ERAWATCH COUNTRY REPORTS 2010:

Poland

ERAWATCH Network – Technopolis Group

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Acknowledgements and further information:

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Executive Summary

With around 38.2 million inhabitants in 2010, Poland is the sixth largest EU member state, which accounts for slightly more than 7.6% of EU27 total population. Although Poland's economic growth in the last few years was around 6% on average and the country was the only EU member state in 2009, which registered a positive annual economic growth of 1.7%, its GDP per capita in purchasing power parity is still relatively low and amounted to 61% of the EU27 average.

Total GERD has been growing continuously in the last decade: in 2009 the gross domestic expenditure on R&D amounted to almost €55 per capita, a 74% increase in nominal terms as compared to around €31 in 2000. After relative stagnation since 2002 the Polish GERD increased between 2008 and 2009 from 0.60% to 0.68% of GDP, which is a 17.7% increase in nominal terms, but still one of the lowest in the EU and thus very far away from the targets set previously by the Lisbon Strategy and further by the Europe 2020 Strategy. However, to grasp objectively the evolution of GERD, it should be highlighted that the Polish GERD between 2000 and 2009 increased in absolute terms by almost 90%. The private R&D expenditures remain relatively low and amounts to around 28% of the Polish GERD.

The knowledge triangle shows a good balance between different aspects of research, innovation and education policies. The current reforms in the respective fields recognise the need for strong coordination between public and private collaboration and places evident emphasis on coordinating of activities between science, business and higher education.

Effectiveness of knowledge triangle policies

	Recent policy changes	**Assessment of strengths and weaknesses**
Research policy	The Building upon Knowledge reform package that entered into force in October 2010, introduced five new legal acts, which are radically changing R&D landscape in Poland: • Act on Principles of Funding Science: new, competitive and performance oriented funding system shifting its focus on top-level research, outsourcing the funding role from the Ministry of Science and Higher Education to newly established executive agencies; • Act on National Science Centre: new executive funding agency responsible for fundamental research, managed by scientists, independently; • Act on National Research and Development Centre: new executive agency funding applied research and development activities, for the economy and supporting cooperation with the private sector. The Ministry assumes that by 2015 at least 50% of all government funds for R&D will be distributed together by the two agencies. • Act on Branch Research Institutes: introduces several new cooperation rules with business; • Act on the Polish Academy of Science: reforms	• The changes are ambitious and radical and may face some resistance by the scientific community; • The awareness of low level of Polish science and innovativeness, represents an important incentive supporting the reforms; • Benefits will not be visible in the very short term.

	Recent policy changes	Assessment of strengths and weaknesses
	the Academy towards excellent and most advanced fundamental research.	
Innovation policy	Strong support from EU Structural Funds 2007-2013, most notably Operational Programmes Innovative Economy (OP IG) and Human Capital (OP KL).	• Low absorptive capacity of Polish enterprises; • High demand for EU Structural Funding that indicates a high interest and awareness of the linkages between R&D, innovation and business-competitiveness.
Education policy	In the field of Higher Education policy, the greatest role is played by the new reform package Partnership for Knowledge, which after wide public consultations is, as of October 2010, a subject of parliamentary works. The reform focuses on three areas: • Reform of studies and students' rights; • New model of academic career; • New model of managing the higher education institutions.	The reform introduces several innovative, but also radical solutions in the academic landscape. It requires now approval of the Parliament.
Other policies	Particular synergies can be observed with respect to the regional policy, generously funded by EU Structural Funds. In the current programming period 2007-2013 there are 16 regional Operational Programmes with the total budget amounting to €16.5b, and around 25% of this amount is dedicated to R&D and innovation activities. The main intervention areas comprise support of research infrastructure at universities and other research organisations, knowledge transfer, support of science-business linkages and promotion of innovation support for SMEs.	Strong complementarities of other policies, most notably regional policies, to the national R&D and innovation policies.

The need to overcome the structural problems of Poland with a weak, and only very limited knowledge-intensive and innovative business sector on the one hand, and an inward oriented academic system are clearly addressed by several recent policy documents and funded substantially by numerous policy measures. However, despite the nominal growth of R&D expenditures, the effects of the recent structural (e.g., the creation of new implementing agencies; merit-based, competitive promotion system) are not clearly visible; in some cases, their implementation is still going on.

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

	ERA objectives	Main national policy changes	Assessment of strengths and weaknesses
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	• Special grants of the Ministry of Science and Higher Education to study technical and natural sciences with the aim to change inadequate structure of courses; • Partnership for Knowledge reform aims to increase incentives for the best students and researchers, simplify academic career, increase international mobility and attract international researchers.	• Low attractiveness of domestic market for highly skilled specialists; • Low attractiveness for inward mobility of researchers; • Strong social recognition of the need for learning and investing in human resources for research.
2	Increase public support for research	• Continuously growing public budget for research and higher education, 15.5% increase in nominal terms between 2007 and 2008; GERD is expected to reach 1.7% of GDP in 2020 as compared to 0.61% in 2008.	• 90% absolute increase in GERD between 2000 and 2009; • Slowly increasing GERD as a proportion of GDP; • The target for 2020 is very ambitious and reliant on a strong and lasting economic growth; • Strong dependence on EU Structural Funds.
3	Increase European coordination and integration of research funding	• Growing participation in European initiatives and research programmes; New programmes launched by the Ministry of Science and Higher Education to increase integration of Polish researchers with those from other EU countries.	• Still very low participation rate in EU initiatives and programmes.
4	Enhance research capacity across Europe	• Public budget reserved for participation in some EU infrastructure projects; Support of further applications to join other projects.	• Willingness of scientific community to participate in international infrastructure projects, however lack of national roadmap and any other official document.
5	Develop world-class research infrastructures (including e-infrastructures) and ensure access to them	• Public budget reserved for participation in some EU infrastructure projects; Support of further applications to join other projects.	• Willingness of scientific community to participate in international infrastructure projects, however lack of national roadmap and any other official document.
6	Strengthen research institutions, including notably universities	• Partnership for Knowledge reform proposed significant strengthening measures with respect to academic career, management of HEI, and students rights and teaching.	• Recognised need for improvement by academic community, however reluctance to radical changes.

	ERA objectives	Main national policy changes	Assessment of strengths and weaknesses
7	Improve framework conditions for private investment in R&D	• Operational Programme Innovative Economy provides unprecedented financial input to private sector for R&D and innovation; • Increasing role of NCBiR to support more R&D in private enterprises following the Building upon Knowledge reform.	• Very low BERD amounting only 0.19% of GDP in 2008, the need for innovation and R&D not fully recognised by most enterprises, particularly small companies.
8	Promote public-private cooperation and knowledge transfer	• New programmes launched by National Centre for Research and Development following the Building upon Knowledge, which focuses on public-private cooperation.	• Considerable contribution to private sector from EU Structural Funds, which is going to increase the demand for knowledge and collaboration; • Low innovativeness and low absorptive capacity of SMEs, thus low interest to acquire knowledge make the knowledge transfer difficult.
9	Enhance knowledge circulation across Europe and beyond	• New programmes established by the Ministry of Science and Higher Education to support knowledge circulation between public and private sector as well as internationally.	• Still very low knowledge circulation, however new opportunities due to considerable support from EU Structural funds.
10	Strengthen international cooperation in science and technology and the role and attractiveness of European research in the world	• New programmes launched by the Ministry of Science and Higher Education to increase international mobility of researchers (e.g. Mobility Plus).	• Although international cooperation aims at fostering linkages with the most advanced countries, there is lack of coherent strategy for international research cooperation and mobility of researchers.
11	Jointly design and coordinate policies across policy levels and policy areas, notably within the knowledge triangle	• Complementarities and synergies between Building upon Knowledge (science reform), Partnership for Knowledge (HEI reform) and EU Structural Funding (Innovation).	• Strong synergies within the knowledge triangle policies, however big implementation challenge to complete the reforms.
12	Develop and sustain excellence and overall quality of European research	• Building upon Knowledge established several new quality assuring elements in research; • Partnership for Knowledge is going to introduce further policies supporting excellence and high quality of research and teaching at HEI.	• New measures (evaluation, competitive funding, creation of centres of excellence) represent a strength; • Reluctance of science community towards more competitive rules; Competitive and entrepreneurial thinking is required for the success of the reforms.

	ERA objectives	Main national policy changes	Assessment of strengths and weaknesses
13	Promote structural change and specialisation towards a more knowledge - intensive economy	• EU Structural Funds, notably OP Innovative Economy and Human Capital, offer unprecedented funding to private sector by supporting innovation and technology transfer, which is expected to increase knowledge demand and knowledge intensive production; • Branch Research Institutes have new rights for collaboration with private section to contribute to knowledge intensive economy following the Building upon Knowledge reform.	• Building upon Knowledge introduced a number of new policy instruments; • However, low innovativeness of Polish economy might make it difficult to implement the changes and absorb the funding in efficient way.
14	Mobilise research to address major societal challenges and contribute to sustainable development	• Establishment of the Implementation Programme of the National Foresight Programme.	• Thorough analysis conducted during the development of the National Foresight Programme; • Implementation of the results will require stronger linkages between private and public sector as well as society, which are not strong.
15	Build mutual trust between science and society and strengthen scientific evidence for policy making	• Reform package Partnership for Knowledge aims explicitly at embedding HEI into regional economies and societies.	• Science recognised as crucial element of regional development in all regional OP, however still little experience in science-society linkages.

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1 Introduction

The main objective of the ERAWATCH Analytical Country Reports 2010 is to characterise and assess the evolution of the national policy mixes in the perspective of the Lisbon goals and of the 2020, post-Lisbon Strategy. The assessment will focus on the national R&D investments targets, the efficiency and effectiveness of national policies and investments into R&D, the articulation between research, education and innovation, and on the realisation and better governance of ERA. In doing this, the 15 objectives of the ERA 2020 are articulated.

The report builds on the 2009 report streamlining the structure and updating the 2009 policy assessment in the domains of human resource mobilisation, knowledge demand, knowledge production and science-industry knowledge circulation. The information related to the four ERA pillars covered in the 2009 report is also updated and it is extended in order to cover all six ERA pillars and address the corresponding objectives derived from ERA 2020 Vision.

Given the latest developments, the 2010 Country Report has a stronger focus on the link between research and innovation, reflecting the increased focus of innovation in the policy agenda. The report is not aimed to cover innovation per se, but rather the **'interlinkage'** between research and innovation, in terms of their wider governance and policy mix.

2 Performance of the national research and innovation system and assessment of recent policy changes

The aim of this chapter is to assess the performance of the national research system, the **'interlinkages'** between research and innovation systems, in terms of their wider governance and policy and the changes that have occurred in 2009 and 2010 in national policy mixes in the perspective of the Lisbon goals. The analysis builds upon elements in the ERAWATCH Country Report 2009, by updating and extending the 2009 policy assessment in the domains of resource mobilisation, knowledge demand, knowledge production and science-industry knowledge circulation. Each section identifies the main societal challenges addressed by the national research and innovation system and assesses the policy measures that address these challenges. The relevant objectives derived from ERA 2020 Vision are articulated in the assessment.

2.1 Structure of the national research and innovation system and its governance

This section gives the main characteristics of the structure of the national research and innovation systems, in terms of their wider governance.

With around 38.2 million inhabitants in 2010, Poland is the sixth largest EU member state, which accounts for slightly more than 7.6% of EU27 total population. Although Poland's economic growth in the last few years was around 6% on average and the country was the only EU member state in 2009, which registered a positive annual

economic growth of 1.7%, its GDP per capita in purchasing power parity is still relatively low and amounted to 61% of the EU27 average. Total GERD has been growing continuously in the last decade: in 2008 the gross domestic expenditure on R&D amounted to almost €55 per capita, which is an increase by 74% in nominal terms as compared to around €31 in 2000. Further, the public R&D expenditures are expected to grow by around 8% in 2010 in nominal terms as compared to 2009. However in relative terms, with 0.68% the Polish GERD ratio to GDP is still one of the lowest in the EU27 as compared to its average of 1.9%. Moreover, the private contribution to R&D, BERD, accounts merely for less than one third of all Polish R&D expenditures.

However, to grasp objectively the evolution of GERD, it should be highlighted that the Polish GERD between 2000 and 2009 increased in absolute terms by almost 90%. The private R&D expenditures remain relatively low and amounts to around 28% of the Polish GERD.

Main actors and institutions in research governance

Since 2009, the Polish research, science and higher education system has been undergoing significant governance changes, which are based on three reform packages: Building upon Knowledge, Partnership for Knowledge, and Long-term Strategy for Science and Higher Education. This means that the entire research system is currently in a transitory phase at the end of which the role of relevant actors will change significantly. In October 2010, the first part of the science and higher education reform has already entered into force creating new organisations: National Centre for Research and Development (NCBiR) responsible for applied research and knowledge transfer (private-public collaboration) as well as National Science Centre (NCN) dealing with fundamental research. Although the NCBiR has been operational since 2007, its role and budget was marginal until the latest reform, i.e. it managed only few small programmes. Both new executive agencies are not fully operational and have not assumed responsibilities yet as defined in the Building upon Knowledge reform package. The summary of the ongoing reform processes is presented in Table 1.

Table 1: Three reform packages for the Polish research and higher education system

	Building upon knowledge	Partnership for knowledge	Long-term strategy for science and higher education
Objectives	• Introducing competitive funding system supporting only top-level research; • Decentralising implementation of science policy by creating two new executive agencies: National Science Centre and National Research and Development Centre; • Improving knowledge transfer, increasing innovativeness and R&D collaboration between science and economy (Branch Research Institutes, JBR); • Reforming Polish Academy of Science with the aim to create excellence research organisation.	• More funds for the best universities and higher education institutions; • More autonomy for universities and academic organisations; • Faster, competitive and more international academic career; • More transparency in recruitment policies at universities and higher education institutions; • System of points enabling for free studies, free second degree only for most talented students; • More financial support for students and PhD researchers.	• Development of a long-term strategy for Polish science, research and higher education.
Main policy instruments	• Act on Principles of funding science; • Act on National Science Centre; • Act on National Research and Development Centre; • Act on Branch Research Institutes; • Act on the Polish Academy of Science.	• New Act on Higher Education, Act on the Academic Degrees and Academic Title, as well as the Art Degrees and Title, e.g. creation of a fund for excellence funds, creation of excellence R&D organisations (KNOW), etc.	• Long-term strategy for science and higher education.
Status of the reform	• Entered into force on 1 October 2010.	• Draft act sent to the Parliament in September 2010. Planned entry into force: 1 October 2011.	• Preparatory phase.

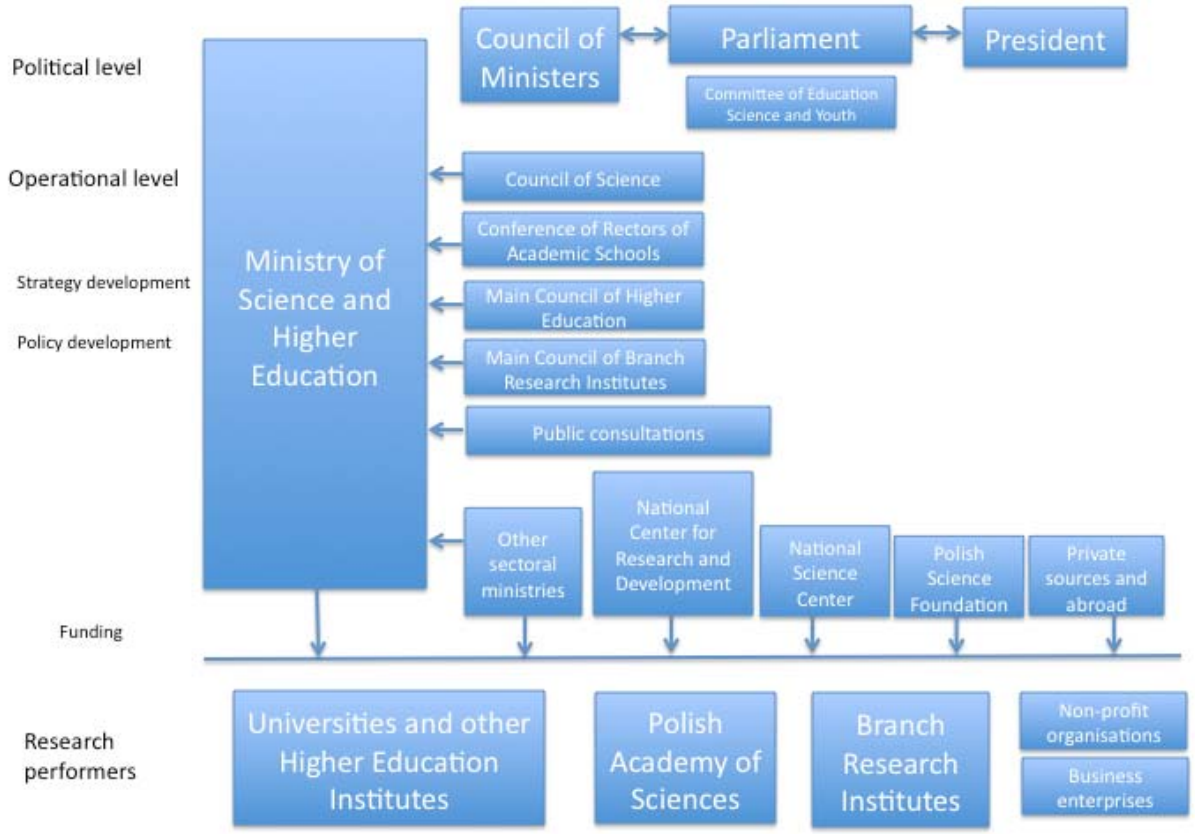
So far, the Ministry of Science and Higher Education has been the main body responsible for the formulation of Polish research policy. Due to the fact that most policy instruments are based on legal acts (e.g. all acts of the Building upon Knowledge reform), the role of the Parliament (Sejm and Senat) including the Parliamentary Commission for Education, Science and Youth, is crucial in the policy development.

The Ministry acts as a large financing agency, creates overall research strategies, defines priority research areas and finances them through subsidies, grants and scholarships. It is also responsible for the assessment of the research proposals as well as evaluation of research performance. As a part of the Building upon Knowledge reform package, the creation of the two executive agencies NCBiR and NCN is going to decentralise the Polish research system in such a way that the

Ministry of Science and Higher Education remains responsible for strategic planning of research policy development, and the two agencies for the implementation of policy measures, development of strategic research programmes and distribution of funds on the competitive basis. The fact that the implementation of programmes and competitive selection procedures will be separated from the strategic development of the policy is seen as an important factor to increase transparency and effectiveness of the funding system. Another advantage of the new system is a significant increase of independence of the agencies from the political decisions, which will ensure more stability in the programming of research activities.

There are also a number of advisory organisations, which actively influence the research policy development process and strategies. The most relevant are: the Science Council, the Higher Education Council, the Conference of Rectors of Academic Schools, and the Main Council of Branch Research Institutes.

Figure 1: Overview of Poland's research system governance structure



Source: ERAWATCH Research Inventory

The institutional role of regions in research governance

From the institutional point of view, the role of regional governments in research policy is limited. The universities and research institutes are fully independent from the regional authorities, and their main source of funding is the national government. However, in the current EU programming period 2007-2013, the role of regions as a source of funding increased significantly due to the EU Structural Funds. There are 16 regional Operational Programmes with the total budget amounting to €16.5b, and around 25% of this amount is dedicated to R&D and innovation activities. The main intervention areas comprise support of research infrastructure at universities and

other research organisations, knowledge transfer, support of science-business linkages and promotion of innovation support for SMEs.

Main research performer groups

The major funding source of R&D activities is the State budget. In 2008, it represented 56.1% of Polish GERD or €1.23b in nominal terms (GUS, 2010). The business sector remained the second largest source of R&D funding and represents around 26.6% of total gross R&D expenditures. Only 5.6% of Polish GERD is financed from the Branch Research Institutes and institutes of the Polish Academy of Science, and 5.4% from abroad; around 6.3% of expenditure in R&D activities comes from other sources.

The largest R&D performers in Poland are the higher education institutions, which absorbed around 33.6% of Polish GERD in 2008, followed by Branch Research Institutes with 27.1%. Further, the business enterprises utilise 22.8% and Polish Academy of Science 12.2% of GERD in 2008.

In terms of human resources, in 2008 the main R&D performers were universities and other higher education institutions: 66%, i.e. 79,517 out of 119,682 employees in R&D activity (including professors, other researchers and auxiliary R&D staff) worked at universities and higher education institutions. The Branch Research Institutes together with Polish Academy of Sciences employed 22.5% of R&D staff, and the private sector accounted for around 10.6% of all employees in R&D activities.

2.2 Resource mobilisation

Since 2000, Europe has made evident progress towards ERA but at the same time it is clear that Europe's overall position in research has not improved, especially regarding R&D intensity, which remains too low. The lower R&D spending in the EU is mainly a result of lower levels of private investment. Europe needs to focus on the impact and composition of research spending and to improve the conditions for private sector R&D investments.

This section assesses the progress towards national R&D targets, with particular focus on private R&D and of recent policy measures and governance changes and the status of key existing measures, taking into account recent government budget data. The need for adequate human resources for R&D has been identified as a key challenge since the launch of the Lisbon Strategy in 2000. Hence, the assessment includes also the human resources for R&D. Main assessment criteria are the degree of compliance with national targets and the coherence of policy objectives and policy instruments.

2.2.1 Resource provision for research activities

Progress towards R&D investment targets

Although after relative stagnation since 2002, GERD increased between 2007 and 2009 from 0.57% to 0.68% of GDP; it is however still one of the lowest in the EU and thus very far away from the targets set previously by the Lisbon Strategy and further by the Europe 2020 Strategy (GUS, 2010). Poland is thus above Latvia (0.48%), Romania (0.48%), Slovakia (0.48%) and Bulgaria (0.53%).

However, to grasp objectively the evolution of GERD in nominal terms, it should be highlighted that the absolute increase of Polish GERD between 2000 and 2009 was

almost 90%. Due to the volatility in the exchange rate to the Euro, GERD decreased from 2008 to 2009. The following table illustrates the evolution of GERD in absolute and relative terms in both local currency and Euro.

Table 2: The relative and absolute evolution of Polish GERD[1]

	1995	2000	2005	2006	2007	2008	2009
GERD/GDP % (based on €)	0.63	0.64	0.57	0.56	0.57	0.60	0.68
GERD/ capita (based on PLN)	55	125	146	155	175	202	238
GERD/ capita (based on €)	17.4 (2)	31	36.3	39.6	46.3	57.6	55
GERD in million PLN	2,132.8	4,796.1	5,574.6	5,892.8	6,673.0	7,706.2	9,070.0
GERD in million €	672.7	1,172.3	1,385.6	1,512.6	1,763.6	2,194.2	2,095.8

Source: Central Statistical Office (2010, 2011), Eurostat

(2) break in series

The strong economic growth in Poland shows with an average annual growth rate of 5-6% in the last few years, and explains the relatively unchanged GERD to gross domestic product in spite of a considerable increase of R&D expenditures in absolute terms. In 2008, for the first time in the last decade, when the GERD increased by 17.7% in nominal terms as compared to 2007, the share of GERD increased to 0.60% of GDP. In 2009 the growth continued reaching the value of 0.68%.

Following the Commission's publication of the Europe 2020 Strategy in March 2010, the Ministry of Science and Higher Education forecasted[2] R&D expenditures until 2020. Taking into account an average economic growth of 3% between 2010-2020, an annual inflation rate of 1.5%, an annual increase of public R&D expenditures of 14%, as well as contributions from the EU Structural Funds, the estimated GERD to GDP in 2020 should be 1.7%. This figure assumes an equal participation of private and public contribution to GERD, which is not the case yet. However, in a scenario with BERD contributions at the current rate, i.e. the worst case scenario, GERD is estimated to be 1.08% of GDP. On the other hand, according to the best case scenario, the ratio could be 1.96%.

This new forecast was prepared after the recent economic slowdown as the last Implementation Document of the National Reform Programme 2008-2011 adopted by the Council of Ministries on 19 May 2009, planned to reach the target of 1.7% already in 2011. Remarkably, the Innovation Strategy of 4 September 2006 set even more ambitious targets to achieve the total R&D expenditures to GDP of 2.3% by 2013. Thus, the latest forecast seems to be based on more realistic assumptions, although it would require a nominal increase of GERD by around four times.

Provision for R&D Activities: R&D strategy and priorities

The particularity of the Polish science budget is the fact that it is not prioritised and budgeted in the framework of multi-annual plans, which hinders the predictability and long-term planning of research investments. However, one of the objectives of the Building upon Knowledge reform and creation of the new executive agencies is to

[1] Due to considerable volatility of exchange rates, the prises are indicated in PLN to better grasp the actual increase in science budget. For example, the official exchange rate in 2004 was 1€ = 4.53PLN, in 2006 1€ = 3.89PLN, in 2008 1€ = 3.52PLN, in the last year 2009 1€ = 4.33PLN.

[2] http://www.nauka.gov.pl/nauka/polityka-naukowa-panstwa/prognozy-rozwoju/nowa-prognoza-gerd-dla-polski-w-2020-r/

develop multiannual research programmes in order to avoid duplication of research efforts, as well as provide more stable and predictable source of funding.

So far, aside from only few small programmes implemented by the National Research and Development Centre, a new **National Programme for the Development of Humanities** was announced by the Ministry of Science and Higher Education in June 2010 with additional funding of around €18m in the pilot phase and around €13m annually. This would be the first long term thematic funding in public research policy. The central National Scientific Research and Development Programme determines the five research priority areas, which are: society and security, accelerated and sustainable socio-economic development, health, energy and infrastructure, modern technologies for the economy, agriculture and environment. The programme, however, does not specify any financial allocation to individual research topics or organisations, i.e. budget that should be spent to each of the priority areas. In turn, it defines merely strategic research fields, which should give directions for any public funding streams.

The last available science and R&D strategy document, Science Strategy in Poland until 2015, was published in 2008. The document was preceded by extensive public consultations and presented a SWOT analysis of the Polish R&D sector. Although it pointed out a number of strengths, e.g. increasing number of scientific publications, increasing number of R&D enterprises and increasing public R&D expenditures, it also highlighted a number of significant weaknesses of the Polish scientific landscape: still very low level of overall (public and private) R&D expenditures, weak public-private collaboration, low innovativeness level of Polish enterprises, low level of implementation of R&D results, etc. The strategy defined very ambitious goals in terms of public as well as private R&D expenditures, assuming that the total GERD would increase four times in absolute terms between 2007 and 2015. However, it can be already seen that the targets set in the strategy are not realistic, mainly due to significant economic slowdown in 2009, and much lower than predicted economic growth. As an example, the envisaged GERD ratio to GDP in the strategy was 0.81%, and the actual value amounted merely 0.61%.

In November 2009, the Council of Ministers adopted a working document, which aims at setting in order all the current 42 Polish strategic documents by limiting their number to nine mid- and long-term strategic documents. The Science Development Strategy should be a part of a wider Strategy for Innovation and Effective Economy. Therefore, the working process on the updating of the existing science strategy was suspended until the plan considering the nine strategies is completed. At the same time, the Ministry confirmed that the main strategic goals of the still existing strategy remain valid and are in line with the EU goals defined in the Europe 2020 Strategy.

Provision for R&D Activities: Funding instruments

Until the Building upon Knowledge is fully operational, the main source of R&D funding is based on non-competitive, statutory public funding: it is estimated that around 75% of the science budget was distributed in this way in 2009. However, as already mentioned, the new reform, which is becoming operational during 2010/11 aims at redirecting the funding streams towards competitive funding based on the principle of excellence and strongly output oriented scientific activity at universities, the Polish Academy of Science, and branch research institutes. All R&D institutes and universities will be evaluated by a newly established Committee of Evaluation of Scientific Units and classified in four different performance categories: A+ – leading

research level at the national level, A – very good level, B – satisfactory scientific level, with recommendation for improvement, and C – unsatisfactory scientific level. According to the new system, the statutory funding will be replaced by a grant for maintaining the research potential, which will be distributed only to the best research performers. The institutes classified in the C-group will be not eligible for the institutional funding. As explained by the Ministry, only such radical steps will allow achieving the highest scientific results.

The Ministry assumes that by 2015, at least 50% of all government funds for science would be distributed together by National Centre for Research and Development (NCBiR) and National Science Centre (NCN), which was created in October 2010 as an effect of the Building upon Knowledge reform. The NCN is not fully operational thus it does not manage any programmes and budget yet.

Provision for R&D Activities: Structural Funds

A significant part of the public and private R&D and innovation budgets is represented by the contribution from EU Structural Funds. According to the Science Strategy in Poland until 2015 the share of EU Structural Funds in GERD amounted 8.5% in 2007, and was expected to rise to around 15% in the following years 2008-2010. Given a lower than expected increase of GERD in the last few years and unchanged amount of Structural Funds available to R&D and innovation, it may be estimated that the share of EU Structural Funds in GERD amounted to around 20% in 2008. In total, the EU structural funding is being provided within the Operational Programme Innovation Economy (OP IE) and Operational Programme Human Capital (OP HC). The first focus of the EU structural funding is the support of strategic research areas in line with the National Scientific Research and Development Programme, i.e. areas that show particular importance for socio-economic development of the country, as well as further increase in quality of higher education. The other focus is to provide support for the micro, small and medium sized enterprises, which still show a very low innovativeness level (see next section).

2.2.2 Evolution of national policy mix geared towards the national R&D investment targets

The share of gross domestic expenditure on R&D for the business sector (BERD) is historically very low in Poland. In 2009, BERD amounted to 0.19% of GDP, which is particularly low as compared with the EU27 average of 1.25%. The low level of BERD (below 0.2% since 2002), indicates that the aforementioned 1.7% GERD target set by the government may be unrealistic.

Table 3: BERD in EU27 and Poland 2000-2009

	2000	2005	2006	2007	2008	2009
BERD EU27 as % of GDP	1.20	1.15	1.18	1.19	1.21	1.25
BERD PL as % of GDP	0.23	0.18	0.18	0.17	0.19	0.19

Source: Central Statistical Office (2010), Eurostat

Among 1,000 EU companies ranked in the 2010 EU Industrial R&D Investment Scoreboard are only five companies from Poland:

Table 4: The most R&D intensive companies in Poland

Company	Rank	Sector	R&D Investment in €m, 2009	Change 09/08 in %
BRE Bank	461	Banks	21.53	4.4
Telekomunikacja Polska	513	Fixed line telecommunication	18.02	21.3
Bioton	708	Pharmaceuticals	9.88	-38.1
Asseco poland	793	Software	7.70	41.6
Nzetia	896	Fixed line telecommunication	5.73	-41.3

The fact that the only five companies from Poland are ranked at among top 1,000 firms indicates the weakness of Polish private R&D. According to the latest data from 2008 (GUS, 2009), the expenditures on R&D of Polish companies amounted only to 8.1% of all innovation investment expenditure in industry and 7.4% in services.

There is a relatively good mix of policy measures towards increased private R&D investment (e.g. Investments related to R&D activities within enterprises, New investments with high innovation potential), although an important problem seems to be the innovative absorptive capacity of Polish enterprises to implement new technologies and R&D solutions.

The main policies in the field are developed by the Ministry of Science and Higher Education and the Ministry of the Economy. These comprise institutional measures in forms of legal acts, as well as financial measures covered mainly by the Operational Programme Innovative Economy 2007-2013 (OP IE). As the EU programming spans over a longer period, there are no relevant changes of policy measures in the context of EU Structural Funds as compared with the previous year. The most significant changes occurred in the context of the Building upon Knowledge reform, which introduced new legal acts and new rules for R&D funding to public and private organisations.

In order to stimulate R&D investment in R&D performing firms, the Polish government adopted in May 2008 the Act on some forms of support for innovative activities. The act introduced a Status of R&D Centre, which gives exemption from certain taxes and grants tax allowances to private companies. A company with such status can create its own innovation fund to which it pays each month not more than 20% of its monthly turnover. In this way the accumulated capital may be spent on R&D activities and related costs, e.g. protection of IPR (patents). Moreover, tax incentives allow the companies to deduct their expenditures relating to the acquisition of new technology (R&D results) up to 50% of their estimated value.

In addition, the OP IE contributes considerably to stimulate R&D investment in R&D performing firms. The support is provided within the fourth priority Investment in Innovative Undertakings, most notably by the measure 4.2 Stimulation of R&D and design activity in companies.

Additional measures will be developed by the National Centre for Research and Development following to the implementation of the Building upon Knowledge, which now will support not only R&D activities at the academic units but also R&D done by Branch Research Universities, companies with the Status of R&D Centre, R&D networks, science-industry centres, and all other enterprises, which perform R&D activities. These measures will replace previous goal-oriented projects and R&D

projects funded by the Ministry of Science and Higher Education. The significant advantage of the new scheme is that the emphasis of the projects funded by NCBiR must be placed on applicability of R&D results by industry as well as private-public collaboration. This is expected to increase the R&D expenditures of private firms and create public-private synergies.

Concerning the promotion of the establishment of new indigenous R&D performing firms, this is implemented in the current programming period mainly by the measure 3.1 of the OP IE Initiating Innovation Activity.

Stimulating firms that do not perform R&D yet represents a considerable challenge for public policy since the level of enterprises that perform R&D activities is very low in Poland. Furthermore, the level of innovativeness is positively correlated with the size of a company. In the period 2006-2008 (GUS 2009), only 14.6% of small (10-49 employees) and 32.7% of medium sized enterprises introduced any product or process innovation. Only among the large companies (at least 250 employees), majority of them, i.e. 60.7% introduced some product or process innovations.

Therefore, beside the NCBiR measures, the OP IE plays a crucial role in motivating firms to perform R&D. The measure 4.3 Technology Credit can be considered as a relevant instrument to stimulate firms that do not perform R&D yet. Further, the measure 3.1 Initiating Innovation Activity aims at encouraging more innovation and R&D in the business enterprises.

With respect to attracting R&D performing firms from abroad, apart from the Economic Free Zones, which were officially established by the Act of 20 October 1994, there are practically no other measures designed to attract R&D performing firms from abroad. Despite an attempt to encourage foreign companies to locate their R&D centres by establishing the Status of R&D Centre, the measure has proved to be ineffective. The functioning of all special economic zones will last until the end of 2020. Until September 2009, the entrepreneurs undertaking activities in these zones invested more than €15b and employ more than 200,000 persons (Ministry of Economy, 2010). The fiscal form of support is considered as suitable and safe for the State budget, because the support is spread for several years and is given after launching the activities and gaining the income. However, the R&D activity is not the primary objective of the Economic Free Zones. Innovation, technology parks and science-industry cooperation are among other criteria e.g. reduction of local unemployment, on which the company is assigned permission for investment. The proposed changes are going in the direction of supporting innovative undertakings in the strategic investments in the following sectors, such as automotive, aerospace, electronics, machinery, biotechnology, chemical industries, R&D, modern services, renewable sources of energy and equipment for the production of fuel (Ministry of Economy, 2009).

However, the regional Operational Programmes in all Polish regions intensively support technology and industrial parks with a focus to foster R&D and/or innovation activities, often by attracting firms from abroad.

In 2010, the Ministry of Economy created a portal "Database of knowledge on new technologies", which brings together information on innovation achievements of research institutes (especially those supervised by the Ministry of Economy) and entrepreneurs whom the Minister of Economy granted the Status of R&D Centre. The portal is in Polish and English in order to attract also R&D performing firms form abroad.

To increase extramural R&D carried out in cooperation with the public sector is another priority of the OP IE during the 2007-2013 period. In the same direction of fostering science-industry co-operation, the measures 'Support to R&D for the knowledge based economy' and 'Support to R&D applied research undertaken by research organisations for the firms' are issued. The Building upon Knowledge reform introduced completely new rules for Branch Research Institutes, which can be transformed into research institutes. Aside from the fact that the new Research Institutes gain a number of competencies (e.g. organise PhD studies and award PhD title), they will be allowed to create research consortia with private companies as centres of science and industry or joint-venture companies, and conduct research activities for the economy in close cooperation with the industry.

The Ministry of Science and Higher Education expects significant increase of R&D activities in public sector, as well as considerable improvement of the quality as a consequence of new strict and competitiveness rules introduced by the Building upon Knowledge reform. In addition, the Partnership for Knowledge reform, aims at creating a sort of excellence research fund, which will finance R&D activities of the highest quality in so called National Leading Scientific Centres (KNOW).

Moreover, the OP IE has two R&D specific priorities. While priority 1 'Research and development of new technologies' was designed to support various initiatives ranging from foresight initiatives, R&D projects, initiatives encouraging the students to pursue scientific career, projects relating to improvement of professional qualifications of the academics and researchers and IP protection, priority 2 basically provides financing for R&D infrastructure projects. The total EU funding earmarked for these two priorities is estimated at about €2.2b (€1.1b each), representing roughly 3% of total planned spending of the EU Structural Funds interventions.

It can be assessed that the publicly supported research and innovation policies are provided in a relatively simple and easy way to the potential beneficiaries. The instruments funded by the OP IE or OP HC are a subject of common EU controls and monitoring procedures. Further, the Building upon Knowledge reform created new organisations with clearly defined goals so that the politics and policy making will be separated, which should increase transparency and efficiency in distribution of public R&D funds.

The last report on public procurement "New approach to public procurement" published by the Ministry of Economy in 2008, underlined the importance and potential of public procurement, including green public procurement, as a successful policy instrument towards more R&D and innovation. At the same time, it identified existing obstacles and made recommendations for better use of public procurement, which is still not widely used in Poland, mainly due to low recognition and awareness of the potential role public procurement can play in R&D policy.

Considering that since 2005 the focus of innovation policy was on supporting technological innovations, it can be concluded that the innovation policy has interacted positively with R&D instruments. In the area of education policy, there is only one specific measure (Measure 1.2) included in the OP IE dedicated to human resources. It aims at strengthening human resources potential in the science sector. Besides that, there are other relevant measures in the OP HC, notably Measures 4.1 and 4.2. Their objective are to strengthen the potential of higher education institutions, increase the number of S&E graduates and to develop skills of R&D personnel, in order to enhance science-industry cooperation. Among the national initiatives, Science Festivals can be considered as a good example of stimulating the

interest of general public in explorations of the different facets of science and potentially attracting young pupils in pursuing science careers in the future. Moreover, The Partnership for Knowledge will play particular role in provision of highly qualified human resources as well as creation of excellence research.

According to the previously indicated forecast, the private R&D spending should represent in the best case half of the 1.7% GERD target by 2020, which is still far away from the ambitious EU goal of 2% BERD. The main barriers and risks for increasing share of BERD in R&D expenditures, is low innovativeness of Polish enterprises, especially the SMEs, and their low absorptive capacity, as well as the weak ties between science and industry. Moreover, the low expenditures on R&D by private companies (8.1% of all innovative expenditures) is motivated by the fact, that the companies face more urgent challenges relating to the upgrade of technologies and infrastructural investments in order to catch up mainly with the West-European industrial level. For example in 2008, 56.6% of all expenditures classified as innovation activity were spent on machines and other technical devices and 27.2% on buildings and other constructions; it means that the focus of innovative investments is the physical capital. It is expected from the OP IE as well as regional OP that they will contribute significantly to the increase of innovative capacities of Polish SMEs and in this way increase R&D collaboration and production.

2.2.3 Providing qualified human resources

The total number of researchers in 2008, without technicians and equivalent staff and supporting staff, was 97,474. The majority of them (72%) worked at universities and other higher education institutions; 17,817 worked on Branch Research Institutes, 12,656 in business enterprises and 6,874 in the Polish Academy of Science.

The human resources in science and technology (HRST) as a share of the economically active population in the age group 25-64 amounted to 34.9% in 2009, which is below the EU27 average of 40.1%.

In terms of the current and future supply of S&T graduates, Poland is doing considerably well. Since the late 1990s, the share of graduates (ISCED 5 + 6) in mathematics, science and technology per 1,000 population aged 20-29 has increased. In 2000, it was still considerably below the EU27 average of 10.1% with 6.6% but it has gradually reached 14.3% in 2009 and is thus on par with the EU27 average. In absolute terms, the number of S&T graduates is far less high than in other fields of study which are lead by the Social sciences and business with a total of 236.100 graduates in 2008 compared to 42.575 in S&T fields. Thus despite the fact of a growing share, the relative low absolute number of S&T graduates may pose a problem if the private sector wishes to hire more extensively S&T graduates.

The main education challenges are addressed by the ongoing reform Partnership for Knowledge (Ministry of Science and Higher Education, 2010):

- Incorrect structure of studied courses: very high share of students in social sciences and humanities, low share of students of technical and natural sciences;
- Complicated and too long academic career;
- Very low level of internationalisation of the academic courses, which amounts only to 0.5% compared to the OECD average of 9.6%;

- Very low salaries for researchers in public academic organisations, and lack of financial incentives supporting quality.

The Partnership for Knowledge reform is expected to revolutionise the situation of researchers, improve the quality of higher education and R&D activities and create strong ties between business and science to match better supply of highly qualified human resources with the market demand.

2.3 Knowledge demand

This section focuses on structure of knowledge demand drivers and analysis of recent policy changes.

2.3.1 Structure of knowledge demand drivers

Data produced by GUS 2010 on GERD in Poland by source of funding indicate that in 2008 the business sector contributed around 26.6% (€580m), while the government sector contributed 56.1%, Branch Research Institutes (JBR) and Polish Academy of Science (PAN) 5.6%, international organisation and from abroad 5.4%, and other sources 6.3%. The business sector contribution increased slightly from 24.5% in 2007.

The total GBOARD appropriations in 2009 amounted to 0.34, compared to 0.74 EU27 average (Eurostat).

Private sector is not a significant R&D driving force for public research organisations: Only 5.6% of GERD was provided by private enterprises to other research organisations, including HEI, JBR and PAN, which reveals very low level of collaboration with public organisations and knowledge demand. As explained by a study on chemical R&D sector in Poland (Jerzyniak, 2009), the main challenge of Polish companies is not the R&D itself but rather technological update in order to approach the Western European level of innovation, as well as infrastructural investments and expenditures aiming at meeting the environmental needs.

Moreover, private demand for R&D is constrained by the sectoral structure of the Polish economy, which primarily focuses on low- and medium-low-tech activities. Hence, publicly funded measures and programmes mainly drive the knowledge demand. It is expected, that the Branch research Institutes, reformed by Building upon Knowledge, will intensify the R&D activities done or co-funded by private sector. Also the new competencies of the NCBiR are expected to increase more business-oriented research, done in cooperation with public research organisations.

The most knowledge intensive sectors in terms of R&D expenditures are transport equipment, which represents 10.5% of BERD, chemicals with 9.2% and pharmaceuticals with 9.1% (GUS, 2010), which is represented in the following table:

Table 5: Share in gross domestic expenditures on R&D in the business enterprises sector by economic activity, in 2008

Sector	Share of BERD
Agriculture, hunting and forestry	0.7
Mining including extraction of petroleum and natural gas	0.6
Manufacture of food products and beverages	4.3
Manufacture of textiles	0.9
Manufacture of coke, refined petroleum products and nuclear fuel	0.2
Manufacture of chemicals and chemical products	9.2
Pharmaceuticals	9.1
Rubber and plastic products, other non-metallic mineral products	2.5
Basic metals, ferrous; basic metals, non ferrous	2.5
Fabricated metal products except machinery and equipment	1.8
Manufacture of machinery and equipment	6.7
Office machinery and computers, electrical machinery and apparatus	8.0
Manufacture of radio, television and communication equipment and apparatus	1.5
Manufacture of medical, precision and optical instruments, watches and clocks	3.7
Transport equipment (motor trailers, semi-trailers, aircraft and spacecraft)	10.5
Electricity, gas, water supply	0.6
Construction	2.0
Transport and storage	1.6
Health and social work; other community, social and personal services activity	6.5
BERD total	100.0

In 2008, around 5.4% of GERD was funded from abroad, mostly through the EU Structural Funds; only around 10% of that amount was spent directly by private enterprises. However, it should be noted that the actual implementation of individual projects within 2007-2013 programming period started in 2008-2009, so that the peak of EU contributions to R&D and innovative activities is expected to occur rather in the middle of the period/second half, i.e., although the value of the concluded funding agreements within OP IE amounted to around 70% by November 2010, the payments made covered around 40% of the total allocation[3]. In addition, in 2008 there had been no payments made by the Commission yet to the OP IE.

Summing up the implementation data, and taking into account the fact that most of the EU SF in the field of R&D is spent on enterprises and collaboration between business and science, it can be assumed that the innovation and R&D production and absorptive capacity of private sector will increase considerable, which will result in higher knowledge demand from private sector.

2.3.2 Research efforts to address major societal challenges

Looking at the distribution of GBAORD by socio-economic objectives, Research financed from general university funds – GUF accounted for the main share with 35.4% of the total GBOARD in 2008. This marks a decrease in share as compared with 40.0% in 2005. Due to the fact that GUF is a first approximation of the size on non-targeted academic research, this change may imply a gradual shift towards more targeted and prioritised research activities. As a result of the new competitive rules

[3] http://www.poig.gov.pl/AnalizyRaportyPodsumowania/Strony/default.aspx

on distribution of funds, it can be expected that the share of GUF in total GBOARD will start dropping significantly starting from 2010/11.

The National Scientific Research and Development Programme, established in 2008, is the main policy document, which addresses major societal challenges by defining five priority research areas. As already mentioned in the report, it does not define any funding allocations but defines strategic research areas, which should be taken into account when distributing any public funds on R&D.

Systemic instruments to identify drivers of knowledge demand have been introduced recently. As for methods to set out the research priorities the main instrument is the National Foresight Programme. In February 2009 scenarios for research in area of security, sustainable development of Poland and information and telecommunications technologies were presented. As a consequence, on 1 October 2010, the Ministry of Science and Higher Education (2010) established the Implementation Programme of the National Foresight Programme. The objective of the Implementation Programme is e.g. to develop directions and technologies of R&D activities based on the foresight methodology, analysis of the results of the National Foresight Programme with the aim to shape national science policy, creation of national monitoring systems for implementation of foresight projects.

2.4 Knowledge production

The production of scientific and technological knowledge is the core function that a research system must fulfil. While different aspects may be included in the analysis of this function, the assessment provided in this section focuses on the following dimensions: quality of the knowledge production, the exploitability of the knowledge creation and policy measures aiming to improve the knowledge creation.

2.4.1 Quality and excellence of knowledge production

Knowledge production in Poland has low quality and relatively low international importance given the size of the country.

For example, there are only two Polish academic organisations ranked among the top 500 in the Academic Ranking of World Universities in 2010: the Warsaw University and the Jagiellonian University in Krakow, both in world rank between 301-400; and six universities listed in the Leiden Ranking 2008, among the group of Europe largest universities with the best University of Warsaw ranked 142 (orange ranking).

In 2007, Polish research organisations submitted only 3.8 patents per million of inhabitants, with the EU27 average of 116.5. The level of publications was also very low: the number of scientific publications per million inhabitants in 2008 was 552, compared to EU leaders Sweden with 2,472 and Finland with 2,337 (GUS, 2010) and other central European Countries, e.g. Czech Republic with 1,016 scientific publications per million inhabitants.

2.4.2 Policy aiming at improving the quality and excellence of knowledge production

In 2009, the Ministry of Science and Higher Education presented the second step of the science and higher education reform Partnership for Knowledge consisting of three parts:

- "Reform of studies and students' rights", which in the light of improving quality and excellence of knowledge production, proposes e.g. to reward the best students and PhD students through special forms of support;
- "New model of academic career", with the objective to remove the barriers for the development of scientists, accelerate the procedure of promotion, while guaranteeing higher quality of Poland's science, increasing the quality of PhD, shortening the habilitation procedure, improving the human resources' policies within the higher education institutions and scientific research institutions; and
- "New model of managing the higher education institutions" that proposes changes regarding the functioning of higher education institutions, which are relevant for the knowledge production: creating the mechanisms of selecting the leading scientific research entities, achieving better utilization of existing research and academic potential, improving the quality of education.

The entire reform aims at increasing internationalization of the scientific landscape in Poland, e.g. by opening management positions at the universities to international researchers. Another aspect aiming at increasing the quality of knowledge production is the planned creation of National Leading Scientific Centres (KNOW), which will be university institutes or other research centres selected in a competition, and granted additional funding to conduct research at the highest European or even global level (similarly to the Exzellenzinitiative in Germany).

In October 2010, the first reading of the entire reform package Partnership for Knowledge took place in Parliament. The overall quantitative objective of the reform is to have five Polish universities among the first 100 best universities in Europe in five years.

Moreover, the Building upon Knowledge is contributing to more quality of research in R&D organizations, not only through competitive and targeted funding, but also for stricter evaluation rules of performance, most notably by creating Evaluation Committee of Scientific Units (see section 2.2.1).

2.5 Knowledge circulation

Tackling the challenges that European society faces in the 21st century will require a multi-disciplinary approach and coordinated efforts. Many debates and conferences, e.g. the Lund Declaration recognise that such complex issues cannot be solved by single institutions, technology sectors or MS acting alone. Hence strong interactions within the "knowledge triangle" (education, research and innovation) should be promoted at all levels. Moreover, in the context of increasing globalisation, cross-border flows of knowledge are becoming increasingly important. This section provides an assessment of the actions at national level aiming to allow an efficient flow of knowledge between different R&D actors and across borders.

2.5.1 Knowledge circulation between the universities, PROs and business sectors

Regarding the promotion of knowledge circulation, both support measures 'Building upon Knowledge' and 'Partnership for Knowledge' introduce a series of actions to increase and strengthen collaborations between universities, public research organisations, and the business sector. Thus, the need for more effective knowledge

circulation is clearly recognised by policy makers and supported by legal and financial means.

The re-established National Centre for Research and Development, which will specifically manage strategic programmes aiming at applied research and development projects, will play the most prominent role in support of public-private research collaboration. One of the tasks of the NCBiR is to stimulate private R&D expenditures by co-financing private R&D undertakings, in collaboration with public R&D organisations as well as commercialisation of the R&D results. Further, new competencies of the Branch Research Institutes, are expected to contribute to the knowledge circulation and collaborative research, in particular between the Institutes and private enterprises.

In addition, specific measures of the OP IE aims at supporting the knowledge transfer and commercialisation of R&D results, in particular placing emphasis on better involvement of SMEs in the knowledge sharing and utilisation process.

2.5.2 Cross-border knowledge circulation

The reform package Partnership of Knowledge in the section 'New model of academic career' proposes to open up the higher education institutions to leading foreign researchers. Several changes will be introduced, and the award PhD and Professorships will be dependent on research activities abroad.

Moreover, the Ministry of Science and Higher Education launched in November 2010 new programmes: "Ideas Plus" (MNiSW 2010, Komunikat) with the objective to motivate and support Polish researchers in the next editions of the IDEAS programme of the European Research Council, and "Index Plus" (MNiSW 2010, Komunikat) with the aim to increase the internationalisation of Polish scientific articles in English language.

The issues of individual mobility of researchers, as well as international collaboration are particularly presented and analysed in the sections 3.5 and 3.6 of this report.

2.5.3 Main societal challenges

The National Scientific and Research Development Programme prioritises five research areas, including society in secure, accelerated and sustainable socio-economic development, health, energy and infrastructure, modern technologies for the economy, agriculture and environment. All public research grants should be awarded according to the specific priorities of this programme.

2.6 Overall assessment

The 2010 marks a radical step towards new, more efficient and competitive national research and innovation system in Poland, most notable due to entry into force of the first part of the large reform of science and higher education Building upon Knowledge. Although at the moment, the entire R&D system is in a transitory state, the new instruments, measures and organisations create a number of opportunities.

Table 6: Summary of main policy related opportunities and risks

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	• Significant shift from statutory funding to competitive funding due to Building upon Knowledge reform; • Considerable contribution from EU Structural funds invested in R&D, higher education and innovation; • Continuously growing public budget for research and higher education, 15.5% increase in nominal terms between 2007 and 2008; • New opportunities for better, more qualified researchers due to Partnership of Knowledge reform.	• Strong dependence on public funding: around 60% of GERD is financed by the government; • Very low mobilisation of private funds for R&D and innovation expenditures
Knowledge demand	• EU Structural Funds, offer unprecedented funding to private sector by supporting innovation and technology transfer; • New instruments (offered by NCBiR) for private-public collaboration have potential to increase the need for more knowledge and innovative solutions.	• Very low knowledge demand from private sector due to a low absorptive capacity of enterprises, especially SMEs. • Additional funding may not be able to induce more private R&D expenditures.
Knowledge production	• Through Building upon Knowledge, shift from project to programme funding; • Partnership for Knowledge introduces merit-based funding rules and academic career development; • Partnership of Knowledge aims at embedding universities into regional development to produce specific regional knowledge; • Creation of KNOW (excellence institutes) with additional funding for top-level research.	• The new executive agencies are not operational yet, it will take time before they are able to fulfil their statutory tasks; • Partnership for Knowledge is dealt with in Parliament. Must be completed before the elections in 2012, otherwise the reform is at risk of being abandoned or delayed; • Reluctance of the scientific community to introduce performance-dependent financing may hamper implementation of changes introduced by Partnership of Knowledge.
Knowledge circulation	• The OP IE is considered as giving a boost to circulation of knowledge between universities and private companies; • New programmes of the Ministry of Science and higher Education to improve internationalisation of knowledge production and circulation.	• Low absorptive capacity of SMEs and still low interest to acquire knowledge, very low innovativeness level, particularly in small companies; • Historically low level of cross-border knowledge circulation, lack of international R&D culture.

Table 7: Main barriers to R&D investments and respective policy opportunities and risks

Barriers to R&D investment	Opportunities and Risks generated by the policy mix
Very low overall level of R&D expenditures	Risk of lagging behind and not catching up; Opportunities in strong political commitment to increase GERD gradually.
Very low level of private R&D investment	Risk of marginalisation of private sector, Poland to become a country of manufacturing, and not knowledge creation, loss of competitiveness and subsequently low economic growth; Opportunities created by Building upon Knowledge and Partnership for Knowledge, unprecedented

	opportunities created by EU Structural Funds.
Lack of competitive culture in science	Risk of marginalisation of Polish R&D organisations and universities, Opportunities created by Building upon Knowledge and Partnership for Knowledge.
Lack of funding and career development depending on performance	Risk of marginalisation of Polish science, Risk of further duration of established inefficient governance structures; Opportunities created by Partnership of Knowledge.
Lack of excellence research	Risk of egalitarian funding distribution, reluctance of scientific community to create excellence; Opportunities created by Partnership for Knowledge: KNOW initiative to create hubs of excellence.
Low level of private-public R&D collaboration	Risk of knowledge production that is not targeted at the needs of economy, Risk of misuse and wasting of public funding, Opportunities created by two reform packages and EU Structural Funds.

3 Interactions between national policies and the European Research Area

3.1 Towards a European labour market for researchers

The Communication Better careers and more mobility: A European Partnership for Researchers proposed by the EC in May 2008 aims to accelerate progress in four key areas:

- Open recruitment and portability of grants;
- Meeting the social security and supplementary pension needs of mobile researchers;
- Providing attractive employment and working conditions;
- Enhancing the training, skills and experience of researchers

The Commission has also launched concrete initiatives, such as dedicated information services for researchers, in particular through the activities grouped under the name of EURAXESS – Researchers in Motion. Based on the assessment of the national situation in the four key dimensions detailed above, this section will conclude if national policy efforts are supporting a balanced 'brain circulation', with outward mobility levels matching inward mobility levels. High levels of outward mobility coupled with low levels of inward mobility often signal an unattractive national labour market for researchers and unsuitable research infrastructures. This may trigger, despite the policy efforts supporting the mobility the 'brain drain' rather than brain circulation.

3.1.1 Stocks and mobility flows of researchers

In 2008, all 1,157 R&D units (Universities and other HEI, JBR, Polish Academy of Science, Business enterprises) employed 119,683 persons, 97,474 of them were researchers. Most researchers, 70,371, worked at the HEI, then in Branch Research Institutes (11,649), Polish academy of Sciences (6,874), Business enterprises (12,656), and other units (1,275).

The international mobility of researchers is rather low, due to the fact that most of the senior researchers do not speak any foreign language, and mobility (national and international) has never been any requirement for career development and promotion. Moreover, low salaries and scarce funding were other important barriers to mobility. Still, the most common career path in Poland is "from a student to a professor" at the same university. In the last years, as a consequence of new opportunities emerged through the EU membership as well as increasing science budget the situation is slowly improving.

In 2007, the Ministry of Science and Higher Education launched a programme "Supporting International Mobility of Scientists" with a generous funding (around €2,500 per month of basic grant, plus additional allowances if applicable) for researchers in their first seven years after the award of PhD title.

3.1.2 Providing attractive employment and working conditions

According to the Law on Higher Education, Art118, employment of academic staff can be established on the basis of appointment or a contract. While the former stipulates a full-time basis, contractual employment can be part-time as well as full-time. Non-academic staff is hired only on a contract basis. The Law on Higher Education provides guidelines for the public institutions of which the private ones may deviate. The details concerning the employment relation in public as well as private higher education organisations are laid out in the statutes of the organisations. Art. 132 concerns the required performance appraisal of academic staff minimum every four years.

Salaries are regulated at the central level, the universities have autonomy in recruiting researchers, but their basic salaries are regulated by the Ordinance of 22 December 2006 of the Ministry of Science and Higher Education. It defines an interval with the lowest and highest possible salary for each group of researchers and the autonomy of the University lies in this interval. In addition, the salary can be increased temporarily by additional profits from research activities. In addition, an autonomous system of boni for research-intensive scientists exists.

On the one hand, the starting salary for young researchers is unfavourable, which is an important disincentive preventing young people from pursuing an academic career. On the other hand, the salaries of professors are higher and can be attractive as compared to other professions in the public sector. Promotion to full professor is however linked to the habilitation, which takes place in general nine years after the Ph.D degree and which leads to a high age once researchers become a full professor (Kwiek 2004). 93.8% of Polish professors are older than 50, and 31% are older than 70. Compared to the salaries in the economically more advanced countries, Poland offers very low salaries. According to the study on remuneration of researchers (CARSA, 2007) the Polish average annual salary of a researcher amounted to €11,559 compared to EU25 average of €37,948.

Poland has still a very low attractiveness level as a destination country for international researchers. Therefore, current policy efforts focus more on attracting Polish researchers abroad to come back and do research in Poland. The so-called reintegration grants are offered by the Foundation for Polish Science.

According to the EC EURAXESS services, the European Charter of Researchers has been signed by six Polish organisations.[4]

In order to increase the female share of researchers in the research organisations and provide a better environment to reconcile private and professional life, the Ministry of Science and Higher Education launched recently a number of initiatives.

3.1.3 Open recruitment and portability of grants

According to the Polish Act on Foreigners of 24 May 2007, foreign researchers or academic teachers do not need a work permit. The researcher is obliged to conclude an agreement with the R&D institute for implementation of an R&D project.

As regards the opening-up up the higher education institutions to leading foreign researchers, it is planned by the Partnership for Knowledge that the Rector (Director of scientific research entity) will not need to consult the Central Commission of Degrees and Titles about the appointment of foreigners for the position of professor 'extraordinarius', who obtained the title of doctor and Polish citizens with the same title who in the last five years worked as independent research staff and have obtained considerable research results.

The other main proposed changes are to introduce into the legislation a principle of open competitions for the position of researchers and academic staff, limitation of multiple employments as well as a proof of professional experience (i.e. scientific title) in the case of appointment through a nomination.

The research grants from the Ministry of Science and Higher Education are awarded to the specified research organisations, and thus not portable.

3.1.4 Meeting the social security and supplementary pension needs of mobile researchers

Since Poland is a member state of the European Union and the European Economic Area (EEA), its social security scheme is coordinated with those of other member states. It means that in the EEA there are common rules, which prevent the situation when a person moving within a territory of several countries of the EEA is subject to the social security legislation of more than one country or no country. The coordination is, above all, defined by two regulations: Regulation (EEC) No 1408/71 of the Council of 14 June 1971 on the application of social security schemes to employed persons and their families moving within the Community and Regulation (EEC) No 574/72. However, these Regulations do not harmonise but co-ordinate the social security schemes of the EEA states, i.e. it does not replace different national social security systems with a single European scheme.

If a person arrives in Poland for the purpose of employment, the European coordination of social security schemes gives the following benefits:

- The social contributions are never lost - it means that contributions from the income gained in each of the Member States are summed up;
- There are no double contributions towards insurance systems in each of those States (EURAXESS Social Security).

[4] http://ec.europa.eu/euraxess/index.cfm/rights/charterAndCode#P

- There are no specific schemes or measures for researchers from third countries. The common regulations on foreign employment apply in this case.

3.1.5 Enhancing the training, skills and experience of European researchers

The doctoral studies are mostly structured according to the Bologna system as the studies of third level. The doctoral schools are organised by the universities. The most common way to obtain a PhD degree is to be in a graduate school and/or working as a research associate.

Several new requirements in PhD activities will be introduced by the Partnership for Knowledge reform. The new condition for awarding a PhD title will be at least one publication in a scientific journal of at least domestic circulation or in a reviewed report on an international scientific conference. The reviewer cannot be employed by the academic institution where the dissertation is defended or from which the candidate comes. The limitations regarding the number of foreign reviewers will be abolished. Introduction of an additional financing of doctoral scholarships (managed by the National Leading Scientific Centers, KNOW) and the doctoral scholarships for the so-called “top students” will aim at improving attractiveness of the academic career. Candidates for the PhD title will be also allowed to submit their dissertations and defend them in a foreign language. Moreover, it will be obligatory to publish the contents of the doctor’s dissertation and the review at the school’s (or institute’s) website in charge of the doctoral programme. The competition procedure will be obligatory in the event of qualification for the full-time doctoral studies. Also legal frameworks will be specified for the purpose of conclusion of contracts between schools and the other (including foreign) academic institutions in order to prepare a joint doctoral programme under supervision of the promoter and co-promoter.

3.2 Research infrastructures

Research infrastructures (RIs) are a key instrument in the creation of new knowledge and, by implication, innovation, in bringing together a wide diversity of stakeholders, helping to create a new research environment in which researchers have shared access to scientific facilities. Recently, most EU countries have begun to identify their future national RI needs, budgets and priorities in the so called National Roadmaps for Research Infrastructures. These strategic documents also set out a strategic view on how to guarantee and maintain access to research facilities. Although some countries invest heavily in RIs, none can provide all the required state-of-the-art facilities on a national basis. Several large RIs have already been created in Europe. While optimising the use and development of existing RIs remains important, new infrastructures are needed to respond to the latest research needs and challenges. European Strategic Forum for Research Infrastructures (ESFRI) was established in April 2002 to support a coherent approach to policy-making on RIs in Europe and to act as an incubator for international negotiations on concrete initiatives. This section assesses the research infrastructures national landscape, focusing on the national RI roadmap and national participation in ESFRI.

3.2.1 National Research Infrastructures roadmap

The degree of amortisation of scientific research equipment was 77.5% in 2008 and during recent years the upward trend could be observed (GUS, 2010). According to

the figures from 2008 slightly more than 8% of the Science budget was allocated for infrastructure-related investments, which was roughly about €94m. The role of the EU Structural Funds interventions has been considerable. The significant financial resources have been allocated in the OP IE. More specifically speaking, the funding earmarked for the Priority 2 of that programme is estimated for the entire programming period at almost €1.3b and is specifically designed to support financing the research investment type of projects. To give a sense of proportion, it is worthwhile mentioning that the same amount of financial resources has been committed for the actual research-related activities.

However, the process to formulate a national roadmap has started, but no official document exists yet.

3.2.2 National participation in the ESFRI roadmap. Updates 2009-2010

Poland was invited to participate in two ESFRI projects: XFEL and FAIR; the government reserved funding for those projects in the current, 2010 science budget with around €8.5m.

The Ministry of Science and Higher Education supports 13 propositions from scientific community to participate in other EFSRI projects:

- Euro Bio Imaging;
- ICOS;
- Partnership for Advanced Computing in Europe;
- European Synchroton radiation facility;
- European Free Electron Laser;
- EPOS;
- CLARIN;
- SPIRAL2;
- EURO-ARGO;
- COPAL;
- ELIXIR;
- Cherenkov Telescope Array.

The level of funds to be committed to the projects is not specified yet.

3.3 Strengthening research institutions

The ERA green paper highlights the importance of excellent research institutions engaged in effective public-private cooperation and partnerships, forming the core of research and innovation 'clusters', mostly specialised in interdisciplinary areas and attracting a critical mass of human and financial resources. The universities and research institutions should be embedded in the social and economic life where they are based, while competing and cooperating across Europe and beyond. This section gives an overview of the main features of the national higher education system, assessing its research performance, the level of academic autonomy achieved so far, dominant governing and funding models.

3.3.1 Quality of National Higher Education System

The output quality of Polish universities is very low in international comparison. For example, there are only two Polish academic organisations ranked in the Academic Ranking of World Universities in 2010 (for more please see section 2.4.1). Altogether

there are 461 Higher Education Institutions in the academic year 2009/2010 (GUS, 2010b): 19 full universities, 23 technical universities, 7 agriculture HEI, 80 economic HEI, 19 pedagogical HEI, 9 medical universities, 2 maritime HEI, 6 sport HEI, 21 universities of arts, 15 theological HEI, 7 HEI of the Ministry of Defence, and 245 other HEI. The total number of students is 1.9m in the current academic year. The HEI dominated the Polish research landscape: around 70,000 researchers out of 97,000 work at the HEI. Further, 1.3m students are registered at 131 public universities and other HEI. There are almost 36 thousands of PhD students but only 228 from abroad.

In most cases, public universities are considered as offering much higher teaching level; private universities (mostly non-public) offer usually courses in social sciences and humanities, where no sophisticated and expensive research infrastructure is required. Most of them do not perform any relevant research activities and concentrate only on teaching activities. However, a limited number of non-public HEI have managed to establish a strong brand supported by high quality of teaching and research. There are officially no elite universities in Poland, and the access to HEI is competitive and based on examination results from high schools. This however does not apply to private HEI, for that reason it is relatively easy to become a student at a private HEI. All HEI are regulated by national legislation, the Act on Higher Education and the Act on the Academic Degrees and Academic Titles as well as the Art Degrees and Title.

During the last year 2009, two documents were relevant to Higher Education were prepared for the Ministry of Science and higher Education: Strategy for the development of higher education 2010-2010 published by the Conference of Rectors and Academic Schools of Poland in December 2009, and Strategy for the development of Higher Education in Poland until 2020 commissioned by the Ministry to external consultants and published in February 2010. Both strategies are first documents in Poland after 1989, which investigate the research and higher education landscape in a very complex way, and put forward a number of concrete, often radical solutions. The strategies considerably contribute to the Higher Education reform Partnership for Knowledge. The quality of research output at HEI is expected to grow in the next years, mainly due to the fact that the new reform introduces better quality assurance mechanisms, e.g. creation of Committee of Evaluation of Scientific Units, and more competitive and transparent academic career paths.

3.3.2 Academic autonomy

The degree of autonomy regarding different sources of public funding is regulated at the central level by the Act of 27 July 2005 on Law on Higher Education, and the Act of 8 October 2004 on the Principles of Financing Science. There is no autonomy with respect to the statutory funding for teaching and research as it is decided by the Ministry of Science and Higher Education based on a set of objective indicators and formulas (Ordinance of 9 May 2008, Ordinance of 17 October 2007, Ordinance of 24 July 2009, all of the Minister of Science and Higher Education). The funds from grants and other competitive research projects as well as fees and tuitions are allocated autonomously.

The universities have autonomy in recruiting researchers; however their basic salaries are regulated by the Ordinance of 22 December 2006 of the Ministry of Science and Higher Education. It defines an interval with the lowest and highest possible salary for each group of researchers. The autonomy of a university lies in

this interval. The main governing body is not open to representatives from outside the university.

The autonomy with respect to their didactic offer is limited to some extent. Partnership for knowledge aims at expanding the autonomy of the HEI regarding specification and fulfilment of their mission, including shaping the didactic offer and management of the material and non-material resources of the school. All the new solutions have been formulated in accordance with the terminology of the National Qualifications Framework that constitutes the Polish counterpart of the European Qualifications Framework (MNiSW, 2010).

3.3.3 Academic funding

So far, most of the funding provided to the HEI was a block or statutory funding. Around 75% of funding received by the HEI from the government is statutory, non-competitive funding. According to the Partnership for Knowledge reform the current level of financing of state HEI will be maintained (with annual valorisation), however a “pro-quality” subsidy will be simultaneously introduced and supplied with the increase of outlays on the higher education. The subsidy will aim to finance the best organisational units in the country and non-public HEI with the status of the National Leading Scientific Centres. In addition, the statutory subsidy will be based on a modified algorithm of allocation enforcing influence of the measureable R&D performance.

An important characteristic of academic funding is its high concentration in only small group of universities. In 2008, 25 public HEI accounted for 44% of all students, and 84% of all R&D expenditures.

3.4 Knowledge transfer

The importance of knowledge dissemination and exploitation in boosting competitiveness and contributing to the effectiveness of public research has been increasingly recognised by EC and EU Member States. Following the publication of the ERA Green Paper in April 2007, the EC Communication "Improving knowledge transfer between research institutions and industry across Europe" was issued, highlighting the importance of the effective knowledge transfer between those who do research, particularly HEIs and PROs, and those who transform it into products and services, namely the industry/SMEs.

Several Member States have taken initiatives to promote and facilitate knowledge transfer (for instance new laws, IPR regimes, guidelines or model contracts) and many others are planning to intensify their efforts in this direction. However, these initiatives are often designed with a national perspective, and fail to address the tran-snational dimension of knowledge transfer. This section will assess the national policy efforts aimed to promote the national and trans-national public-private knowledge transfer.

3.4.1 Intellectual Property Policies

A quick scan of Polish Universities and HEI shows that almost all research-intensive universities, technical universities and other research intensive HEI have their own knowledge transfer office and information office on intellectual property rights. The offices usually employ a group of people and provide comprehensive information and specific trainings to the researchers on IPR and knowledge transfer between science

and industry. The staffing varies between universities: e.g. among the five best Polish universities included in the European Observatory of Research Universities project, the knowledge transfer office at the Wroclaw University of Technology employed 31 persons, while the office at the Poznan University employed only 3 persons; often staff is employed on a project basis and therefore varies depending on the current activity of the offices.

Furthermore, the Polish Patent Office provides all kind of IPT related information (legal acts, procedures, several guidelines and handbooks, etc.), maintains publicly available database of Polish patents, provides links to all relevant international databases, as well as makes available Polish translation of all European patents.

The Ministry of Science and Higher Education launched in 2008 a programme Patent Plus, which aims at providing financial support to patent registration in Polish or international patent offices, as well as commercialisation of patents and training on intellectual property right. In addition, the Priority 5 of the OP IE "Diffusion of innovation", Action 4 "Management of intellectual property" supports two sorts of initiatives: Action 5.4.1 reimburses costs to obtain a patent, and Action 5.4.2 supports various trainings on IPR methods, opportunities and economic advantages.

3.4.2 Other policy measures aiming to promote public-private knowledge transfer

Public-private knowledge transfer, Incubators, spin-offs etc. are high on a policy agenda, especially in the framework of Cohesion Policy: the OP IE as well as the regional operational programmes as it ha already been pointed out in previous sections. The entire Priority 5 of the OP IE "Diffusion of innovation" supports such activities.

The National Centre for Research and Development launched in 2010 two relevant programmes: KadTech (in July 2010) and BroTech (October 2010).

The KadTech programme aims at strengthening collaboration between enterprises and highly skilled scientist from research organisations. The programme addressed micro, small and medium enterprises. The main objective of the programme is the provision of support to the knowledge commercialisation processes by employment of researchers in private enterprises for at least three and not more than 24 months.

The BroTech programme aims at increasing the effectiveness and efficiency of knowledge transfer process between science and industry by providing funding to technology brokerage services helping the micro, small and medium enterprises, which commercialise R&D results and technology transfer. The objective of the programme must result in a formal technology transfer agreement.

So far, the main governing bodies of HEIs have not been open to representatives from outside the university, but the private companies can be included in governance systems of the Branch Research Institutes. However, it should be noted here, that one of the important changes postulated by the Partnership for Knowledge is the integration of HEI with social and economic development so that the respective legal act will include explicitly the right to educate with the participation of a potential employer as well as to educate upon the employer's order. Professionals representing economic, state and social organisations are expected to be involved in the academic process regarding the creation of study programmes, execution of the educational process and evaluation of its effects. All those measures aim at strengthening (or in most cases creating) links between universities, regional

economies and society and promote public-private-third sector synergies, which should result in more knowledge transfer for the needs of society and economic development.

3.5 Cooperation, coordination and opening up national research programmes within ERA

The articulation between the R&D Framework Programmes, the Structural Funds and the Competitiveness and Innovation Programme 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 of critical masses of research excellence, leads to the duplication of efforts, sub-optimal impacts of the different instruments and unnecessary administrative overheads. Differences between research selection procedures and criteria can also be an obstacle to the overall spread of excellence. This section assesses the effectiveness of national policy efforts aiming to improve the coordination of policies and policy instruments across the EU, all part of the drive to create an integrated ERA.

3.5.1 National participation in intergovernmental organisations and schemes

The total public budget for international R&D cooperation amounted in 2009 around €41.5m, which accounts for around 3.6% of the government expenditures on R&D activities. This comprises international scientific projects as well as fee for participation in international science organisations, excluding co-financing of EU Structural Funds and international research infrastructure projects.

Participation in EUREKA programme is coordinated by the National Centre for Research and Development, which allocated around €1.42m in 2008 to that initiative.

According to the annual report of COST (2009) Poland's participation rate in COST was slightly more than 80% of the total number of running actions. In 2008 Polish research teams took part in 152 COST Actions. The fields most widely represented include chemistry and molecular sciences and technologies, agriculture, biomedicine and molecular biosciences, information and communication technologies, materials, physics and nanosciences.

Participation in EU research framework programmes is traditionally low and the collaboration opportunities not fully exploited by Polish researchers. Following the summary of major Polish achievements in science and research in the five years after the accession (Commission, 2009), the FP6 supported Polish research with only €215m. In the EU27 classification regarding the success rate Poland has been ranked 19th. By October 2008, Polish research organisations had secured EC contributions of around €37m through FP7, compared to €702m for Germany and €531m for United Kingdom. As analysed by Supel (2008), Poland could be ranked 11th in terms of number of registered teams, and 13th in terms of funding. As explained by the Interim Evaluation of FP7 (Commission, 2010) the overall share of EU12[5] participants in all projects is low and projects with a coordinator from EU12 countries are still very rare.

Poland also participates in other collaborations: CERN, EFDA (Institute of Plasma Physics and Laser Microfusion has a Contract of Association with the European

[5] EU12 are all Member States which joined the EU in 2004 and 2007

Commission), EMBO, ERCIM, ESA, ESO, EUI, NATO Science Programme, EURATOM.

3.5.2 Bi- and multilateral agreements with other ERA countries

According to the Ministry of Science and Higher Education, the bilateral initiatives that currently receive primary focus are: cooperation with Polish-German Foundation for Science, Cooperation with Singapore, and Convention concerning the Construction and Operation of a Facility for Antiproton and Ion Research in Europe (FAIR).

Multilateral agreement with other ERA countries is concluded within the International Visegrad Fund (Poland, Czech Republic, Slovakia and Hungary). The Fund, with a modest budget of €6m in 2010 provides a limited number of small research grants on an annual basis to researchers from the four countries.

In general, according to the Ministry of Science and Higher Education the priorities of bilateral agreements are threefold: to increase the mobility of Polish researchers going to the leading international R&D institutes as well as increase mobility of internationally renowned scientists coming to Poland; short-term bilateral cooperation (few weeks), and cooperation in joint research projects. The Ministry is currently working on a document, which will organise and specify motivations and directions of bi- and multilateral agreements. The document will be completed during 2011.

The programme Supporting International Mobility of Scientists, launched by the Minister of Science and Higher Education in 2007, will be continued in 2011 by launching the fourth edition as Mobility Plus programme. Although some procedural aspects will change, the content of the programme remains the same, i.e. support of Polish researchers going to the internationally leading R&D institutes for a period of at least 6 and no more than 36 months

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

- Polish research teams participate in several ERA-NET and ERA-NET PLUS initiatives; The National Centre for Research and Development provides funding for potential applicants. However, given the size of the country, the participation of Polish partners is relatively low. For example, in ERA-NET Plus participate 4 partners out of total 141 (European Commission, 2010);
- Poland participates in two initiatives undertaken under Art. 185: AAL (Ambient Assisted Living) and Eurostars;
- Participation in European Technology Platforms is very low as well. Gasowski (2010) assessed that only a few individual organisations participate in ETPs. For example in ACARE,
- among 47 members there is only one from Poland; the average participation rate (number of Polish members in a total number of members) is around 1%;
- In 2010, Poland participated in 7 programmes within the European Science Foundation.

3.5.4 Opening up of national R&D programmes

The general rule for publicly funded R&D is that the research proposals are eligible for contractors that have a legal address in Poland; it should be also the place where the projects are implemented. However, the Programme Team, which is managed by the Polish Science Foundation in the framework of the Measure 1.2 of the OP IE requires that project manager organises an open competition to select team members from the national and foreign candidates. The same procedure applies for the Welcome Programme of the Polish Science Foundation and Doctoral International Studies. The purchase of research service and technical and financial expertise from foreign entities is eligible for funding under the condition that these are necessary for the execution of the project.

3.6 International science and technology cooperation

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. Having in view these aspects, the following section analyses how national policy measures reflect the need to strengthen the international cooperation in S&T.

3.6.1 International cooperation

By 2008, Poland has concluded 95 bilateral agreements on research and technology cooperation, which resulted in the realisation of (among the others) 178 projects implemented together with Ukraine, 156 with Russia, 128 with Japan, 120 with France, 110 with Germany and 99 with China. It is worth underlying that there are some agreements that have never been implemented by any kind of cooperation (e.g. Mongolia). The intensity of these agreements varies considerably.

As already mentioned (section 5.3.2), in general, according to the Ministry of Science and Higher Education the priorities of bilateral agreements are to increase the mobility of Polish researchers going to the leading international R&D institutes as well as increase mobility of internationally renowned scientists coming to Poland; short-term bilateral cooperation (few weeks), and cooperation in joint research projects. Due to the fact the Polish science is lagging behind in terms of quality and quantity of research outputs, the focus of any collaboration with third countries is placed on the countries with internationally leading R&D activity, as well as countries with the highest growth potential.

3.6.2 Mobility schemes for researchers from third countries

There are no specific instruments supporting inward mobility for researchers from third countries, except collaborations within bilateral agreements. The policy emphasis is rather on outward mobility to increase the mobility of Polish scientists to the leading research institutes and in this way increase the inward flow of top-level knowledge.

4 Conclusions

4.1 Effectiveness of the knowledge triangle

The knowledge triangle shows a good balance between different aspects of research, innovation and education policies. The current reforms in the respective fields recognise the need for strong coordination between public and private collaboration and places evident emphasis on coordinating of activities between science, business and higher education.

Table 8: Effectiveness of knowledge triangle policies

	Recent policy changes	Assessment of strengths and weaknesses
Research policy	The Building upon Knowledge reform package that entered into force in October 2010, introduced five new legal acts, which are radically changing R&D landscape in Poland: • Act on Principles of Funding Science: new, competitive and performance oriented funding system shifting its focus on top-level research, outsourcing the funding role from the Ministry of Science and Higher Education to newly established executive agencies; • Act on National Science Centre: new executive funding agency responsible for fundamental research, managed by scientists, independently; • Act on National Research and Development Centre: new executive agency funding applied research and development activities, for the economy and supporting cooperation with the private sector. The Ministry assumes that by 2015 at least 50% of all government funds for R&D will be distributed together by the two agencies. • Act on Branch Research Institutes: introduces several new cooperation rules with business; • Act on the Polish Academy of Science: reforms the Academy towards excellent and most advanced fundamental research.	• The changes are ambitious and radical and may face some resistance by the scientific community; • The awareness of low level of Polish science and innovativeness, represents an important incentive supporting the reforms; • Benefits will not be visible in the very short term.
Innovation policy	Strong support from EU Structural Funds 2007-2013, most notably Operational Programmes Innovative Economy (OP IG) and Human Capital (OP KL).	• Low absorptive capacity of Polish enterprises; • High demand for EU Structural Funding that indicates a high interest and awareness of the linkages between R&D, innovation and business-competitiveness.

	Recent policy changes	Assessment of strengths and weaknesses
Education policy	In the field of Higher Education policy, the greatest role is played by the new reform package Partnership for Knowledge, which after wide public consultations is, as of October 2010, a subject of parliamentary works. The reform focuses on three areas: • Reform of studies and students' rights; • New model of academic career; • New model of managing the higher education institutions.	The reform introduces several innovative, but also radical solutions in the academic landscape. It requires now approval of the Parliament.
Other policies	Particular synergies can be observed with respect to the regional policy, generously funded by EU Structural Funds. In the current programming period 2007-2013 there are 16 regional Operational Programmes with the total budget amounting to €16.5b, and around 25% of this amount is dedicated to R&D and innovation activities. The main intervention areas comprise support of research infrastructure at universities and other research organisations, knowledge transfer, support of science-business linkages and promotion of innovation support for SMEs.	Strong complementarity of other policies, most notably regional policies, to the national R&D and innovation policies.

4.2 ERA 2020 objectives - a summary

The need to overcome the structural problems of Poland with a weak, and only very limited knowledge-intensive and innovative business sector on the one hand, and an inward oriented academic system are clearly addressed by several recent policy documents and funded substantially by numerous policy measures. However, despite the nominal growth of R&D expenditures, the effects of the recent structural (e.g., the creation of new implementing agencies; merit-based, competitive promotion system) are not clearly visible; in some cases, their implementation is still going on.

Table 9: Assessment of the national policies/measures supporting the strategic ERA objectives (derived from ERA 2020 Vision)

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses with regard the specific ERA objective
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	• Special grants of the Ministry of Science and Higher Education to study technical and natural sciences with the aim to change inadequate structure of courses; • Partnership for Knowledge reform aims to increase incentives for the best students and researchers, simplify academic career, increase international mobility and attract international researchers.	• Low attractiveness of domestic market for highly skilled specialists; • Low attractiveness for inward mobility of researchers; • Strong social recognition of the need for learning and investing in human resources for research.

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses with regard the specific ERA objective
2	Increase public support for research	• Continuously growing public budget for research and higher education, 15.5% increase in nominal terms between 2007 and 2008; GERD is expected to reach 1.7% of GDP in 2020 as compared to 0.61% in 2008.	• 90% absolute increase in GERD between 2000 and 2009; • Slowly increasing GERD as a proportion of GDP; • The target for 2020 is very ambitious and reliant on a strong and lasting economic growth; • Strong dependence on EU Structural Funds.
3	Increase European coordination and integration of research funding	• Growing participation in European initiatives and research programmes; New programmes launched by the Ministry of Science and Higher Education to increase integration of Polish researchers with those from other EU countries.	• Still very low participation rate in EU initiatives and programmes.
4	Enhance research capacity across Europe	• Public budget reserved for participation in some EU infrastructure projects; Support of further applications to join other projects.	• Willingness of scientific community to participate in international infrastructure projects, however lack of national roadmap and any other official document.
5	Develop world-class research infrastructures (including e-infrastructures) and ensure access to them	• Public budget reserved for participation in some EU infrastructure projects; Support of further applications to join other projects.	• Willingness of scientific community to participate in international infrastructure projects, however lack of national roadmap and any other official document.
6	Strengthen research institutions, including notably universities	• Partnership for Knowledge reform proposed significant strengthening measures with respect to academic career, management of HEI, and students rights and teaching.	• Recognised need for improvement by academic community, however reluctance to radical changes.
7	Improve framework conditions for private investment in R&D	• Operational Programme Innovative Economy provides unprecedented financial input to private sector for R&D and innovation; • Increasing role of NCBiR to support more R&D in private enterprises following the Building upon Knowledge reform.	• Very low BERD amounting only 0.19% of GDP in 2008, the need for innovation and R&D not fully recognised by most enterprises, particularly small companies.

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses with regard the specific ERA objective
8	Promote public-private cooperation and knowledge transfer	• New programmes launched by National Centre for Research and Development following the Building upon Knowledge, which focuses on public-private cooperation.	• Considerable contribution to private sector from EU Structural Funds, which is going to increase the demand for knowledge and collaboration; • Low innovativeness and low absorptive capacity of SMEs, thus low interest to acquire knowledge make the knowledge transfer difficult.
9	Enhance knowledge circulation across Europe and beyond	• New programmes established by the Ministry of Science and Higher Education to support knowledge circulation between public and private sector as well as internationally.	• Still very low knowledge circulation, however new opportunities due to considerable support from EU Structural funds.
10	Strengthen international cooperation in science and technology and the role and attractiveness of European research in the world	• New programmes launched by the Ministry of Science and Higher Education to increase international mobility of researchers (e.g. Mobility Plus).	• Although international cooperation aims at fostering linkages with the most advanced countries, there is lack of coherent strategy for international research cooperation and mobility of researchers.
11	Jointly design and coordinate policies across policy levels and policy areas, notably within the knowledge triangle	• Complementarities and synergies between Building upon Knowledge (science reform), Partnership for Knowledge (HEI reform) and EU Structural Funding (Innovation).	• Strong synergies within the knowledge triangle policies, however big implementation challenge to complete the reforms.
12	Develop and sustain excellence and overall quality of European research	• Building upon Knowledge established several new quality assuring elements in research; • Partnership for Knowledge is going to introduce further policies supporting excellence and high quality of research and teaching at HEI.	• New measures (evaluation, competitive funding, creation of centres of excellence) represent a strength; • Reluctance of science community towards more competitive rules; Competitive and entrepreneurial thinking is required for the success of the reforms.

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses with regard the specific ERA objective
13	Promote structural change and specialisation towards a more knowledge - intensive economy	• EU Structural Funds, notably OP Innovative Economy and Human Capital, offer unprecedented funding to private sector by supporting innovation and technology transfer, which is expected to increase knowledge demand and knowledge intensive production; • Branch Research Institutes have new rights for collaboration with private section to contribute to knowledge intensive economy following the Building upon Knowledge reform.	• Building upon Knowledge introduced a number of new policy instruments; • However, low innovativeness of Polish economy might make it difficult to implement the changes and absorb the funding in efficient way.
14	Mobilise research to address major societal challenges and contribute to sustainable development	• Establishment of the Implementation Programme of the National Foresight Programme.	• Thorough analysis conducted during the development of the National Foresight Programme; • Implementation of the results will require stronger linkages between private and public sector as well as society, which are not strong.
15	Build mutual trust between science and society and strengthen scientific evidence for policy making	• Reform package Partnership for Knowledge aims explicitly at embedding HEI into regional economies and societies.	• Science recognised as crucial element of regional development in all regional OP, however still little experience in science-society linkages.

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List of Abbreviations

BERD	Business Expenditures for Research and Development
CERN	European Organisation for Nuclear Research
COST	European Cooperation in Science and Technology
ERA	European Research Area
ERA-NET	European Research Area Network
ESA	European Space Agency
ESFRI	European Strategy Forum on Research Infrastructures
EU	European Union
EU27	European Union including 27 Member States
FDI	Foreign Direct Investments
FP	European Framework Programme for Research and Technology Development
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
GUS	Central Statistical Office
HEI	Higher education institutions
HERD	Higher Education Expenditure on R&D
HES	Higher education sector
IP	Intellectual Property
JBR	Branch Research Institute
MNiSW	Ministry of Science and Higher Education
NCBiR	National Centre of Research and Development
NCN	National Science Centre
OECD	Organisation for Economic Co-operation and Development
OP HC	Operational Programme Human Capital 2007-2013

OP IE	Operational Programme Innovative Economy 2007-2013
PAN	Polish Academy of Sciences
PRO	Public Research Organisations
R&D	Research and development
RI	Research Infrastructures
RTDI	Research Technological Development and Innovation
S&T	Science and technology
SF	Structural Funds
SME	Small and Medium Sized Enterprise
VC	Venture Capital