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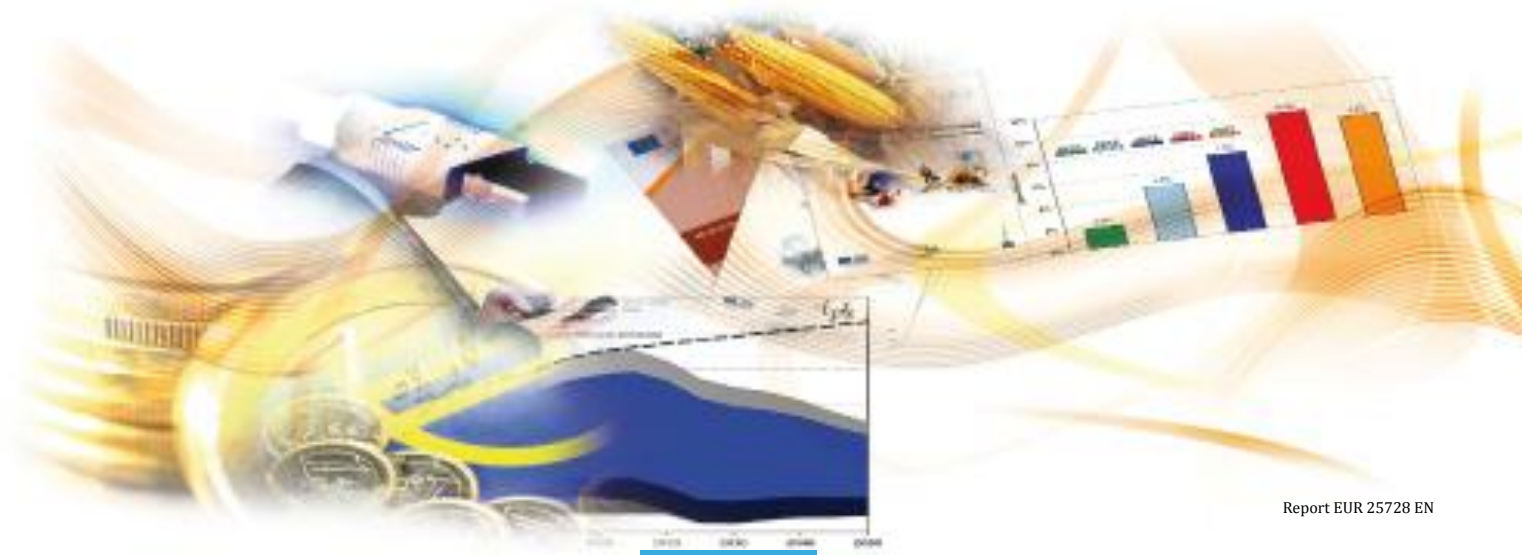

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Executive Summary

Since 2000 Estonia has shown a significant economic growth making it one of the fastest growing economies in the EU. A tight monetary and fiscal policy twinned with a liberal economic policy has resulted in Gross Domestic Product (GDP) per capita growing from 37% of the EU average in 1996 to 64% in 2010 (Eurostat, 2011). Besides tight fiscal and monetary policy Estonia's one main advantages has also been high quality educational system and flexibility to adopt the economic changes. Estonia has become an innovation follower having gross expenditure on R&D (GERD) from 1.1% from GDP in 2007 up to 1.62% in 2010 (Eurostat, 2011).

The innovation system in Estonia was mainly set up in the beginning of 2000's when not only the legislation and institutions related to R&D and innovation but the whole public functional system was created. Today the basic principles of developing the R&D and innovation as well as policy and implementation system and legislation have remained the same in broad sense. Estonia as a small and open country on the one hand needs to be flexible to the global changes but on the other hand needs to keep its values and direction - the R&D and innovation principles, institutions and legislation have been cosmetically refreshed in order to adopt better to the changes in global environment.

The current trends in GERD (both in terms of its intensity and structure) show that **Estonia is moving towards a more knowledge-intensive economy**. There are positive developments in the RDI system towards the EU2020 targets (3% of R&D investments in GDP) through implementing a set of coherent national plans (RDI Strategy, Estonia 2020).

Since 2000 Estonian R&D and innovation policy is financed from four main sources: targeted and baseline financing (national financing), foreign funds (mainly Structural Funds) and private funding. National funding has grown 7.5 times since the year 2000 in line with the R&D share in GDP from 0.61% in 2000 up to 1.63% in 2010 (MER, 2011). The target is to get 3.0% of R&D share in GDP by 2020. The share of foreign funding (Structural Funds) has been about 64% of total funding into R&D and innovation infrastructure (ERAC Peer-Review Report 2012, 2012). Similarly, business sector investments into R&D and innovation have also grown 7.5 times (€8.9m in 2000, €116.2m in 2010), while the most rapid growth was during the high economic development years 2006-2008 (Eurostat, 2011). The balance between the sources of financing has been changed in favour of private sector. The private sector share has been grown from 24.2% in 2000 to 43.6% in 2010, when the public sector share has been decreased from 59.2% in 2000 to 44.2% in 2010. The share of foreign financing has been remaining on the level of 11.4% in 2010 (Statistics Estonia, 2011). Other sources like private non-profit and higher education sectors finance together 0.8% of national GERD. There are no loans from international financing institutions taken and no public-private partnership programmes run for developing the R&D and innovation. The investments are mainly done into modernisation of R&D technology. At the same time investments into human resources are lagging behind (Innovation Activities of Estonian Enterprises 2006-2008, 2011). Hence, during 2007-2013 the investments into human resources have been increased, this still remains one of the major challenges for Estonia (ERAC Peer-Review Report 2012, 2012).

There are three main structural challenges Estonia has:

Underinvestment of the private sector in R&D and innovation

The development of R&D and innovation has been publicly supported since 2000, when the first public support measures were launched. The annual size of public support into private R&D has been increasing year by year. Still, the sector is able to absorb more finances than there are opportunities today. So far the public priorities were mainly set on building up the socio-economic infrastructure (educational and social institutions, transport and environment infrastructure). Today, the shift towards knowledge-based economy has been done, which means more attention will be paid on knowledge creation and transfer. In order the level of private sector R&D investments would increase, the input needed to be expanded.

Weak links between academia and business sector

The links between public and private sector R&D and innovation remain relatively weak. In addition there is an insufficient supply of highly educated employees, especially in science and technology, as well as a shortage of the number of researchers in the public sector R&D (Estonia 2020, 2010).

Insufficient supply of high skilled employees, especially in S&T

The overall development of R&D and innovation as well as economic development may soon tackle the lack of qualified human resources. However, today there is a lack of highly qualified and knowledgeable engineers and researchers on the labour market (ERAC Peer-Review report 2012, 2012). The number of graduated engineers in S&T has been in decline during last 10 years – these curriculums have not been popular among young people, as the rapid economic growth required knowledge in economics and law. The recently launched science popularisation measures are unexpectedly popular and wanted, which gives us hope the labour market will survive. Meanwhile the human resources may have to be imported.

According to the competitiveness strategy “Estonia 2020” Estonia faces **two key challenges** in the context of opportunities for future growth:

- Achieving fast and balanced productivity growth through increased capital intensity as well as products and services with higher added value;
- Restoring the high level of employment.

R&D and innovation are one of the key priorities of Estonian strategy for competitiveness “Estonia 2020” setting the objective of R&D investments in GDP on the level of 3% by 2020 (1.42% in 2010), of which the business sector investments cover more than half (2% of GDP by 2015; 0.64% in 2010) and public sector cover a bit less than a half (1% of GDP by 2015; 0.72% in 2010) (State Budget Strategy 2012-2015, 2011).

The R&D and innovation strategy defines three key technologies – **biotechnology, material technology and ICT**. The prioritised key areas are selected as likely to have a strong impact on economic sectors, replace or improve existing technologies and stimulate development of new technologies and have a profound effect on productivity growth. The overall innovation level has been increased, but there are very few ‘high peaks’ and the overall impact of innovation is still very low. In general, **the right direction of R&D and innovation policies was taken in 2000**. The public support measures since 2000 have in broad sense remained the same, only some of the measures have been reshaped according to the market needs. This direction should be kept, putting emphasise on three main challenges: increasing the funding

of private R&D and human resources as well as motivating cooperation between academia and business.

The RDI strategy does not distinguish **international cooperation** inside and outside the European Research Area (ERA). International cooperation in higher education and research (particularly in the fields of national importance: ICT, energy, material sciences and technologies, biotechnology) is a priority as a whole for Estonian R&D institutions. Estonia's participation in international cooperation programmes has grown – increased participation in COST[1], FP[2], ERA-NET[3], bilateral cooperation programmes[4] show the increased awareness and quality of Estonian researchers.

Summarising the recent studies the policy mix has been set in the right direction being successful in short term. In the long run, taking into account the ageing population, increasing energy price and economic volatility, the basement for sustainable development should be strengthened. The studies and evaluations stress the need for more researchers and engineers especially in the field of science and technology, but also strengthening the linkages between academia and business. The most widely used innovations can be seen in ICT sector, especially in banking and e-services, at the same time the real R&D and innovations are provided in very specific narrow niches, than they hardly will be publicly known and widely used. Also, the overall awareness of the innovation among companies is very low – the innovation (public support measures) has to be made better accessible for (young) entrepreneurs at the same time making efforts raising the awareness (through science popularisation measures) among students of primary, secondary and tertiary education institutions.

The recent study on innovative enterprises also stresses the need for more focusing on certain priority areas instead of supporting the RDI widely in all business areas (Innovation Activities of Estonian Enterprises 2006-2008, 2011). Remarkable investments into the R&D infrastructure development are also expected to create additional values for companies to establish more efficient R&D cooperation with R&D institutions. Public-private venture capital investments through the Estonian Development Fund have given significant impulses for high-growth internationally oriented companies to develop in Estonia. More and wider possibilities for venture-capital investments would attract more start-ups to invest in their ideas. The further investments into R&D and innovation are extremely needed in order to shift the economic structure towards knowledge-based economy and encourage young scientists to look for new technological solutions.

[1] COST – European Cooperation is Science and Technology

[2] FP – Framework Programmes

[3] ERA-NET – Coordination of Research Activities

[4] Estonian-French Cooperation Programme, Norwegian and EEA Financial Mechanisms or Estonian-USA Energy programme

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Introduction

Estonia is one of the smallest EU Member States accounting for ca 0.26% of the population of the EU-27 (Eurostat, 2011). The national economy growth in 2000-2008 was rapid but went into a decline from 2008 onwards, when the real GDP growth rate was negative by -3.7% in 2008 and further negative -14.3% in 2009 (Eurostat, 2011). The growth in 2010 was already 2.3% and forecast for 2012 is 4% (Eurostat, 2011). The Government budget cuts in 2008 and 2009 allowed Estonian economy to recover quickly making Estonia one of the best-recovered European countries. Still, the average GDP from EU-27 GDP remains under the EU-27 average – 44%, which leaves Estonia the recipient of full Cohesion aid. At the same time the real average EU-27 Gross Domestic Product (GDP) growth (0.5% in 2008; 1.8% in 2011) has almost always remained less than Estonian real GDP growth (-3.7% in 2008; 4.9% in 2011). The structural weakness of the national economy remains, with relatively lower share of high tech and knowledge-intensive companies. However, the GERD has tripled in 2003-2008 and the private sector share in it slightly increased in 2008-2009 (from 45% to 47%), in 2010 the impact of the recent economic crisis turned it back on the level of 2008. The slight decrease in GERD intensity and its structure can be explained by the slightly decreased GDP level, which was affected by the economic crisis in 2008-2009.

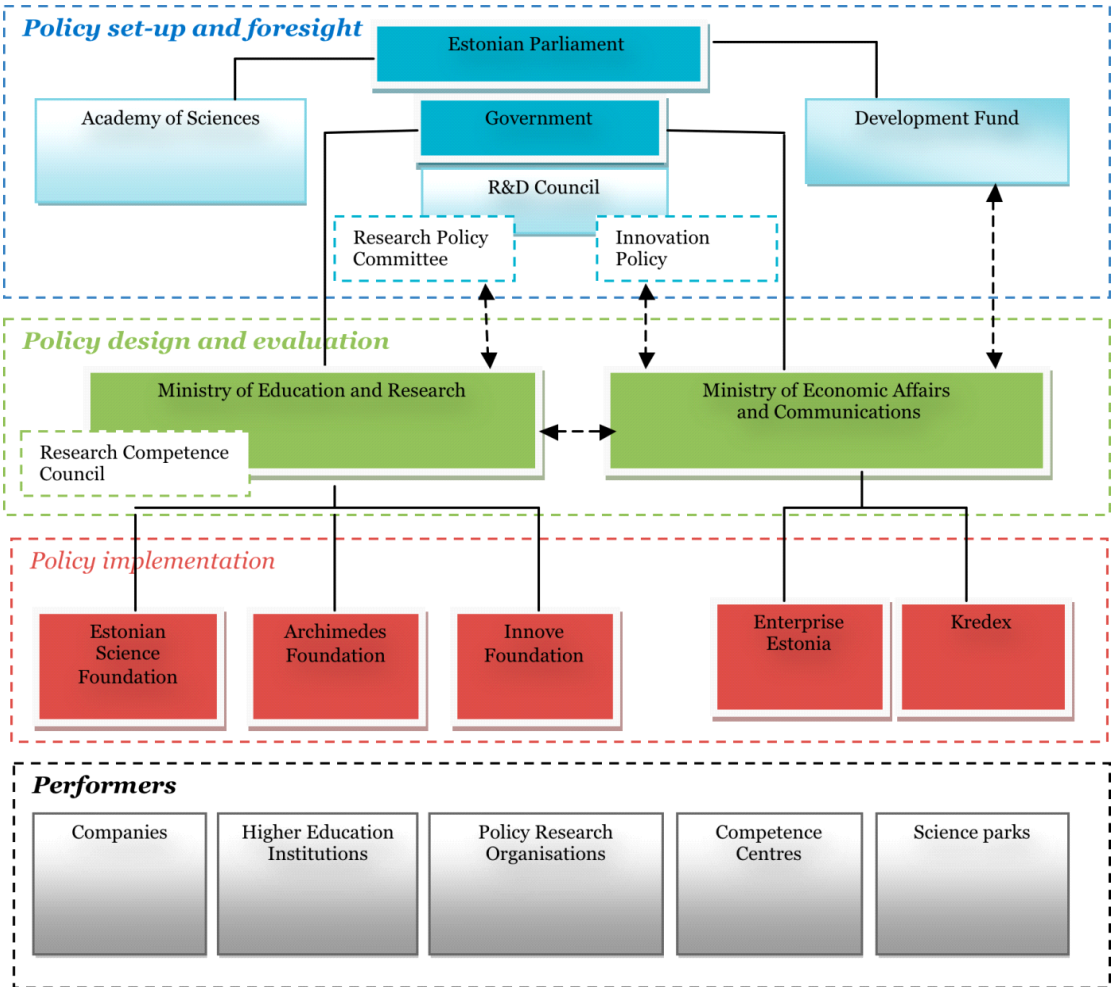
Due to a steady growth since 2004, GBAORD amounted to 1.75% of the total Government expenditures budget in 2011 (EU-27 1.5%). Stable financing has supported the capacity of public HEIs to provide also qualified graduates and future personnel in engineering and science and technology. Indeed, trends for patenting and for scientific publications are positive. However, in absolute terms the number of patents increased from 152 in 2008 to 269 in 2009 (WIPO, 2011). The main reason for relatively low number of patents is described with the less favourable structure of the economy and industry, high costs of patenting and complexity and legal uncertainty (MER, 2011). Hence, HEIs research and knowledge production skills need to be leveraged more, both by supporting the development of existing businesses and as recommended earlier, by “creating new businesses through spin-outs and spin-ins” (SQW, 2003). The number of publications as well as international co-publications by researchers in Estonia has grown rapidly started from 779 publications in 2008 up to 1102 in 2011 (MER, 2008, 2009, 2011). Most collaboration partners are from Finland, Sweden, Germany, the UK, and the US. The Estonian RDI strategy “Knowledge-based Estonia 2007-2013” includes the objective to increase the number of scientific publications listed in the Web of Science database to 1,500 publications by 2013 (Government of Republic of Estonia, 2009).

More than 71% of the Estonian GDP is derived from the service sectors, industrial sectors yield 25% and primary branches (including agriculture) approximately 4% of the overall output. The important sectors of the Estonian economy are the processing industry (approximately 14.5% of the overall production), transport, warehousing and communications (10%), commerce (13.5%) and estate, rental and letting, as well as business services (21%) (Statistics Estonia, 2011). The most important branch among processing industries in Estonia is timber, paper and furniture industry followed with food and light industry, engineering and chemical industry. The key technologies – bio- and material technologies and ICT – support the development of the existing economic structure. Still, in spite of the rapid economic growth and the increased volume of investments into R&D, it is noteworthy that Estonia’s economic

structure is not oriented to knowledge-intensive manufacturing and services (with the exception of the ICT sector), and it is far less competitive and productive in comparison to more developed economies. CIS surveys (Viia *et al*, 2007) indicate that innovation in Estonian companies (which is relatively high) is mainly related to processes and acquisition of new equipment, and far less to knowledge-intensive outcomes (as indicated by patenting and high-tech export data).

The innovation governance system has remained basically intact, and for a good reason. The present system is uncomplicated with rather clear division of responsibilities and a firm connection with the political leadership (see Figure 1). There seem to be no obvious reasons for major changes. At the same time the government system has been criticised as having low competence in designing economic policy and having weak administrative capacity in implementing the public measures (National Audit Office, 2010). The overall strategic planning has also been a concern – to what extent the different policies match with each other and serve the overall objectives set in the strategies "Knowledge-based Estonia 2007-2013"[5] and "Estonia 2020"[6].

Figure 1: Innovation policy governance framework



Source: Ministry of Economic Affairs and Communications

[5] http://www.hm.ee/index.php?03242

[6] http://www.valitsus.ee/en/government-office/estonia-2020

Policy design and evaluation is carried out, principally, by the Ministry of Economic Affairs and Communications and the Ministry of Education and Research. The ministries are responsible for strategic planning (including policy studies), implementing the policies in cooperation with the intermediate bodies as well as supervising and evaluating the policy implementation. This is the task of the ministries to create a legal environment for R&D and innovation. The former overseas support for and funding of industrial R&D, as well as planning, coordination and implementation of innovation policy; the latter is responsible for research and education policies, the financing and evaluation of research institutes and coordination of international cooperation in research. Two permanent **advisory bodies** (the Research Policy Committee and the Research Competence Council) provide advice to the Ministry Education and Research and the Innovation Policy Commission advises the Ministry of Economic Affairs and Communications.

The Research and Development Council (R&D Council) is an expert consultative body that advises the Government on R&D and innovation matters – all policy documents in the way for approval by the Government have to pass the R&D Council.

One advisory body for the Government and innovation oriented projects promoter is Development Fund, a government-owned fund for venture capital, which was established in April 2007. The aim of the Development Fund is to initiate and support changes in the Estonian economy and society that would accelerate modernisation of Estonian economic structure, lead to growth in exports and contribute to the creation of new jobs requiring high qualifications. For that purpose, the Development Fund (together with the private sector) performs risk capital investments into the starting and growth-oriented technology companies and carries out socio-economic and technology foresights.

At the operational level, both ministries have implementing agencies/bodies and intermediaries. The main implementing body of the Ministry of Economic Affairs and Communication is the Enterprise Estonia Foundation, which is responsible for managing business support, innovation and technology programmes. KredEx's mission is to facilitate the increase of competitive strength of Estonian companies by improving the availability of financing and managing credit risks, and the improvement of the housing conditions of Estonian people by expanding financing possibilities and offering financing solutions aimed at energy efficiency.

From the research policy perspective, the Ministry of Education and Research has two main agencies that deliver funding and support: the Archimedes Foundation is responsible for national activities related to the European Research Area (ERA), international research programmes, academic mobility measures, etc. In addition, the Estonian Science Foundation provides grant funding to scientific researchers. In 16 March 2011 the Parliament adopted the new Development and Organisation Act, which provides changes in the public funding system. Since 1 March 2012 the Estonian Research Council will be launched taking over the functions of Estonian Science Foundation. The aim of the Estonian Research Council is to reorganise the financing system, in first hand to decrease the fragmentation of financing, and improve the efficiency of the research institutions.

The INNOVE foundation manages a range of programmes and support measures in the fields of lifelong learning and active labour market policies.

Structural challenges faced by the national system

Estonian strategic objectives for R&D, innovation and enterprise policy have been relatively stable over the last decade (at least since 2004). The analysis of objectives, indicators and targets underlines that there are a number of well-established headline and secondary objectives with broadly consistent targets against baselines from the 2004–2006 period. Similarly, while there has been an evolution towards a number of new measures and funding patterns have evolved (greater funding for infrastructure, new forms of financial instruments, etc.); the core set of measures has been in place for a period of between 6 to 10 years. It should, therefore, be possible to conclude that the policy makers are following the right direction towards making Estonia an innovation leader. Still, there is long way to go and there are plenty of challenges Estonia needs to force in order to reach the level of 3% from GDP of R&D investments by 2020.

Underinvestment of the private sector in R&D and innovation

The two key strategic documents are the Estonian Research and Development and Innovation Strategy 2007-2013 "Knowledge-Based Estonia" (adopted in 2007) and Estonian competitiveness strategy "Estonia 2020" (adopted in 2011). The first is focused mainly on R&D and innovation policies objectives and the latter involves the objectives for sustainable socio-economic development of the whole country. The "Estonia 2020" sets the strategic objective of reaching the R&D and innovation investments to 3% of GDP by 2020. The R&D and innovation is supported and discussed at the highest (Government) level and the significant amount of programmes and policy measures are launched to support the research institutions as well as private sector.

GERD as a share of GDP has shown a significant growth during the last four years (by 25%). One has to note that it was partly achieved at the expense of a rapid fall in GDP in 2008-2009. However, absolute numbers reflect a relative stability both in the government allocations to R&D (45.5% in 2007 and 44.2% in 2010) as well as in the private sector R&D investments (from 41.6% in 2007 to 43.6% in 2010) (MER, 2011).

However, the main strategic document "Knowledge-based Estonia 2007-2013" defines three key technologies (bio-, material and information and communication technologies), there are no sectoral strategies developed focusing on reaching the strategic objectives. There has been criticism that the state is lacking an integral, carefully planned entrepreneurial policy with clear impact objectives (National Audit Office, 2010). The missing 0.88% (as of 2009) from GDP should in first hand expected from the increasing investments in private sector. Today, in spite the clearly defined objectives, action plans and policy measures, the policy makers have not clearly agreed how the strategic targets should be achieved – this should be agreed in R&D and innovation strategy 2014-2020. Recent study on innovative enterprises 2006-2008 also concluded that the R&D and innovation investments should be focused on the narrow field of activities (specific sectors) rather supporting the broad base of R&D and innovation fields (CIS6, 2011).

This sectoral question is crucial for the Estonian small economy with limited resources, small market and dependent on external trade, needing to efficiently adapt to the European and global R&D and innovation system. The risk is that Estonian businesses will simply follow trends instead of identifying the best matches for a country with Estonia's particular strengths and weaknesses. In addition, the strong dependency from the foreign financing (mainly Structural Funds) makes

Estonian R&D and innovation system very fragile – about 64% of the R&D and innovation financing is funded by the foreign funds (ERAC Peer-Review report 2012, 2012). Estonia should intensify its efforts to define smart specialisation strategy to identify sectors in which the Estonian small-scale economy can truly be competitive internationally.

Weak links between academia and business sector

The links between public and private sector R&D and innovation remain relatively weak. In addition there is an insufficient supply of highly educated employees, especially in science and technology, as well as a shortage of the number of researchers in the public sector R&D. Both sectors seem to be busy with their internal business and the solutions for problems are rather looked from internal resources than knowledge transfer. In addition, the lack of human resources also makes the business difficult to implement R&D and innovation.

The fact that 75% of the R&D expenditure can be attributed to only 58 SMEs (Statistics Estonia, 2010) reflects also to the structural weakness of Estonian BERD (none of them belong to the top R&D performers in Europe). Business sector is dominated by a limited number of high tech SMEs (ICT, biotech, cleantech) and the service sector (financial and telecom services providers) and their R&D activity is largely intramural. The telecom and financial sector have been the main R&D and innovation implementers during last 10 years making Estonia known as IT-country.

Compared to other EU countries, Estonian general R&D intensity performance is still below the EU-27 average. Currently the share of Estonian public sector expenditure exceeds the EU average, but the share of private sector (BERD) is much below the EU-27 level. The share of private sector expenditure (BERD) in Estonian general expenditure (GERD) was 0.64% in 2009, but the corresponding EU-27 indicator was 1.25% (Eurostat, 2011).

The Government has made efforts linking better the tertiary education, research and business – there are number of public support measures, but the real links have remained weak. The impact of R&D and innovation in the economy as a whole is not significant yet, thus the real outcomes of R&D and innovation are not really convincing (low level of cooperation between industry and academia, relatively low level of patents or scarcity of skilled human resources). Indeed, the Government has not clearly defined that Estonia would like to become an innovation leader, but at least in order to move towards 3% of R&D investments from GDP, the investments into R&D and innovation have to be kept at least on the same level. Hence, for any development, the investments should be increased. The Structural Funds have provided substantial support to R&D and innovation activities and this support should be extended next financing period (2014-2020). Also, the overall awareness of business sector about the impact of R&D and innovation and possibilities for using R&D and innovation is low – only 12.6% of Estonian companies have used the possibilities of public support (Statistics Estonia, 2011).

The low activity of enterprises implementing R&D&I also expresses in the low level of patents - 152 registered patents in 2008 up to 269 patents in 2009 (WIPO, 2011). This can be argued that the level of patents has always been low in Estonia, but this cannot be an argument for future. Even more, 80-90% of patents in Estonia are registered on foreign business units or R&D institutions. The culture of patents needs to be better adopted in Estonia, otherwise the level of R&D will never will show sustainable growth.

Insufficient supply of high skilled employees, especially in Science and Technology (S&T)

The strategy "Estonia 2020" sets the demographic trends as one main precondition to achieve the set objectives (Estonia 2020). Estonia, as a small country having population 1.3m people (Statistics Estonia, 2011), is lacking also the sufficient number of researchers and engineers (RDI Strategy, Report on achieving the objectives and implementing the strategy in 2010 and 2011 2011; ERAC Peer-Review Report 2012, 2012). Today, the level of researchers is extremely low – 1.1% from the total labour force in 2009 (2.18% in Finland as an innovation leader). In 2008 there were 5.6 researchers for every 1000 employee. In order Estonia would like to reach the objective of 3% R&D investments from GDP, the number of researchers per 1000 employees has to reach up to eight. The annual increase on 2008 in the number of researchers was 5%, but for reaching the strategic objective the annual increase has to be at least 6% (RDI Strategy, Report on achieving the objectives and implementing the strategy in 2008). In State Budget Strategy the Government has set the target to increase the number of researchers up to 5,521 full time equivalent (4,314 in 2009) (State Budget Strategy 2012-2015, 2011).

The number of PhD students at Estonian HEIs has increased, but the growth is still lacking behind the "3% countries" – while in Finland there are 2.9 researchers per 1000 of the population aged 25-64, then Estonia has only 0.8 researchers (Eurostat, 2011). Simply saying, when in 2007/2008 161 new doctors graduated, then for answering the needs of private and public sector as well as guaranteeing the sustainable development of HE in Estonia, the 300 new doctors need to be graduated in 2013 (Knowledge-based Estonia 2007-2013). The slow onward trend is complemented with the low scholarships of researchers being close to €400 monthly, which is about half of the national average salary (€792, Statistics Estonia, 2011). Also, the social guarantees of the researchers are still unsolved, which makes the mobility of foreign researchers extra difficult. Hence, the recently (in February 2011) adopted Research and Development Organisation Act enables the young researchers to be recruited on the same basis with employment agreements. This fundamental change tends to increase the motivation of young researchers, fixes the obligations of the research institutions on supervising the doctoral studies and should provide the material and social guarantees. Still, there is too early to say whether and how much the Act has influenced the real situation.

The level of internationalisation is also low in Estonia. There are public measures to support the students and researchers mobility, but still the researchers and students coming to Estonia prefer to stay for short periods rather to stay for a longer time. One main reason is the underdeveloped system of social guarantees, but also limited range of well-developed scientific fields, which could motivate the researchers to provide their research in Estonian universities (RDI Strategy, Report on achieving the objectives and implementing the strategy in 2009). Normally, the foreign researchers in Estonia are focused on some narrow and very specific field. At the same time the outflow of students to foreign universities remains on the relatively high level – the share is about 1:5 in the favour of outgoing students. The rising trend of outgoing students doesn't show any signs of going downwards – there are opening more possibilities for Estonian students to get the tertiary education abroad (Statistics Estonia 2011).

Assessment of the national innovation strategy

National research and innovation priorities

Since joining the EU in 1 January 2004, Estonia is following the seven years EU programming cycle. The State Budget Strategy is compiled for four years and the sectoral strategies for seven years perspective. This planning period would enable to implement strategies and plan the finances in a sustainable way without any rapid and immediate changes in main policy areas. Since 2007 the recent R&D and innovation strategy "Knowledge-based Estonia 2007-2013" is under implementation without any substantial changes.

The most important **new strategy** adopted by the Government on 28 April 2010 is the strategy "Estonia 2020" prepared by the Strategy Unit of the Government Office with co-operation of ministries. The aim of this document is to lay down Estonia's strategic objectives for competitive growth until 2020. With this document the targets for 2020 and measures for addressing these challenges have been agreed and taken into the Governments' work-plan. The objectives of "Estonia 2020" complement to the existing RDI strategy objectives.

According to "Estonia 2020" Estonia faces two key challenges in the context of opportunities for future growth:

- Achieving fast and balanced productivity growth through increased capital intensity as well as products and services with higher added value;
- Restoring the high level of employment.

For taking these opportunities the highest strategic objectives are set for:

- long-term economic policy growth;
- well educated people and inclusive society;
- competitive business environment;
- environmentally sustainable economy and energy sector.

In "Estonia 2020" the demographic trends as a precondition for the economic development are seen – the decreasing number of population (1.3m in 2011; prognosis 1.25m in 2050), early stage of school leaving or high unemployment rate should be solved first. RDI is one of the key priorities of Estonian strategy for competitiveness "Estonia 2020" setting the objective of R&D investments in GDP on the level of 3% by 2020 (1.42% in 2010), of which the business sector investments cover more than half (2% of GDP by 2020; 0.64% in 2010) and public sector cover a bit less than a half (1% of GDP by 2020; 0.72% in 2010) (State Budget Strategy 2012-2015, 2011).

Estonian research and innovation **policy objectives** were comprehensively outlined for the first time in the Knowledge-Based Estonia: Research and Development Strategy 2002-2006. The new RDI strategy for 2007-2013 stresses that the central research policy objective is "**updating the pool of knowledge"**, while the goal for innovation policy is to **"increase the competitiveness of enterprises"**. Research and innovation policy also put much emphasis on increasing the international experience and thereby the competitiveness of Estonian researchers as well as companies. The current strategy prioritises some key research areas - **IT, biomedicine, and materials sciences**. The prioritised key areas are selected as

likely to have a strong impact on economic sectors, replace or improve existing technologies and stimulate development of new technologies and have a profound effect on productivity growth.

The strategies "Estonia 2020" and Knowledge-Based Estonia 2007-2013 (including the national research programmes covering different fields) are implemented under the leadership of the Ministry of Education and Research and the Ministry of Economic Affairs and Communications in cooperation with other ministries, which are responsible for initiating and implementing national R&D programmes in their areas of administration. The Government, advised by the Research and Development Council, organises the overall implementation of the strategy. One of the priorities of the strategy for growth and jobs is to increase the ability of R&D activities, and direct these to be more commercial.

Thematic R&D priorities

The RDI strategy states that the national research and development programmes are initiated in the fields of research, which already have high quality and are important to the Estonian economy to the extent that the private sector would also actively participate. The distribution and implementation of key technologies have to be ensured in other sectors of economy (particularly in traditional industry, energy sector, transport, etc.) and socio-economic fields (health care, life environment, etc.).

Five technology programmes in the fields of ICT, biotechnology, material technologies, energy, national defence and security are presented to launch by the Government during 2008-2013 (already launched: energy programme, biotechnology programme, ICT programme, space programme). National programmes will be launched primarily for developing RDI enhancing cooperation among R&D institutions and companies; and conducting high-level research in the fields that are a priority for the state. The programmes aim to gather necessary critical resources. Programme measures have to support the achievement of thirteen specific indicators (e.g. growing share of R&D employment, growing number of PhD students and PhDs, growing number of foreign researchers and students, improving science-industry cooperation, growing business R&D and innovation investments, growing productivity, etc.).

The RDI strategy does not state any industrial priorities concerning the RDI activities in Estonia. There are thematic national R&D programmes included in the strategy. For supporting the greater R&D investments in R&D performing firms the Competence Centre programme is running involving eight Competence Centres. The mid-term evaluation of Competence Centres, provided in 2008, concluded that the Centres are building knowledge-based communities whose networking is increasing the level of interest and activity in innovation, extending planning horizons and making innovation more knowledge based. The evaluation also stressed the Centres are having the right kind of impacts to lead to economic benefits (Mid-Term Evaluation of the Competence Centre programme, 2008). The studies on Biotechnology Programme (2009)[7] and Material Technology Programme (2011)[8] analysed the most promising fields of interest for the Estonian biotechnology and material technology sectors given the current strengths and potential both in academic and industrial sectors. The set of recommendations were made concluding that the fields of technologies have great potential in raising the level of R&D in

[7] http://www.mkm.ee/public/inno_13.pdf

[8] http://www.mkm.ee/public/inno_15_par.pdf

business sector in Estonia, but also gave the policy makers the basis to keep the development of these technologies as key technologies in RDI strategy in the future (Feasibility Study for an Estonian Material Technology Programme, 2011). In 2009 the Estonian Development Fund provided a foresight study on Estonian ICT sector[9], concluding that the focus should be put on the development of those ICT competences, where Estonia has potential in the perspective of 5-10 years as well as develop these areas, where the global problems are the most enormous (ageing population) and the ICT export could have the biggest potential (EST_IT@2018, 2009). The recent study on the innovative enterprises in Estonia during 2006-2008 found that the Estonian enterprises appreciate innovation high, but the overall increase in the number of innovative companies is not the result of sustainable public policy but rather a naturally grown out economic need. Also, so far the innovation has basically involved the modernisation of technology rather than generating value added from new innovative solutions (Technopolis Group, 2011)

To summarise, so-called hot spots in the R&D&I area in Estonia have grown out from spontaneous needs rather than as a result of particular sector or area-specific prioritisation. A variety of policy measures encourage the development of different types of companies (performing R&D, capable for R&D but not yet performing, innovating but not performing R&D, etc.). Despite the RDI strategy defines the key technologies; **there has been no explicit focus on developing the priority areas in first hand**. The recent study on innovative enterprises also stresses the need for more focusing on certain priority areas instead of supporting the RDI widely in all business areas. In terms of the R&D&I budget, a significant part has allocated to private-public R&D cooperation and knowledge and technology transfer. The increased size of investments into the R&D infrastructure development (started in 2009) are also expected to create additional values for companies to establish more efficient R&D cooperation with R&D institutions. Public-private venture capital investments through the Estonian Development Fund have given significant impulses for high-growth internationally oriented companies to develop in Estonia. Still, the knowledge base for R&D remains significantly weak and the knowledge transfer between academia and business needs to be fostered. The further investments into RDI are extremely needed in order to shift the economic structure towards knowledge-based economy and encourage young scientists to look for new technological solutions. Hence, these suggestions still exist only on the paper and would hopefully turn into reality during the next strategy implementation period, which planning has already started.

Trends in R&D funding

Gross expenditure on R&D (GERD) in absolute terms has increased by 30% during 2007-2010 (from 1.08% in 2007 up to 1.62% in 2010). As a percentage of GDP it is still below the EU average. Particularly in 2009 one can note a significant growth, this is partly due to rapid GDP fall in 2009. During 2006-2008 the positive signals can be found from the business enterprise sector, which result in 38.4% of the GERD in 2009 (18% growth compared to 2006). In 2009 the growth was turned into slight decrease due to the heavily hit economic crisis in Estonia. However, the overall level of R&D investments during the crisis in 2008-2009 remained on the same level due to the previously committed Structural Funds, but as the business sector felt

[9] http://www.arengufond.ee/eng/foresight/estit2018/

uncertainty, the business development projects were frozen until the business environment stabilises.

Table 1: Basic indicators for R&D investments in Estonia

	2008	2009	2010	EU average 2010
GDP growth rate	-3.7%	-14.3%	2.3%	2,0
GERD as % of GDP	1.29	1.42	1.62	2.0
GERD per capita	155.1	147.3	173.3	490.2
GBAORD (€ million)	104,074	96,366	101,751	92,729.05
GBAORD as % of GDP	0.65%	0.7%	0.71%	0.76
BERD (€ million)	89,879	88,128	116,2	151,125.56
BERD as % of GDP	0.56%	0.64%	0,81%	1.23
GERD financed by abroad as % of total GERD	9.4	11.4	11.4[10]	N/A[11]
R&D performed by HEIs (% of GERD)	0.5%	0.7%	0.6%[12]	24.2
R&D performed by PROs (% of GERD)	0.3%	0.7%	0.2%[13]	13.2
R&D performed by Business Enterprise sector (as % of GERD)	39.8%	38.4%	43.6%[14]	61.5

Source: Eurostat 2011,

Estonian R&D and innovation policy is financed from four main sources: targeted and baseline financing (national financing), foreign funds (mainly Structural Funds) and private funding. National funding has grown 7.5 times since the year 2000 (€23m in 2000, €179m in 2011) in line with the R&D share in GDP from 0.61% in 2000 up to 2.0% in 2011 (Estonian R&D strategy report 2009). The target is to get 3.0% of R&D share in GDP by 2020 (strategy "Estonia 2020"). The share of foreign funding (Structural Funds) has been about 64% of total funding into R&D and innovation infrastructure. Similarly, business sector investments into R&D and innovation have also grown 7.5 times (€8.9m in 2000, €88m in 2009), while the most rapid growth was during the high economic development years 2006-2008. The balance between the sources of financing has roughly remained the same - about half of the expenditure into R&D and innovation is from public sources[15], 39% is from business sector and 10% from foreign funds. Other sources like private non-profit and higher education sectors finance together account for 1% of national GERD. The

[10] MER, 2011

[11] 8.4 (2009), 9.04 (2005)

[12] MER, 2011

[13] MER, 2011

[14] MER, 2011

[15] The share of public funds remains high due to the high level of running costs covered by national sources. The trans-national or regional funding do not play a significant role.

possibilities of international financing institutions and public-private partnership projects are not really used in Estonia.

The biggest part of financing is going into research and technology policy development (total €53.8m during 2007-2013) and is financing mainly the modernisation of technological equipment. At the same time investments into human resources are lagging behind. This **share of financing as of categories of policies as well as financing sources has been remained the same** since 2007 when the 2007-2013 financing framework was approved within the state budget strategy by the Government. For guaranteeing reaching the target of 3% of R&D expenditures from GDP the funds for supporting the private investments into R&D and innovation should increase, as well as investments into human resources.

Since 2001 the public support given to develop the innovation policy is mainly given in grants. The size of the grant varies according to the measure conditions and legal status of the applicant. Almost in all cases the grants are a subject of the European state aid rules, mainly *de minimis* or block exemption.

Evolution and analysis of the policy mixes

As a member of EU Estonia designs its strategic objectives for seven years and specifies the strategic framework for four years every year within the state budget strategy update. The main priorities for R&D and innovation policies were set down in the "Knowledge-based Estonia 2007-2013" (adopted in 2007) and these priorities have been followed. In "Estonia 2020" (adopted in 2011) the specific R&D and innovation objectives were updated and specified in the light of the recent economic developments (the target of reaching 3% of R&D costs in GDP was postponed to 2020 instead of 2013). Every year the state budget strategy is updated in the light of next four years keeping the long-term objectives in mind. Recent changes in the Research and Development Organisational Act, reorganisation of Estonian Science Foundation into Estonian Research Council or launched reform in higher education system are tools in order to achieve the strategic objectives. **The recent changes in policy mix have been more adjustments of the existing strategy than substantial changes**.

The public intervention aims to boost the intensity of business R&D and innovation in order to shift the economy towards higher productivity and enable Estonian companies to increase export. A 2010 study by the National Audit Office on the "Impact of the state's enterprise supports on the competitiveness of Estonian economy" concludes that the reason for a limited impact of enterprise support is rigid, untargeted and dispersed system which tries to deal at the same time with many problems of entrepreneurship and very often does not consider the actual needs of enterprises (National Audit Office, 2010). As the overall platform for R&D and innovation is wide, the target groups have mainly used the opportunity to modernise their technological equipment base. Estonian companies have also been eager to implement innovation in organisational development or optimising the processes as well as improving business models, less attention has been paid on services innovation. The public support measures are rather oriented on supply side innovation, than demand side – there are only few examples on demand side innovation – the Electric Mobility Programme, government e-services and the programme on energy saving in residential buildings.

In the current ongoing financing measures the emphasis is mainly put on the development of the knowledge and technology transfer, modernisation of technology,

internationalisation of research (incl. researchers' mobility) and business, supporting start-up companies and developing cooperation between business and academia. The focus areas have been more or less remained the same since 2000. At the same time planning the financing period of 2007-2013, the set of studies and analyses were made in order to optimise the focus of public support – in the result some of the public support measures were replaced, but there are also examples of sustainable measures like direct support on R&D investments or Competence Centres. There is no tax incentives given to the R&D and innovation investments except the companies are free of tax if they reinvest their benefit. There are no instructions whether the reinvestment has to be made in R&D and innovation or anywhere else, the only criteria are for the investment to be made into the development of the company. The tax policy of the Government of Estonia follows the rule of taxing everything similarly and allowing as less exemptions as possible – so far the idea of extra tax incentives for R&D and innovation expenditures has not been supported by the Government. The PPP projects are not common in Estonia as well as loans from international financing institutions as the large projects are mainly financed by the Structural Funds.

Estonian R&D and innovation policy is in force since 2000 and is built up on the equal development of the R&D and innovation policies as a whole – while three key technologies are identified, in reality significant advantage is not given to them. The current strategic approach for innovation is designed for 2007–2013 in coherence with the EU budgeting period as the majority of the innovation funding is coming from the EU Structural Funds. There are a number of measures developed specifically for supporting the R&D and innovation, developing human resources and supporting business (including start-up companies) activities both in HEIs/R&D institutions and business sector. There is no centrally managed monitoring system other than Structural Funds management system, hence, these results don't give us any major information on strategic objectives – we can only get quantitative information on the performance in terms of Structural Funds objectives. In addition, the ministries are reviewing or providing studies on the state of play and development of potential sectoral strategies or programmes, but there is no common tradition and these actions are mainly provided time by time. Despite the significant success in developing R&D and innovation, still, the measures taken have not been enough for reaching the strategic objectives – the performance results have been perfect in short-term, but not sufficient for long-term development.

The higher education system in Estonia has been developed since 1995, when the Act of Universities was adopted. The Act relied on the credit system based on the actual workload of the students (today known as ECTS system), the accreditation of the study programmes involving external experts, the wide autonomy of the universities and involving the student representative in the decision making process of the universities. Today, the universities are autonomous institutions with their own management system and budget. The rapid economic growth during 1995-2008 demanded the skilled and experienced people in social sciences – economics, law, public administration. The labour market demand dictated the number of graduates and as the market prioritised practical experiences, the level of PhD students fell rapidly. As the total import was higher than export, the new technology was mainly imported and installed by the manufacturers; there was no need for highly skilled personnel in science and technology. Today, the knowledge-based economy sets us new challenges – we need more skilled engineers with knowledge of business performance as well as people generating new ideas and having research

experience in order to increase the level of R&D and innovation. As the basis of natural growth of the level of engineers and researchers are low (the population is only 1.3m people), the more carefully the investments need to be focused on the development of human resources – in first hand the number of science and technology PhD graduates need to be increased.

In the end of 2011 the Minister of Education and Research launched a reform of higher education, which aim is to rearrange the financing of higher education, strengthen the quality and effectiveness as well as to increase more fair accessibility to higher education. Hence the ambitious idea of the new Government elected in February 2011 was the fully state financed higher education, the higher education reform 2012+ has already gained many opposite arguments in first hand from students organisations. In hand with the fully state financed higher education the students also are required to pass their studies within nominal study period with reaching the required academic credits during the whole studies. This means the students have fully to commit on studies, while the majority of students divide themselves between studies and work in order to survive economically. The reform also bears in mind increasing the level of internationalisation of Estonian universities through increasing the quality and efficiency, as well as motivate students for further studies in doctoral programmes. The discussions are still ongoing and the new legislation is still in Parliament, hence the new financing system of higher education should be applied from the autumn of 2012.

Assessment of the policy mix

As about 64% of the public funds going into R&D and innovation are coming from Structural Funds, the evaluation traditions have been established (ERAC Peer-Review Report 2012, 2012). Normally, the evaluation is one part of the policy planning cycle, hence, depending from the ministry the evaluations may have not been provided very systematically and often. Here, the Ministry of Finance and the Ministry of Economic Affairs and Communications can be good examples.

The recent evaluations of Operational Programmes in 2009 (Ernst & Young Baltic, Institute of Baltic Studies, Praxis, Stockholm Environment Institute, 2009) and the R&D and HE measures of the Ministry of Education and Research in 2011 (Praxis, Technopolis Group, Institute of Baltic Studies, 2011) conclude that the **investments into R&D and education have to be increased** in order Estonia would like to achieve its R&D investments level of 3% from GDP by 2020. The strategic objectives taken today will not be reached only with the Structural Funds – the public support has to increase in parallel.

The National Audit Office also supports this opinion - the visible impact of public support measures (including Structural Funds) on business innovation remains limited. On its audit provided in 2010 focusing on the impact of state's enterprise support on the competitiveness of Estonian economy, the National Audit Office concludes that while in the short-term the programme objectives may be fulfilled, in the long-term, the strategic objectives (higher productivity, increased export, more innovation and larger international cooperation) of enterprises are still a challenge - **the not clearly focused public support, narrow basic science platform, R&D concentration in a narrow range of companies and weak international cooperation makes the economy fragile** – the export and productivity growth depends to a large extent on the domestic demand. Even more, the audit report of the National Audit Office suggested reshaping the entrepreneurial policy – so far, the

measures of entrepreneurial policy is to a great extent only financed by the Structural Funds and it does not consider different developmental problems of enterprises (National Audit Office, 2010). Indeed, this broad policy has also been criticised and suggested to focus on at least some specific field (UT, Praxis, Technopolis Group, (2011). The broad base of financing without any specification fields has brought Estonia to the situation, where new policy approach in terms of focusing is needed.

A study "Innovation activities in enterprises 2006-2008" of the Community Innovation Survey 2006-2008 (CIS6) 2011 is the only official study of the innovation policy effectiveness (UT, Praxis, Technopolis Group, (2011). In a broad way, the study concludes that Estonia has been moving in the right direction. At the same time, while the level of innovative activities and intramural business cooperation is high, the level of significant innovative initiatives or cooperation between academia and business is still very low. Also, the innovation inside the organisations and market innovation are not implemented very much. The study also underlines the need for a stronger focus on a limited number of fields and on key growth companies and high-value added start-ups in new and emerging sectors. Enhancing the knowledge transfer to the business sector and expanding the recruitment of innovation managers would foster better networking of companies and create international cooperation. The study stresses that innovation policy needs to remain flexible to adapt to the evolving needs of the key existing and emerging competitive strengths of Estonian businesses so as to help to cushion 'external shocks' and allow Estonian firms to rapidly grab opportunities arising from shifts in global demand in their markets. These are findings in 2011 about the period 2006-2008 – by today the situation may have changed, and taking into account the overall economic increase, the increased level of innovation awareness and an interest towards some support measures, the change, one can hope, has taken place in a positive direction.

To get the better position on planning of 2014-2020 financing period the Ministry of Education and Research and the Ministry of Economic Affairs and Communications have asked for external peer review from the European Research Area Committee. The aim of the peer review is to get the external feedback and international view on the innovation policy objectives and implementation success in Estonia. The peer review is still ongoing, but should be finalised by the end of 2011.

In the field studies "Feasibility study on material technology"[16] (published in 2011) and "Feasibility study on Estonian biotechnology programme"[17] (published in 2010) the current situations of the both technologies were analysed and future development opportunities with the most promising business fields and future scenarios were presented. The foresight study on ICT sector in Estonia was already provided in 2008[18], concluding that Estonia has had significant success in developing ICT (mainly in financial sector and ICT security) and has great potential for ICT export. The main promising areas in the field of ICT are education, energy, industry and health sectors. There are no such studies provided in energy sector, despite the fact that Estonian economy is very energy intensive. The oil-shale industry makes Estonia one of the biggest ecological footprint countries in the world, explaining the Estonian poor position on the Eco-Innovation Scoreboard[19]. In coming years the

[16] http://www.mkm.ee/public/inno_15_par.pdf

[17] http://www.mkm.ee/public/inno_13.pdf

[18] http://www.ibs.ee/et/publikatsioonid/item/52-ict-sector-in-estonia-foresight-study

[19] http://www.eco-innovation.eu/

attention should be paid on energy saving and increasing the share of renewable energies in the total energy consumption. The Estonian Development Fund has recently launched a new foresight study on green economy[20], in spite there is no activities taken yet, the policy makers can already have a signal of increased importance of green economy in Estonia.

Summarising the recent studies the policy mix has been set in the right direction being successful in short term. In the long run, taking into account the ageing population, increasing energy price and economic volatility, the basement for sustainable development should be strengthened. The studies and evaluations stress the need for more researchers and engineers especially in the field of science and technology, but also strengthening the linkages between academia and business. The most widely used innovations can be seen in ICT sector, especially in banking and e-services, at the same time the real R&D and innovations are provided in very specific narrow niches, than they hardly will be publicly known and widely used. Also, the overall awareness of the innovation among companies is very low – the innovation (public support measures) has to be made better accessible for (young) entrepreneurs at the same time making efforts raising the awareness (through science popularisation measures) among students of primary, secondary and tertiary education institutions.

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Table 2: Assessment of the policy mix

[20] http://www.arengufond.ee/eng

Challenges	Policy measures/actions[21]	Assessment in terms of appropriateness, efficiency and effectiveness
Increase the level of investments of the private sector in R&D and innovation	Modernisation of R&D equipment; R&D institutions infrastructure; Investments into test- and semi-industrial laboratories; Technology investments of industrial enterprises; knowledge and technology transfer; R&D grants; Product development; Venture capital investments	The measures are under implementation since 2008/2009 and generally have been **very successful**, as they are basically the only ones, which support business R&D. The funds are all committed by today and the size of the measures was increased in 2009, as the demand was higher than expected. On the other hand the R&D support measures meet their boundaries on the lack of appropriate human resources. Increasing the size of business R&D investments needs also increasing the investments into human resources, which in hand, would increase the effectiveness of these measures. In order to reach the level of 3% of R&D investments from GDP, the size of investments into business R&D need to be increased – these studies are ongoing. There could be more ideas for financing by venture capital, but the fact that most seed-fund receivers in Estonian Development Fund are expanding and performing well, may assess the success of the investments. No changes in legislation or strategy have taken place.
Strengthen the links between academia and business sector	Business incubators; Cluster development; Competence Centres; Innovation vouchers Centres of Excellence	The measures are under implementation since 2008/2009 and generally have been **successful**. They are appropriate in terms of strategic objectives, but rising the financing should increase the effect. The innovation vouchers measure focusing on SMEs have been very successful. The eight Competence Centres are popular and need to be supported in the future. For more visible results the financing should be increased and maybe the scope of activities expanded, which needs also involving more human resources. No changes in legislation or strategy have taken place.
Increase the level of high skilled employees, especially in S&T	Collaboration of HEIs; PhD studies and internationalisation; Researchers mobility; Involvement of innovation staff	The measures are under implementation since 2008/2009. The measures have generally been appropriate and **successful**. The involvement of innovation staff has to be reshaped, as there is no need for such a support on the market – instead of foreign innovation staff maybe hiring local researchers could be supported. The support measures for researchers are open for all areas – prioritising the S&T could be an option for increasing the number of researchers S&T. For better effect and accessibility, the size of the measures should be increased in the future. No changes in legislation or strategy have taken place.

Source: author's own compilation on the basis of the information from Enterprise Estonia[22]

[21] Changes in the legislation and other initiatives not necessarily related with funding are also included.

National policy and the European perspective

R&D and innovation is definitely not domestic, especially in such small country like Estonia. In a short-term, current RDI policy has pretty effectively served the fulfilling of strategic objectives – the levels of R&D investments and innovative companies have increased, as well as the number of students and PhD holders, the level of internationalisation and cooperation between HEIs and HEIs and business has expanded. Still, current developments are not enough for reaching the 3% of R&D investments from GDP by 2020.

The Estonia 2020 objectives are set according to the objectives in Europe 2020 and in some cases set even higher. The EU target towards R&D investments is set also on 3% of GDP. The main growth is foreseen from the business sector (0.7% in 2009), where the major investments need to go. In spite of the fact that there are policy measures in place already today, the size of investments is not enough enabling the needed growth rate, therefore the funds for private R&D need to be increased in the coherence with the increased investments into human resources.

In 2014-2020 the policy frame should remain the same, just focusing better on supporting the private R&D, motivating collaboration between business and academia and increasing the investments into tertiary education. The latter will have crucial impact on the further R&D and innovation development in Estonia. The science popularisation measures started a few years ago will have their impact after ten years, which means the gap of researchers has to be managed meanwhile. The access to PhD studies with social guarantees (including increasing the salary) has to be made easier in order to motivate the young people to become researchers. For fostering the researchers' mobility these conditions have also to apply on foreign researchers.

The young entrepreneurs have to be more intensively supported and venture capital has to be made more easily accessible. Today mainly the experienced entrepreneurs can use the venture capital and young businesses are successful only in some circumstances. Today, in many areas there are plenty of good ideas focused on improving the processes or creating new products for smaller markets, but still a lack of good scientific and business ideas influencing the behaviour of the market – the initiatives to come up with new ideas need to be motivated by the policy makers. If needed, the policy makers can create a demand for certain areas or services the market can offer – this is the way the public sector can initiate the innovation. At the same time in the main technology areas innovation is needed in energy, material and biotechnology. The ICT remains one of the main innovation fields in Estonia; hence, it can also be seen as a tool for R&D and innovation.

One of the most developed fields in Estonian R&D and innovation is dramatically increased number of scientific publications during the last years. The European Innovation Index 2010[23] shows that international co-publications in Estonia per million people is 85% higher than the EU average, but at the same time doctors from EU coming to make their research in Estonia are only 9% from the EU average. The possibilities for Estonian scientists and doctoral students to study or conduct research abroad have broadened a lot, at the same time there are a limited number of foreign scientists working in Estonia and their research is usually focused on a

[22] http://www.eas.ee/index.php?setlang=en-GB

[23] http://www.proinno-europe.eu/page/summary-innovation-index-0

very specific area. Furthermore, it's a question of public policy whether the stay of foreign researchers and their families are made comfortable enough to provide long-term research in Estonia.

On the international research level the Ministry of Economic Affairs and Communications is the leading institution in Estonia in the European Space Programme[24]. Developing space technology and its applications on earth are seen as one of the basis for future economic development. On the one hand participating in the European Space Programme Estonian companies have the possibility to develop new technologies, but on the other hand, the quality of public services could be improved through the space technology applications on earth.

Finally, the most important factor for Estonian further development is human resources – the lack of qualified employees and knowledgeable researchers may hamper the overall R&D and innovation as well as economic performance. Therefore the investments in increasing the number of researchers and PhD cooperation programmes need to be expanded in the financing period 2014-2020. At the same time overall R&D and innovation awareness need to be continued and widely promoted, starting with primary education institutions up to entrepreneurs. International cooperation as significant part of knowledge transfer may support Estonia to reach the 3% of R&D investments in GDP faster than inventing the wheel itself. Moreover, the international specialisation on scientific market can be a key towards increasing the level of R&D investments in DGP.

Table 3: Assessment of the national policies/measures supporting the strategic ERA objectives (derived from ERA 2020 Vision)

	ERA dimension	Main challenges at national level	Recent policy changes
1	**Labour Market for Researchers**	Increase the number of researchers, especially on S&T	There have been no policy changes. Public support measures have been under implementation since 2008/2009.
2	**Cross-border cooperation**	Finding common interests in cross-border research areas	Bilateral cooperation programme with Russian Federation (2008), Sweden and Finland (2007)
3	**World class research infrastructures**	Participation in European Space Programme	Estonian Space Office launched in 2008. No other strategic or legislative changes have taken place.

[24] http://www.eas.ee/index.php?option=com_content&view=article&id=2711&Itemid=1356

	ERA dimension	Main challenges at national level	Recent policy changes
4	**Research institutions**	Increase the number of scientific publications; Modernising the scientific infrastructure; Providing the HE reform (inc. financing principles)	Higher education reform is launched in 2011 and is still under discussion. No political decisions are made yet. The public support measures are under implementation since 2008/2009. No other changes have taken place.
5	**Public-private partnerships**	Find common areas for PPP.	No strategic or legislative changes have taken place.
6	**Knowledge circulation across Europe**	Increase the share of knowledge transfer between academia, PROs and business; Ease the business sector to hire foreign researchers (lower the bureaucratic level of social guarantees).	No strategic or legislative changes have taken place.
7	**International Cooperation**	Increase the mobility of students and researchers; Increase the number of foreign long-term researchers in Estonia	The public support measures are under implementation since 2008/2009. No strategic or legislative changes have taken place.

Source: author' own compilation

Annex: Alignment of national policies with ERA pillars / objectives

1. Ensure an adequate supply of human resources for research and an open, attractive and competitive single European labour market for male and female researchers

1.1 Supply of human resources for research

The share of researchers in the total labour force is around the EU average (0.71% in 2010; EU-27 average is 0.72%). At the same time comparing the same figure in Finland is 1.69%. In 2010/2011 academic year there share of foreign PhD candidates accounted for 5.8% of enrolments at doctoral level (MER, 2011), 2008). Almost half of the all doctorates (40%) and even more (58%) from the foreign doctorates taking the PhD in social sciences and humanities. Comparing with 2009, the number of foreign PhD students increased by 39%. At the same time 12 scholarships have been given to provide the PhD in foreign universities in 2011. The vast majority of researchers in the higher education sector was nationals (94.3%); followed by EU15 researchers 5% and 0.7% from other countries in 2011. More recent data suggests that since Estonia joined the EU, more exchange students and visiting PhD students are coming to study in Estonia supported by various programmes. The number of foreign students for example increased from 1,007 in 2006 to 1,279 in 2009 (Ministry of Education and Research, 2011). At the same time students outflow from Estonia keeps rising as there are more opportunities opened for students to get their tertiary education abroad. The share of students' inflow and outflow is roughly about 1:5 in the favour of students' outflow. While more students are going abroad the national labour market suffers from the highly professional S&T specialists. The highly skilled S&T PhDs are looked on the labour market both from the private and public sector – the business sector is ready for taking the next steps in innovation and the public sector lack of educated people understanding the policy mix and ability of analyse and develop the governance of policies.

In terms of the number of doctoral candidates continuing their doctoral education in another EU country, the figure for Estonia was one of the highest in the EU in 2004 (JRC-IPTS, 2008). They can obtain funding via several sources and programmes.

There are two specific programmes running for financing the activities of post-doctoral researchers – the Mobilitas programme (financed by European Social Fund) supports mainly the foreign scientists providing their research in Estonia and Ermos (financed by FP7) is oriented for Estonian researchers to provide their post doc research. During 2009-2013 there will be financed 104 post docs under the Mobilitas programme and 45 post docs under Ermos programme during 2010-2012. Today, the most covered fields are bio- and environmental sciences, followed by technology sciences (Estonian Science Foundation, Annual Book 2009).

1.2 Ensure that researchers across the EU benefit from open recruitment, adequate training, attractive career prospects and working conditions and barriers to cross-border mobility are removed

The Estonian Universities Act (1995, consolidated in 2005) provides universities with a significant degree of self-governance and autonomy, including rights to set their academic and other collaborations, employment requirements and conditions (contract forms, extra remuneration), salary rates. The universities have budgetary autonomy and thus distribute internally the state (and other) non-competitive, generic funding allocations, etc. The salary level and other conditions of employment can be based on university regulations as long as they are in full accordance with the articles of the Employment Contracts Act (2009) on general working time, holidays and vacations, maternity benefits, parental leave, social and public health securities, etc (Riigi Teataja, 2009). To adopt the main principles of the Charter for Researchers, all six Estonian public universities have signed the Agreement on Good Practice in the

Internationalisation of Estonia's Higher Education Institutions (2007) (UT, TUT, Estonian Academy of Arts, EULS, Estonian Academy of Music and Theatre, Tallinn University).

Low salaries of researchers are one of the main reasons why despite rapid growth in R&D funding, the number of R&D personnel has not grown sufficiently (Ministry of Education and Research, 2011). In order to tackle this problem, all state budget-financing instruments that have an impact on research personnel salaries were increased by 30% in the 2008 budget. Compared to other European countries, researchers' salaries in Estonia rank among the lowest, and the same is true domestically in comparison to salaries in the private sector (CARSA, 2007; Rõõm, 2007). The salary rules vary for professors, docents (assistant professors), specialists and other academic positions, and the rules are reviewed on a regular basis. For example an assistant at the University of Tartu obtained in 2008 as a starting salary €610, a full professor €1,500 (EUI, Academic Careers Observatory).

Provision of attractive employment and working conditions is viewed as a priority area for Estonia (European Commission, 2009). This is in particular aimed at young researchers. Estonia aims at increasing the number of doctoral students; with this general objective in mind, the key goal is to change the legal status of PhD students from that of students to that of employee status with related employee rights. Currently**,** PhD students enjoy only health insurance but do not contribute to the pension system nor do they obtain pension rights. Legislative action is foreseen in this area (European Commission*,* 2009). Today, there are no significant changes taken place. Nevertheless, the level of researchers has been increased, but not such that it could significantly influence the level of R&D.

Employment stability in terms of permanent positions is currently secured only for professors who have been (re)selected for the same position for three times and have more than 11 years of experience[25].

Staff may have one sabbatical semester of paid leave for every five years of service. Part-time employees shall have the same benefits as full-time employees (EUI 2009).

In order to apply for a lecturer, teacher, or assistant position, the applicant must have a Master's Degree or a corresponding qualification. Associate professor and professorship positions require a PhD: a person who possesses an Estonian PhD or a corresponding foreign degree may apply for these positions. To become Lead or Senior Research Fellow, candidates must hold a Ph.D. conferred in Estonia or another academic degree of an equivalent level. A MA is enough for obtaining a Research Fellow position. Members of the academic staff are increasingly selected on the basis of "their competence in research" and "teaching experience."

Post-doctoral research grants are for two to three years. Notices of opening of post-doctoral competition are published on the websites of the Estonian Science Foundation, the Estonian Research Portal, and the Information Centre for foreign researchers. Grants are awarded to applicants on the basis of an open international competition for a specific research project. Grants include the remuneration of the post-doctoral researcher (incl. payable taxes), research costs and a one-time relocation support (EUI 2009).

On the portability of grants, Estonia has signed EUROHORC's letter of intent 'Money follows researchers'[26], which aims to improve the starting conditions of researchers who accept a position at a research institution.

1.3 Improve young people's scientific education and increase interest in research careers

General legislation for HE in Estonia is laid down in the following legal acts: Republic of Estonia Education Act, Universities Act, Institutions of Professional Higher Education Act, Private Schools Act, Vocational Education Institutions Act, and Standard of Higher Education. The framework document the Standard of Higher Education specifies the requirements for higher education programmes and quality

[25] However, in this case, the council of a university may give the name "*Professor Emeritus*" to professors who have worked for at least ten years or at least twice in the regular professor related to a person who has received the age pension. A *professor emeritus* has the right to participate in activities of the university and get the salary established on procedure of the council of the university. A *professor emeritus* fees are supported from state budget with the submission of public education budget through the MER (European Commission*,* 2009).

[26] http://www.eurohorcs.org/SiteCollectionDocuments/EUROHORCs_MFR_Letter_of_Intent_Revised_081105.pdf

assurance. It is a fundamental legal act concerning licensing and accreditation of study programmes or higher education institutions. The Standard of Higher Education is based on other acts related to higher education and is valid for all cycles and forms of higher education, irrespective of the ownership or the legal status of the higher education institution, but there are no priorities set in favour of science, technology, engineering and mathematics.

As said before the rapid economic growth during 1995-2008 required mainly people with knowledge in economics and law, leaving the science and technology matters behind. Today, the economic situation is changed and skilled and knowledgeable engineers are looked for. It can be concluded that the number of students in S&T both in HE and vocational education has increased (Statistical Yearbook 2011). At the same time the Tallinn University of Technology do not believe the number of students in S&T will significantly increase in coming years. The reason behind it is the low level of students and high level of dropouts on S&T curriculums. Also, looking at the low number of high school graduates passing the final exams in S&T (mathematics, physics, chemistry, biology), there is no hope for increased interest against S&T (Kübarsepp. J, TUT, 2011).

On the other side, in order to broaden the base for development of curriculums in S&T and motivating young people to study S&T, the programme of science popularisation[27] is launched in 2009. The aim of the programme is to popularise science, raise the awareness of the importance of the S&T in the economy and attract more people to be interested in science. The activities of the programme are wide - starting from the elementary school up to wide awareness rising through media.

Coming to the level of basic education, the new national curriculum was launched in academic year 2011/2012, which has to be fully implemented by the end of 2013/2014. The aim of the new curriculum is to give children on primary and high school level wider understanding of linkages between different fields of life, support creativity and critical thinking, teach teamwork, social and communications skills. The new curriculum requires modernising educational infrastructure and new attitude on promotional system. This is not a challenge only for children, but rather for teachers and educational managers. One important aspect of the new curriculum is the requirement of the three scientific fields at the level of high school, in order to prepare young people for future professional choices. While, the results of new curriculum will be visible after years, the basic school curriculum together with HE reform should compile a synergy for Estonian further economic growth.

1.4 Promote equal treatment for women and men in research

Today, there are about 60% of female students in Estonian HEIs. There is no gender based inauguration quotas set. Hence, the ongoing HE reform has created a discussion whether the gender quotas have to be set in HEIs. Indeed, there are curriculums, where 90% of students are women and on the opposite, there are curriculums, where 90% are men. In case the gender quotas will be set, many talented men or women may be excluded from the studies, which may lead us to the ineffective use of human resources. Today, the gap of salaries between men and women on labour market is among the biggest in Europe most probably caused by the gender standard thinking, which may even deepen in case the gender quotas will be set (Eurostat, 2011). Having said this, one constant is that– there are significantly more PhD students among men than women. On the other hand implementation of gender quotas may decrease the quality of education as a whole and not less important is the fact that there are demographically more women at this age group (19-25) than men, describing the naturally higher share of potential female students in the society.

At national policy level the regulations create equal opportunities both for men and women. Hence, the statistics show there are fewer women in research; besides, they have lower positions on labour market and lower salaries (Statistics Estonia, 2011). The problem is rather in traditions and in the way of thinking as well as the level of democracy. Since the society does not treat men and women equally in knowledge and intellectual capability, the women remain more home with children, are not self-confident in becoming top managers or do not believe in their capability in research (Basnet, 2007). The number of PhD holders among women has increased (47% in 2008; 53% in 2010) (Statistics Estonia, 2011), but still, the efforts need to be done in order to encourage more women to become researchers.

[27] http://www2.archimedes.ee/teadpop/index.php?leht=389

In 2004 the Government introduced a new law enabling mothers staying home with newborn babies for 12 months getting paid with their last year's average salary (some years later the period was prolonged to 18 months). This change in legislation created many discussions as it differentiates women according to their income level. For students the minimum average salary is guaranteed during the maternity leave. The Ministry of Social Affairs[28] has declared that around 10% of fathers use the possibility to stay home with their babies (Ministry of Social Affairs, 2009). The new Employment Contracts Act (2009) includes special conditions for working conditions for pregnant women and an obligation for employer to restore the same position after maternity leave (Riigi Teataja, 2007). So far, there have been no studies on the effectiveness of the Act, hence, in the media there have been reflected opinions that the Act is benefitting more the employers than employees. At the same time the idea behind this Act was to modernise the labour market judiciary to better adopt with the European labour market.

[28] http://uudised.err.ee/index.php?06184732

2. *Facilitate cross-border cooperation, enhance merit-based competition and increase European coordination and integration of research funding*[29]

The articulation between the R&D Framework Programmes, the Structural Funds and the Competitiveness and Innovation Programme (since 2010 "Estonia 2020") is still underdeveloped in terms of coordination, synergies, efficiency and simplification. The policy fragmentation at EU and national level, and between EU and national policies can hinder the build-up of critical mass of research excellence, leads to the duplication of efforts, suboptimal impact of different instruments and unnecessary administrative overheads. Differences between research selection procedures and criteria can also be an obstacle to the overall spread of excellence.

National participation in intergovernmental organisations and schemes

The draft "Estonia 2020" strategy (State Chancellery, 2010a) prioritises the international competitiveness of higher education and research institutions. This is to be facilitated through creating a favourable environment for world-class level research, supporting mobility, and participation in international research endeavours.

Estonia is participating actively in the European Cooperation in Science and Technology (COST) scheme. Estonian researchers are equally active in the EU Framework Programmes. Estonian organisations coordinate project consortiums in the ICT programme (APPRISE Ltd, TUT) and the SME programme (Estonian Innovation Institute, LAPI MT Ltd, Remedium Ltd). With four Estonian organisations participate in the Research Potential programme which is a positive result. In total, Estonian organisations cooperate with partners from 56 countries. The largest share comes from the UK, Germany, Italy, Spain, Finland, and Sweden (Archimedes Foundation, 2010).

There are state budget support schemes to stimulate and support the participation of Estonian participations in European collaboration programmes. They were established by the MER and Archimedes Foundation in 2008. They support directly the Estonian organisations, for example, by compensating for VAT incurred in FP7 projects (MER, 2008).

On a strategic level, Estonia has expressed a general commitment to participate in the joint programming and international research infrastructure projects linked to its national strategy for RI development (2009). Estonian organisations thus participate in five ESFRI projects. The only inter-governmental agreements concluded to ensure access to major European infrastructures, are those with CERN (signed in 1996, complemented in 2004 with a research collaboration protocol), the European Molecular Biology Conference, with EUMETSAT (on the use of weather satellites) in 2006, and with ESA from 2007. The agreement of the European Cooperating State (ECS) was signed in November 2009. This agreement will open international business-research cooperation in developing space technologies and their applications (Ministry of Education and Research, 2009).

Bi- and multilateral agreements with other ERA countries

There are several bi- or multilateral agreements signed with other ERA countries. The ones presented below are the most relevant active ones in 2009/2010 (according to the report of the R&D and innovation strategy Implementation Plan).

Given its geographical position, agreements with Baltic and Nordic partners are rather important. This includes collaboration with the Nordic Council and the EU Strategy for the Baltic Sea Region (2009). These schemes are useful for opening new opportunities for R&D collaborations for Estonia. Estonian researchers participate in programmes of the Nordic Council of Ministers such as NordForsk (start-up grants for research groups and trainings), Nordplus (education cooperation) and several exchange programmes.

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[29] Promote more critical mass and more strategic, focussed, efficient and effective European research via improved cooperation and coordination between public research funding authorities across Europe, including joint programming, jointly funded activities and common foresight.

- Ensure the development of research systems and programmes across the Union in a more simple and coherent manner.
- Promote increased European-wide competition and access of cross-border projects to national projects funding

A research cooperation grant scheme of the Norwegian Financial Mechanism and European Economic Area Mechanism opened for Estonian researchers in 2007. In addition, Archimedes Foundation has bilateral agreements with nine EU Member States and seven non-EU countries that enable students and PhD candidates to apply for scholarships in Estonia. Similarly the Estonian Academy of Sciences has 24 bilateral agreements with partner organisations, used for its exchange programme.

Also, the Estonian-French science and technology cooperation programme PARROT finances travel grants of joint research groups based on the principle of parity. The programme encourages cooperation between researchers from the two countries and also promotes their participation in EU research programmes.

Other instruments of cooperation and coordination between national R&D programmes

The Estonian participation in ERA-NETs has been relatively modest (ERA-NET Review, 2006, Archimedes, 2007). During the period of FP6, Estonia participated in 12 out of the 899 subtotal ERA-NETs (ERA-NET, 2006). Under FP7, Estonia is involved in 12 ERA-NETS and two ERA-NET plus. The Estonian Science Foundation is the leading organisation in terms of participation rate; it participated in six ERA-NET projects: NORFACE, BIODIVERSA, AMPERA, HERA, EUROPOLAR, PRIOMEDCHILD in 2009 (Ministry of Education and Research, 2009).

Concerning participation in initiatives under Art 185 (ex 169), Enterprise Estonia participates in the FP7 funded Eurostars programme as well as in EMRP, which brings together the European Association of National Metrology Institutes (EURAMET). The ESF participates in BONUS, the Joint Baltic Sea Research Programme, an integral part of the EU Strategy for the Baltic Sea.

European Science Foundation ('0ESF) Research Networking Programmes are 4-5 year cooperation schemes for networking researchers studying the same research theme across national and research field borders. Estonia took part in 17 ESF programmes in 2008 (Ministry of Education and Research, 2008b). ESF Cooperative Research Programme (EUROCORES) enables European researchers to develop collaboration and build scientific synergies in fields, where pan-European scale is needed in order to reach world-level excellence. Estonia was participating in three programmes (BOREAS, EuroDIVERSITY, FANAS) in 2008 (Ministry of Education and Research, 2008b).

Joint technology initiatives of public and private sector started in 2008. Estonia is a founding member of joint undertaking of embedded systems ARTEMIS and nanoelectronics joint undertaking ENIAC. Estonian researchers also participated in an innovative medicine joint undertaking project call in 2008[30] (Ministry of Education and Research, 2008b).

3. *Develop world-class research infrastructures (including e-infrastructures) and ensure access to them*

National Research Infrastructures roadmap

After the transition period, a strategic basis for modernising the higher education, research and innovation infrastructure was developed by Ministry of Education and Research and Ministry of Economic Affairs and Communications in 2004[31]. The initial estimate of the investment required to bring the research infrastructure up to date was in the range of €256 to €383m; a figure that had not changed significantly by 2008 (Ministry of Education and Research, 2008a). It concerned about 20% of all RI.

The RDI Strategy Implementation Plan 2009-2013 however aims at having 80% of R&D&I infrastructure modernised by 2013 (Government of Republic of Estonia, 2008). The size of upgraded and new research infrastructures at universities and other research institutions will be close to 6,000m^2 in total. In 2008, about 1000m^2 of upgraded or new RI were publicly funded (Ministry of Education and Research, 2008).

The overall budget planned for infrastructure objects of national importance is €29.4m during the EU SF period of 2007-2013 (Government of Republic of Estonia, 2009). From the Structural Funds

[30] http://www.imi.europa.eu

[31] https://www.etis.ee/Portaal/includes/dokumendid/strateegilised%20alused.mkm.doc

approximately €256m will be allocated for R&D&I infrastructure investments. In addition, the Government has decided to gradually increase its support for R&D&I from the state budget (Government of Republic of Estonia, 2009).

The creation of up-to-date R&D infrastructures is one of the sub-objectives of the RDI Strategy. In parallel to the investment plan, the Estonian Research Infrastructures Roadmap was developed in 2009 by the Ministry of Education and Research and the Estonian Academy of Sciences, and approved in 2010 as an annex to the RDI Strategy Implementation Plan in June 2010 (Ministry of Education and Research, Estonian Academy of Sciences, 2010). This strategy document concerns investments of national importance over a 10-20 years period. It covers 20 proposed RI in social sciences and humanities, environmental sciences, biological and medical sciences, materials science, natural sciences and engineering, e-infrastructures. The roadmap will be updated every three years and will be used as an input for the forthcoming investment decisions.

Estonia hosts the Estonian Genome Project a large RI that is open to other European and international researchers, public and private organisations. Estonian partners are participating in RI projects funded under the Framework Programme such as the EU-NMR (FP6) and its follow-up EAST-NMR (FP7).

National participation in the ESFRI roadmap; Updates 2009-2010

In parallel with selecting the Estonian Roadmap projects, participating in ESFRI projects in the coming years was also decided. The selected projects are:

- Common Language Resources And Technology Infrastructure (CLARIN);
- European Social Survey (ESS);
- Biobanking And Biomolecular Resources Research Infrastructure (BBMRI);
- An Integrated Structural Biology Infrastructure For Europe (INSTRUCT);
- European Spallation Source (Ministry of Education and Research, Estonian Academy of Sciences, 2010).

The national budget for the ESFRI projects is not available (Ministry of Education and Research, 2010).

4. Strengthen research institutions, including notably universities

There are two types of higher education institutions in Estonia: universities providing academic higher education and applied and professional higher education programmes; and the higher education institutions providing professionally oriented diplomas. In total, there are 12 universities, six public and six private. Access to higher education is regulated by the Universities Act (1995, consolidated in 2005) and the Institutions of Professional Higher Education Act[32]. HEIs are major performers of R&D and providers of researchers for the public sector in Estonia.

There are neither Estonian universities listed in the top of Academic Ranking of World Universities (2011), in the World University Ranking (2011), nor in the European research universities by scientific production in 2000-2006 (JRC-IPTS, 2009). Estonian research institutions in principle should be evaluated at least every seven years. The aim of the external evaluations is to measure the level of professionalism of certain research institution while the internationally accepted standards are taken as a target. Basically, the results of the evaluation show whether the research institution has the minimum required scientific level and can be classified as research institution. The responsibility for this lies with the Ministry of Education and Research, in practice by inviting foreign expert groups. The last evaluation of Estonian research institutions took place in 2010.

The number of publications as well as international co-publications by researchers in Estonia has grown rapidly - about 50% of 1,077 publications of 2009 were co-publications (Ministry of Education and Research, 2011). Most collaboration partners are from Finland, Sweden, Germany, the UK, and the US.

[32] http://euraxess.ee/?utm_source=smartestonia&utm_medium=redirect-301&utm_campaign=smartestonia-to-euraxess-transfer

In international comparison, Estonia occupies an average position in terms of the number of publications per full-time researcher. This ratio remained the same in 2008 and 2009 at 0.39 (Ministry of Education and Research, 2009). The Estonian RDI strategy includes the objective to increase the number of scientific publications listed in the Web of Science database to 1,500 publications by 2013 (Government of Republic of Estonia, 2009).

Estonian public universities have a **high degree of autonomy** guaranteed by the Universities Act (1995, consolidated 2005). The university council is the collegial decision-making body, the procedure for the formation of which and the basis for the activities of which are provided for in the statutes of the university. An elected rector ensures the day-to-day management of a university. The governing bodies of universities are not open non-academic individuals. In research and teaching positions, over 40% of the staff in Estonian universities is female (JRC-IPTS, 2010). Autonomy, self-governance and the relative financial independence of public universities are supported by the state financing system. Moreover, universities have the right to enter into agreements under civil and commercial law.

Estonian higher education institutions **receive funding** from the public budget for the provision of graduates, so-called State-commissioned places, for capital investment and for other expenditure such as foreign aid projects, education allowances for students, library expenditure, etc. Finance from the public budget is provided primarily in the form of a state commission. Its share is about 80% of the budgets. The remaining 20% are provided for SCSPs in the form of a block grant. Private institutions receive funding through the State commission, however, the allocation is relatively small (OECD, 2009).

The amount of the grant is determined by the number and distribution of State-commissioned places by funding categories. Funding for capital infrastructure is provided as a separate funding stream. Institutions have to bid for investment funding for particular projects.

Institutional funding for 2010, administered mainly by the Ministry of Education and Research is divided into the following categories:

- targeted funding (€25m);
- base funding (€8.1m);
- infrastructure expenses (€7.7m).

Individual funding in form of ESF grant financing amounted to €8.7m. Programme funding – which equalled €52.5m – is another source for the universities. The Centres of Excellence obtain funding of €53m (2007-13) from the SF for their activities.

Both public and private institutions receive income from tuition fees, however, the share within the total HEI's budget is not available.

5. Facilitate partnerships and productive interactions between research institutions and the private sector

The fact that 75% of BERD can be attributed to only 58 firms (Statistics Estonia, December 2010), reflects a structural weakness of the Estonian economy. Equally, the role of high-tech firms in the economic structure remains weak - the high-tech export share of total exports was 8% (compared to 16.6% in the EU-27) in 2006, (Eurostat). The high-tech sector employs less personnel than more industrially developed economies.

The policy mix to support increased private R&D investment

There are four particularly important routes in terms of the structural reorientation of the Estonian economy:

1. Promoting the establishment of new indigenous R&D performing firms;
2. Stimulating greater R&D investment in R&D performing firms;
3. Stimulating firms that do not perform R&D yet, and
4. Increasing extramural R&D carried out in cooperation with the public sector.

A priori, the promotion of new indigenous R&D performing firms (route 1) is supported by various business start-up measures, notably of Enterprise Estonia, and the generally favourable regulatory framework in favour of entrepreneurship (e.g. simple registration of a new business, e-taxation, liberal employment laws, and particularly taxation policies). In October 2010, the MEAC launched a new initiative for start-ups and SMEs, called Start-up Estonia (estimated budget €3.7m). However, the policy effort is focused on the promotion of entrepreneurship in general, not specifically in R&D-intensive sectors. Exceptions include seed-capital investments through the Estonian Development Fund into high-growth, and hence generally technology intensive, early-stage firms.

In terms of routes 2 and 3, and given the acknowledged need to re-orientate the Estonian economy to knowledge-intensive business activities and promote structural change, there are a number of well-established measures, which have been extended in the 2007-2013 period. In addition, in 2010, two new programmes relevant to routes 3 and 4 were launched The common goal of these programmes is to stimulate local companies to shift to higher added value or R&D intensive manufacturing via technological modernisation.

The insufficient business-academia collaboration is a persistent challenge in the Estonian R&D system (OECD, 2007; PREST, 2003). In general, Estonian R&D and innovation programmes are effectively managed (Technopolis Group, 2006) but findings about performance, impacts and results are not sufficient to draw an overall conclusion, as the evaluations so far are not systematic and comparable.[33]

To support development in the key technology areas identified in the R&D and innovation Strategy, two types of thematically oriented programmes are planned. First, the existing technology programmes on energy and biotechnology of Enterprise Estonia, plus one new programme, under preparation, on materials. These programmes, despite their titles, do not provide funding but have a coordination and integration function of stakeholders and research activities in these fields. The thematically oriented national R&D programmes, managed by Archimedes, are a completely new type of funding measure. In 2009-2010, three such programmes were under preparation: in ICT, health care, and environment technologies. Due to the overarching nature of these programmes, they support all policy routes mentioned above.

In Estonia, innovation oriented procurement policies are in a very initial development phase and, mostly takes the form of one-off initiatives or specific elements of regular procurement procedures. There is no visible political or organisational leadership so far to define the principles and steps for a more systematic, comprehensive approach.[34] The Ministry of Finance (MF) is responsible for public procurement policy and drafting the respective laws and hence, formally, should oversee the development of a framework for innovation oriented procurement policies.

In general, Estonian universities own the economic rights of industrial inventions (i.e. patents and utility models) created during the execution of contractual duties of their employees (UT 2003, TUT 2003). This rule is generally included in the employment contract but it can also be concluded by a separate contract. Applications for patents and utility models are made to the Estonian Patent Office (EURAXESS, 2010).

Knowledge circulation between the universities, PROs and business sectors

Since the early 2000s, there are a considerable number of policy measures aimed at increasing extramural R&D by enterprises carried out in cooperation with the public sector as well as support for commercialisation of research by HEIs and knowledge transfer. In addition, certain higher education policy measures launched in 2009 address this issue.

The share of the higher education sector funded by the business sector (HERD funded by BERD) has declined since 2005 from 5.2% (with a small increase in 2007) to 4.3% in 2009. The EU-27 average

[33] As common, all competitive programmes clearly define their target groups, scope and objectives of support, and the qualification, selection and eligibility rules and criteria. All this programme information is stated directly in the respective programme regulation, which makes the application process clear and streamlined even if it is sometimes subjectively argued to be a rigid (Technopolis Group, 2008).

[34] The lack of organisational leadership could be explained by a fact that there is no governmental agency on public procurement: the activity of the Public Procurement Office was terminated and since 1 July 2010, the Ministry of Finance (MF) holds the rights and obligations of this former entity.

shows an opposite trend and in 2008 was 7% (OECD: MSTI 2010). However, Estonia compares favourably to several other larger EU countries, such as France or Sweden. This share should also be seen in light of the limited size of the business sector and notably the limited number of R&D personnel in firms.

However, according to the Community Innovation Survey (CIS8), the public sector is not the main source of knowledge provision. More than 60% of the respondents point to the business sector itself (the own enterprise, suppliers, competitors). Estonian companies use the public research organisations the least as a source of information for innovation (0.9%) while universities and other higher education institutions were mentioned by 2.7% of respondents. This is far below scientific journals (3.9%), consultants (4.4%) or conferences (6.4%). From the business sector's perspective, the public sector is a rather unpopular cooperation partner. Again using CIS8 data, the public research institutes are the least often mentioned with 1.4% and the universities with 3.2% of all co-operation 'encounters'. Estonian companies tend to cooperate more often with their national competitors than with public sector researchers.

These findings may point to a mismatch; it seems likely that the public research sector supply is not matching the business structure's needs. This conclusion is reinforced by the finding in CIS8 that innovative Estonian firms engaged in cooperation, cooperate very often with foreign partners.

Other policy measures aiming to promote public-private knowledge transfer

The main constraints for the commercialisation of research and proof of concept are, amongst other factors, limited knowledge and practical experience on how to protect and commercially exploit IP in universities. The most acute barrier was judged to be IPR related to spin-off creation (Zernike, 2004).

Various other measures support business-academia collaboration such as the Competence Centre Programme, R&D grant support, Involvement of Development Specialists, and the transfer of research-intensive technologies. The Innovation vouchers programme is expected to contribute to change of academic attitudes towards interactions with business and more business-thinking in universities.

Concerning inter-sectoral mobility of research personnel, the general employment and working conditions legislation applies. Mobility of researchers and other innovation staff is encouraged through two measures: Support for the involvement of the innovation staff and the Development of collaboration and innovation in HEIs.

In the context of the governance of Estonian universities the involvement of business participants in university boards is not yet common practice. However, the topic is widely discussed and University representatives participate in the governing bodies of the science and technology parks: Tartu Science Park[35] and Tallinn Technology Park (Tehnopol)[36]. This is one of the main ways for universities to develop relations with businesses and to receive relevant feedback from the market.

6. Enhance knowledge circulation across Europe and beyond

Today, there is no straightforward public policy set up for better enhancing knowledge circulation across Europe. For reaching different strategic objectives there are some public programmes supporting knowledge circulation, cooperation or internationalisation of HEIs or business units across Europe and motivating students and researchers mobility. There are also several European mobility programmes and bilateral cooperation contracts running supporting the knowledge circulation. These measures are focused both on the HEIs and business sector and mainly facilitated by Enterprise Estonia or Estonian Science Foundation, where the funding procedures have been in place for the last 10 years. The Estonian Science Foundation enables also access to Estonian researchers to the European Science Foundation programmes.

The international dimension of knowledge circulation is addressed by the specific mobility measure for HEIs, the Mobilitas programme (budget of €20.3m for 2008-2015), and scholarships. Cross-border activities are eligible for funding under most of the competitive R&D and innovation support measures too

[35] www.teaduspark.ee

[36] www.technopol.ee

(cluster development, competence centres, development specialist). Indeed, the Estonian competence centres have visibly advanced in terms of internationalisation of their activities and providing teaching and research opportunities for Master and doctoral studies (Technopolis Group, 2008).

Estonia is involved in a number of international research endeavours such as CERN and other European research infrastructures as well as in the European Framework Programmes. For the business sector, no special national measures are in place but there is an administrative support to apply for participation in international programmes like the Framework Programme, as well as EUREKA and COMPERA (facilitated by Enterprise Estonia). Further measures are provided by Enterprise Estonia via funding for study visits abroad and thematic meetings (on space technology, high tech and traditional manufacturing, quality and creativity management, etc) and awareness events.

In conclusion, the level of enhancing knowledge circulation across Europe is still pretty low in Estonia. Despite there are public support measures and international programmes in place, the participation in them still remains modest. There are rather some highly shining scientific peaks in biotechnology, genome research, material technology or ICT, than an outstanding wide level of scientific participation in international research. At the same time the level of publications has grown rapidly during last three-four years, but this is mainly due to the co-publications with European researchers. One reason for this kind of low international scientific performance can be the limited number of people in Estonia, but the other aspect is definitely the low popularity of science as general among population. The latter has recently started to improve with the science popularisation measures implemented widely already in elementary schools.

7. Strengthen international cooperation in science and technology and the role and attractiveness of European research in the world

In 2008, the European Commission proposed the Strategic European Framework for International Science and Technology Cooperation to strengthen science and technology cooperation with non-EU countries. The strategy identifies general principles which should underpin European cooperation with the rest of the world and proposed specific orientations for action to: 1) strengthen the international dimension of ERA through FPs and to foster strategic cooperation with key third countries through geographic and thematic targeting; 2) improve the framework conditions for international cooperation in S&T and for the promotion of European technologies worldwide. In view of these aspects, the following section analyses how national policy measures reflect the need to strengthen the international cooperation in S&T.

International cooperation

The RDI strategy does not distinguish between international cooperation inside and outside ERA. As noted earlier, international cooperation in higher education and research (particularly in the fields of national importance: ICT, energy, material sciences and technologies, biotechnology) is a priority for Estonian R&D institutions.

Provisional figures from contracts signed as a result of FP7 calls for proposals launched in 2007 and 2008, show that Estonian cooperation with third countries represents 3% of overall Estonian activities under FP7 (EC Member States 87%, associated countries 10%). In absolute terms, cooperation with third countries is very small, with Russia leading with seven partnerships, followed by South Africa with five and Belarus and Canada with four each.

Complementing the list of bi- and multilateral international agreements with the countries outside ERA there are three agreements identified as relevant in the 2009 implementation report of the RDI Strategy. Estonia-USA cooperation takes place in the fields of information technology and materials science and the US Civilian Research & Development Foundation and Estonian Science Foundation co-financed four projects in these fields. In 2009, a call for joint energy projects was announced to co-finance four projects from 2010. The Estonian Science Foundation (ESF) and the Russian Foundation of Humanitarian Sciences co-finance seven projects in the field of society and cultural studies as a result of a call in 2008. The ESF also coordinates post-doctoral stipends for conducting research in Japan for 12-24 months. One researcher was funded in 2009.

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List of Abbreviations

BERD	Business Expenditures for Research and Development
BBMRI	Biobanking And Biomolecular Resources Research Infrastructure
CERN	European Organisation for Nuclear Research
CIS	Community Innovation Survey
CLARIN	Common Language Resources And Technology Infrastructure
COST	European Cooperation in Science and Technology
ECS	European Cooperating State
ECTS	European Credit Transfer and Accumulation System
EMRP	European Association of National Metrology Institutes
ERA	European Research Area
ERA-NET	European Research Area Network
ERAC	European Research Area Committee
ERP Fund	European Recovery Programme Fund
ESA	European Space Agency

ESF	European Science Foundation
ESFRI	European Strategy Forum on Research Infrastructures
ESS	European Social Survey
EU	European Union
EU-27	European Union including 27 Member States
EUI	European University Institute
FDI	Foreign Direct Investments
FP	European Framework Programme for Research & Technology Development
FP	Framework Programme
FP7	7th Framework Programme
GBAORD	Government Budget Appropriations or Outlays on R&D
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
GUF	General University Funds
HE	Higher Education
HEI	Higher education institutions
HERD	Higher Education Expenditure on R&D
HES	Higher education sector
ICT	Information and communications technology
IP	Intellectual Property
IPR	Intellectual Property Rights
IPTS	Institute for Prospective Technological Studies
JRC	Joint Research Centre-Institute for Prospective Technological Studies
MER	Ministry of Education and Research
MF	Ministry of Finance
MSTI	Main Science and Technology Indicators
PPP	Public Private Partnership
PRO	Public Research Organisations
OECD	Organisation for Economic Co-operation and Development
R&D	Research and development
RDI	Research Development and Innovation
RI	Research Infrastructures
RTDI	Research Technological Development and Innovation
SF	Structural Funds
SME	Small and Medium Sized Enterprise
S&T	Science and technology
TTU	Tallinn University of Technology
UT	University of Tartu
VC	Venture Capital
WIPO	World Intellectual Property Organisation

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Abstract

The main objective of the ERAWATCH Annual Country Reports is to characterise and assess the performance of national research systems and related policies in a structured manner that is comparable across countries. EW Country Reports 2011 identify the structural challenges faced by national innovation systems. They further analyse and assess the ability of the policy mix in place to consistently and efficiently tackle these challenges. The annex of the reports gives an overview of the latest national policy efforts towards the enhancement of European Research Area and further assess their efficiency to achieve the targets.

These reports were originally produced in November - December 2011, focusing on policy developments over the previous twelve months. The reports were produced by the ERAWATCH Network under contract to JRC-IPTS. The analytical framework and the structure of the reports have been developed by the Institute for Prospective Technological Studies of the Joint Research Centre (JRC-IPTS) and Directorate General for Research and Innovation with contributions from ERAWATCH Network Asbl.

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As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new standards, methods and tools, and sharing and transferring its know-how to the Member States and international community.

Key policy areas include: environment and climate change; energy and transport; agriculture and food security; health and consumer protection; information society and digital agenda; safety and security including nuclear; all supported through a cross-cutting and multi-disciplinary approach.

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