulate and codify the analysis of the state of the Swedish research and innovation system. The general assessment of the national Swedish research and innovation system in the 2012 bill highlights the following structural challenges for the Swedish research and innovation system: (1) The general level of quality of Swedish (academic) research is already high but needs significant improvements to become globally competitive in coming decades. (2) Interaction between the academic sector (basic research) and industry (applied research and development) is generally too low and inefficient, which shows not least in the suboptimal performance in commercialization of research results from academia, and (3) Swedish public research is impressive in its breadth but needs to improve its specialization and performance in certain cutting-edge fields, and prioritize more clearly between focus areas and less important areas.
Governmental policy formulation has been explicit in at least three consecutive research bills (2004, 2008, 2012), as well as other official documents (e.g. the 2012 National Innovation Strategy) that the public R&D system is in need of strategic mobilization and purposeful efforts to enhance the level of interaction between academia and industry/society to strengthen the innovativeness of the economy at large. Several specific policies have also been launched to enable and enforce strategic mobilization (the Strategic Research Areas and the recent programs to recruit internationally leading scientists), to raise overall quality levels (resource increases) and to facilitate commercialization of research results (investments in the institute sector and in innovation offices).

Table of Contents

Quick guide to Swedish Innovation System

	Name	Description	Link
Institutions	Swedish Research (Policy) Council Vetenskapsrådet	VR's mission as funder of basic research (in the academic sector) through competitive programs is combined with a strategic role as an advisor for the government on issues relating to research policy	http://www.vr.se/inenglish.4.12fff4451215cbd83e4800015152.html
	Royal Swedish Academy of Sciences	The Royal Swedish Academy of Sciences is an independent organisation whose overall objective is to promote the sciences and strengthen their influence in society.	http://www.kva.se/en/
	Royal Swedish Academy of Engineering Sciences	Royal Swedish Academy of Engineering Sciences aims to influence societal development and policy making through knowledge transfer activities and projects. The projects always have a scientific approach, and mobilize the expertise in Academy's network.	http://www.iva.se/iva-in-english/
	Ministry of Education and Research	The Ministry of Education and Research is responsible for the Government's education, research and youth policy. The Ministry works on issues including school performance, conditions for teachers, study financing and living conditions for young people.	http://www.government.se/government-of-sweden/ministry-of-education-and-research/
	Ministry of Enterprise and Innovation	The Ministry of Enterprise and Innovation is responsible for matters relating to housing and urban development, state-owned enterprises, information technology, enterprise and industrial policy, rural affairs, regional growth, post issues and infrastructure.	http://www.government.se/government-of-sweden/ministry-of-enterprise-and-innovation/
	National Agency for Innovation Systems	Vinnova was founded in 2001 and funds programmes which develop new knowledge and expertise within areas which are strategically important for Sweden. Recently there is a gradual shift of priorities which signals a move from pure R&D policy and funding to broader R&I policy and funding.	http://www.vinnova.se/en/

Swedish Agency for Economic and Regional Growth	intermediary agency that is responsible for the promotion of innovation, providing venture capital and advice at different stages in the innovation process as well as incubator functions	http://www.tillvaxtverket.se/sidhuvud/englishpages.4.21099e4211fdba8c87b800017332.html
Swedish Higher Education Authority	Government agency that deals with questions concerning universities and university colleges. UKÄ is responsible for the official statistics on higher education and also works with the quality assurance of higher education courses and programmes, monitoring and evaluating efficiency, legal supervision and leadership development in higher education.	http://www.uk-ambetet.se/2.4149f55713bbd91756380004301.html
Swedish Research Council for Health, Working Life and Welfare	Forte funds research for people's health, working life and welfare. We are a government agency under the Swedish Ministry of Health and Social Affairs. Forte represents the strength and the power that our funding means for the Swedish research community and in the long run the development of the individual and society at large.	http://www.forte.se/en/
Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning	The mission of Formas is to promote and support basic research and need-driven research in the areas Environment, Agricultural Sciences and Spatial Planning. The research that is funded should be of the highest scientific quality and relevance to the areas of responsibility of the Council.	http://www.formas.se/en/
Swedish Foundation for Strategic Research	The Swedish Foundation for Strategic Research was founded in 1994 with capital from the former wage-earner funds, with the objective to support research in natural science, engineering and medicine that strengthens Sweden's competitiveness.	http://www.stratresearch.se/en/
Regional Boards	Regional Boards are overtaking responsibilities for regional development from Country Administrative Boards. Regional	http://skl.se/english

		Boards and an association of municipalities and the county administrative board in the north of Sweden called the Västerbotten Region, have made independent efforts to formulate regional innovation strategies.	
	Swedish Government		http://www.government.se/
	Ministry of Finance	Responsible for central government finances	http://www.government.se/government-of-sweden/ministry-of-finance/
	Prime Minister's Office	Coordinating and leading the work of the Government Offices, Swedish EU policy and emergency management	http://www.government.se/government-of-sweden/prime-ministers-office/
	Ministry of Employment	Responsible for the functioning of the labour market	http://www.government.se/government-of-sweden/ministry-of-employment/
	Research Institutes of Sweden	Research Institutes of Sweden are governmentally owned holding companies that coordinate the publicly funded research institutes, work towards better coherence among institutes within industrial sectors, streamline the institutes' legal and organizational structures, deepen its collaborations with academia and industry, give financial support to innovation activities in SMEs.	http://www.ri.se/en
Policy Papers	quadrennial research and innovation bill	The quadrennial research and innovation bill, identifying long- and short-term goals for the public research system and a budget framework for the coming four years, is the key national policy document in this area. All research agencies, universities, and colleges provide input to the work to formulate the bills. It has two main functions: It lays out the framework for investments and	

		priorities for the coming four years and it formulates and codifies the state of the Swedish research and innovation system. This analysis can be seen as a collected and mediated opinion of the relevant actors in the Swedish research and innovation landscape.	
	research and innovation bill 2012	The Government's Research and Innovation Bill presents measures that involve a gradual increase in the appropriation for research to SEK 4 billion in 2016. The need for measures has to be examined regularly to ensure that investments in research and development are at an economically efficient level.	http://www.regeringen.se/contentassets/4ef9d72bd1b84b3fad482671b5509fa7/forskning-och-innovation-prop.-20121330
	Swedish National Innovation Strategy (2012)	The National Innovation Strategy is a general framework policy document formulated and issued by the Ministry of Enterprise, Energy and Communication. It lays out some broad objectives for the Swedish innovation system, such as a continued strengthening of the national innovative capacity to keep up with international competition, an improvement of the innovation climate for SMEs, an increased direct innovation support, and the strengthening of the rather weak Swedish research institute sector, but little or no concrete policies.	http://www.regeringen.se/contentassets/f4877afdcc2b44a290853b2788e7d003/den-nationella-innovationsstrategin
Programmes / Projects	Strategic Research Areas	Funding of 20 research areas, funding awards for 22 projects in the areas of medicine, e-science, healthcare, geography and politics.	http://www.vr.se/inenglish/shortcuts/strategicresearchareas.4.1f599ea412a30327ccf80001572.html
	Science for Life Laboratory	Science for Life Laboratory, SciLifeLab, is a national center for molecular biosciences with focus on health and environmental research. SciLifeLab is a national resource and a collaboration between four universities: Karolinska Institutet, KTH Royal Institute of Technology, Stockholm University and Uppsala University.	http://www.scilifelab.se/

Nordic MAX IV Laboratory	MAX IV Laboratory is a national laboratory hosted by Lund University. It operates accelerators producing x-rays of very high intensity and quality. Almost 1000 scientists per year come to the lab and use the x-rays for scientific research making the invisible visible. It is presently building a new project which will be the brightest x-ray source in the world when opening to users in 2016.	https://www.maxlab.lu.se/
European Spallation Source	The European Spallation Source (ESS) is a multi-disciplinary research centre based on the world's most powerful neutron source. This new facility will be around 30 times brighter than today's leading facilities, enabling new opportunities for researchers in the fields of life sciences, energy, environmental technology, cultural heritage and fundamental physics.	https://europeanspallationsource.se/
Decisions Grants for international recruitment of leading researchers	In the 2012 research bill this specific program was launched to incentivize the HEIs to make international recruitments of especially "prominent" researchers. The program was launched in the spring of 2013, and as of May 2015, twenty internationally renowned professors had been recruited to six Swedish universities as part of the program.	http://www.vr.se/inenglish/researchfunding/fundinggranted/grantsforinternationalrecruitmentofleadingresearchers
Vinnova – JSPS Joint Projects	Programme for two-year visiting research fellowships between Sweden and Japan that should increase and support the transnational mobility of post-docs and other skilled researchers between Sweden and other countries.	http://www.vinnova.se/sv/EU-internationellt-samverkan/Internationellt-samarbete/Asien/VINNOVA--JSPS-Joint-Projects/
Swedish Incubators & Science Parks, Vinnova incubator program	With 65 members focusing to stimulate growth in knowledge-based companies. SISPs members include 43 business incubators and 33 science parks, hosting 5000 companies with more than 70 000	http://sisp.se/?language=en

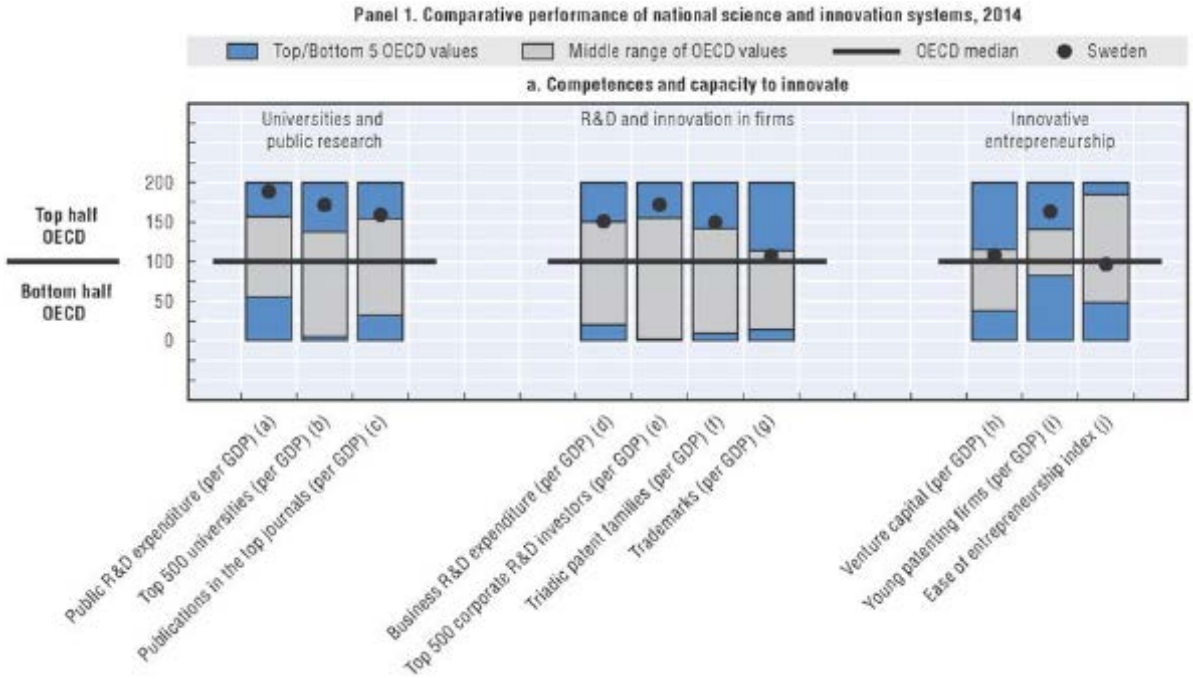
	employees.	
R&D centres of excellence	These environments are often regionally based and represent a physical space for both industry and academia to interact and exchange ideas. Industry PhDs and different types of joint affiliations are another way of ensuring exploitation of knowledge generated in academia. The focus of these types of triple helix initiative has been a measure to improve the level of collaborations between industry and universities. Examples include "VINN Excellence" programme and "Berzelii Centres".	
Lineaus Environments	Supports strong basic-research environments at universities.	
SwePub database	Database run by the Royal Library that indexes articles, conference papers and doctoral dissertations published by researchers at Swedish universities and higher education institutions.	http://www.kb.se/libris/teknisk-information/SwePub/
OpenAccess.org	OpenAccess.org project, run and funded by the Royal Library in collaboration with the Association of Swedish Higher Education, the Royal Academy of Sciences, and the Knowledge Foundation, works on all topics regarding open access publishing.	http://openaccess.org/index.php?section=1
BSR Stars Programme	BSR Stars Programme aims to speed up innovation in the Baltic Sea Region using transnational cooperation to create strengthened competitiveness and sustainable growth.	http://www.bsrstars.se/
RegLab	RegLab is an interest group formed by relevant actors from Swedish regions, Vinnova and the National Agency for Growth. In a collaborative project the regions work together to develop their Smart Specialization strategies, mainly through the method of "twinning" by which is meant that two or more actors share knowledge and experience. The project engages all	http://www.reglab.se/om-reglab/english

		Swedish regional authorities and can therefore be seen as the first national initiative around smart specialisation.	
	Challenge-driven innovation	Large-scale Vinnova program that strongly reflects EU2020 priorities and the international perspective.	http://www.vinnova.se/en/Publications-and-events/Publications/Products/Challenge-driven-Innovation1/
Others	Swedish Paradox	The shortcomings of the Swedish research and innovation system can, somewhat simplified, be described in terms of a "Swedish paradox". First identified and conceptualized some academic studies of innovation and entrepreneurship in the 1990s, this concept has earned great influence in policy circles and been established as common knowledge: Relative to the strong showing in annual R&D investment as percentage of GDP, the returns in the shape of research-based innovations, knowledge-based entrepreneurship, and economic growth in knowledge- intensive sectors, are too low. The paradox has been attributed to several structural deficits in the Swedish society, public and private sectors alike.	https://ideas.repec.org/p/hhs/lucirc/2006_001.html

1 General features of the Swedish research landscape

1.1 Basic characterization

With a population of 9.6 million, Sweden is the home of approximately 1.9% of the total EU-28 population (Statistics Sweden). Sweden's GDP per capita (2014) is almost 1.6 times that of the EU-28 average, namely €40,300 (EU-28 average €25,800), and the GDP growth rate was 1.1% in 2014, compared to 0.3% in 2011 (Eurostat). Sweden has long since been one of the countries in the world with a highest annual R&D investment in percentage of GDP and is consequently the EU country with the **second highest total annual R&D expenditure relative to GDP**, after Finland. In 2013, Swedish domestic R&D expenditure amounted to 3.21% of GDP, compared to an estimated average of 2.02% for EU-28. The long-term trend for Sweden is however 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 3.21% 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 has shrunk from 2.74% in 2008 to 2.31% in 2012. 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 (Eurostat; OECD Science, Technology and Industry Outlook 2014).



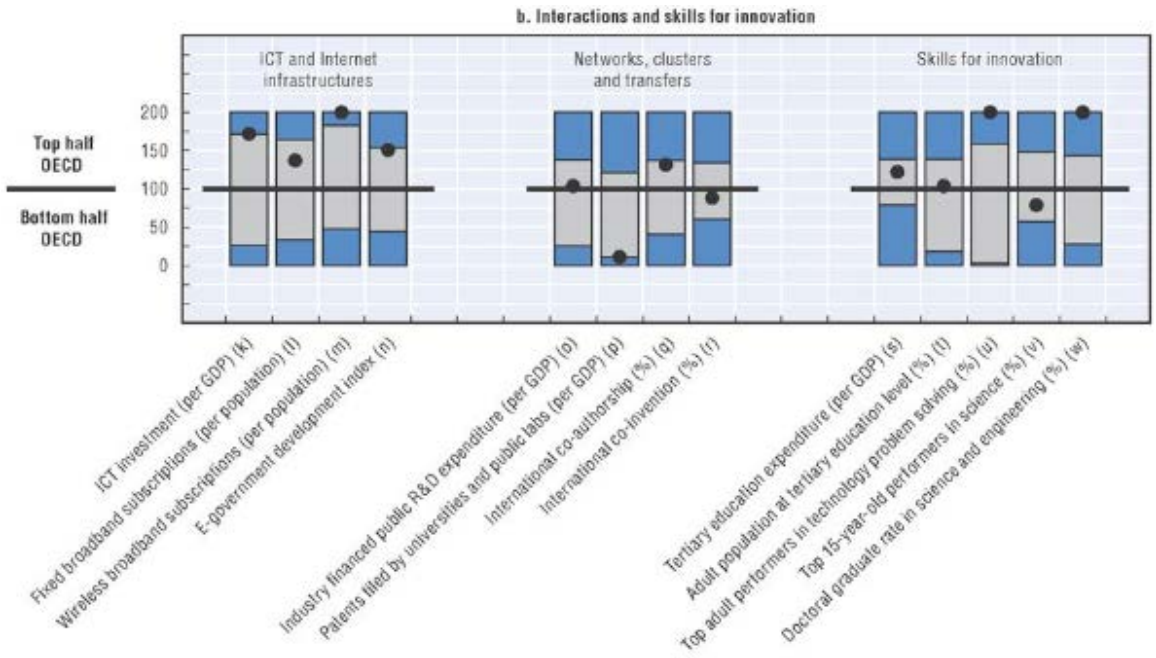


Figure 1. OECD overview of science and innovation in Sweden (OECD Science, Technology and Industry Outlook 2014)

Sweden is widely regarded as one of the world's most knowledge-intensive countries, and is mentioned as part of the group of "very high knowledge-intensity countries" (together with Denmark, Finland and Switzerland) in the Innovation Union Competitiveness Report (2011). On the performer side, the public R&D system is dominated by the universities and higher education institutions (HEIs). The **universities, in total 15, consume over 90% of the governmental appropriations for R&D** and are in principle responsible not only for basic research, but also applied and strategic research programs, including those launched in recent governmental research and innovation bills to strengthen Swedish long-term competitiveness and increase the societal benefit and commercialization of R&D. The several regional university colleges and the very small (albeit growing) R&D institute sector complement the universities but account for a very small share of the public R&D appropriations (Hallonsten and Holmberg 2013). Both the education and research missions of the university and HEI sector expanded dramatically in the second half of the 20th century. The unusual breadth and scope of the mission of the Swedish university sector compared to other countries is partly the result of this development. As part of the expansion, the university sector swallowed all new missions (including vocational training and a lot of application-oriented public R&D) invented by policymakers.

A key structural feature of the Swedish research and innovation system is the **compartmentalization of different sectors** within which funding flows tends to stay. A manifest feature of the current governmental research and innovation policy doctrine is therefore also to loosen this sharp division and incentivize collaboration across the boundaries between academia and industry, in order to secure long-term competitiveness of the Swedish economy, and adjacently thereto, to partly break the heavy dominance of a few very large actors in both sectors (large universities and large MNCs, respectively). The business sector R&D is mainly internal to large enterprises, as the majority of the funding of R&D in the private

sector remains within the comparatively small number of very large companies, i.e. the same organizations (firms or groups) are both funder and performer.

Another prominent feature of the system is the **high level of institutional autonomy** on the level of the performers in the public R&D system, which stems from a historical combination of strong academic autonomy and relatively weak central political power in the area of research policy. Among the effects of this heritage in today's research and innovation system is a continued prevalence of informal governance at ministry and agency levels, a decentralisation of responsibilities for innovation policy to regional authorities (counties) and universities, a default division of labour between a small number of "top" universities accounting for most of the public sector research and a larger number of education-intensive higher education institutions, and a relatively weak research institute sector.

1.2 Governance of the Swedish research system

The **quadrennial research and innovation bill**, identifying long- and short-term goals for the public research system and a budget framework for the coming four years, is the key national policy document in the area, and all research agencies, universities, and colleges provide input to the work to formulate the bills. In addition, the Research Policy Council (VR) established in 1962 has an important advisory role in governmental research policy bills every fourth year. Other bodies in regular but informal advisory roles are the Royal Swedish Academy of Sciences (KVA) and the Royal Swedish Academy of Engineering Sciences (IVA).

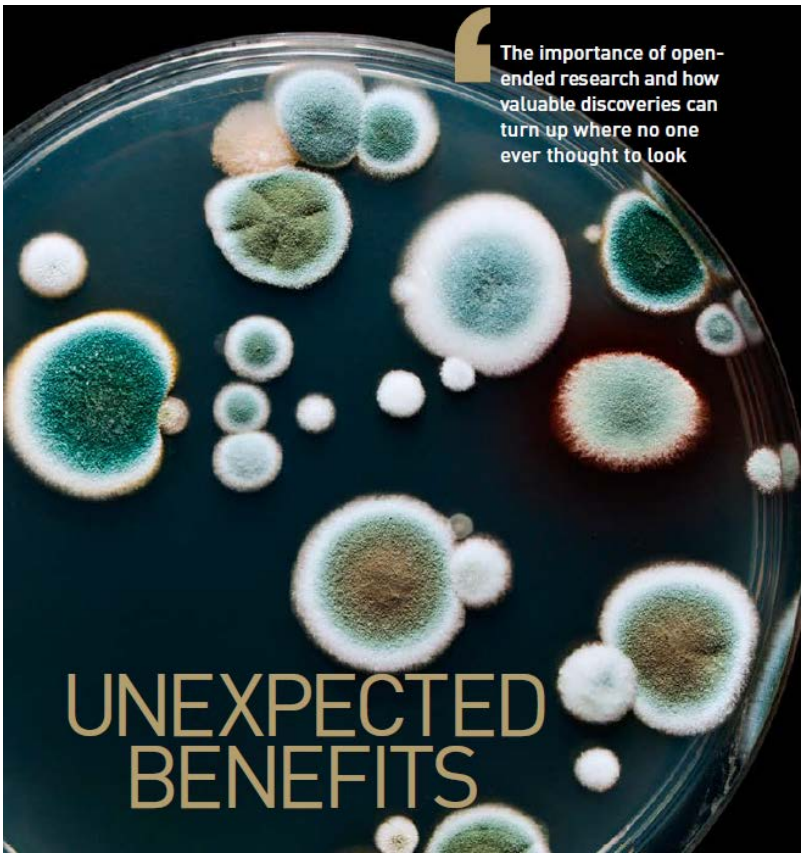


Figure 2. In the publication Unexpected benefits, the Royal Swedish Academy of Sciences aims to highlight a few examples of how basic research, without being driven by ideas about applications, has nonetheless yielded myriad everyday benefits

The latest research and innovation bill (2012) outlines the government's aim of its national research policy to be that Sweden remains a strong global player in R&D, by enhancement of the quality of research and the contribution of research to society and the economy. Like its predecessor (2008), the 2012 bill is explicitly aimed **at enhancing quality and stimulating commercialization of research**, and also adds substantial increases of funding in several areas over the years 2013-2016, which will mean that annual governmental investments in R&D will have increased with approximately one billion Euro between 2008 and 2016. The priorities in the 2012 research and innovation bill reflect well the overall priorities in the Swedish national research and innovation system. The only disciplinary area specifically identified as prioritized in the bill is life science.

Other than that, the bill is focused on strengthening funding for universities and HEIs, both via the base grants and various competitive schemes, **significant investments in research facilities** (including the Science for Life Laboratory in Stockholm/Uppsala and the European Spallation Source and MAX IV facilities in Lund), and on enhancing academy-industry collaboration and the commercialization of research results.

Apart from the research bill, the government also drives the research policy development through annual budgets, regulations, and the appointment of board members in agencies and foundations. The late 2012 **Swedish National Innovation Strategy** issued by the Ministry for Enterprise lays out some broad objectives for the Swedish innovation system, such as a **continued strengthening of the national innovative capacity** to keep up with international competition, an improvement of the innovation climate for SMEs, an increased direct innovation support, and the strengthening of the rather weak Swedish research institute sector, but little or no concrete policies. Policy development is reserved to the research bill and other future legislative action by the Ministries of Education and Enterprise, respectively.

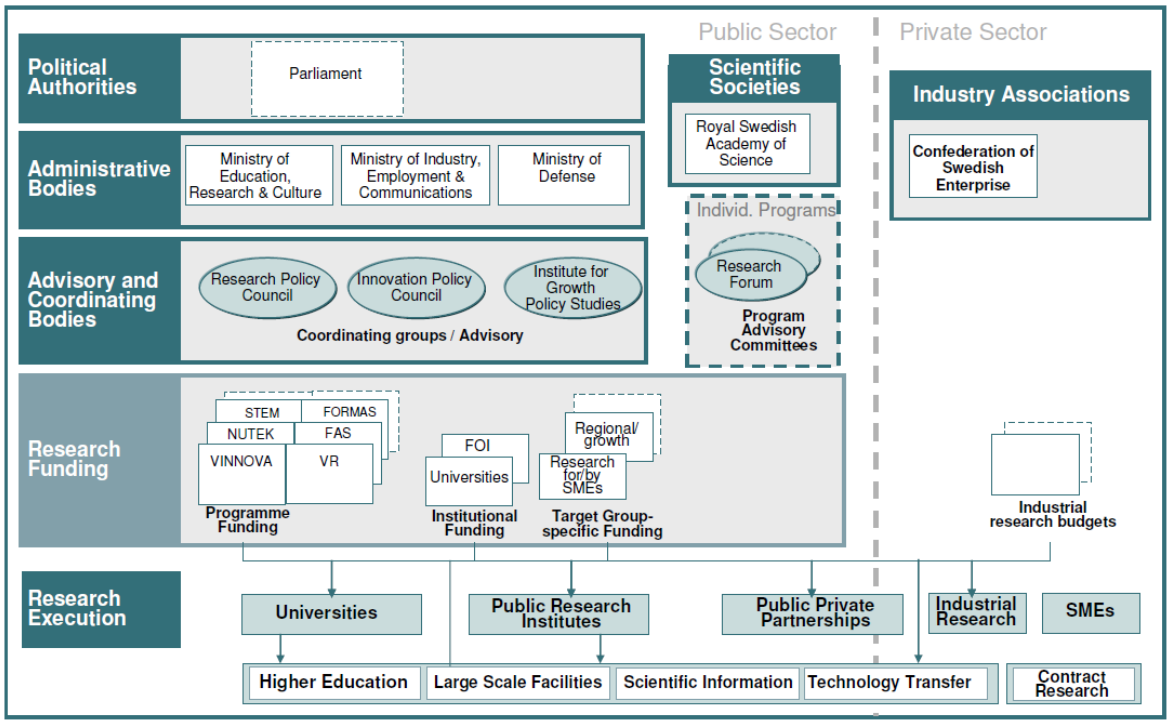


Figure 3. Structure of the Swedish research and innovation system (Source: EU, Meissner)

Apart from the government, two other authorities play an important role in policymaking, the **National Agency for Innovation Systems (Vinnova)**, working to promote growth through innovation, and the **Swedish Research Council** whose mission as funder of basic research (in the academic sector) through competitive programs is combined with a strategic role as advisor to the Government on issues relating to research policy. Besides the Swedish Research Council, a number of specialized research councils as well as public and private research foundations also fund R&D, and besides Vinnova, a number of intermediary agencies work with the promotion of innovation, providing venture capital and advice at different stages in the innovation process as well as incubator functions, such as the Swedish Agency for Economic and Regional Growth and the Swedish Energy Agency.

The **regional promotion of research and innovation** takes place on the level of the 21 counties, whose relative power and influence has increased over the past few decades. The current reorganization of the administrative division of Swedish regional government, aiming at gradually replacing the counties with larger regional authorities with a broader and more comprehensive portfolio, is also strengthening the responsibility for innovation policy on regional level. The 2012 governmental research and innovation bill stresses the necessity to link regional growth initiatives with national research and innovation policy. In May 2013, the government assigned to regional and national authorities the task of developing regional development programmes for 2014-2020, including research and innovation strategies.

2 Overall Research and Innovation strategy

2.1 Economic context

The global financial crisis of 2007-2009 and the subsequent crisis of the Euro zone left its mark on Sweden just as other countries across Europe, although the Swedish economy was spared from the most disturbing effects of the crisis. That Sweden is not a member of the Economic and Monetary Union (EMU) has also put the country and its domestic economy in a relatively less exposed situation, and has also meant a direct advantage in most recent years. Swedish growth in GDP was negative in 2008 and 2009 (-0.6% and -5.0% respectively) but turned up again in 2010 and reached the highest among the EU-28 countries that year, +6.6%. In 2011, the growth rate returned to a slightly lower but still historically high level of +2.9%, compared to the EU-28 average of +1.5%, and in 2012, it fell to +1.0% compared to the negative EU-28 average (-0.4%) (Eurostat). In all, the **Swedish economy appears to have managed the financial crisis and the Euro crisis well**, and these can therefore not be said to have had significant impact on the Swedish R&D system, although there are signs of coming impacts in the shape of possible cuts in the labour forces of large exporting companies, due to currency appreciation and the recession in some parts of the Swedish export markets.

The **increases in public research funding have, to some extent, mitigated the effects of the gradually diminishing private Swedish investments in R&D** that are visible in statistics: estimated BERD as % of GDP has shrunk from 2.73% in 2008 to 2.31% in 2012 (Statistics Sweden). Among the distinct events that play a part in this development is the closing of two of the research sites of the multinational company (MNC) AstraZeneca, in Lund (2010) and Södertälje (2012) that brought a layoff of thousands of professionals in drug development and associated life sciences areas. Partly in response to these events, the government decided to invest heavily in a new life science laboratory (the Science for Life Laboratory, SciLifeLab) in Stockholm/Uppsala. In addition, two large publicly funded research facilities for materials science are planned and under construction in Lund in Southern Sweden; the Nordic MAX IV Laboratory for synchrotron radiation (under construction) and the intergovernmental collaborative European Spallation Source, ESS (under construction). Together with SciLifeLab, these constitute investments in R&D on a scale unprecedented in Sweden (Benner 2012b). On the level of direct financial support to industry, some funding was also directed towards saving the Swedish car manufacturing industry in the wake of the global economic crisis and the ensuing crisis for Ford and General Motors whose financial trouble in 2009, as owners of SAAB Cars and Volvo Cars, worried the Swedish government.

Table 1. Basic indicators for R&D investments

Indicator	Sweden	OECD Total	Year
Gross domestic expenditure on R&D (GERD) [Mio. USD*]	14.151	1.128.468	2013
GERD Growth rate compared to previous year [Percent]	3,3	3,8	2013
Gross domestic expenditure on R&D (GERD) as a percentage of GDP [Percent]	3,3	2,4	2013
Government-financed GERD as a percentage of GDP [Percent]	0,9	0,7	2013
Industry-financed GERD as a percentage of GDP [Percent]	2	1,4	2013
Business enterprise expenditure on R&D (BERD) [Mio. USD*]	9.757	768.910	2013
Percentage of BERD financed by government [only direct funding, Percent]	6,1	6,6	2013
Percentage of BERD financed by abroad [Percent]	6,9	6,5	2013/2012
Higher education expenditure on R&D (HERD) [Mio. USD*]	3.841	205.193	2013
Percentage of HERD financed by industry [Percent]	3,7	5,9	2013
Government intramural expenditure on R&D (GOVERD) [Mio. USD*]	521	127.355	2013
Percentage of GOVERD financed by industry [Percent]	3,7	3,8	2013
Total researchers in full-time equivalent	62.294	4.403.168	2013/2012
Total researchers in full-time equivalent per thousand total employment	13,3	7,8	2013/2012
Business enterprise researchers as a percentage of national total [Percent]	69,3	60	2013/2012
Patents with foreign co-inventors as a percentage of patent applications filed under the Patent Cooperation Treaty (PCT) [Percent][(1)]	22,2	7,2	2012

Source: OECD Main Science and Technology Indicators, 2015/1; [(1)]OECD Patents Statistics
*** at current prices and Purchase Power Parities (PPPs)**

2.2 Research and Innovation policy

The Swedish R&D system is **dominated by the two comparably insulated sectors of business enterprises**, responsible for two-thirds of the total annual investment in R&D in Sweden and largely spending this money internally, on in-house R&D, **and the public side** which is still dominated by the academic sector and funded by the government. The reach of

national policymaking therefore extends mainly to the academic sector, and though efforts are and have been made to strengthen the role of actors working in the borderland between academia and industry, the main structural challenge is still the **relatively stark separation between the two dominating sectors.**

This separation is also the foundational reason for the structural deficit of Sweden that is usually referred to as the "**Swedish Paradox**" – it is generally believed that **despite strong showings in many indicators, results and returns do not match investments**, compared to other countries. In the Innovation Union Competitiveness Report (2011), R&D intensity in Sweden is higher than the reference group (measuring GERD as % of GDP; BERD as % of GDP; and GBAORD as % of GDP), and the figures on doctoral graduates per thousand population aged 25-34 and researchers per thousand labour force also come out in Sweden's favour compared to the reference group. However, as the 2011 country report highlights, Sweden scores lower than the reference groups when it comes to e.g. highly cited publications and patent statistics.

In policy rhetoric, the promotion of research and innovation is considered a key policy instrument to enhance long- and short-term competitiveness and economic growth, address major societal challenges and improve general quality of life. Repeated reviews and scholarly publications have, however, **criticized the lack of coherence and coordination of the research and innovation policy system**. These critics claim that policy is determined rather out of path-dependence in the political system than inventiveness and the mobilization of relevant policy tools for the challenges of structural transformation (Sandström et al 2008; Hallonsten and Hugander 2014; Benner 2012a; Hellström and Jacob 2005). Although policy is typically formulated and developed in dialogue with key stakeholders, and occupies a central position among governmental priorities, its implementation largely hinges on the deliberations and efforts of actors at lower levels of the system; such as universities and governmental agencies (research councils) and of course the private sector actors. In addition, recent policy efforts to guard what is seen as positive elements of a pluralized and decentralized system (e.g. academic self-governance, participation, and consensus) have likely not improved the capabilities of a coherent and effective national research and innovation policy formulation and implementation.

The **strategic priorities** launched in the three recent research and innovation bills have doubtlessly been aimed at solving grand challenges and mobilizing strategically in the Swedish R&D system but their **relative share of the R&D funding system is still marginal**, given that the lion share of all public appropriations for R&D is still channelled to the universities largely on basis of tradition (Hallonsten and Silander 2012; Engwall and Nybom 2007).

Swedish governmental research and innovation policy is almost exclusively built on the analysis that the competitiveness of the Swedish national economy hinges upon a strengthening of the Swedish national research and innovation system, and an associated determination on behalf of policymakers to take action to secure this competitiveness with a heavy focus on the national needs of Sweden. Swedish national research and innovation policy is in rhetorical terms very much geared towards excellence and the creation of favourable conditions for private sector innovation but has also been **criticized for a lack of correspondence between** this **rhetorical level of policy and the actual implementation**.

2.3 R&D funding

2.3.1 Funding flows

The Swedish government has no explicitly set national R&D investment targets, but appears largely satisfied with the current situation where Gross Domestic Expenditure on R&D (GERD) exceeds the EU goal of 3% of GDP (Eurostat). The effects of the economic crisis in Europe have had an indirect impact on the performance of Sweden relative to other European countries. The decline in Business Expenditures for Research and Development (BERD) has not been discussed to any length in recent important governmental policy documents (e.g. the 2012 research and innovation bill and the 2012 national innovation strategy); these instead highlight the **increase in Government Budget Appropriations or Outlays on R&D (GBAORD**) in the past three years and in coming budgets, which indeed amount to a total increase in the annual GBAORD with almost one billion Euro in 2016 compared to the level in 2009 (Swedish Government 2012a). The decline in BERD has mostly been caused by downsizing by a few very prominent players in the R&D-intensive private sector. Since private sector R&D in Sweden is dominated by a few very large MNCs, it is especially vulnerable to their reorganization and reprioritization in the wake of globalization.

The governmental appropriations for R&D in the academic sector is still the largest share of the total GBAORD, amounting to approximately 1.6b euros or 48% of the total annual GBAORD. The share channelled through the research councils and similar agencies for R&D amount to approximately 900 million euros or 26.5%, and the remaining 25% are shared by the governmental budgets for defence, energy, foreign aid and a number of smaller civilian agencies. Little more than approximately 140 million euros were paid out for R&D activities by the public research foundations in 2012, and approximately 220 million euros of EU funding for R&D was channelled to the public Swedish R&D system in the same year, and local and regional government spends approximately 200 million euros on R&D annually. These relative shares of the GBAORD and the income in the public R&D system have been almost unchanged in the past few years and are also expected to remain so, with the possible exception of a **relative increase in direct governmental appropriations for R&D in the academic sector and the governmental funding channelled through research councils**, both of which are affected by the further increases of governmental R&D investments envisaged in the 2012 research bill (Swedish Government 2012a, Statistics Sweden, Eurostat).

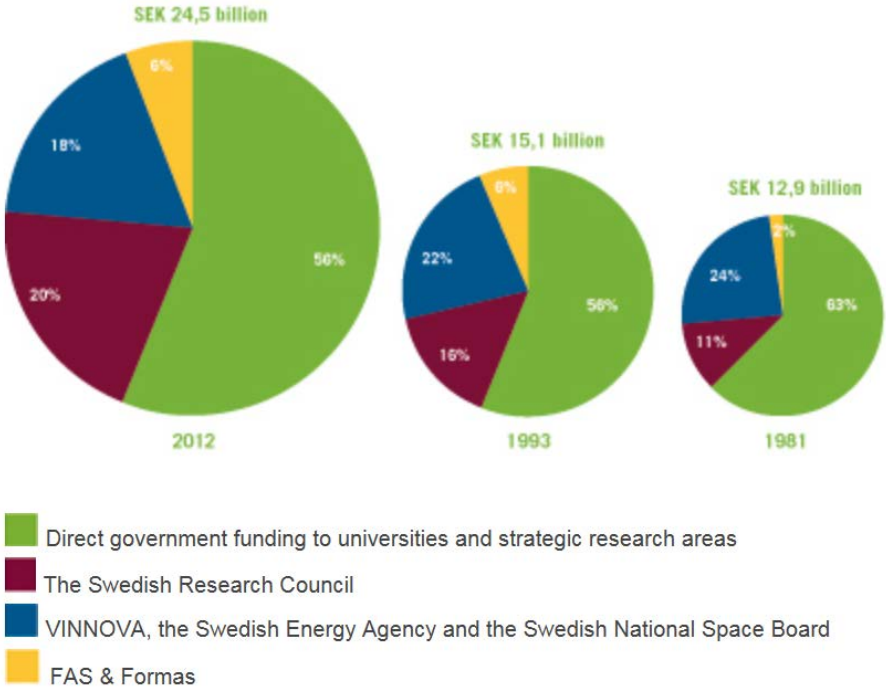


Figure 4. Government R&D funding distributed by control and cooperation requirements, 1981-2012 (Source: Vinnova)

While this increase to some extent increases the spending on R&D across the whole academic sector**, it has also especially benefited the large and old universities**, both by the explicit decision of the policymakers to increase funding in the established universities and because the focus of some of the programs on academic excellence have tended to make the programs favour research environments of a certain volume, which are more likely to exist in the larger universities (Benner et al 2010; Hallonsten and Silander 2012; Sandström et al 2010).

Vinnova has received substantial increases to its annual budget in the past decade, with governmental appropriations to the agency rising from approximately 150 million euros in 2007 to approximately 260 million euros in 2014 (Vinnova).

2.3.2 Funding mechanisms

The **two latest major reforms to the funding system** were (1) the creation, in the early- to mid-90s, of a number of public research foundations, and (2) the 2001 restructuring of the research councils. While the former meant an injection of a large amount of money into the system, the effect of the latter in pure monetary terms is more disputable.

The **public research foundations created in the 1990s have been the result of the decision** by the then centre-right government **to abolish the so called "wage earners funds"**, a remnant of 1970s social democratic policies to gradually socialize Swedish industry and transfer ownership to funds controlled by the trade unions. The research foundations created by the dismantling of these funds in 1992-94 were all specialized in certain areas of funding such as internationalization of research, academy-industry interaction, and support for research in the newer (post-1977) higher education institutions (HEIs) (Benner 2005).The share for these new foundations of the total amount of competitive funding for R&D in the academic sector has oscillated between 8% and 14% in the past ten years (or between

approximately 100 million euros and 150 million euros in real terms) (Swedish Higher Education Authority).

The **2001 restructuring of the research councils merged four previous research councils** (the Humanities and Social Sciences Research Council, the Medical Sciences Research Council, the Natural Sciences Research Council and the Technical Sciences Research Council) as well as the National Council for Planning and Coordination of Research into the larger, broad-encompassing Swedish Research Council, **and simultaneously created Vinnova**, as well as two specialized research councils (the Swedish Research Council for Health, Working Life and Welfare, Forte, and the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, Formas). It did not alter the funding streams from the research councils significantly, but did add another funder, Vinnova, with its own funding portfolio geared towards commercialization of academic research and funded by the former Ministry of Enterprise, Energy and Communication rather than the Ministry for Education and Research, which expanded the funding source for the universities.

Figure 5. During 2010-11, filmmaker Folke Rydén made his film Livsviktigt (Vital). The film demonstrated the importance of R&D and innovation and was funded by the Swedish Council for Working Life and Social Research, the Swedish Research Council Formas, the Swedish Research Council and Vinnova. A number of excerpts from this film appeared on Swedish Television's science magazine Vetenskapens Värld (World of Science) in the spring of 2011 (Livsviktigt in Youtube).

The **overwhelming majority of the governmental appropriations for R&D is generic funding** in the sense that **broad research areas are defined and the funding provided with no other specific earmarks**. This is of course true for the institutional block grants, making up little less than 50% of the R&D funding in the universities, and the lion share of funding allocated through the Swedish Research Council, which channels approximately 1/4 of the total competitive funding (Swedish Research Council, Vinnova).

The **largest areas of support subject to thematic and sectorial funding in Sweden are energy, environment, space technology, foreign aid, and medicine**. These are identified by the government as important areas for Sweden to prioritize, and while they partly overlap with the grand challenges as identified on European level, there is no mentioning of the latter in the R&D policy documents and budgetary documents of the Swedish government. In

addition, substantial parts of the funding from other governmental agencies and especially the semi-governmental public research foundations is funding earmarked for innovation activities in the universities (channelled mostly through Vinnova, but also to some extent, by other actors), internationalization of Swedish research, and academy-industry relationships.

Of the GBAORD in 2013, 62% was channeled to the universities, within which **a minuscule amount (only 3.8%) was funding within the Strategic Research Areas grants** that is one of the major thematic priorities of the governmental policy. It is difficult to estimate the amount of other funding within thematic priorities, since such funding is allocated through many different channels including the governmental appropriations to the universities, the budget of the Swedish Research Council and Vinnova, and the other research councils. However, as noted in the previous paragraph, the bulk of the GBAORD remains non-earmarked.

2.4 Knowledge base

Sweden performs above EU-28 average in the number of researchers as share of the total economically active population in the age group 25-64, as defined in the 1995 OECD Canberra Manual and counting **people having successfully completed tertiary education and/or in occupations normally requiring completion of such education. The Swedish figure for 2012 is 52.6%,** which is the fifth largest in the EU (after Luxemburg, Finland, United Kingdom and Denmark; outside of the EU also Switzerland and Norway score higher than Sweden) and a significantly higher figure than the average of 42.9% across the EU-28 countries (Eurostat).

The overall unemployment rate in Sweden in 2012 was 8.0%, which is a typical figure in recent history (the past 20 years) and somewhat lower than the EU-28 average of 10.5%. The **Swedish unemployment rate in the population aged 25-64 and with completed tertiary education is significantly lower than the overall**, namely 4.0% in 2012, which is also somewhat lower than the 2012 EU-28 average of 5.6% (Eurostat). None of these figures have fluctuated heavily during the past ten years, which again is testament to the appropriateness of the general supposition that Sweden has been left relatively untouched by the global financial crisis and the Euro crisis.

The strong prioritization in current research policy and public R&D funding, shown in the 2008 and 2012 research bills have been followed by some attempts to further promote education in engineering fields in order to strengthen long-term competitiveness (Swedish Government 2009b), but the **education system is still based on strong principles of students' freedom to choose subject areas and study lines which means that some imbalances of supply and demand of highly skilled labour is built into the system.**

2.4.1 Young people's scientific education

In recent years, there have **been concerns regarding the low number of engineers and students studying natural sciences. Policies to ensure the medium and long-term supply of those skills are therefore prioritised**. The Government decided in 2009 to invest SEK125 million (13.5 million euros) to improve the quality of mathematics, natural science and engineering teaching at primary and secondary level, and provide a knowledge base that is of importance for high tech companies carrying out R&D (Swedish Government 2009b).

On 4 May 2015, the Organisation for Economic Cooperation and Development (OECD) presented the Government with its report "**Improving schools in Sweden: An OECD Perspective**" (OECD 2015). The review was conducted in light of Swedish pupils' falling performance in the OECD's PISA survey. According to the report, Sweden should implement a comprehensive education reform to bring about system-wide change and strengthen the performance of all Swedish schools and students. It needs to define priorities, establish clear education responsibilities across the system and consistently provide appropriate support and challenge to schools, municipalities and private organisers in their improvement efforts.

The curricula for higher education are legally required to focus on, amongst other, critical thinking, problem solving and ability to adapt to changes in work life. Creativity, teamwork and communication skills are usually viewed as key skills to achieve those goals. **Entrepreneurship training** is widely available at Swedish HEIs. It is usually organised in specific organisational arrangements and available to those students who are interested, instead of being integrated in ordinary curricula.

2.4.2 Human resources for research

The demand for researchers in Sweden is relatively high, which is indicated by the **strong positions of research graduates on the labour market**. Of the 7,400 graduating PhDs in 2000, 2003 or 2005, about 90 per cent were established on the labour market in 2008. Almost all of these, between 90 and 98 per cent depending on scientific field, were either managers or had an employment that demanded theoretical specialist competence. The largest scientific fields for research graduates in 2010 were medicine (850 graduating PhDs) followed by engineering sciences (500) and natural sciences (420). Graduates in those fields also established faster than others (Swedish Higher Education Authority). The graduation rate for PhDs in Sweden was in 2009 3.0%, in comparison to the EU average where the graduation rate for PhDs in 2009 was 1.9% (OECD 2011).

The 3,120 new entrants to third-cycle courses and programmes in 2014 included 1,250 **international students**. They constituted 40 per cent of the total number, which is the same level as for the last three years. The numbers of third-cycle students have varied between 18,000 and 20,000 during the last ten-year period. The international third-cycle students accounts for 35 per cent of the total. The share of foreign citizens among first-year PhD students is highest in engineering (47 per cent) and the natural sciences (45 per cent). About 50 per cent of the foreign citizens among first-year PhD students are from Asia. Another 30-40 per cent are from the European Union or the other Nordic countries. The three largest countries are China, Iran, and Germany. In addition, about 800 PhD students visited Swedish HEIs for periods of three months or more. About half of these came from another EU country. Engineering received the largest number of incoming visiting PhD students in 2010 (Swedish Higher Education Authority 2015).

PhD studies at Swedish HEIs are attractive to foreign citizens mainly because of a reputation of high-quality studies; because PhD students receive salaries that are high enough to cover normal costs of living; because there is typically no requirement to know Swedish; and because Swedish HEIs generally offer access to good research infrastructure. **About 50 per cent of the PhD students have studentships that include social benefits**. Studentships make no difference between Swedish/EU citizens and citizens in other countries. The requirement that non-

EU/EEA/Switzerland students pay tuition fees, introduced in 2010, does not cover PhD students. Most of those reasons also make Sweden attractive to researchers at post-doctoral levels. Most Swedish HEIs have increased their efforts to boost inward and outward flows of researchers during the last years.

A number of national policy measures have been taken to increase transnational mobility. The government highlights transnational mobility as important. **Most public research funders specifically target transnational mobility** as positive criteria for research funding or have specific programs for incoming or outgoing researchers. Beside EU programmes, examples include programmes to increase and support the transnational mobility of post-docs and other skilled researchers between Sweden and other countries such as the Vinnova – JSPS Joint Projects programme for two-year visiting research fellowships between Sweden and Japan, as well as a number of Nordic initiatives to increase mobility across the Nordic countries and between Nordic countries and neighbouring countries.

Initiatives stimulating the inward mobility of foreign researchers such as tax reductions are in place. Such **tax incentives include the provision that foreign experts, executives, scientists and researchers** only pay tax on 75 per cent of their income during the first three years in Sweden, a benefit that again applies to both EU and non-EU researchers.

2.4.3 Women in research

In 2007, the f**emale proportion of all researchers (FTEs) in Sweden was 29.5 per cent**. The rate differs between sectors: in the higher education sector 44.1 per cent of the researchers were women, in the business enterprise sector there was 25.0 per cent women, and in the government sector 40.4 per cent were women (Eurostat).

Swedish governments have prioritised equal treatment for men and women in academic environments at least since the 1990s. During the last three years policies to promote the equal treatment for men and women have been relatively unchanged. The main differences have been that **government in 2010 chose to abandon the quantitative goals of recruiting equal shares of male and female professors and lecturers and to abandon some of the demands on research funders and universities to report statistics on men and women in academic research** (Swedish Government 2011).

In the late fall of 2013, the government charged its agency The Swedish Agency for Public Management with the task of **investigating the overall gender balance in publicly funded research in the higher education sector, institutional first-stream funding and competitive grants alike**. Accordingly, women have less access to research appropriations than men at the institutions examined. This applies both in absolute terms and in relation to the proportion of women and men among research personnel. In 2013, 39 per cent of appropriations funding was used for women's salaries and 61 per cent for men's salaries. Women accounted for 42 per cent of the research personnel at these higher education institutions (Swedish Agency for Public Management 2014). The committees involved in the recruitment of academic staff in the Swedish academic sector are, by law, required to have gender balance. This regulation has remained in place also after the implementation of the 2010 Autonomy Reform which otherwise deregulated several similar procedures within academic institutions.

2.4.4 Research Infrastructures

The **Swedish national policy for research infrastructures (RIs) is under intense restructuring** (National Roadmap for Research Infrastructures 2012). Although relatively small and rather peripheral in Europe, Sweden has been strongly involved in collaborations around transnational research infrastructures in Europe in the second half of the 20th century. Until just recently, Sweden has never actively sought to host any major European RIs but rather kept its national RIs at a small scale, arguably appropriate for the size of the country, yet high-performing. In 2007, however, the Swedish government publicly announced its candidature to host the European Spallation Source (ESS) and build it in Lund, Sweden, and a simultaneous grassroots movement promoted the next-generation synchrotron radiation facility MAX IV in Lund as an international collaboration. In the spring of 2009 Lund emerged as the likely future location for both the ESS and the MAX IV facilities, bringing a need for investments for RIs at an unprecedented level in the Swedish domestic R&D budget.

AstraZeneca decided to close two research sites in Lund (2010) and Södertälje (2012) that brought a layoff of thousands of professionals in drug development and associated life sciences areas. Partly in response to these events, the government decided to invest heavily in a new life science laboratory (the Science for Life Laboratory, SciLifeLab) in Stockholm/Uppsala.

Figure 6. A specific investment of 52 million euros was made in the life sciences and to SciLifeLab (Source: SciLifeLab).

3 New initiatives/emerging technology fields

3.1 Recent policy developments

Sweden got a left-wing government at the end of 2014. With their budget for 2015, "the Government is presenting measures for a Sweden that keeps together. Greater cohesion and gender equality are crucial for Sweden's development. With **reforms for jobs, schools, the environment and a functioning Swedish model**, Sweden's economy and labour market can be strengthened and can perform better." (Swedish Government 2015)

On 1 January 2015, most of the tasks previously handled by the Ministry for Rural Affairs, and certain tasks previously handled by the Ministry of Finance (company management), the Ministry of Health and Social Affairs (planning, construction and housing issues) and the Ministry of Employment (urban development issues), were transferred to the **new Ministry of Enterprise and Innovation.** The Ministry of Enterprise and Innovation will drive the Government Offices' work to create jobs and sustainable growth throughout the country.

The former Ministry for Enterprise, Energy and Environment, through the evaluation commissioned to the OECD, and the Ministry of Education and Research, through its main policy documents the 2008 and 2012 research bills, have identified similar **key structural deficits in the Swedish innovation system**. These can be summarized as follows:

- A historical division of labour between public R&D, funded by the state and carried out by the higher education sector and mostly 'basic' in its nature, and private sector R&D which is dominated by applied research and development carried out primarily in a handful of very large MNCs.
- A related dominance of large MNCs in the industrial sector, due to financial policy of the 20th century, and a relative lack of venture capital and other critical resources for innovation in SMEs.
- An entrepreneurial climate posing significant challenges to firm start-ups (those challenges generally consisting of inadequate incentive structures) compared to regular employment.

An evaluation by the **Royal Swedish Academy of Engineering Sciences** makes a similar analysis, criticizing the Swedish innovation system for **lack of coherence** and too many actors working independently of one another. The report proposes a comprehensive strategy to create a more favourable culture for innovation in Sweden, largely driven by a strong policy showing that signals a determination on behalf of Swedish policymakers to enhance the innovation climate. A number of concrete proposals are also made, including changes in the incentives structures for innovation and entrepreneurship, such as tax deductions for venture capital, simplification of regulations, and better legal frameworks for intellectual property. (IVA 2011)

There are **three main domestic developments of importance**. First, the current process to deregulate the university sector, within which the major reform was implemented in 2010, giving universities and higher education institutions full discretion of determining their internal organizational structures. An extension is currently under discussion that would give universities and higher education institutions the opportunity to privatize within the framework of private

foundations (Swedish Government 2008b; Swedish Government 2013a). Second, the effects of the 2008 and 2012 research and innovation bills and their major increases in funding for university research, including the large Strategic Research Areas (SRA) grants of 2008 and their follow-ups in 2012 (Swedish Government 2012a; Hellström 2012). Third, the formulation and implementation of the National Innovation Strategy, which has begun at a smaller scale.

The two past years have seen the beginning of the implementation of the policies launched in the 2012 research and innovation bill. The **main parts of the 2012 research bill** are as follows:

- The government considers **increases in the appropriations for research** and the stimulation of innovation to be important measures for increasing the general level of quality of Swedish research and accordingly launches several general and specific funding increases.
- The total R&D appropriations are given an increase of 200 million euros for 2013, and the government signals its intention to make further increases of 110 million euros in 2014 and 42 million euros in 2015.
- The appropriations for **research and doctoral training in the academic sector gets an increase** of 25 million euros 2013, and the government signals its intention to commence further gradual increases so that the level of appropriations for research and doctoral training in the academic sector in 2016 will - compared to 2012 - be in total 140 million euros higher.
- The Swedish Research Council is given the task of launching **targeted programs to make international recruitments** of prominent researchers to Swedish academic institutions and to support young researchers, for which the council is given an additional funding of 20 million euros for 2013.
- A specific investment of 52 million euros is made in the life sciences, including targeted efforts in infections and antibiotics, aging and health, treatment research, and drug development. Part of this investment goes to **SciLifeLab** and a new institute for process development and catalysis.
- Specific investments of 48 million euros for 2013 are made in **areas judged to be of particular importance** for Swedish industry and the welfare society, including forestry and biomass, mining, minerals and steel, the sustainable society, space research, energy research and evidence-based education and preschool.
- A number of policy measures aimed at increasing the commercialization of academic research are also presented, including efforts to strengthen the institute sector and further develop innovation support structures at universities and university colleges.

Most of these policies are currently being implemented, and it is too early at this point to make any qualified evaluation of their effects on the system.

The **National Innovation Strategy** **is a general framework policy document** formulated and issued by the former Ministry of Enterprise, Energy and Communication. Contrary to the quadrennial research bill, it is not a governmental bill and consequently, it **does not launch specific policies**. Its weight as a policy document can therefore be questioned, especially since

the actual policies delegated to Vinnova have been stipulated in the already discussed research bill. However, the main elements of the National Innovation Strategy are as follows:

- Acknowledging that Sweden faces growing international competition as a knowledge-based economy, and that Sweden, Europe and the world will have to rely on its innovative capacity to meet the challenges of the future, there is a **need for a purposeful and coordinated national innovation strategy in Sweden**.
- Sweden has a favourable position but will have to mobilize to keep up with international developments.
- The **framework conditions for innovation need to be improved**, including high quality education, a vitalized innovation climate, especially among SMEs, increased mobility between different sectors of the economy and society, and quality enhancements of research in academia.
- Direct innovation support has to be intensified, foremost in the shape of **bridging institutions between different societal sectors and especially academia and industry**, and other innovation support infrastructures.
- The research institute sector is in need of vitalizing and strengthening.

In the fall of 2013, a national meeting was held to mark a "stopover in the **implementation of the National Innovation Strategy**", where the Minister for Enterprise presented the latest implementation state of the strategy. Among the items discussed were the work of Vinnova to define criteria for the eventual evaluation of the innovation strategy, and the recent launch of a governmental policy to strengthen business incubators in Sweden which includes an addition of 3 million euros in the annual appropriations of the incubator program run by Vinnova (Swedish Government 2013b; 2013c).

3.2 Research and innovation system changes

3.2.1 Education

Swedish HEIs have three core missions: (i) to teach, (ii) to conduct research, and (iii) to interact with the surrounding society and inform about their activities as well as to ensure that benefit is derived from their research findings. These are legal obligations. The legal regulations changed 1 July 2009 on the third point above to include also the **mission that HEIs ensure that benefit is derived from their research findings** (Swedish Government 2009c).

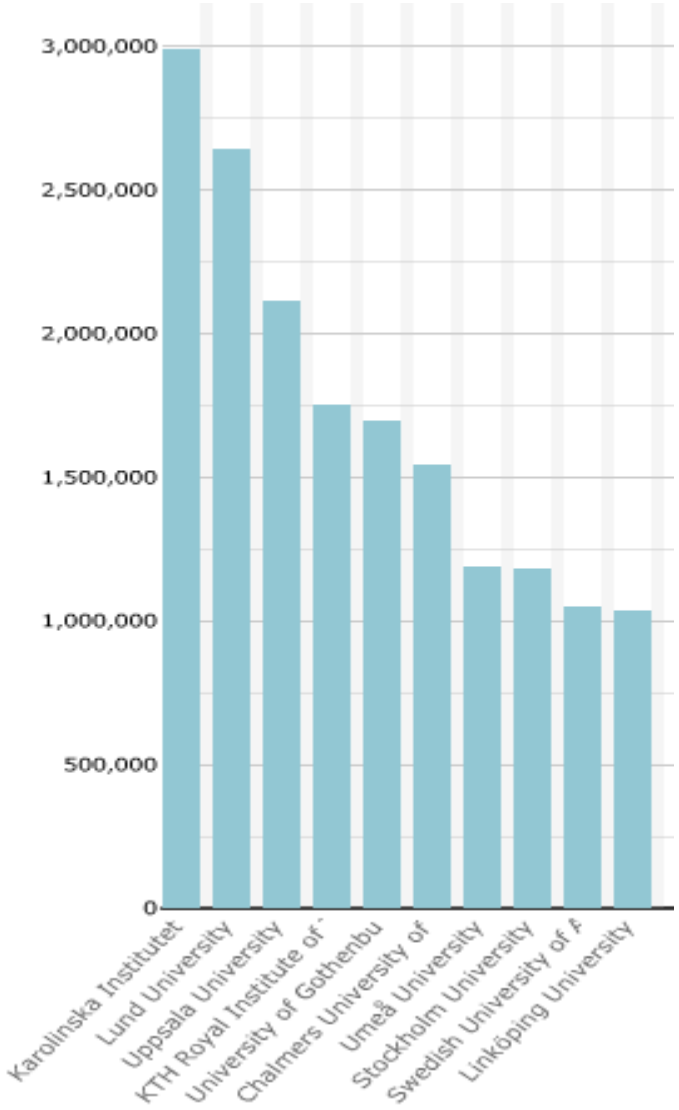


Figure 7. Top 10 Swedish universities in external funding for research in 2013 (thousand SEK). The external funding comes mainly from research councils, other public funders and the EU, but also from private sources (Source: Swedish Higher Education Authority database).

Swedish HEIs are either universities or university colleges. A **majority of these are public authorities**, subject to the same legislation and regulations as other public authorities in Sweden, as well as to the particular statutes, ordinances and regulations relevant to the higher education sector. A small number of universities and university colleges are self-governing and independent and operate on the basis of an agreement with the government. In addition, they are obliged to follow the statutes, ordinances and regulations relevant to the higher education sector. Universities typically have degree awarding powers at first cycle (university diplomas and bachelors' degrees), second cycle (one-year and two-year masters' degrees) and third cycle (licentiate and doctoral degrees). They are also entitled to direct government funding for research.

University colleges typically have degree awarding powers at first cycle (university diplomas and bachelors' degrees) and second cycle (one-year masters' degrees). They can apply to the Swedish National Agency for Higher Education (HSV) for the entitlement to award two-year Masters' degrees and third cycle qualifications in specific domains.

The **differences between universities and university colleges have decreased** during the last three years. The government has declared that degree awarding powers should be determined by quality rather than the traditional categorisation into universities and university colleges. The quality will be determined in recurring evaluations conducted by National Agency for Higher Education. Thus, the right to award for example third cycle degrees can be won by a university college or lost by a university. The government has encouraged universities and university colleges to merge with each other. One major merger has occurred since 2009.

According to the European University Association's (EUA) Autonomy Scorecard, presented in November 2011 and reflecting the level of university autonomy in European countries in 2010, Sweden takes a medium position when it comes to organisational autonomy and academic autonomy (Estermann, Nokkala, Steinel, 2011). These two dimensions capture among other things the capacity to autonomously design research agendas. Similarly, Sweden takes a medium position when regarding financial autonomy and the capacity to manage research budgets. Regarding staffing autonomy, Sweden scores higher and has one of the top positions, compared to other countries. Since 2010, an **autonomy reform** has been launched, resulting in significant change for Swedish universities. The details are as follows.

- HEIs shall have a board and a rector but are otherwise **free to develop their own organisations**.
- Decisions requiring a particular, qualified assessment must be taken by people with scientific or artistic qualifications.
- The students must have the right to be represented when decisions are taken or preparations are made that significantly affect the education or the situation for students.
- Staff in the categories Professor and Senior Lecturer will be regulated in the Higher Education Ordinance. Otherwise, HEIs can choose their own career structures and categories of staff. They can also **recruit key individuals to a professorship without the traditional open competition**.
- Education is regulated at a less detailed level than before.

The Government Bill "A Reformed Constitution" also includes two amendments to the Instrument of Government that increase the freedom of higher education institutions. The amendments entered into force on 1 January 2011. **Researchers will continue to be free** to design their own research agendas and free to choose where to publish their results.

HEI boards include internal representatives, staff and students, and external members. It should be possible for a non-Swedish citizen to be a vice-chancellor or member of the board of a HEI. Rectors, deans and other HEI managers can either be recruited through an open tender process or elected among peers. One of the main reasons to the increased autonomy is that HEIs to an increasing degree want to decide over funding sources. The **mission to cooperate and inform society has put pressure on HEIs to interact with other actors**. Increased autonomy will make it easier for HEIs to develop their own strategies and hopefully lead to increased funding. At the same time one of the hopes is that HEIs will further specialise in specific fields, which is hoped to result in increased international competitiveness as well as national competition between HEIs with the overall aim of increasing research quality. Since external funding plays an

increasingly important role the debate also raised the issue on whether private HEIs should be allowed.

3.2.2 Research

The government has declared that it intends to distribute a larger share of **block funding for research on the basis of quality** than is presently the case. Quality will be measured by two criteria: number of (high quality) publications/citations and the ability to attract external research funds. The government has also **specified research areas of national interest and distributed specific funding to these**. Research quality in those areas is specifically monitored. Swedish researchers perform well in some of those areas and not so well in other. The largest difference compared to relevant countries of reference is that Sweden has comparably few world-leading researchers (Öquist and Benner 2012). There is no broad national evaluation of block funded research. However, since 2007 several universities have conducted extensive evaluations of their research activities. Those evaluations have largely been conducted by panels with international experts. The Swedish Research Council (VR) has the national responsibility to monitor publication and citation patterns for Swedish research fields as well as for different HEIs/PROs. Depending on their profile, most other public research funders also keep track of the production of for example publications, citations and patents.

The Swedish public research and innovation system is dominated by national governmental funding on the supplier side and the higher education institutions on the performer side. The research income in the HEI sector from governmental sources is split almost equally between institutional block grants and competitive project funding which are both in steady increase. The **institutional block grants are largely distributed on basis of tradition**, that is, on basis of historical patterns, which meant that the 11 largest universities consumed an average of 89% of the annual institutional block grants around 2010, with the 18 newer university colleges sharing the rest (Hallonsten and Holmberg 2013).

Recent efforts by the government to make large parts of their real increase of the **block grant funding subject to allocation on basis of performance evaluation is currently being implemented**, and will likely reinforce this structural division of the academic system, since it is generally the larger universities that are well-performing. The same can probably be said about the new special funding programme launched by the Swedish Research Council, aimed at supporting the recruitment of world-leading scientists to Swedish universities as an effort to strengthen some especially promising research environments. The 2012 research bill introduced a general funding increase of about 400 million euros until 2016. The exact results of these efforts remain to be seen, as the policies are quite new.

The most recent, and reasonably most significant, move towards an internationalization of peer review as a process for the allocation of research funding is the sharp **shift of governmental research funding policy in the 2012 research bill, from bibliometric assessment to international peer review evaluation**. In practice, this applies to the share of governmental institutional block grant funding allocated in a competitive scheme, which is roughly 10% of the overall annual block grants, although a doubling of this share to 20% is envisioned for the coming years. The system and the procedure is however only vaguely described in the bill, and the Swedish Research Council has been charged with designing the system in all its specifics so that it can be implemented in 2018, at the earliest. The previously

launched excellence funding schemes (the Linnaeus Grants of 2005-2015 and the Strategic Research Areas of 2009-2019) also meant a partial increase of the role of international peer review assessment of funding applications in the public Swedish R&D system.

3.3 Emerging technology fields

3.3.1 Strategic research areas

There is a growing appreciation in Sweden as in many other countries that there is a need to mobilise research resources in certain areas. For this reason and started in 2010, Sweden makes an **investment in strategic research areas** amounting to almost 200 million euros on a yearly basis. This is a new element of Swedish research funding. The strategic investments aim at building up a number of new world class research environments in research areas that have been specifically selected because of their strong strategic importance for society. A number of the strategic research areas are also appropriate for partnership programmes with industry, where institutions of higher education, authorities, companies and research institutes make joint investments. In the long-term the aim is to contribute to raising research quality, improving conditions for commercialisation, encouraging cross-disciplinary scientific approaches and increasing opportunities for the system to make use of EU funding.

The Government has used **three criteria to determine the strategic areas** to be given priority:

- research that can contribute to finding solutions to important global problems and issues,
- areas in which Sweden already carries out world class research,
- areas where companies in Sweden are carrying out their own research and development, and where state investments reinforce the development and competitiveness of the business sector in Sweden.

The **areas have been chosen on the basis of strategies** that have been drawn up by research funding agents, universities, other research actors, as well as companies and organisations representing industry. The Swedish Research Council has also carried out an assessment of the areas of strength in Swedish research. In addition a total of 8 infrastructures within the strategic areas such as epidemiology, molecular biology, climate research, material science, computer science and biodiversity will be funded. The strategic areas are (with 2012 funding allocations):

- Energy (~17.2 m€)
- Sustainable exploitation of natural resources (~5.2 m€)
- Effects on natural resources, ecosystems and biological diversity (~4.3 M€)
- Climate models (~2.9 m€)
- Marine environmental research (~1.9 m€)
- Cancer (~6 m€)
- Diabetes (~6 m€)
- Epidemiology (~2.2 m€)

- Molecular biology (~15.6 m€)
- Neuroscience, incl. brain- and nerve system diseases (~6.0 m€)
- Stem cells and regenerative medicine (~6.3 m€)
- Nursing research (~5.4 m€)
- Nanoscience and nanotechnology (~6.5 m€)
- E-science (~6.0 m€)
- Material science, incl. functional materials (~5.6 m€)
- IT and mobile communication, incl. future solutions for communication and monitoring systems (~6.9 m€)
- Manufacturing technology (~5.2 m€)
- Transport research (~8.3 m€)
- Security and crisis management (~2.0 m€)
- Politically important geographical regions (~2.2 m€)

Even though these strategic areas are specifically pointed out by the government, calls are to a large extent open and follow the regular procedure where proposals are submitted by the research community. The identified 20 research areas are divided between four different agencies and councils that are responsible for the funding and monitoring of 43 research environments that are carrying out research in the areas.

An **evaluation of the outcome of the government's investment in strategic research areas** was published in May 2015 (Swedish Research Council 2015). The evaluation was carried out on by an expert panel of six professors with vast experience of university and research management, as well as research policy formation and evaluation. 28 external reviewers supported the panel with an initial assessment of the performances of each individual strategic research environment.

3.3.2 Priority Areas of the Swedish Foundation for Strategic Research

The Swedish Foundation for Strategic Research is **prioritizing the following main areas**:

- Life Sciences
- Life Science Technology
- Materials Science and Technology
- Information, Communication and Systems Technology
- Data-X and Computational Sciences and Applied Mathematics

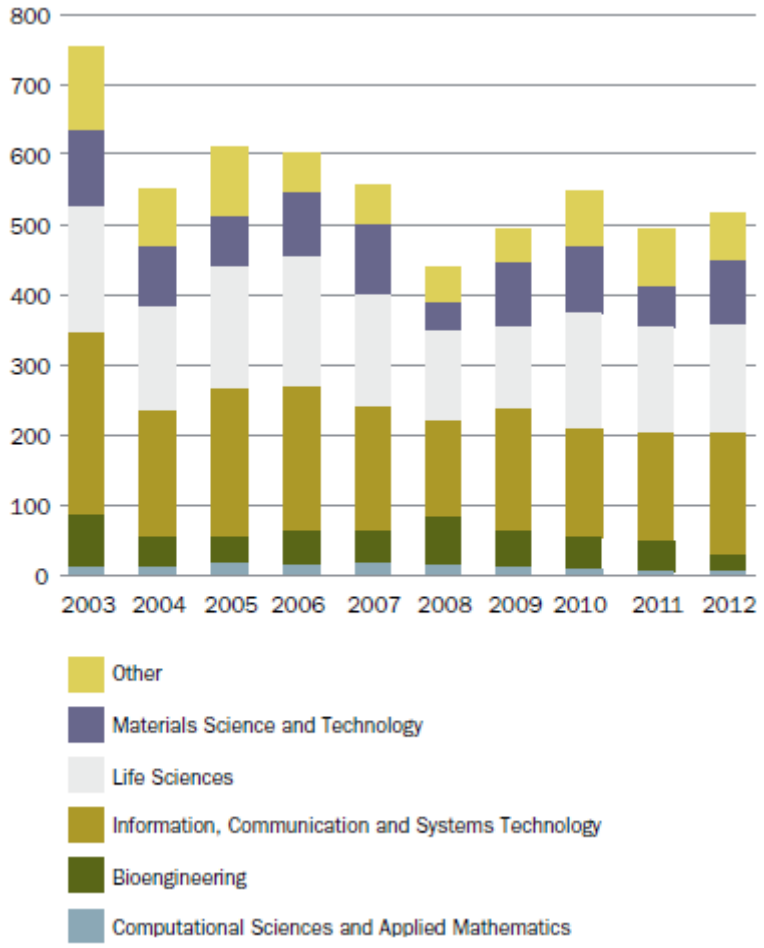


Figure 8. The Swedish Foundation for Strategic Research payments per research area (SEK millions (Source: The Swedish Foundation for Strategic Research))

The **Life Sciences** area includes research in clinical, preclinical medicine and veterinary medicine, as well as research on infections in trees and plants. It also includes research on biological production systems. Examples are plant biotechnology, forest biotechnology, synthetic biology and cultivation of e.g. algae for energy purposes.

Life Science Technologies is an area, where research in many of its subareas has to be carried out in close collaboration between scientists from the life sciences, the engineering sciences and the natural sciences. Subareas include Bioimaging, Regenerative Medicine, Biosensors, Biomaterials and Systems Biology.

New Materials Technology is enabling for the development of important areas of application, such as energy conversion, ICT and medicine. Sweden is among the world leaders in industrial production of steel and advanced surface coatings. Surfaces, boundary layers and thin films for applications in environments with high temperature, high wear or pressure and high chemical or electromagnetic stress make high demands on resistant materials and are examples of areas where Sweden is strong both industrially and academically. Initiatives in the area of materials science will take two forms: targeting a specific application, and development of new material classes.

The focus of the **Information Communication and Systems Technology research area** is on high-performing and well-functioning communications networks, not only for pure communications applications, but also as carriers of critical information for various purposes in electric power distribution (smart electricity networks), transport, health and the like. Nearly all advanced industrial products today contain systems that can be described as software-intensive. They create a platform for the ICT on which we are becoming increasingly dependent. This imposes numerous demands on the properties of the infrastructure. Accordingly, various requirements on design, analysis, availability, security, integrity and reliability must all be satisfied, often in real time.

Another field is divided into **Data-X** on the one hand and **Computational Sciences & Technologies and Applied Mathematics** on the other, where the main focus of the first area is within Information Technology and the other within Mathematics. Subareas within Data-X include Visualisation, Database systems, Information systems, Data mining, Streaming data and Bioinformatics. Computational Sciences and Technology and Applied Mathematics include the subareas Tools for high-performance computing, Simulation and modelling, Applied and engineering mathematics. Calls for proposals may address both of these areas to guarantee that applications that overlap both areas are considered.

3.3.3 Vinnova's eleven focus areas

Vinnova funds programmes which develop new knowledge and expertise within areas which are strategically important for Sweden. It partly involves funding of research required for renewal within different industries and partly funding of tests and demonstration of applications of research-based knowledge. Projects can be managed by several different types of actors within these programmes, but it is necessary for at least one of the parties in the project to be a university, college or research institute.

Vinnova's programmes within "Development of strategic knowledge" are divided into four strategic areas:

- **Health and Healthcare**: More and more people are living longer, and keeping themselves fit and vital thanks to medical advances, diet and exercise. An ageing population, which is better informed, healthier and with more financial assets, will require higher quality care, services and homes. The key areas for this strategic area are: services within health and social care, the link between health, climate and environment and the healthcare sector as a production system.

- **Manufacturing and Working Life**: This strategic area deals with opportunities for Sweden to compete in the production of goods and services in an increasingly globalised market. The most important trends include: demand for more individualised products, products with increased customer benefits and resource-smart products. Moreover, innovative leadership will be highly significant in competitive production, both within industry and in other important areas such as health and social care.

- **Transportation and Environment**: Trade and travel in Sweden are increasing as a result of an on-going urbanisation, closer European

integration and rapid advances in global communication. This increased mobility brings benefits, including greater freedom of movement for goods and for millions of people. This strategic area addresses challenges in the fields of resource-efficient and safe transportation as well as technologies for sustainable development.

- **Services and ICT**: Reliance on information and communication technology has been accentuated by its enabling role in practically every sector. Information technology has fundamentally changed the way we do business, develop products and services, run companies and act as consumers. This strategic area deals with meeting the challenges and opportunities in society, resulting from new information technology.

Moreover, Vinnova manages programmes for developing leadership, innovation strategies and development projects which are important for the innovative capacity of specific target groups. The programmes for strengthened innovative capacity mainly target small and medium-sized companies, actors within the public sector as well as universities and colleges, and are divided into four strategic areas:

- The **Knowledge Triangle**: aims to create an interaction between education, research and innovation thereby creating the conditions for increased relevance and utilisation of universities' activities. Programmes within the area include Verification for Growth, The Key Actors Programme, Mobility for Growth and VINNMER.

- **Innovation Capacity in the Public Sector**: support and develop innovation capacity in systems, in organisations and for individuals. Programmes within the area include Innovation Procurement and Innovation Centers and Test beds within the Health Service.

- **Innovative Small and Medium-sized Enterprises**: ability to accept, apply and develop new knowledge and techniques in new business medium-sized enterprises (SMEs) takes place through the programmes Forska&Väx (Research&Grow) and VINN NU.

- **Individuals and Innovation Milieus**: create an infrastructure of strong research and innovation milieus which strengthen their international competitiveness and increase cooperation. Programmes within the area include VINN Excellence Center, Berzelii Centres, VINNVÄXT and Gender and Diversity for Innovation.

Vinnova finances large and long-term programmes which are aimed at pooling of resources by connecting actors within different industries and areas of knowledge and where societal challenges are the driving force for innovation. Vinnova's programmes within "national pooling of resources" are divided into three strategic areas:

- **EU and international co-operation**: build actively networks between different actors in Sweden and other countries and promote Swedish participation in international research.

- **Challenge-driven Innovation**: Vinnova has identified four societal

challenges in which Sweden's prospects for internationally leading innovativeness are considered good.

- **Partnership Programmes**: Programs with industrial partners in the areas of forestry and timber, transport, IT and telecommunications, mining, steel, bioscience and financial market research.

During 2007 - 2014, Vinnova financed a special program, "**Produktionslyftet**", that aimed to increase the knowledge base surrounding modern production technology and lean-strategies, primarily within small manufacturing companies. In 2012, the project was evaluated in terms of key performance index (KPI) for companies that participated prior to 2012. The evaluation comprised 48 Produktionslyft companies which were compared with a reference group of approximately 1000 companies. The companies' sales, profit margins, solvency and stock turnover were analysed and the assessment showed that Produktionslyft companies improved their key performance index (KPI) considerably more than the reference companies.

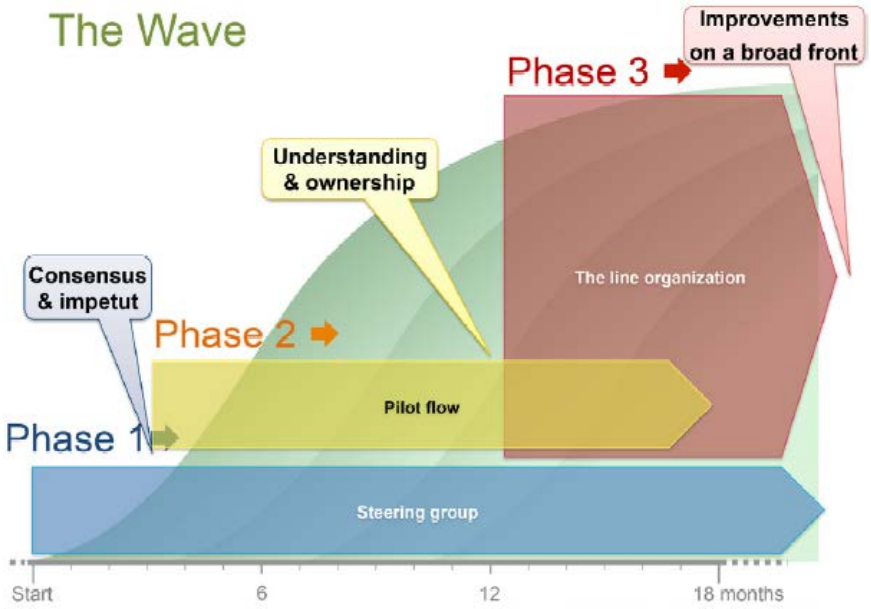


Figure 9. The Production Leap offers businesses a development program of 18 months; the program develops businesses' own intrinsic capabilities to improve their competitiveness and applies Lean-based principles (Source: Produktionslyftet).

4 University – industry collaboration and commercialization of university research

4.1 Facilitate partnerships and productive interactions

Knowledge circulation between academia, industry and the public sector has increasingly been stressed in Swedish research and innovation policy. This is particularly reflected in a number of programmes in which **funding is conditioned by e.g. industry involvement**. Such programs are especially launched by Vinnova. Ongoing programmes range from sector-specific programmes to programmes that facilitate regional innovation milieus. Specific programs intend to establish Centres of Excellence; those programs are particularly ambitious both with regard to scale and scope of funding and with regard to demands on research quality.

In the National Reform Programme 2008-2010, it is stated that Sweden needs to **prioritise and improve management of intellectual property rights**. Some measures have been taken in this regard, which will make it easier and less costly for firms to protect their inventions, e.g. in relation to patents applied for through the European Patent Office. Specific government-funded innovation liaison offices have been set up at eight universities: Uppsala University, Lunds University, Umeå University, Linköpings University, Karolinska Institute, Royal Institute of Technology, Chalmers Technical University, Mittuniversitet (coordinating an office also including Karlstad University, Örebro University and Linnaeus University). The offices are supposed to advice on for instance patenting, licensing and contract research. Most other HEIs also have specific divisions that support such activities. The government has also taken measures to facilitate the financing of academic spinoffs.

Figure 10. KTH Innovation (Kungliga Tekniska Högskolan aka KTH) supports the commercialization of ideas and research results from KTH´s researchers and students. They offer commercialization support for innovation projects in all stages of the development from a research result or idea to marketable product or service. KTH Innovation is particularly focused on commercialization of new technology and the early stages of the development and verification of the idea. (Source: KTH Innovation)

In addition, the introduction of innovation offices and other infrastructure to support knowledge transfer has resulted in a **growing professionalisation and standardisation of knowledge transfer** activities. Since 1 January 2010 most research generated by Swedish public funding must be made available to the public for free. This includes for example research funded by

HEI/PRO base funding and all research funded by the Swedish Research Council and Swedish Research Council Formas. Local HEI/PRO policies differ, however.

In Sweden, the **intersectoral mobility of researchers** is widely regarded as low. This is particularly true of mobility from industry to HEIs/PROs. Policy-makers have identified intersectoral mobility as a prioritised area (2012 research bill). One measure to increase the mobility is the extended rights for HEIs/PROs to call professors without traditional open competition. Another way is to ensure that the supply of research funding and academic positions continues to be considerably lower than the demand.

An **HEI board** must consist of 15 members of which at least eight must be external to the HEI. HEIs nominate board members to the government, which makes the formal decision. All HEIs have members from the business sector in their boards.

4.2 Knowledge circulation between the universities, PROs and business sectors

Knowledge circulation between academia, industry and the public sector has increasingly been stressed in Swedish research and innovation policy. This is reflected in the number of programmes, especially launched by Vinnova, that build on the **triple-helix rationale**. Ongoing programmes range from sector-specific programmes, to programmes facilitating the development of regional innovation milieus. Another example is the focus on the establishment of R&D centres of excellence, for example, the "VINN Excellence" programme, "Berzelii Centres", "Institute Excellence Centres" programme and "Industry Excellence Centre" programme. These environments are often regionally based and represent a physical space for both industry and academia to interact and exchange ideas. Industry PhDs and different types of joint affiliations are another way of ensuring exploitation of knowledge generated in academia. The focus of these types of triple helix initiative has been a measure to improve the level of collaborations between industry and universities. According to a number of evaluation studies, analysing the impact of these initiatives, the majority of initiatives have resulted in new and stronger collaborations between the triple-helix actors (see e.g. Measuring the Impact of University Business Cooperation, European Commission 2014).

Even though **SMEs have been encouraged to participate in these initiatives the participation rate has been moderate**. It is expected that, due to the financial crisis, many SMEs might have had to reprioritise their activities and focus on short term financial goals rather than investing in long-term research activities. Therefore, the Vinnova has a variety of funding programs for innovation and R&D in the private sector, especially SMEs, among which the Forska&Väx programme has been the most prominent, awarding an approximate 6 million euros annually to innovative projects in SMEs. Forska&Väx programme has recently been replaced with the Innovation Project in a Firm programme.

5 Partnership models to encourage clustering and precompetitive research

5.1 Public-private knowledge transfer

The Swedish government has adopted a strongly articulated policy that **favours open access publishing** and comprehensive efforts in the system to facilitate a great relative increase in open access publishing at Swedish universities. It is assumed that long-term competitiveness in the Swedish R&D system, and by extension, Sweden's innovative capacity, hinges upon easy and timely access to scientific information and publications. In terms of concrete policy measures, however, the government largely leaves the initiative to the universities and other actors in the system.

Since 2010, the Swedish Research Council, the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas), the Swedish Council for Working Life and Social Research (FAS), the Bank of Sweden Tercentenary Foundation (RJ), the Knut and Alice Wallenberg Foundation (KAW) **demand that their grantees publish their results with open access**. Almost all Swedish universities and higher education institutions have open, searchable databases where publications are listed and in many cases online versions of publications are openly accessible.

The potential of governmental policy efforts to enhance or support the **flow of information in scientific communities is limited**, regardless if it concerns the public or private R&D systems. Governmental policy in this area does not go beyond what has been written in the 2008 and 2012 research bills in support of efforts, conducted on agency level, to facilitate open access publishing and publicly available online information databases. As noted, the 2012 research bill also took an active stand by ordering the Swedish Research Council to develop and suggest national guidelines and standards

Two national initiatives, none of them the result of direct governmental policymaking but rather collaborative efforts between public and private national organizations (agencies and foundations), deserve mentioning in this context. First, the **SwePub database**, which is run by the Royal Library and indexes articles, conference papers and doctoral dissertations published by researchers at Swedish universities and higher education institutions (all institutions except the Stockholm School of Economics are part of SwePub). Second, the OpenAccess.org project, run and funded by the Royal Library in collaboration with the Association of Swedish Higher Education (a voluntary interest organization for Swedish universities and higher education institutions), the Royal Academy of Sciences (KVA), and the Knowledge Foundation (a public research foundation). Within this project, the collaborators are working on information and counselling, infrastructure and services, and policy development regarding open access publishing.

5.2 Regional innovation strategies

With the 2012 National Innovation Strategy in place, and with the current implementation of the first policy changes of the 2012 Research and Innovation Bill, the policy roadmap on national governmental level is laid out. On regional level, however, the situation is slightly more complex. Sweden is currently undergoing a gradual transformation of its regional government

subdivisions; and new so called Regional Boards are overtaking responsibilities for regional development from Country Administrative Boards. These Regional Boards, and an association of municipalities and the county administrative board in the north of Sweden called the Västerbotten Region, have made independent efforts to formulate **regional innovation strategies**.

For example, the Swedish Agency for Economic and Regional Growth launched a conference together with Vinnova and the Skåne Regional Council in November 2013 under the headline "Get smarter together in the Baltic Sea Region", where **regions are invited to establish contacts and discuss their future innovation strategies**, in generally oriented sessions as well as in specialized sessions on so called "e-Health" and "Smart Cities". In general, the BSR Stars Programme aims to "speed up innovation in the Baltic Sea Region using transnational cooperation to create strengthened competitiveness and sustainable growth".

RegLab is an interest group for learning and competence development where Swedish regions, Vinnova and the Swedish Agency for Economic and Regional Growth are members, and they have started a collaborative project where the regions work together to develop their Smart Specialization strategies, mainly through the method of "twinning" by which is meant that **two or more actors share knowledge and experience**. The RegLab is only in its infancy but engages all Swedish regional authorities and can therefore be seen as the first national initiative around smart specialisation.

6 Cross-border institutions and arrangements

6.1 International scientific cooperation

The **importance of international cooperation in R&D** is highlighted in the 2012 government bill for research and innovation. Swedish participation in European programs is highly prioritised. The bill also stresses the importance to cooperate with emerging economies in which the growth in R&D is relatively strong. The government also points at the links between on the one hand research and innovation policy and on the other hand other policy fields, such as industrial and foreign policies, which include European interests. A recent large-scale Vinnova program, "Challenge-driven innovation", strongly reflects EU2020 priorities and the international perspective. Vinnova has identified four societal challenges in relation to promoting sustainable growth in Sweden. These are based on Sweden in many respects having the prerequisites to be at the forefront when it comes to innovative solutions.

- Future Healthcare – stimulating business opportunities and social benefits for better health and care
- Sustainable Attractive Cities – for new solutions within areas such as environment, energy, transport and community building
- Information Society 3.0 – for new and secure IT solutions and services that can be accessed by more users
- Competitive Production – for flexible, resource-efficient and integrated production of sustainable goods and services

Overall, the international dimension is considered important in almost all R&D funding programmes and activities by Swedish public funders.

Figure 11. Challenge-driven innovation is one of Vinnova's eleven strategic areas. (Source: Vinnova)

in general, the Swedish Research Infrastructure landscape holds relatively high quality in international comparison. However, in several fields internationally competitive research cannot be conducted without access to infrastructure that is too expensive to be covered by national funding alone. Nationally funded research infrastructure is normally located at HEIs/PROs and accessible by foreign actors through research co-operations or in commissioned projects conducted by researchers at these institutions. Sweden is also engaged in a number of European infrastructures. The **Swedish Research Council's Committee for Research Infrastructure** represents Swedish interests in various national and international research infrastructures. Sweden participates in several international infrastructure initiatives and has been a long time member of CERN, EFDA, ESO, IceCube, JET, EMBL, ESRF, IARC, ILL, ISIS, PRACE, GBIF, IODP/ECORD, ESS, EUI, INCF and ITER. Furthermore, a number of Nordic initiatives exist such as NORDSIM, NDGF, NORDUnet, and NOT.

The allocation of competitive public R&D funding in Sweden (mainly executed within the framework of the research councils) typically follow the procedure of internal peer review assessment boards with predominantly Swedish or Scandinavian members. Two specific policy

measures have been taken that deviate from this typical pattern. First, the allocation of funding within what is typically identified as the excellence funding programs, including the Linnaeus Grants of 2005-2015 and the Strategic Research Areas of 2009-2019. Second, the new assessment scheme introduced in the 2012 research bill will replace the current bibliometric scheme for the redistribution of approximately 10% (eventually 20%) of the total annual institutional block grants. This **peer review scheme is supposed to make use of internationally composed review panels**; however, the scheme is only vaguely described in the bill, and will be laid out in detail in the coming years and implemented (at the earliest) in 2018.

Sweden has, up until a decade ago, **not been actively seeking to become host of any international research collaborations**. The national facilities, at its height five in number, were all domestic and comparably small-scale (though strong in scientific and technical performance), run as departments of their respective host universities but with a specific status as national laboratories. This **changed radically** when in 2007, the Swedish government publicly announced its candidature to host the European Spallation Source (ESS) and build it in Lund, Sweden. Simultaneously, a grassroots movement had promoted the next-generation synchrotron radiation facility MAX IV in Lund. On basis of a heavy lobbying effort, Lund emerged as the future location for the ESS and the MAX IV facilities, which means that investments on completely unprecedented scale in the Swedish public research system are being made in accelerator facilities in Lund. These investments were decided upon by the government (the ESS) and by a consortium of the willing (MAX IV), thus partly sidestepping the long-term planning and evaluation effort of the Swedish Research Council formalized in its National Roadmap for Research Infrastructures.

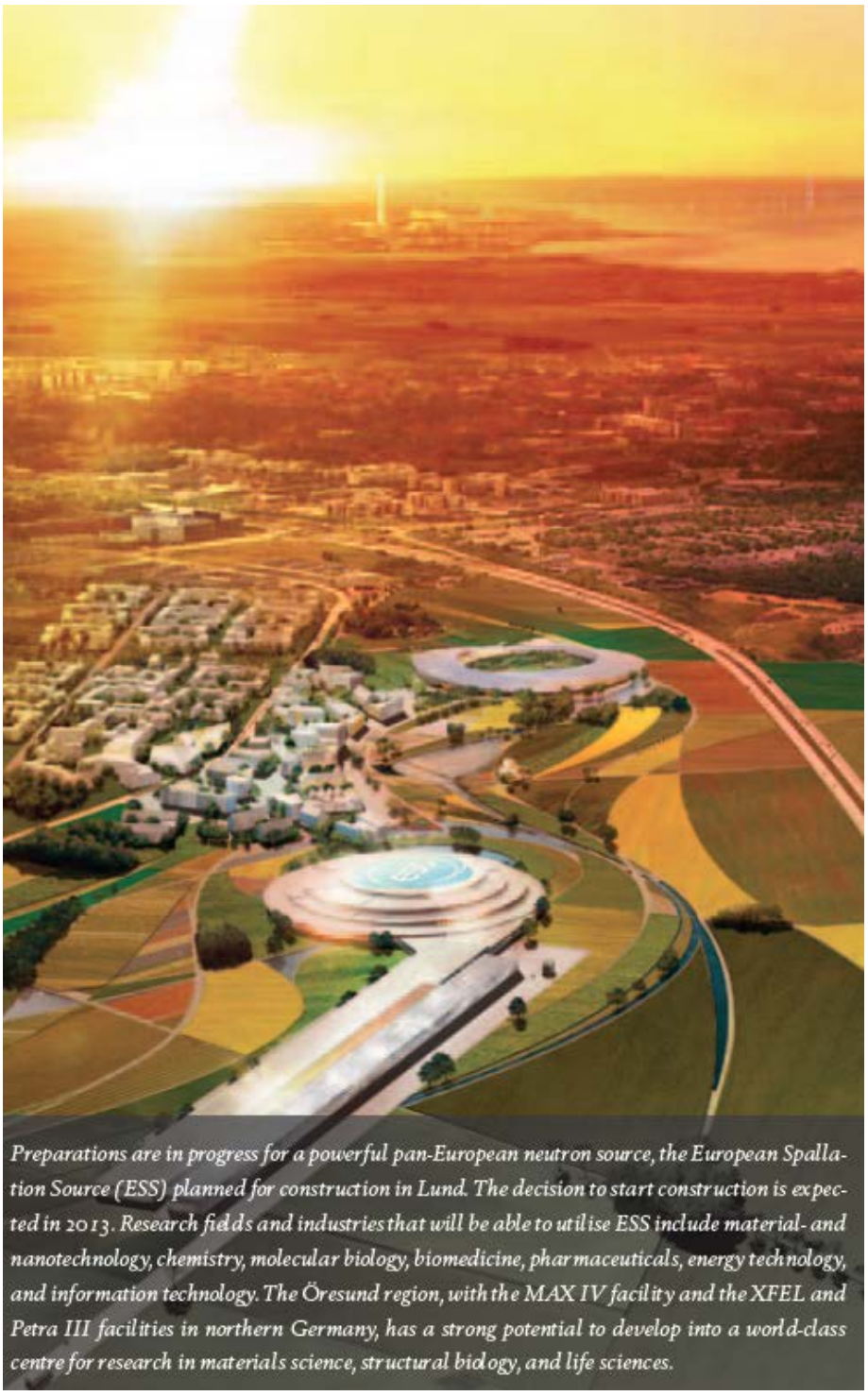


Figure 12. Excerpt from National Roadmap for Research Infrastructures (2012).

6.2 Transnational cooperation

The government **links research and innovation policy to other policy fields, such as industrial and foreign affairs policies**, which includes European interests. In addition, Sweden participates in international collaborations by taking part in Nordic and European programmes. Those programmes typically involve the Nordic countries and often also neighbouring countries such as the Baltic states and sometimes also countries with interests in

the Arctic region. The international dimension is considered important in most R&D funding programmes and activities by Swedish public funders.

There are no priorities of certain countries on national level. However, in its current policy, the **government emphasises the need for strategies to cooperate with countries** in other parts of the world, most notably emerging economies in which the growth in R&D is strong, for example China, India, Brazil, Singapore, South Africa, and Mexico. South Korea and Taiwan are also identified as important partners. Vinnova organises bilateral programmes primarily within biotechnology and ICT. Examples of biotechnology programmes include cooperation with India on tuberculosis research, with Japan on multidisciplinary biotechnology, and with Canada and United Kingdom on structural genomics. Examples of ICT programmes include cooperation with China on materials science, with India on health and ICT, with China on wireless technology, and with Israel on mobile technologies and ICT security. Examples of other programmes include cooperation with Brazil on advanced technology and innovation, and with Japan on exchange of researchers.

Sweden also engages in **Nordic collaborations**. This engagement largely takes place through the Nordic Council and Nordic Council of Ministers for Education and Research where Denmark, Finland, Iceland, Norway and Sweden participate. The Nordic Council participates in the Baltic Sea co-operation in the Baltic Sea Parliamentary Conference (BSPC) and has observer status in the Standing Committee of Parliamentarians of the Arctic Region (SCPAR). Strategies include to further develop the Nordic Research and Innovation Area (NORIA); to improve research and innovation through increased efforts in the joint Nordic research and innovation institutions as well as to intensify co-operation between the national research funding bodies; to improve NordForsk in the co-ordination of Nordic research activities; to identify the Nordic positions of strength in the area of research and innovation; and to promote co-operation around research infrastructures.

Funding in national programmes is rarely available to foreign entities or to non-Swedish researchers who are not based in Sweden. The main reason is that the community of Swedish researchers is reluctant to share its national funding resources with researchers in other European countries unless it receives equal opportunities to compete for funding in other countries. If such guarantees can be made, the researchers are likely to be positive towards opening up of the national research funding. That is indicated by the strong support from the Association of Swedish Higher Education (SUHF) for an extensive ERA framework. Also, the 2012 Research and Innovation Bill states that **opening funding programmes to external collaborators and funding international actors may become a viable option**.

6.3 Open labour market for researchers

The former centre-right coalition government undertook a certain shift in policy formulation of the internationalization aspects of the Swedish public research system, as seen both in the two recent research bills (2008 and 2012) and in some bills there between, most of all perhaps the 2010 structural reform of the organizational independence of the universities and other higher education institutions (HEIs), invoking what has popularly become called the **Autonomy Reform**.

The Autonomy Reform is **likely to have some effects on mobility of researchers and the openness of the Swedish system to foreigners**. It is important to note, however, that the purpose of the reform was to strengthen self-governance in order to secure academic freedom which is believed to generally enhance quality. Possible positive effects on mobility and internationalization are rather indirect than purposive.

In the 2012 research bill, a specific program was launched to **incentivize the HEIs to make international recruitments of especially "prominent" researchers**. In the bill, the annual governmental grant to the Swedish Research Council is increased with an earmarked amount of 150 million SEK (18 million euros) in 2013, followed by increases of 50 million SEK (6 million euros) in 2014 and 2016 to be spent on a program – designed an launched by the council – "for the international recruitment of researchers who conduct research of the highest quality." The program was launched in the spring of 2013, and as of May 2015, twenty internationally renowned professors had been recruited to six Swedish universities as part of the program.

Karolinska Institutet

- Applicant: Anders Hamsten, Vice-Chancellor at Karolinska Institutet
- ecruited researcher: Jiri Bartek, Danish Cancer Society Research Center, Denmark
- Area of science: Cell Biology
- Grant period: 10 years (2015-2024)
- Total amount granted: 100 000 000 SEK
- Ref: 2014-7427

Stockholm university

- Applicant: Astrid Söderberg Widding, Vice-Chancellor at Stockholm University
- Recruited researcher: Frank Wilczek, Massachusetts Institute of Technology, USA
- Area of science: Theoretical physics
- Grant period: 10 years (2015-2024)
- Total amount granted: 60 000 000 SEK
- Ref: 2014-7424

Uppsala university

- Applicant: Eva Åkesson, Vice-Chancellor at Uppsala university
- Recruited researcher: Don Kulick, University of Chicago, USA
- Area of science: Anthropology
- Grant period: 10 years (2015-2024)
- Total amount granted: 80 000 000 SEK
- Ref: 2014-7404

Karolinska Institutet

- Applicant: Anders Hamsten, Vice-Chancellor at Karolinska Institutet
- Recruited researcher: Nils-Göran Larsson, Max Planck Society, Germany
- Area of science: Cell and molecular biology
- Grant period: 10 years (2015-2024)
- Total amount granted: 100 000 000 SEK
- Ref: 2014-7405

Figure 13. Approved applications 2015 (source: Swedish Research Council)

The aforementioned autonomy reform for the Swedish academic sector was less of a specific policy reform and more of a general loosening of regulation. Granting greater organizational freedom to the HEIs, including liberties to change the procedures for hiring and promotion of academic staff, this autonomy reform does undoubtedly impact mobility on almost all levels and in almost all instances; vacancy announcements (including job profile, skills and competences required, and eligibility criteria); the selection process and criteria; time periods for various stages in the recruitment process; possible feedback to applicants; routines for appeals against decisions; and the composition of selection panels as well as rules for the composition and publication of the composition of panels. However, since the reform granted the HEIs increased freedom and not explicitly changed the procedures in any direction, it is difficult to assess the effects. This will be done in future governmental investigations and will thus have to be returned to in due time. It is, however, reasonable to suspect that the **autonomy reform can have a slightly harmful effect on the transparency of the recruitment processes** as universities, by this reform, have been given the freedom to also call individuals to specific posts, thus short-circuiting the typical open recruitment process.

7 Public support mechanisms to stimulate innovation

7.1 Government direct and indirect R&D funding

The two most recent governmental research bills have been named "research and innovation bills", a name change that breaks with a 25-year old tradition of quadrennial governmental research bills and that signals a **move from pure R&D policy and funding to broader R&I policy and funding**. In addition, the 2001 founding of the Vinnova with its specific task of supporting innovation in the public and private sectors, and this agency's recent budget boost signals a gradual shift in priorities in this direction.

However, the absolute lion's share of governmental R&D appropriations is either generic funding to the universities or generic funding for competitive schemes (run by e.g. the Swedish Research Council), and although universities are nowadays required by law to seek the utilization of research results, most university research is still rather on the R side in R&D, and most definitely on the R side of R&I. As for the balance between research funding and innovation funding, this is therefore still heavily tilted towards research funding. **Developments in the direction of a more comprehensive inclusion of innovation into the government's R&D policy and support have, however, been significant**. Value changes such as the legislation change that added innovation to the mission of universities, or the name change to the governmental research bills, do typically have far reaching impact on long-term, also beyond what is measurable in pure funding numbers.

On the side of the private sector, the **regulations regarding tax deductions and tax incentives for R&D have not changed significantly** since the launch of the current tax code in 1970. R&D expenditure is deductible if the R&D activities can be proven to have direct relevance for the main business activities of the firm. A governmental investigation, charged with making a general and exhaustive assessment of tax deductions and tax incentives for R&D in the private sector, delivered its report to the government in September 2012 and suggested some minor changes to the tax code, most importantly a lowering of the general payroll tax for employees in R&D, and some adjustments to current EU regulation, but the result of the investigation has yet to become translated into policy (Swedish Government 2012d).

A **recent governmental investigation evaluated the innovation support activities at Swedish universities** and found that the capacity was "surprisingly well functioning, despite the imperfect conditions." The evaluation concluded that the deficits in the Swedish innovation system are extensive but possible to alleviate with a deliberate governmental strategy. The strategy should strengthen the role of the universities as leaders in regional innovation systems by adapting regulations and increasing the earmarked funding for their innovation support activities. According to the investigation especially the **lack of room for providing seed money and management support for start-ups**, are striking. (Swedish Government 2012c)

Swedish Incubators & Science Parks (SISP) is running the following two projects on behalf of Vinnova and Tillväxtverket (Swedish Agency for Economic and Regional Growth), respectively.

Innovation Excellence is a strategic development project. It consists of sub-projects: identification and development of key value creation processes; and several local pilot projects to illustrate trends and good practice in the regionally-based business development. Innovation Excellence is also expected to contribute to the innovation systems, in becoming even more accessible and value-creating in an international context and on a local, regional and national level. In addition, the project will provide a basis for a future national development programs for science parks.

The **Swedish Seed Funding** Project is a national project to encourage the start-up and development of regional seed funds and business angel activity in Sweden. A significant number of SISP's members are already having own funds linked to incubators, angel investor networks etc. Seed funds involve local and regional venture capital and contribute to Sweden's business growth by investing equity capital and active ownership in the early stages of companies with high growth potential.

MEMBERS

Åkroken Science Park
Arctic Business Incubator
Atrinova Affärsutveckling
Blekinge Business Incubator
Borlänge Science Park
Brewhouse
Chalmers Innovation
Create
Encubator
Entreprenörsarenan
Faxe Park
Flemingsberg Science Foundation
Företagsfabriken i Kronoberg AB
Framtidens Företag
Gothia Science Park
Green Tech Park
GU Holding
Idélab
Ideon Innovation
Ideon Science Park
Inkubatorn i Borås
Inkubera
Innovation Park
Innovatum Teknikpark
Inova
Johanneberg Science Park
Kalmar Science Park
Karlskoga Science Park
Karolinska Institutet Science Park
Kista Science City
Krinova Incubator & Science Park
LEAD
Luleå Science Park
Lund Life Science Incubator
Medeon Science Park
Medicon Village
Mid Sweden Science Park
MINC - Malmö Incubator
Mjärdevi Science Park
Movexum
Munktell Science Park
Netport Science Park
Norrköping Science Park
Örebro Science Park
Piteå Science Park
Sahlgrenska Science Park
Sandbacka Park
Science Park Gotland
Science Park Halmstad
Science Park Jönköping
Science Park Systemet
Serendipity Innovations
Skellefteå Science City
Spaceport Sweden
Stiftelsen Teknikdalen
Sting
Strängnäs Business Park
SU Inkubator
Teknopol
Telecom City
THINK Accelerator
Umeå Biotech Incubator AB
Uminova Innovation
Uminova Science Park
Uppsala Innovation Centre AB
Västerås Science Park
Videum Science Park

Figure 14. There are 67 members in Swedish Incubators & Science Parks association. (Source: SISP)

While policy formulation at the Ministry for Enterprise, Energy and Environment in the area is rather vague and deals with establishing a strategic framework rather than launching concrete reforms, as shown in the 2012 National Innovation Strategy, the Ministry has been able to launch some measures to mitigate the problems, including some **efforts to reduce the red tape for SMEs**. On December 4, 2013, the government decided to go ahead with its recently proposed project to reduce the required paperwork in companies' contacts with authorities under the name "one door in". The project is expected to deliver an online solution for a significantly simpler procedure that is supposed to replace and reduce red tape, evaluate which agencies and governmental authorities should be part of this solution, and work out a reasonable time frame (Swedish Government 2013b).

7.2 Public procurement and enhanced public-private interaction

One of the main initiatives launched by the government in its 2012 research bill was a broad effort to **strengthen the interaction between the public R&D system (academia) and private enterprise**. This initiative was, in part, articulated as an answer to a long-since identified structural deficiency in the Swedish research and innovation system usually named the "Swedish Paradox" and also a direct response to the recommendation to Sweden by the Council of the European Union (2012) that the research bill should be focused on "measures to improve the commercialisation of innovative products and the development of new technologies to support high-growth innovative firms." The initiative can be divided in four major actions:

(1) **Strengthening of the industrial research institutes**, which operate in the borderland between academia and industry and work to enhance knowledge and competence in innovation, by a substantial funding increase. In addition, the governmentally owned holding company called Research Institutes of Sweden (RISE), which coordinate the publicly funded research institutes, are instructed to work purposefully towards better coherence among institutes within industrial sectors, streamline the institutes' legal and organizational structures, strengthen its own brand to increase recognition, deepen its collaborations with both academia and industry, increase its financial support to innovation activities in SMEs, and strengthen its in-house competence in intellectual property.

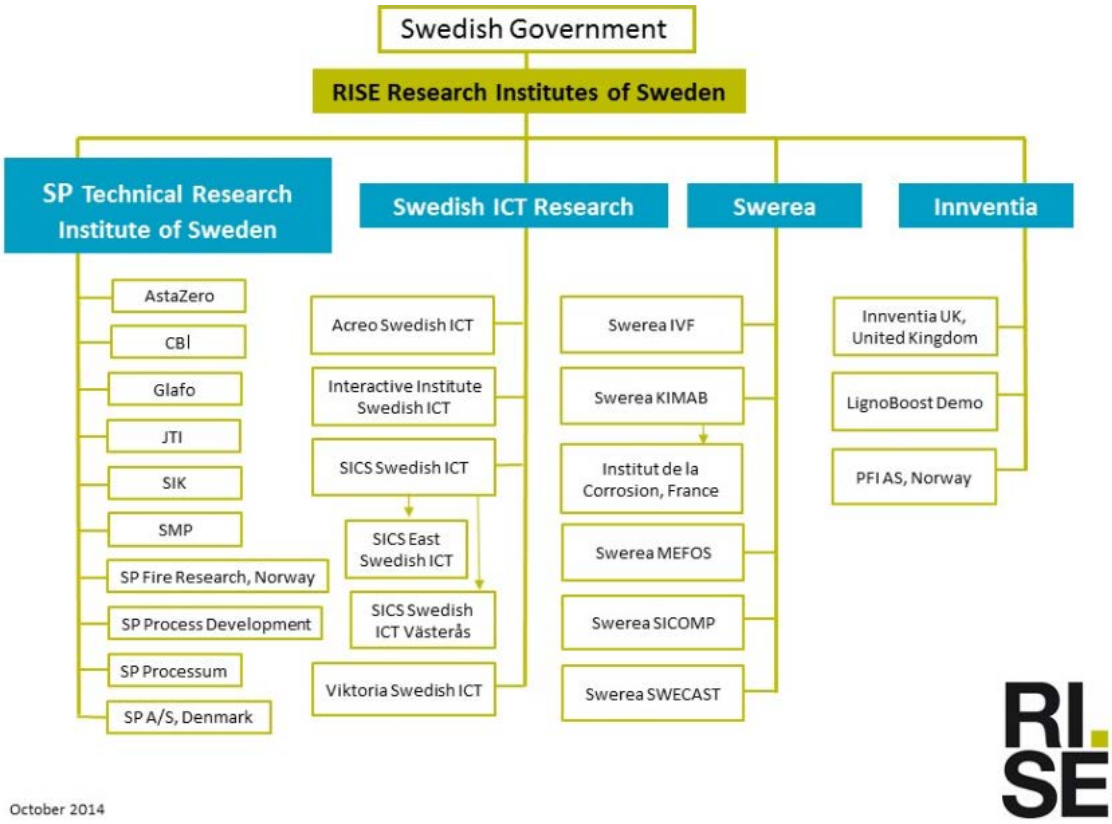


Figure 15. RISE's task is to gather, develop and renew the RTOs of RISE into an internationally competitive and efficient Swedish force for industrial research and innovation. (Source: RISE)

(2) Support of efforts in the academic sector to interact with society and **commercialize results**, by a funding increase directed to efforts of strengthening the "innovation offices" at the universities and higher education institutions. These "innovation offices" support academic staff in their efforts to commercialize their results. (see Chapter 4.1)

(3) **Strengthening of the innovation infrastructure**, by a resource increase to the Vinnova directed to the increase of the availability of technical facilities for testing and validation within the institutes of RISE.

(4) Ongoing work to **modify patent rights and the deductibility of donations to R&D**. This is work in progress and has not reached any concrete stage (Swedish Government 2012a).

The national innovation strategy also puts great emphasis on the role of public procurement in supporting and enhancing innovation. The strategy defines the role of public procurement in the area as twofold: **innovation-friendly procurement**, which is inclusive and facilitates the use of new solutions, and **procurement of innovation**, by which is meant procurement of entirely new solutions not previously on the market.

Indeed, the government has worked for several years with an active strategy to support **public procurement of innovation, through a program managed by Vinnova** since 2006. In its first years, the program focused mainly on policy formulation, investigations and small-scale pilot projects, but in 2011, Vinnova launched an innovation procurement program that was followed, in 2012, by a substantial increase of the support to the program of

approximately 2.5 million euros, followed up by approximately 1 million euros yearly. The conclusions of a governmental investigation, which submitted its final report in 2010, lays the foundation for the targeted investment and the Vinnova program: There is a great need for increased knowledge and change of attitudes among public actors that can increase the demand for new and better solutions in a variety of areas. The public procurement of innovation program at Vinnova is consequently focused on support functions and training of personnel in the public sector.

8 Summary

The paramount document formulating and compiling Swedish national research and innovation policy is the aforementioned quadrennial **governmental research bill**, which has two main functions. First, it lays out the **framework for investments and priorities for the coming four years**. Since all appropriations are decided in the annual governmental budgets, expenditure and thus investments and regular resource distribution for the research and innovation can only be outlined in this and other bills.

The second goal is to **formulate and codify the analysis of the state of the Swedish research and innovation system** and its virtues and challenges, which is an amalgamated collection of opinions and analyses from all governmental authorities, including the universities and other HEIs, and a large number of relevant stakeholders and interest groups in other sectors, e.g. trade unions, academies and research foundations. Although all these actors involved in the consensus-oriented preparatory work clearly do not subscribe to the conclusions of the analysis and the suggested priorities, the basic analysis can be seen as a collected and mediated opinion of the relevant actors in the Swedish research and innovation policy field.

The general assessment of the national Swedish research and innovation system in the 2012 bill largely follows previous analyses in highlighting the following **structural challenges for the Swedish research and innovation system**:

- The general level of quality of Swedish (academic) research is already high but needs significant improvements to become globally competitive in coming decades.
- Interaction between the academic sector (basic research) and industry (applied research and development) is generally too low and inefficient, which shows not least in the suboptimal performance in commercialization of research results from academia.
- Swedish public research is impressive in its breadth but needs to improve its specialization and performance in certain cutting-edge fields, and prioritize more clearly between focus areas and less important areas.

The shortcomings of the Swedish research and innovation system can, somewhat simplified, be described in terms of a "**Swedish paradox**". First identified and conceptualized some academic studies of innovation and entrepreneurship in Sweden in the 1990s, this concept has earned great influence in policy circles and been established as common knowledge: Relative to the strong showing in annual R&D investment as percentage of GDP, the returns in the shape of research-based innovations, knowledge-based entrepreneurship, and economic growth in knowledge- intensive sectors, are too low. The paradox has been attributed to several structural deficits in the Swedish society, public and private sectors alike. These are:

- A **structural division** of labour between on one hand basic research, publicly sponsored and performed almost exclusively in universities and HEIs, and on the other hand applied research and development sponsored and performed internally

in the business sector and predominantly internally to single companies.

- Breadth rather than specialization in public R&D system; historical lack of appropriate strategic prioritization.
- A relative dominance of large MNCs in the industrial sector.
- A centralized and incoherent research and innovation policy system.
- A relative **lack of venture capital and other critical resources for innovation in SMEs**, and a poor entrepreneurial climate due to poor incentive structures for starting firms compared to regular employment that largely stems from the structure of the welfare system which favours wage earners.

Governmental policy formulation has been explicit in at least three consecutive research bills (2004, 2008, 2012), as well as other official documents (e.g. the 2012 National Innovation Strategy) that the public R&D system is in need of strategic mobilization and purposeful efforts to enhance the level of interaction between academia and industry/society to **strengthen the innovativeness of the economy at large**. Several specific policies have also been launched to enable and enforce strategic mobilization (the Strategic Research Areas and the recent programs to recruit internationally leading scientists), to raise overall quality levels (resource increases) and to facilitate commercialization of research results (investments in the institute sector and in innovation offices).

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